RECORDING IN DAIRY CATTLE IMPROVEMENT

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INTRODUCTION

This review deals with the recording, transfer and processing of dairy herd performance data and communication of resultant information. A major use of this information is for extensive and within-herd breeding programs.

Information not directly relevant to genetic improvement may be the main requirement of the herd manager. Provision of this herd management information to owners may contribute to the operation of an effective breeding program by inducing farmers to use performance recording schemes.

DATA REQUIRED

Data requirements for genetic improvement programs are detailed in the reviews on Definition and Measurement. However, in anticipation that data for generating herd management information might not be adequately covered elsewhere, we have considered this requirement. Additional needs are minor. Most items required by herd managers involve measures of environmental influences (e.g. liveweight or body condition changes) which are usable in refining the estimates of major selection criteria, or of conditions involving a genetic predisposition which may warrant inclusion in breeding programs (e.g. mastitis). Oestrus observations are of interest only to the herdsman, but recording of all matings can improve breeding program precision by more reliable sire identification.

DATA RECORDING

Data recording, as the initial capture of observations in a form suitable for subsequent transcription, warrants explicit consideration as a source of controllable error. Failure to separately focus on this step probably derives from its being intrinsic in the choice, which may be predicated on other grounds, of measuring instruments and recording media.

The frequency of accidental errors at this point is unknown as only extremely aberrant values are detectable as probably wrong, and "true" values are not available for comparison. However, as a disturbingly high incidence of errors is known to occur in manual transcription of numeric data under more favourable conditions, a problem probably exists.

Ultimate elimination of this problem with machine measurable variables (including identity) by electronic transfer of on-farm readings to initial record is discussed by Rathie (1979). The most advanced system presently used in Australia represents an intermediate stage in which proportional samples are transported to laboratories for milk yield and composition recording. This improves accuracy when machine recording is used, but may not do so when the laboratory procedure involves manual transcription.

Hand held key punch encoding equipment is available (MSI.Data Limited, brochure, 1978; Plessey, brochure, 1978). Even at the present initial high price, use of this equipment, by eliminating subsequent data input, may be cost effective for services employing recorders or operating delivery and pick-up arrangements for owner recording. When owners deliver records to a depot, their punching of their own data at that point would achieve the same purpose.

Motivation of operators to be careful of the accuracy of their observations and records must continue to be most important. As automatic equipment is introduced, this responsibility shifts to the persons who maintain the machines. The requirement will also continue with respect to those variables which are not machine measurable. Other measures are needed, but tangible demonstration of concern with accuracy - such as use of fine graduations on milk meters and second decimal digits from machine displays - is likely to be a significant motivator.

The possibility of intentional exaggeration in recordings performed by herd owners has prompted Breed Society advocacy of the need to employ independent operators and/or check testing. Rathie (1979) has discussed the implications of falsification by erroneous initial records and other means of the data used to estimate breeding values.

Supervision to detect falsification of records may not warrant discussion in a livestock improvement conference. However, if it is to be examined the following aspects are relevant:

a) Tolerances for record rejection.

b) Penalties.

c) Distortion of evaluations other than by erroneous recording, e.g. by within-herd preferential treatment.

d) Manipulation of progeny tests by, for example, selective mating of sires and selective presentation of daughters for "official" recording.

e) Parentage checks by blood grouping.

f) Statistical testing, both within recording system data and by comparison with herd production (factory delivery) figures, as an adjunct or alternative to field checking.

g) Check testing mechanics - supervised strip out, additional observations without notice, validation of cow identity, etc.

DATA DEVELOPMENT

We define this step as the manipulation of data in order to make it more useful for the intended purpose, short of applying the interpretative procedures which produce information upon which decisions can be based. In the past the main output of production recording services was developed data in the form of lists of cows with estimates of progressive and completed lactation yields. Farmers were encouraged to process these data further to produce, e.g. lists of cows for replacement breeding and culling. Recording services are now moving towards directly outputting such information, but data development remains a necessary prior step.

All schemes use validation routines in data compilation to minimize errors. These can range in complexity and reliability from simple range checks to comparison of recorded values with yields predicted with varying degrees of sophistication.

The most commonly used method of estimating lactation yields simply accumulates sequential sub-period estimates. Sub-period estimates of milk and component yields are derived by averaging adjacent milk yield observations and component production estimates (milk yield x component percentage) and multiplying by the number of days between observations. By accepted convention, daily yield during the first sub-period (calving to first observation) is assumed to be at the level first observed, and zero at exit date.

Adjustment for missing data - recording missed, or nominated and accepted as abnormal - is commonly by interpolation from adjacent observations.

1. Lactation Prediction from Preliminary Records

Several authors (e.g. Van Vleck and Henderson, 1961) have demonstrated that, because of the high correlation between partial and full lactation records, genetic improvement can be hastened by evaluating sires before all daughters have completed lactations. Some Australian schemes include predicted final results of partial lactations in claculations of progeny test rankings. Very early estimates of the genetic value of heifers (based upon the first two months production plus pedigree data) should also be useful for farmers concerned with within-herd selection for breeding replacements.

