Daisy: Dairy Information System, An Aid to Record Keeping & Health Management

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Introduction

The Unit's work on herd monitoring was motivated by the need for a system to record data for a Study of Methods of Improving Oestrus Detection (Esslemont, 1973). These interests were shared with Dr. R. S. Morris, then at Melbourne University, and he made available a suite of computer programs for analyzing dairy herd health and fertility data which suited the immediate needs (Morris *et al.*, 1978). Out of this generous co-operation has evolved the 'MELBREAD' Herd Health and Fertility Reporting Scheme, the more comprehensive 'DANDAIR' system, the 'YOUNGSTOCK' system for recording heifers, and now 'DAISY' with which data processing is being decentralized to farms and veterinary practices. We are also starting to develop similar systems for intensive pig interprises.

This paper presents background information on the development of herd monitoring and a description of computerized record systems for the dairy herd developed by V.E.E.R.U., especially the 'DAISY' software package for small computer systems.

An estimate of breakdown of fixed and variable costs on a per cow basis for a U.K. dairy herd is shown in Table 1a, and typical good performance levels in table 1b. These figures show the need for very high technical performance in order to produce truly economic results. They also show that costs per cow for improved management information systems (at £5/cow/year) can be kept below 1% of turnover.

Herd Health and Productivity Control

U.K. dairying has become very capital intensive, much of it strictly uneconomic with increasing mechanisation and diminishing use of labour, and the trend to fewer larger herds continues. This herd size increase has been facilitated by the eradication of most of the major plagues including foot-and-mouth disease and tuberculosis, and rapid progress towards the complete elimination of brucellosis. It has also led to an increasing demand for veterinary services. According to an official 'Committee of Inquiry', which reported in 1975 (Swann, 1975), 5,570 veterinarians were actively engaged in professional activities. About half of the working time of the 3,900 veterinarians employed in general practice was devoted to the care of farm animals and horses. A very large part of the work on official veterinary schemes is contracted-out to private practitioners, but income from this now often represents less than 10% of gross turnover from farm practice activity so that almost all veterinary costs are borne directly by the farmer. the majority by the dairy farmer.

Various attempts have been made to develop officially supported veterinary preventive medicine schemes, starting with a programme for the Control of Diseases in Dairy Cattle (1942-50) and later the Mid-West Veterinary Association's Scheme, between 1964-67 (Grunsell *et al.*, 1969), followed by a larger-scale pilot exercise involving 144 farms over the period 1970-74 (Anon, 1976), but to date no general scheme has been introduced and official agencies have concentrated on providing specialist support for the private practitioner's initiatives. As official work has dwindled and herd management problems have increased, following intensification, an expanding nucleus of veterinarians have developed their own herd health and productivity programmes for some of their clients. Regular advisory and routine treatment visits, paid on an hourly basis, extend and partially supplant the traditional 'fire-brigade' service to such farms. To be most effective these programmes must involve planning and monitoring herd management policy to ensure thorough integration of veterinary activity. Thus the veterinarians is drawn into herd health and production monitoring.

Herd Monitoring and information services

Veterinarians who offer herd health and productivity control services require *information* to: —

- draw up targets, and action plans to achieve them
- predict the effect of a suggested course of action; both in physical terms and financial terms
- monitor effects of their plans (tactical and strategic) and to assess progress
- investigate shortcoming in performance compared with planned objectives.

TABLE 1a

An estimate of the fixed, variable and total costs per cow in 1980, for Friesians in the U.K. *(after Nix J. 1980)*

Fixed Costs		£	
Direct labour		85	
Labour for forage production and conservation		20	
Power and machinery		70	
Rent (excluding buildings)		30	
General overhead expenses		35	
Total (excluding items below)		240	
New buildings : depreciation (10 years) and interest (15%) on £750 per cow, less grant (22½)		115	
Management		20	
Interest on capital (excluding land and buildings)		75	
Total fixed costs		450	450
Variable Costs (excluding concentrate feed)			
Forage variable costs : say 5 year leys with stocking rate 2 cows/Hectare			
Seed per cow	4		
Fertilizer per year	80		
Sprays	2		
	86	86	
Bedding straw for cubicles : 0.4 t./cow for 6 months @ £30./t		12	
Veterinarian and medicines		14	
Variable sundries (excluding bedding)		18	
Herd depreciation : cost of newly calved heifer @ £495 less cull value of cow @ £285 = £210 total depreciation over 5 years, @ £42./cow/year		42	
Total variable costs (excluding concentrate feeds)		172	172
Total fixed + variable costs (excluding concentrate feeds)			622
less average value of calves (per cow per year)			70
Net costs to be recovered as margin between milk revenue and concentrate feed costs (MOC) to break even			552

Thus preventive medicine programmes - we prefer to more comprehensive term Planned Animal Health and Production Services - are really about CONTROL, that is the maintenance of a desirable balance between animals and their physical and financial, internal and external environment. This control-loop and a simple representation of its realisation in terms of herd health and production control activity *and* a supporting data and information management system is shown in the following diagram.

