Future Developments in the Genetic Improvement of Animals

Edited by

J. S. F. Barker

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Preface

The intensive application of genetics in animal breeding dates from only about 40 years ago. Over the last 25 years, there has been increasing application of quantitative genetic theory in animal breeding programs. This has been facilitated by:

1. experimental validation of that theory and the translation of the theory in the development of appropriate operational procedures for practical animal breeding programs,
2. objective measurement of animal performance, the use of computers in large-scale performance recording programs, the application of artificial insemination in and the development of national or regional dairy cattle breeding programs, and the recognition by the animal industries of the cumulative gains possible from genetic improvement.

At the same time, the science of genetics has developed enormously, and expanded and divided into specialized areas including molecular genetics, immunogenetics, quantitative (or statistical) and population genetics. All of these have implications for and applications in the economic improvement of domestic livestock.

Given the relatively short time-span, the contributions of quantitative genetics to improvement in animal production have been substantial. However, it is apparent that future improvements depend not only on this branch of the science. It seemed appropriate then to bring together ideas from various branches of genetics and to consider them, together with recent developments in reproductive biology and physiology and electronics, so as to provide a perspective of their interrelationships and their possible future development and application in the genetic improvement of animals.

This book consists of the invited papers presented by scientists from New Zealand, Norway, U. K. and Australia, and summaries of discussions at a Symposium held at the University of New England, Armidale in February 1982. The objective of the Symposium was to project, from current knowledge, those areas where the most important developments in the application of genetics and associated disciplines could and should take place. The book thus represents a step towards the necessary integration of these branches of genetics and related disciplines.

The Symposium would not have been possible without the generous financial support of the Australian Meat Research Committee and The Angus Society of

Australia. We wish to thank the contributors for their cooperation and excellent papers, and to acknowledge the enthusiasm, views and ideas of all participants in the Symposium. Our thanks also go to Dorothy Cordingley and Jill Parker for their untiring assistance with the preparation of the final manuscripts and index.

Contents

Part 7 Population Size

Part 8 Electronics

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Part 1
A General View of Animal Breeding
The Results of 20 Years Selection for Production in Cattle, Sheep and Pigs — Which Way Now?

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Research, development and implementation of animal breeding techniques over the past 20 years have given good results. The rate of genetic improvement has increased considerably in all farm species.

Despite this success, optimum rates of improvement are, for different reasons, not yet being realised.

The decisions for increased genetic improvement in the later 1980's are now being implemented, but a biological delay precedes the expression of this.

Technical innovations are being researched and developed for use in increasing genetic improvement. Biophysical profiling, embryo manipulation, genetic engineering, computer tomography and miltibreed mating strategies are examples of techniques which may become commonplace before the end of the century.

I A Review of the Past 25 Years

Twenty-five years ago, in the 50th anniversary issue of the Journal of Dairy Science, Jay L. Lush reviewed the improvement which had been made in animal breeding during the previous few decades.

Dr. Lush mentioned the development of biometrical methods, the evaluation of different selection methods, and the

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introduction of artificial insemination. He remarked: "Some of the parameters are known only within wide limits, and much is uncertain ... but at least a good beginning has been made."

During the last 25 years, animal genetics and breeding has been very productive. The purpose of this address is to review the major components that have contributed to this great progress in animal breeding. The intention is also to venture some predictions.

A. Developmental Work

During the last two decades, we have witnessed accelerated activity within the field of quantitative genetics. This development is especially pronounced in investigations which are of fundamental interest in the applied field of this science, such as:

(1) Estimation of phenotypic and genetic parameters. As shown in Figure 1, this developmental work exhibits an exponential growth. We know these parameters for an increasing number of traits and for an increasing number of populations and the estimations are based on steadily increasing amounts of data.

(2) The last two decades are also characterised by great improvements in the accuracy of estimation of breeding values. Progress is notable in methods of progeny testing bulls, boars and rams. The key-word in this connection is BLUP (Best Linear Unbiassed Prediction).

(3) Much work has been done in developing effective selection indices which can be directly applied in practice.

(4) Since the late 50's, the development of integrated breeding schemes has begun. This synthesis of different elements within quantitative genetics has gradually resulted in more efficient breeding strategies being put into use.

B. The Computer

The computer revolution has passed through a handful of "generations" of equipment in the past 20 years, and the rate of change does not seem to decrease.

Thanks to the development of the computer, it has been possible to conduct the enormous quantity of developmental work mentioned above. Without the use of computers, it seems unlikely that quantitative genetics really could have been introduced into animal breeding in the way it has been.

