
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

TWO NEW METHODS OF TEACHING ANIMAL BREEDING WITH POTENTIAL IN AGRICULTURAL EXTENSION

R. A. FAWNS* and A. T. G. MCARTHUR
Lincoln College, Canterbury

SUMMARY

A successful auto-instructional programme has been developed and evaluated for a target population of pre-entry diploma students on the genetic theory of herd improvement. This and a herd performance simulator which is in the development stages may have a potential in agricultural extension for teaching animal breeding.

THE APPLICATION of the modern theories of animal breeding to livestock improvement by New Zealand breeders has been slow. In part, this has been due to the difficulty of breeders understanding ideas which are complex and mathematical. Now that sheep and beef cattle recording schemes are in operation, there is renewed interest in teaching animal breeding concepts. Specialist staff have been appointed by the Department of Agriculture to advise farmers on the use of records in livestock improvement. However, the writers are not aware of either a planned approach towards this difficult task or of any research on the effectiveness of extension methods for teaching animal breeding.

Previous experience by the New Zealand Dairy Board under the Herd Improvement Plan of 1940 indicates how difficult it is to teach animal breeding to breeders. It therefore seemed useful to attempt to devise new teaching aids which might find a place in livestock improvement extension.

The senior author of this paper developed and evaluated an auto-instructional programme as part of his graduate studies at Lincoln College. This course of material on animal breeding theory was evaluated on pre-entry diploma students but would probably produce good

*Faculty of Education, Melbourne University, and John and Eric Smyth Travelling Scholar 1968-69 at Lincoln College.

results among motivated breeders who would meet at regular intervals with a specialist extension officer.

The second teaching aid is yet in the development stages. It is a herd performance simulator which will allow breeders to try out breeder plans for beef cattle on a computer — a breeding game. The computer system will help breeders follow through the consequence of their breeding decisions. It is possible that a herd performance simulator would not only be a useful teaching aid to go with a course built around the auto-instructional programme, but it might motivate progressive breeders to participate in more formal extension activities.

THE PRINCIPLES OF PROGRAMMED INSTRUCTION

Over the past fifteen years, the work on teaching machines and programmed learning has been one response to education's growing demand for a scientific and technological base. Particularly, it has been the response of certain behavioural scientists, primarily experimental psychologists, who have attempted to apply their methodology to the design of the teaching processes and educational environments. Present interest was probably sparked by Skinner's 1954 and 1958 papers which reported his analysis of the influence of reinforcement and the techniques by which reinforcement can be manipulated with considerable precision to influence learning. Skinner (1954) indicated that perhaps the most serious criticisms of current teaching are the relative infrequency of reinforcement and the teachers' mounting incapacity, using existing techniques, to cater for individual differences in interest and rates of learning. The development of this movement has been reviewed by Skinner (1965) and Schramm (1962), and criticized by Pressey (1963).

In essence, programmed instruction is "an effort to package for the student the essential aspects of the tutorial method of instruction" (Ofeish, 1964). In format, it is a sequence of items, steps or frames which present material to the learner. Each frame contains new information and/or a recapitulation of information, combined with some material requiring a response.

Markle (1963) has outlined the steps taken in producing useful auto-instructional texts. These steps involve the clear definition of terminal behaviour and the sequencing of objectives together with testing and revision cycles. A flow diagram of these steps is shown in Fig. 1.