Many farmers and their advisers including veterinarians are good at 'doing something', but not so assiduous about the other essential stages of the cycle

— Without objectives you merely continue 'doing something' indefinitely
— Without measurement you don't know what effect your 'doing something' is having, if any,
— Without comparison of measurement and objective you don't know if you are 'doing something' useful,
— Without education you don't know what to do apart from 'something veterinary'

To set objectives and the plan 'doing something' requires that you have a good idea of how the system - for example, a dairy farm - works. It may be a conceptual model that you have but if it can be further refined and the relationships quantified it becomes a mathematical model, which can be used for forecasting, for example the formula for predicting milk yield.

To 'measure the effect' requires the collection of data.

To 'compare the measure with your objective' requires analysis, so that you can monitor the effects of your 'doing something'.

Two further aids are useful: firstly, 'Action Lists' - prompts to help you to 'do something' at the right time - and secondly, a means of investigating when the monitoring system shows that objectives are not being met.

Thus data must be collected, and analysed to provide information to guide action, and to refine objectives. This is another cyclic process.

These days farmers and veterinarians are increasingly concerned with subclinical rather than clinical disease and the effects this has on performance and profitability. A good way of detecting subclinical disease is to monitor productivity, for example milk yield, calving-to-conception interval or live-weight gain - biological indicators of health

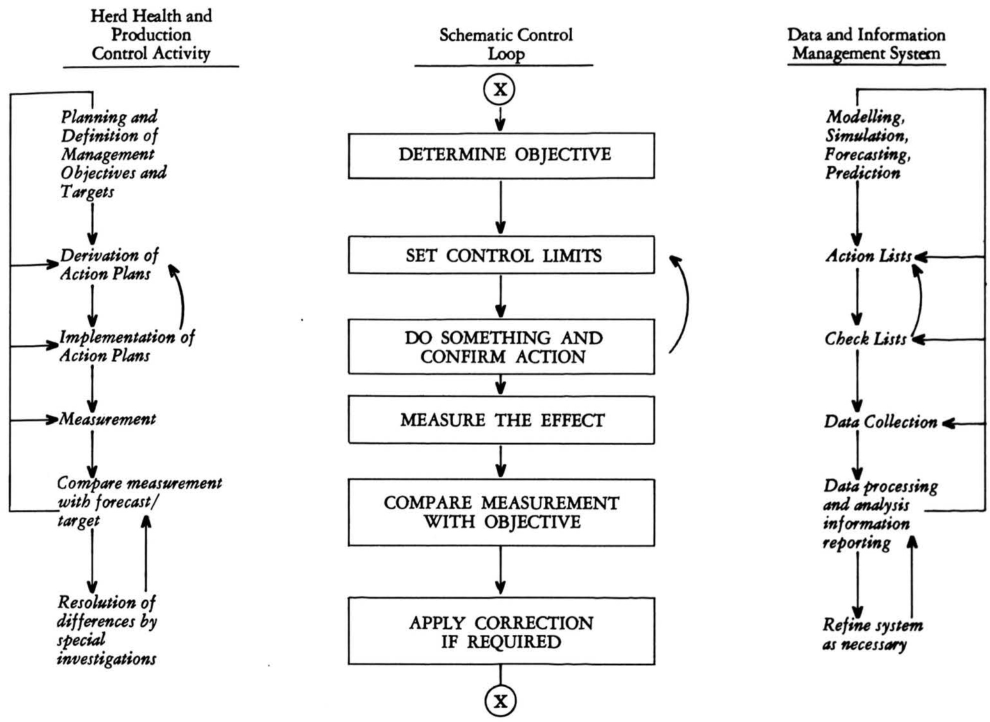
TABLE 1b

Typical performance levels and expected margins over concentrates

	National average	*Good performance standards*			
Milk yield liters/cow/year	4,750	5,000	6,000	7,000	7,250
Milk revenue : £ @ 12.4p/liters expected price 1980-81	589	620	744	868	899
Concentrate feed used (kg./litre)	0.32	0.27	0.32	0.37	0.37
Concentrate feed use (t./year)	1.52	1.35	1.92	2.59	2.68
Concentrate feed cost @ £130/t.	198	175	250	337	348
Margin over concentrates	391	445	494	531	551