Conclusions from the recent papers by Schaeffer *et al* (1977), Schaeffer and Burnside (1976), AGBU (1978), Wiggans and Van Vleck (1979) and Dommerholt *et al* (1977) may be summarized in terms of the main predictive procedures.

a) Multiplicative factors - Keown and Van Vleck (1973) demonstrate that the procedure ignores correlations amongst observations and their correlations with lactation yields.

b) Linear regression procedures - these are applied to sub-period data and require retention of the separate uncorrected data for each observation. This can demand extensive computer capacity. Estimates also tend to be more variable than the other two methods.

c) Non-linear techniques - AGBU (1978) suggests that these require less computer capacity than methods based on multiplicative factors, but share the disadvantage that they make no allowance for variation between individual cows in persistency. These procedures, however, seem the most potentially useful (Kellogg *et al*, 1977; Schaeffer *et al*, 1977), and have similar accuracy to that of method (a).

2. Adjustment for Environmental Variables

To accurately estimate breeding balues the effects of systematic environmental variables should be removed from production records. Variables which affect milk production include - herd, year, season of calving, age at calving, parity, length of lactation, length of dry period, days open, and some interactions between these effects.

The best adjustment method depends on the variable under consideration, and the subject has been recently reviewed by Hammond *et al* (1979). The methods can be summarized:

a) Within class comparisons - these are suitable when there are many observations within classes and the precise effects are random, or not likely to recur, and there is no need to estimate effects. The method suits variables such as herds and years, and sometimes seasons.

b) Additive and multiplicative factors - these are suitable for variables of intrinsic interest which have a manageable number of classes, and constant expected effects. Additive factors are appropriate with constant within-class variance, and multiplicative when variance is proportional to class mean. Adjustment should be to the mode or median class to minimize the number of records needing modification. This approach is suitable for age at calving, season of calving, lactation length, days open, and parity.

c) Covariates - some effects, particularly those of intrinsic interest which have a wide range of values, are best included as covariates (partial regression coefficients) in the statistical model. They then do not have to be fitted into a fixed number of classes. This approach is suitable for variables such as age at calving and days open.

d) Elimination of effects - effects such as those mentioned under (a) can be included in the statistical model but not explicitly estimated. The effect is absorbed during calculations, but is still accounted for in estimating other effects. This is a common ploy with BLUP techniques, where memory space is often at a premium.

Many variables and interactions have different effects between populations and environments, and so the "best" adjustment method may not be known *a priori*. Also, a compromise is usually needed between statistical/genetic efficiency and computational/recording capability.

With the expertise and data processing capacity now available for dairy herd improvement in Australia, more accurate adjustment procedures should replace the simplistic use of "standard adjustment factors" such as age standards derived from other environments.

DERIVATION OF INFORMATION

Information is derived by summarizing data to the point where the bare essentials are available for decision, e.g. the identities in rank order of the top 10% of sires from a progeny test or of cows to receive mastitis therapy. Continued provision of a mass of data may be necessary until users have been re-educated to accept that they require only the essential information, and until they have become confident that the output from production recording/management information services is correct.

The essential information required for genetic improvement is estimates of breeding values of sires, cows to breed bulls, and cows to breed replacements in commercial herds. There appears to be no room for argument that BLUP procedures, which effectively utilize all available data, are the most generally efficient for situations such as in Australia, where environmental and temporal effects are substantial. Computer capacity and/or processing costs may require use of alternative or preliminary ranking procedures to identify elite cows from large populations and for evaluation of large numbers of bulls which are not vitally involved in the improvement system.

Whether comprehensive procedures, as distinct from simple adjustments for fixed effects, can be employed to rank cows within herds for farmer use will also depend upon cost. Although this source is inconsequential for genetic improvement, provision of apparently accurate rankings is likely to be important in building farmer confidence in the herd improvement system. As farmers will be impressed, favourably or otherwise, by the repeatability of rankings, compromise procedures, which do not eliminate environmental effects which have a lasting effect on the phenotype, might warrant consideration. Such an effect is first calving at an unduly low liveweight.

Herd management information cannot readily be derived with established techniques. This follows from the diversity of farmers' specific requirements, which in turn derive from variations in environment and production systems. Development of useful information services will depend more upon investigation of potential users' needs, and the service systems E.D.P. development and extension capabilities, than on a study of the scientific literature.

The following are some of the information service components likely to be useful to effective herd managers:

a) Culling lists - it should be readily possible to derive a composite "eligibility for culling" index, thus saving the farmer time and computational errors, in himself combining relevant data.

b) Mastitis control actions - lists of cows requiring respectively veterinary examination, dry cow therapy, and culling.

c) Reproduction control - lists of cows warranting examination for anoestrus, failure to conceive and confirmation of pregnancy, and indices of herd performance.

d) Feed management - simple pre-scheduling of cows expected to calve at specified times is commonly provided. Much more extensive guides to feed supply and utilizaiton are conceivable.

With regard to presentation of information, the farm manager should have more productive uses for his time than study of collated data or even extensive supporting information. He requires brief appropriately formulated lists as a basis for action.