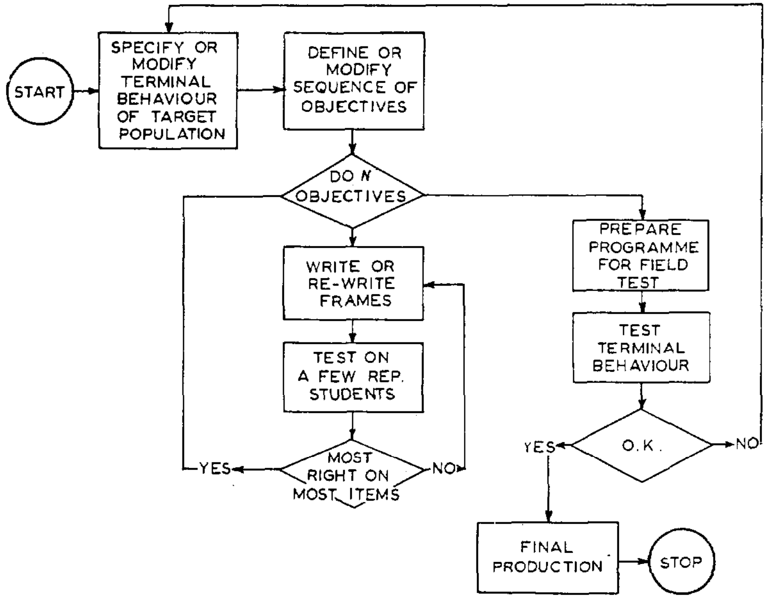

Fig. 1: Flow diagram of the steps in programme development and testing.

PROGRAMME ON THE THEORY OF HERD IMPROVEMENT

DEVELOPMENT

Groups of pre-entry students who visited Lincoln College for orientation courses of one week's duration were used in the initial phase of defining the knowledge and awareness of the target population and, hence, the terminal behaviour and sequence of objectives. A part of the sequence of these objectives is shown in Appendix 1. Upon their return to their farms, these students were mailed the prototype lessons without the answers and the revision recycle procedure began. Twelve months later, after 1,200 hours of student time and repeated revisions, all lessons appeared to be near the 80/80 status which was the arbitrary objective (80% of the subjects correct in 80% of their responses). About 800 hours of secretarial time had been invested in the typing and duplicating and packaging in this development-revision phase.

EVALUATION

The programme was evaluated against a nil treatment and a set of notes with end of chapter problems derived straight from the developed programme. An extract from the auto-instruction programme is shown in Appendix 2, and some of the post-test items are shown in Appendix 3.

The 69 eligible students, who were working on farms in Canterbury, were distributed randomly to the three treatments in a split-split plot design based on eight school certificate categories, three pre-test categories, and a total of seven missing plots. The post-test scores and gain in scores were subjected to analysis of variance. The post-test was administered in eight Canterbury towns over ten days. The students had a maximum of only twenty-six days to complete the eight lessons.

RESULTS

The programme performed significantly better than the notes on both post-test score and gain score (*F* values 4.5 and 7.9). Active treatments performed significantly better than the nil treatment (*F* values 239 and 364).

The mean gains and the range for each treatment are presented in Table 1.

TABLE 1: GAIN IN PERCENTAGE SCORES

Type of Instruction	*Mean (%)*	*Range (%)*
Programme	62	45-87
Set of notes	53	18-73
Nil	5	0-20

An analysis of the error rate for each of the initial objectives showed that one section of the programme will require more revision before publication of the material for more general use.

DISCUSSION

Although no evidence has been presented, it is possible that this programme may also provide a useful teaching aid in extension. It would probably produce best results among motivated farmers who could meet the extension officer at regular intervals. The discussion group members could well work on one programme lesson per meeting, with the extension officer available for assistance and subsequent discussion throughout the evening.

The programme's emphasis upon growth rate in beef cattle provides fundamental background. Extension officers in dairy or sheep may find it worth while to write added programmed lessons to convey relevant information on other traits which may have a more complex genetic basis. Many educationists claim that a major benefit from the programme movement accrues to the programmer who is brought face to face with the problems of effective communication and the manipulation of successful learning processes. It is likely that the young extension officer, who embarks upon such an exercise in applied psychology, will be as amply rewarded as his discussion group members who participate in the experimental exercises which he devises.