FIGURE 1

THE RELATIONSHIP BETWEEN MANAGEMENT ACTIVITIES AND DATA AND INFORMATION MANAGEMENT IN HERD HEALTH AND PRODUCTION CONTROL



status which are closely related to profitability. This might be termed "Performance Diagnosis" and it can be used at herd level or for individual animals.

The potential profits lost as a result of poor performance are enormous - Esslemont (1979) has estimated that more than £1.15 per day is lost if the calving-to-conception interval exceeds 85 days or £40/cow is lost if conception rate is 40% instead of 60%. It is well worth monitoring performance closely if something can be done to avoid these losses. But to monitor performance effectively requires frequent, accurate measurement of production (data collection) and frequent, rapid processing of data (analysis) to produce timely, accurate, and appropriate information to assist effective intervention.

Manual systems of record keeping and analysis, which are often satisfactory on small herds, break down when the adviser is dealing with perhaps 20 - 30 herds, and the herd size goes over 80 cows. Manual systems demand consistent attention to detail and involve more time and effort than many farmers or vets are willing, or able, to spare. Small computers are now cheap enough, reliable enough and can be made 'friendly' enough to meet the needs of veterinary surgeons and farmers, and can provide a simple, flexible, cost-effective solution to the problems of record keeping, analysis and reporting.

Of course, someone still has to collect the basic data - but much of it is already available on farms; what was lacking was a system to organize and analyze it to produce useful information, at the right time. In the last two years a range of mini-computer based monitoring and forecasting systems for agriculture have evolved in the U.K. (Stephens and Esslemont, 1978). Some of these have been designed to replace the motley collection of schemes that a farmer had to be on to enjoy full data processing.

Unfortunately, there has been a single comprehensive scheme for the dairy herd. There were few links between the schemes of different agencies and some farmers found the data processing services from remote centres too slow for reports to serve as day-to-day management aids, nor do they provide sufficiently detailed information on individual cows.

In 1972, a group of U.K. farmers and veterinarians learned of the Melbourne Scheme (Morris *et al.*, 1978) and they asked the Unit (VEERU) to create a similar scheme. Thus, 'MELBREAD' - in honor of Melbourne and Reading Universities - was born (Esslemont and Ellis 1975, Study No. 21). It has become the corner-stone of a programme of research and development to create an integrated herd data and information management system, which serves as many needs as possible and reduces manual record-keeping.

The Development of the Dairy Herd Health and Productivity Monitoring Systems 'Melbread'

The MELBREAD scheme is a computerized dairy cow health and fertility records-analysis and reporting system. The original computer programs from Melbourne have been extensively redeveloped, with the co-operation of farmers and their veterinarians, to help farmers manage large herds, and to assist veterinarians in private practice who provide herd health and fertility control services based on regular routine visits. We have now transferred herds from the MELBREAD system to the small computer and DAISY.

The Melbread Monthly Report was used to monitor current herd performance, and to assist with day-to-day management of individual cows. An Annual Report is available, with detailed statistical tabulations of herd reproductive performance which are used to identify and investigate longer-term variations in herd fertility, and to plan fertility management for the next calving season. Cumulative sum charts (Q-sums) can be plotted by the computer to monitor trends in calving-to-conception interval and conception rates (Esslemont and Eddy, 1977), and to investigate periods of the year in which problems have arisen.

Because so much effort has been made to meet the information needs of farmers and veterinarians using the scheme, we have been able to create a databank of good quality data on dairy cow health and fertility. This is good enough to support research studies (Van den Bergh 1975, Scarr 1976, Traa and Esslemont 1977, Gartner 1980), clinical field trials (Esslemont, Eddy & Ellis 1977) and computer simulation modelling (James and Esslemont, 1977) which in turn, have led to improvements in the data system and reporting service, and the development of new management practices and veterinary techniques which have been widely adopted outside the scheme. Further details are given in a report of the changes in reproductive performance observed in 22 herds in the MELBREAD scheme between 1972 and 1975 (Esslemont and Ellis, 1975).