DATA AND INFORMATION TRANSFER

For client decision, the value of information provided by a recording service depends on its timeliness. Users vary in their needs. Delays of weeks may be relevant in breed improvement systems, e.g. progeny testing, but a delay of only days may be unacceptable for farm management decisions.

Even in the case of breed improvement systems spanning several recording services, rapid collation and processing of data should be relatively straightforward, given collaboration to arrange compatability, and use of available transfer and processing technology.

For the farmer, the procedures now most commonly used leave milk yield records on farms. Sufficiently reliable cow rankings for component production, or indices of estimated overall merit, could be derived for animals which have even a few previously recorded observations, if farmers'

concern at not having data on the test day warrants this procedure. However, rapid return of information may be demanded by farmers when milk yield data also are not immediately available.

It is likely that farmers will become increasingly dependent upon off-farm E.D.P. for herd and farm management information. Hard copy records will remain effective where rapid delivery services between information centre and farm can be operated, but will require messy and difficult arrangements in situations, such as in Queensland, where clients are sparsely distributed in remote regions. The problem can be overcome with presently available technology which is likely to soon become cheap enough for general use. Data input via a district terminal or from the farm via a portable terminal, and information print-out at the district terminal within 36 hours, is likely to be most used. However, if farm consultants and service agencies are alert to new technology, effective farm businesses will have terminals in their offices.

PRACTICAL SYSTEMS

We have examined, but will not include, discussion of operational or conceptual practical systems as such. Some reasons are:

a) Different systems suit particular circumstances, but may not be effectively transferable to dissimilar situations.

b) Any tendency to accept or reject systems as packages, rather than looking for components which may suit a particular situation, should be discouraged; e.g. centralized recording, data processing and operational management can be used jointly or independently.

c) Any detailed examination of operational systems would involve criticisms which may be invalid in terms of the special circumstances which conditioned the decisions.

d) A catalogue of the component procedures in use in production recording/information systems, sufficiently detailed to assist communication of useful information, is beyond the scope of this paper.

An appropriate system - in terms of extent and frequency of recording and adequacy and timeliness of information in relation to users' willingness to pay - can be readily developed for any situation. Most of the components can be derived from local experience in this specific field, but some can be accepted with confidence from other sources; e.g. lengthy delays in acceptance of BLUP procedures or hand held electronic encoding devices are unnecessary.

ECONOMICS

Because of the variable extent of subsidy provided by State Governments, costs of operating production recording and dairy cattle improvement services in Australia are not known. The aggregate estimate of $3.5 million for 1974-75 herd recording scheme operating costs (I.A.C., 1976) has been rendered obsolete by cost saving procedures, but these savings have probably been more than offset by inflationary cost increases in other areas.

Aggregate cost estimates contribute little to partition of the costs of the three quite separate aspects of production recording/management information services - extensive genetic improvement, within herd genetic improvement and herd management information.

These three aspects warrant separate consideration because of their quite different contributions to industry/farm production, and their quite different beneficiaries.

The main differences are:

a) Extensive genetic improvement - all commercial users of dairy cattle are primary (in economic terms) beneficiaries. As only a minority contribute directly to costs, there is a case for an industry/government subsidy.

b) Within-herd genetic improvement - only the individual herd owner benefits, and might thus reasonably be expected to pay for the service. However, this service has traditionally received government support.

c) Herd management information - this will also directly benefit only the herd owner, but differs from (b) in the much greater and more immediate benefits likely to result. It appears to warrant subsidy equally as much as extension and other production improvement services which governments provide.

Useful measurements of the benefits of recording services are also unavailable. While some overseas studies have indicated substantial net benefits (e.g. Conlin, 1974; McCaffree *et al*, 1971), there is an apparent conflict between Ryan and Badham's (1976) conclusion of positive net social benefits in Victoria and Ryan's (1975) estimate of an annual net loss in N.S.W. Across population studies of this type are unlikely to yield valid results as herd recording services are probably used routinely by an abnorally high proportion of the better managers. Previous Australian studies have, in any case, been overtaken by the improvements now occurring in the effectiveness and efficiency of the services.

Substantial net benefits have been predicted from a proposed herd health (management information) program (I.A.C., 1976).

There is a need for soundly based separate predictions of benefits from each of the three components identified above in relation to feasible operating programs and usage rates. These are necessary pre-requisites to informed decisions regarding systems to be developed, charges and subsidies.

CONCLUSIONS

Recording systems should provide information of sufficient reliability for adequate management decisions. They must meet the requirements of genetic improvement systems, but their orientation to farmers should be paramount. Effective management information components may make these schemes more cost effective and encourage wider use.

The N.Z.D.B. has evaluated the effectiveness of the promotion of its A.B. program (N.Z.D.B., 1977). Promotion and advisory support may be critical for effective use of recording services in Australia. T.H.I.O. has shown the value of enthusing recording officers by the 200% increase in its identified

progeny test daughters (T.H.I.O., 1979). Will service usage be maintained with F.O.S. without other changes?

U.N.E., Armidale, is investigating animal identification and at least one company (Foss Electric) has developed fully automated recording systems. These developments will not only increase farmer acceptance but will also improve data integrity.

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