HERD PERFORMANCE SIMULATOR

Management games are becoming an integral part of graduate and undergraduate courses in the business faculties of U.S. universities (Babb and Eisgruber, 1966) now that computers have become available to do the laborious arithmetic and record keeping.

Games have some educational advantages. First, they motivate the student. Secondly, games introduce dynamic aspects into decision-making which is an advantage over the static approach dictated by case studies used in management training. A life-time of business experience can be simulated in a day with a game. Thirdly, simulators can be used to practise decision-making under uncertainty, and, finally, they have the educational advantage of using the discovery method. While these advantages may prove to be valid for teaching animal breeding, experience at Lincoln College and elsewhere suggests that management games can confuse students unless they are used in conjunction with other teaching methods.

The Herd Performance Simulator is being designed to reinforce the learning objectives of the programmed learning text. More particularly it will be used to demonstrate the variability in genetic response possible from identical selection programmes.

The simulator will consist of computer routines which use Monte Carlo methods to generate the genetic and environmental components of each individual in a simulated 100 cow beef breeding herd. Records for three traits will be generated — growth rate up to weaning, growth from weaning to 18 months, and conformation score. Monte Carlo methods will be used to determine the sex of each animal and its survival.

The computer will print out the "annual" records of the phenotype performance of the herd. It turn, the pupil breeder will input his mating plan and culling instruction on the basis of these records.

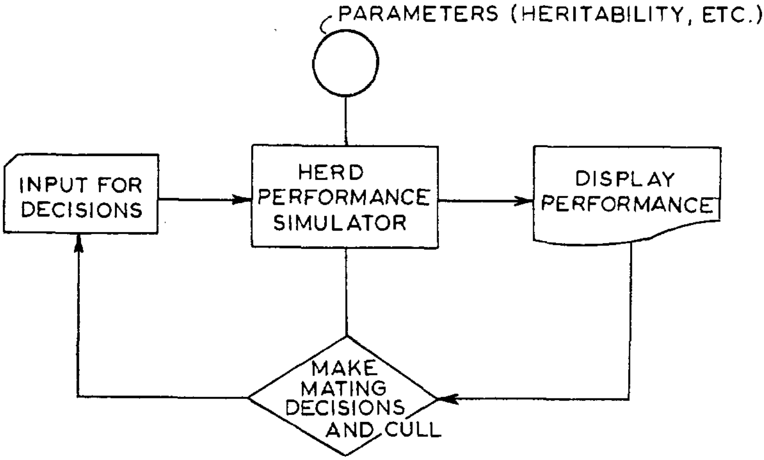

Fig. 2: Flow diagram for herd performance simulator.

Figure 2 shows a flow diagram of the cycle. At any stage of the simulation it will be possible to display the genotype of the animals in the herd for comparison with estimates of their genotype from their own performance or the performance of their offspring.

REFERENCES

Babb, B. M.; Eisgruber, L. M., 1966: *Management Games for Teaching and Research.* Educational Methods Inc.

Markle, S. M., 1963: *Good Frames and Bad.* Wiley, N.Y.

Ofeish, G. D., 1964: The emergence of instructional technology. In *Trends in Programmed Instruction* (Ed. Ofeish and Meierhenry), pp. 7-10. National Education Association and National Society for Programmed Instruction, Washington, D.C.

Pressey, S. L., 1963: Teaching machine (and learning theory) crisis. *J. appl. Psych., 47:* 1.

Schramm, W., 1962: *Programmed Instruction Today and Tomorrow in Four Case Studies of Programmed Instruction.* Fund for the Advancement of Education, N.Y.

Skinner, B. F., 1954: The science of learning and the art of teaching. *Harvard educ. Rev., 24:* 86-97.

——— 1958: Teaching machines. *Science, 128:* 969-77.

——— 1965: Reflections on a decade of teaching machines. In *Teaching Machines and Programmed Learning* (Ed. Glaser, R.). National Education Association, United States.