Feasibility Study of Use of Small Computers

Developments of a mainframe based integrated recording scheme (DANDAIR) which was too awkward to operate via a card system, and the lack of interested farmers keen enough to weigh heifers regularly for a sophisticated youngstock recording scheme (HEIFERLUMP) led to the production of a specification for a minicomputer based Dairy Scheme in 1973.

The Scheme had to cover

1) all ages of stock
2) all types of data
3) varied data entry timing
4) simple data collection methods
5) thorough checks at data entry to facilitate error detection and correction
6) rapid and frequent reporting
7) flexibility report formats

A feasibility study (Stephens and Esslemont, 1978) convinced VEERU that the best way to meet these objectives was to have the data processing equipment as close as possible to the sources of the data. A pilot exercise in 1978, using 16 bit minicomputer system with 32K words of memory, a visual display terminal, a twin floppy-disc drive unit and a printer demonstrated that a small computer had the necessary capability at an acceptable price, in the U.K. economic context. The enthusiastic response of farmers and veterinarians encouraged us to proceed with a research and development programme to develop a high-quality dairy herd data and information management system for small computers aimed at farmers, veterinarians and other agricultural advisers - from which DAISY has emerged. The feasibility study drew groups of interested people to the University on many occasions and amongst these were the directors of Farmplan, Farmfax and Farmdata all of whom offer different types of dairy recording schemes on microcomputers.

'DAISY' Dairy Herd Information System

VEERU has used a Computer Automation LSI 4/30 minicomputer, with floppy diskette units and a cartridge disc unit to develop a suitably comprehensive and integrated suite of programs - DAISY - using the Computer Automation DOS4 and FORTRAN software development system. This machine was selected in early 1978 after much soul-searching, as offering the best facilities for the restricted financial resources available. These issues are discussed more fully elsewhere (Brooke 1980). Today this computer looks relatively expensive when compare with the more powerful microcomputer systems that are now available, e.g. the Cromemco System 3. The software development facilities available on small operating systems, and high level language processors have also improved dramatically, since 1978 especially for minicomputers, and most recently for the new generation of microcomputers. The price of terminal equipment has also dropped in the last two years.

Regrettably much less progress has been made on improving compatability between different makes of computer, and on improving portability of software between different computers. Very recently new software development products have emerged which promise to ease the problems of software producers in the face of rapid developments in computer hardware.

DAISY was designed from the outset as a stand-alone, single user system, with data and programs held on diskette, to be situated on or near the farm. Initially cost considerations have meant that the system would only be cost-effective on the largest dairy farms, but the shared use of a machine has proved successful, based around a machine in the veterinarian's practice office. Two such systems are in regular commercial operation by veterinarians who offer data-processing services, linked to herd health and production control programmes, to some 30 of their farmer clients. These systems have been operating very satisfactorily for 18 months and 11 months respectively and altogether 70 herds are currently using DAISY.

Data entry and validation

One of our objectives was to simplify data entry and ensure consistent data quality by interactive data entry and validation. This was fairly easily achieved using a simple visual display unit, plus a lot of smart software.

The data entry/validation system is man-driven and the veterinarian or farmer enters his own data using the conventional typewriter keyboard of the visual display terminal, in response to program questions or prompts. We have used the MELBREAD two-digit coding system for health and fertility data, but other data is entered in its natural form as numbers or plain words. Data can be visually checked as it is displayed on the screen, and is also automatically checked for field and format and for logical consistency with data already in store, before it is added to the data-files. If field maxima or minima are exceeded or format errors are detected the cursor is repositioned at the start of the current field beneath the error so that the offending item can be seen and corrected. The detection of logical inconsistencies with previous data provokes the display of messages on the screen explaining the nature of the inconsistency detected. Logical checking is conservative, by design, and generate two alternative types of message to the operator - a COMMENT or less often an ERROR. The entry of data which provokes an ERROR-type message is not permitted. Data provoking a COMMENT-type message can be entered if the operator chooses to do so. However, a continuous printed log, or audit trail, of attempted data entries is generated automatically complete with ERROR and COMMENT messages and a record of whether or not the operator chose to enter the data items provoking COMMENT messages.

Should the explanatory COMMENT message be insufficiently specific the operator may choose to display the complete detailed record before determining whether or not the data item should be entered. If necessary the existing record can be interactively edited immediately before proceeding with further data entry. Each data type - e.g. new cows, health and fertility, milk yield and quality, weight and condition score, and groups - has its own data entry, validation, record display and editing program. Even so, these programs are complex and quite large, the health and fertility data entry program for example require about 32k bytes, and contains about 60 logical error detection values, several of which may be relevant to a single data item. Thus a combination of COMMENT and ERROR messages can be presented by a single data item, in which case the ERROR message functionally overrides the comments and the data item cannot be entered.