Without computers and with the cost of labour today, it would be impossible to estimate all the parameters and calculate the selection indices, etc. on which animal breeding is based today.

The computer has made it possible to use sophisticated statistical models and to store and utilise all relevant information when evaluating breeding values. Sophisticated evaluations of sires and dams are now possible using BLUP. Thanks to the computer, it has also been possible to practise selection among females based on breeding indices (cow index, sow index and ewe index). Further, all relevant data for each female can be stored in a data bank to have an up-to-date "account" for each animal.

Apart from packaged statistical programs, many other opportunities for aiding research have come about because of progress in computer science. Various aspects of simulation and systems analysis have been useful in different branches of animal science. Such simulations have been very useful in the development of integrated breeding schemes.

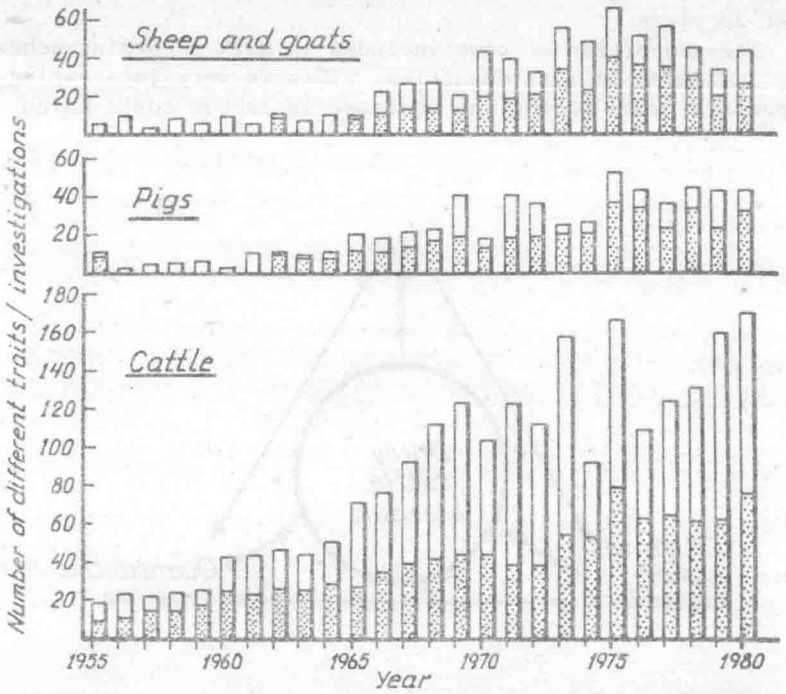

FIGURE 1. Number of publications concerning estimation of heritability 1955-80.

C. The Development of Artificial Insemination

Parallel to the development of applied quantitative genetics we have witnessed a large expansion in AI during the 60's and 70's. Twenty years ago AI was in its "teens" in most countries. During the last two decades AI has become the most important mating method and, moreover, it has given cattle breeding a new dimension (Fig. 2). Its importance in cattle breeding has been further emphasised by the introduction of deep frozen semen.

During the last 20 years AI also has been introduced into pig breeding and in some countries more than half of the services are covered by AI. However, this method has not yet contributed very much to genetic improvement as cryopreservation of semen has not been successful in the pig.

D. Recording Schemes

Recording schemes, which greatly influence the results of animal breeding, have shown positive developments during the last 20 years.

The proportion of cows included in milk recording schemes has increased in most countries. This is very interesting especially when noting the increase in labour costs which

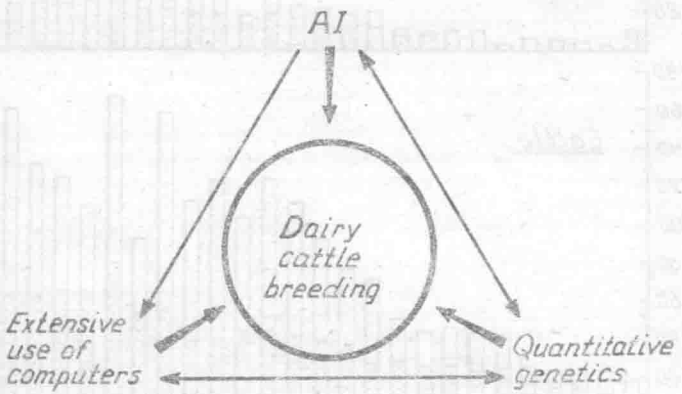

FIGURE 2. Dairy cattle breeding today is a synthesis of artificial insemination, quantitative genetics and extensive use of computers.