APPENDIX 1

Part of the Sequence of Objectives

5. The students will demonstrate, through the use of a normal distribution curve for measured growth rate, that they realize that, in the average commercial herd, selection pressure applied to cows in a herd will be less than that applied to bulls.

6. (i) The students will list the following five factors as causes of retarded improvement in a herd under selection.

   (a) Regression — caused by imperfect selection.

   (b) Regression — caused by the action of dominance.

   (c) Non-additive gene action.

   (d) Selection for many characteristics at once.

   (e) Low reproductive rate.

   (ii) The students will demonstrate through their responses to multiple choice items, that the accuracy of selection could be improved if —

   (a) the heritability of the characteristic is high;

   (b) the stock are raised under uniform environmental conditions;

   (c) corrections are made for factors such as sex and age of dam;

   (d) measurements, and not eye appraisal, are used;

   (e) records, and not memory, are relied upon.

APPENDIX 2

An Extract from the Auto-instructional Programme

Factors which determine success in herd improvement

3. *The Heritability of the Characteristic*

The rate of progress possible is limited by the selection differential, but also by the *heritability* of the ———————— selected.	CHARACTERISTIC
(a) Factors associated with fertility (e.g., calving %, milk production etc.) have ———— heritabilities (less than about 0.20). Herd	LOW
improvement in these traits would be expected to be ————. This	SLOW
is because heritability is a measure of the proportion of the parents' ———————— that is passed on to the *offspring.*	SUPERIORITY
Put another way, heritability is a measure of the animals' ———————— that is due to ———————— gene ————————.	SUPERIORITY ADDITIVE ACTION
Herd A has a calving % better than herd B. The heritability of calving % is about 0.1. What fraction of the superiority of A is due to *environmental factors and non-additive gene* action? 0.1 of the superiority 0.6 of the superiority 0.9 of the superiority 1.0 of the superiority	
Therefore, what would you suggest would be the quickest way farmer B could lift his calving %?	IMPROVE THE MANAGEMENT OF HIS HERD (CARE AT CALVING, ETC.)

APPENDIX 3

Some Post-test Items

14. Let's consider the possibility that growth rate in beef cattle is controlled by 3 genes which act additively. A bull with genotype AABBCC grows at the rate of 4 lb/day (under the best conditions). A bull with genotype aabbcc grows at the rate of 1 lb/day (under the same conditons). Bulls with genotype aaBBcc, AaBbcc, aabbCC, grow at the rate of 2 lb/day (under the same conditions). A, B and C are the favourable alleles.

    (a) This data suggests that each favourable allele adds ———— to the growth rate of a bull under optimal conditions.

    (b) The growth rate of cattle is a ———— characteristic and will exhibit ———— variation if a whole herd is measured. A curve which illustrates this type of variation is called a ———— ———— curve.

    (c) If a bull which grew at 4 lb/day was mated with a cow which carried a genotype of 1 lb/day growth rate, the growth rate of their offspring (under optimal conditions) would be ————.

    (d) A bull and a cow both with genotypes of 2 lb/day growth rate were mated. Is it possible that they could produce offspring which could grow at: (Yes/No)
    4 lb/day ————
    3.5 lb/day ————
    3 lb/day ————
    2.5 lb/day ————

20. Answer T (true) or F (false) to the following:

    (a) Heritability can be less than 0.

    (b) Heritability of a characteristic is likely to be higher in a herd which is roughly managed.

    (c) The heritability of growth rate in cattle averages about 0.8.

    (d) If a herd average is 1.3 lb/day, the selected parent average is 1.8 lb/day and the offspring average is 1.5 lb/day, then the heritability of growth rate in this herd is 0.4.

    (g) If the herd average is 1.5 lb/day and the heritability of growth rate is 0.5, and parents' average growth rate is 2.5 lb/day the *the probable offspring average will be:*
    0.5 lb/day
    2.0 lb/day
    2.2 lb/day
    2.5 lb/day