"Soft errors", that is erroneous data which is logically acceptable to the DAISY system, if detected by other means, can be removed or amended by the EDIT facility on another occasion.

If the existing record is amended in any way the whole record is subject to full validation again, just as at data entry. If removal or amendment of a previously accepted data item would corrupt the record then ERROR and/or COMMENT messages are displayed as at data entry, attempted amendments or deletions provoking ERROR messages are not permitted, thus preserving the integrity of the database.

Much time and effort has gone into the data entry editing system, as obviously the quality of the information produced by the reporting and analysis programs is wholly dependent on the quality and integrity of the database. After a period of progressive sophistication we are now happy that data entering the DAISY system is of high quality and will support sophisticated processing to generate sound dependable information for decision-making by the farmer, veterinarians and other advisors. DAISY has by far the most sophisticated validation procedures we have seen in any dairy herd data and information management system on either small or large computers. To be doubly sure many of the analysis and report programs have additional special data validation procedures to ensure the quality of the information produced. The computer is programed to produce special recording forms, but a simple daily diary or even the back of an envelope, would suffice if data is input frequently. The advantages of continuous access, direct input and immediate error detection and correction should put minicomputer systems ahead of all others for day-to-day herd health and productivity data management.

The DAISY database

The main DAISY database stores physical records for individual cows including geneology, selected health and fertility events, milk yield and quality records, and records of grouping and grouping changes within the herd. Special subsystems - for example the Ration Calculator, the Brinkmanship system and the Herd Forecasting/Monitoring system (SIBYL) have additional special databases monitored and accessed solely by these programs, to supplement the main individual cow database. This leads to a flexible, extendable modular design which can be implemented partially or completely for each herd, depending on the requirements of the farmer, veterinarian or other adviser.

The DAISY system also has a built-in back-up procedure. Two back-up copies are kept of each data diskette, and the system ensures that back-up copies are made at least every seven days, before new data can be entered. The reporting programs developed so far produce extended and improved versions of all the reports and lists available from MELBREAD with many additional reports to monitor and forecast feed use and milk output. Reports and analyses of the data base are produced only on request by the operator - no reports are generated "automatically" without operator intervention.

The selection of reports and analyses is man-driven - the operator loads the appropriate program diskette as indicated by the system and in response to system prompts selects the period of interest, and defines various other qualifying conditions for each report, such as desired sort order for lists of cows, whether the information should be initially displayed on the visual display unit or printed immediately, number of copies required, etc.

It is always a problem to decide how much freedom to give the user in generating reports. Some systems attempt to allow the user total freedom to select items of information from the database and to format these into a custom-built report. We have mostly rejected this approach, on the basis that good information should provide a sound guide to action, which presupposes that the user has a clear understanding of the system he wishes to control - in this case a dairy production unit - and also understand which factors are critically important to success. It is as easy for the uninformed to generate rubbish as it is for him to produce information given complete freedom. (The uninformed use of statistical program packages exemplified this problem).

Instead we have adopted the approach of offering a large number of structured reporting programs - with a more limited capability of custom tailoring - which support a consistent philosophy of desirable, effective and profitable dairy herd management. Contentious issues of farm management philosophy, such as feeding practices and principles, are resolved by offering a range of alternative "standard" options to reflect the various fashionable methods presently in widespread use.

Thus DAISY embodies a philosophy of dairy herd management and is not simply an automated records system. To some extent the adviser is represented within the DAISY system; we believe this is important if a "stand-alone" system is to be operated by the farmer as opposed to a centralized Data processing service controlled by an advisory agency.

Most reports and analyses can be presented in several formats either displayed on the visual display unit or printed, in summary or in detailed form, and in various sorted orders. Thus the user may select a style and presentation appropriate to his needs although the basic analytical concepts are firmly embodied in the report program design.

A fast matrix printer of robust design and good quality is used to improve throughput, and reduce tedious waiting for information - this is important in a single user, single-programming system, as printing speed largely determines the speed and throughput of the whole system and the ability to produce multiple copies is essential.

The reports and analyses can be divided into major categories.

1. *Action Lists* - e.g. cows due to be dried off, cows due to calve etc. In other words aids to help the farm staff do the right thing at the right time in accordance with action plans to achieve managemental objectives.
2. *Recent Event Reports* - e.g. cows which have calved, cows dried off, reproductive examinations performed. These serve two purposes, as an archive record of events for quick reference in hand copy, and as a check list against plans, to practice prompt early warning of developing problems.
3. *Herd data analyses* - Herd Fertility Summary, Herd Lactation performance summary etc. These are the principal herd-level monitoring tools, to assess progress against management objectives for the herd as a whole, or for identified sub-groups within the herd. e.g. cows calving in a particular month.
4. *Investigational tools* - e.g. Conception rate Q-sum plots, conception rate analysis, oestrus detection efficiency analysis, culling analysis etc. The programs are used to investigate in detail problems identified by monitoring programs such as Herd Fertility Summary. A progressive decline in performance can be analyzed and contributing factors identified, enabling corrective action to be taken, or management practices modified to avoid a recurrence. We are working to much more in this area, particularly with respect to mastitis control and prevention.
5. *Feed management tools* - two major systems, the Ration Calculator to assist those using Metabolisable Energy Concepts of rationing (HMSO, MAAF 1975) and complete diet feeding, and the DAISY - Brinkmanship System for monitoring lactation performance week by week with concentrate allocated according to yield on an individual cow basis.
6. *Cull Sorter* - a program to identify cows not meeting managemental objectives for individual cows, the user can establish a "potential cull profile" and progressively modify "culling pressure" to identify the number of least productive cows (in a range of senses) which he can afford to replace.
7. DAISY/SIBYL - herd-level forecasting and monitoring tool, based on a simulation model, incorporating both physical and financial factors. This can be used to establish targets, to predict physical and financial performance, to evaluate alternative strategies, and to monitor actual performance against targets.
8. *Recording Forms* - the computer is programmed to produce convenient recording documents which may be used for milk yield recording and for recording health and fertility events.

The DAISY/SIBYL Herd Forecasting - Monitoring - Subsystem deserves special mention. The SIBYL was the title given to the priestess of Apollo at the Delphic Oracle. She would, for a small payment, go into a trance and make predictions in verse. The predictions were of sufficient ambiguity that they were always adjudged correct. We hope that we can improve on her performance, and DAISY/SIBYL aims to produce sufficiently precise forecasts to be of value in target setting, and comparative strategy evaluation, as well as herd-level monitoring of a number of important physical and financial indices of herd performance.

The DAISY/SIBYL system has its own data base at present, but will shortly be linked to the main DAISY data base from which it will obtain many of the physical data items required to parameterise the simulation model, at the heart of the system.

The Simulation model used in DAISY/SIBYL is a de-tuned version of models developed for research studies of the relationship between fertility, feeding and profitability in the dairy herd. (James and Esslemont 1979, Van Der Lende *et al.,* 1979). DAISY/SIBYL keeps a record of twenty-six variables relating to the dairy herd, which are recorded each month. Given the values of the variables for a twelve month period, and certain other information, the system can forecast the values for the next twelve month period, and from this information can print forecasts of many important herd productivity parameters such as percentage of cows in milk and margin over purchased feeds. As the actual values of the variables are entered for succeeding months, the printed forecast contains the values actually achieved, together with the difference between forecast and actual values so comparison can be made. The main value of the system lies in demonstrating these deviations from expected performance, and it is normally a fairly simple matter to identify the reason for the deviation, which may lie in the assumptions made for the forecast of in a physical change in the herd conditions. A new forecast can be made at any time, since there will always be recordings of actual data for at least twelve months, once the first forecast has been run.

The initial twelve months' back data is collated from farm records and entered into the system through the monthly update option of the SIBYL menu. The first forecast may then be run. The data used in the forecast are printed once their values have been confirmed. The run of the forecast programme may take up to 20 minutes to complete, depending on the herd size. When it is completed a graph is printed in three 4-month sections showing the daily forecast milk yield for the next year. A report may then be run which will produce a series of tables covering herd structure, milk production, feed use, financial margins as forecast and actuals months by month past and future and a rolling 12 month values. A form is also printed to be used for entry of the next month's data. This is entered through the monthly update option, and then another report may be run, which will show the latest forecast versus actual situation. A new forecast may be run whenever desired; even immediately after a forecast if the assumptions made do not seem to be appropriate in the light of predictions. Any erroneous data that is entered may be corrected by using the data modification option from the SIBYL menu.

After two or three trial forecasts with progressive timing of the model parameters to achieve a good correlation between actuals and predictions based on back-data reflecting a herd's level of achievement, then monthly processing for the herd or the group is best performed as soon as possible after the end of the month. The predictions of milk yield are made on the basis of the M.M.B. standard curves (Wood 1969) but without corrections for calving month. Seasonality is effectively entered by the user, since yield potential of the cows is entered for each month of calving individually. Spring hump seasonality is an artefact of management, and if it exists on a particular farm, the manager's attention should be drawn to it as a deviation from forecast, because it may demand changes in rationing, for example. Feed requirement is forecast on the basis of energy required for maintenance (Heifers 55 MJ/day, cows 63 MJ/day) growth and production (5.15 MJ/litre). Cows are assumed to convert liveweight to energy in the earlier part of the lactation (28 MJ/Kg) and to require more feed energy in the later part of lactation (34 MJ/Kg) to recalve 50Kg. heavier. Forage is fed up to daily intake limit specified as data and additional energy requirement is met, if possible, from other purchased feeds and, then concentrates, up to the total dry matter intake limit. Any additional energy required is taken from liveweight loss, to be made good later in the lactation. This represents a feeding regime of near perfect efficiency which is not likely to be achieved in practical situations. To make more realistic feeding forecasts it may be necessary to assume a lower availability of energy from forage than a laboratory analysis would suggest. The same effect could be achieved by lowering the energy value of concentrates to allow for efficiency in the feeding policy.

It seems that a combination of DAISY/SIBYL, the main DAISY system, and particularly the use of DAISY Brinkmanship to ration concentrates, can encourage the better use of grass and considerable improvements in margins are being found in practice where herds have DAISY.

DAISY/SIBYL is presently undergoing tests at Reading, and will shortly be used commercially there and released to our two veterinary practice customers.

The Future - Plans and Problems

The first of the two veterinary practice systems was installed in May, 1979, the second in December and we have regarded these installations as test-bed sites. Reaction has been very favorable from both veterinarians and their farmer clients. These two systems are operated as commercial activities by both practices and they are very satisfied with performance so far.

We are now in something of a dilemma. The newer micro-computer systems, which were not in production when we selected our minicomputer system, now appear capable of running the DAISY system. Hardware and software development for microcomputers is proceeding rapidly, and we feel the total package cost of a DAISY hardware and software system could be significantly reduced by converting the DAISY software for microcomputer use. This would result in more DAISY sales, we believe, particularly for on-farm systems. The other small computer system available in the U.K. are all based on upgraded hobbyist microcomputers, and although their dairy herd software packages are primitive when compared with DAISY, their total systems (hardware and software) costs much less. The market is still rather unsophisticated and price is an important criteria in choosing systems.

We believe that for DAISY to remain a viable commercial product, the software should be made available for wide range of small computers. However, with rapid hardware developments there is a substantial risk of becoming "trapped" with the types of small computers which are presently popular, but which will certainly be superceded by new machines in the relatively near future.

To resolve this problem we have been investigating the merits of a number of portable systems software tools which are now emerging. The UCSD - PASCAL system which is produced, and supported principally in the U.S.A., and British system, CAP-MicroCobol. Software developed using these systems is directly portable across a wide range of small computers from hobbyist microcomputers up to substantial minicomputer systems. Although the conversion cost for DAISY will be high, this investment should protect us against rapid hardware developments, which can be exploited when they become generally commercially available. Increasingly software development costs dominate total system costs, and portability must be the key to protecting investment in software devlopment.

We have found that system software support for U.S. products is poor in the U.K. - at least for most minicomputers and all microcomputers. Therefore, we presently favor the use of the CAP - MicroCobol system, which is supported by a very large software house in the U.K., Europe and also in North America, as the basis of our future program development work for commercial small computer systems, where reliability and maintainability override the attractions of technical ingenuity and fashion.

Concluding Comments

DAISY is one of the products of long-term, phased research and development activity carried out by an interdisciplinary group of agriculturalists, veterinarians, economists, electronic engineers, computer programmers working with farmers. The visible end product - the DAISY software package - has proved to be a commercially viable, and effective aid to farmers and practicing veterinarians in improving dairy herd production efficiency and profitability. Just as important is the demonstration that interdisciplinary team-work is not only feasible, but successful and, for those involved, challenging, enjoyable and satisfying.

It is important to remember that data and information management is not really about computers or printed papers, it is about people and their stock - people who develop programs - people who collect data, people involved in processing data, and people who use the information produced - and their relationships. VEERU's successes are mainly attributable to the inter-disciplinary nature of the team; its policy of open communication and co-operation with farmers and veterinarians and a willingness to take risks and try new things, with dogged determination.

NOTE: A detailed description of the DAISY software package, DAISY - the Manual, and sample printout sets can be obtained from the authors. (£5.50).

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Appendix I

A Description of the types of data that may be held in the DAISY database.

The DAISY software package is designed for small computers and the data for each herd is kept on 8" floppy discs. Four hundred and eighty cos-lactation records can be kept on a disc. At any one time two floppy discs can be loaded on the computer. Large herds (more than 300 cows) have a two disc data storage system which allows 700 cow lactation records to be kept for current access. As time passes 'old' data can be transferred to archive discs. This means the data from culled cows, or animals which have recalved, or where cow numbers have been reused, can be kept for occasional retrospective searches. Any cow whose detailed past lactation records are archived like this, but which remains in the herd, will still have a full set of summarized information for each previous lactation as part of the current lactation record.

Three generations of 'current' discs are kept (A, B, C), and copies must be taken every seven days, so back-up copies never get too far out of date. The data discs simply hold the original detailed data as entered while aggregation, summarizing and analysis is performed by the report programs as appropriate.

The data stored for each cow

The space allocated to a disc for *each cow* allows the following information to be held (if required).

Identification Information

1. Cow Number (3 digit))
2. Cow Identity Herdbook or Ministry of Agriculture) identification number (10 digit))
3. Cow Name; Herd book Number; Calf Identity, Breed)
4. Sire Name; Herd book number; Breed)
5. Dam Name; Herd book Number; Breed)
6. Birth Date) Optional
7. Previous Lactation Summaries:)

Lactation number, Calving date, Yield (total), Yield (305d), number of tests, average butterfat, average protein, lactation length, number of services, calving to conception interval, number of cases of mastitis, number of cases of lameness. A 'running' summary is monitored for the current lactation automatically.

Health and Fertility Information

Up to 44 events per lactation can be stored. These events comprise a two digit code and the date of that event. The coding concentrates on fertility events and treatments. With simple categories for events observed and recorded by farm staff and more detailed classifications available to the veterinarian.

Calving, Live/Dead Calves
Bull codes (14 codes)
Pregnancy diagnosis positive (5 codes)
negative (10 codes for findings/treatments)
Oestrus not observed (10 codes for findings/treatments)
Failure to conceive (5 codes for findings/treatments)
Farmer treatment for health (mastitis, lameness, metabolic disorder etc. 10 codes)
Veterinarian treatments for health (as above)
Culling, sold (10 reasons, more than one reason may be reported)
Died (10 reasons)
Drying off (2) Calf rearing, abortions.

Milk Yields

Up to fifty-three recordings can be kept per lactation. The information can be entered from three times a day records if required or simply as one total for the day. The data is entered as the amount in kilograms and the date of recording against a cow number.

Milk Quality

Up to fifteen (monthly) butter fat and protein analyses can be kept per lactation per cow. They can be entered out of sequence when the results are back from the laboratory.

Cow Grouping

Feeding grouping can be recorded as a number (from 1 to 15) and changed when required. For convenience, if required, it can be entered at the same time as the yield record as cows will be recorded in such a manner. A complete history of recorded group changes is monitored.

Cow Weight and Condition Score

Where this data is available the scope exists to enter 29 weight and score recordings per lactation. These can be entered as weights alone, scores alone or both.

Other types of data

Some of the reporting sub-systems, such as the Ration Calculation Package and DAISY/SIBYL, the herd-level forecasting/monitoring system, maintain special additional databases, which are accessed by these programs in conjunction with the main DAISY individual-cow database.

Interactive data entry, validation and editing

Data items are usually recorded on the farm in a simple duplicate note-book. The format for its collection need only be cow number, code (or data) and the date. The top copy of the notebook page is torn off and taken by the veterinarian or the farmer to the computer. The information is entered by a clerk (who should be experienced in cow matters rather than computers). Any anomalies that cannot be coped with there and then, are noted in a queries book (and the top copy of that goes back with the reports to the farmer).

Summary of DAISY Reporting and Analysis Facilities

When the data-base has been updated (usually weekly) reports can be run. At present about 35 different reports can be called up from floppy discs. (About 10 floppy discs are needed to carry the DAISY programs).

The reports are flexible in nature and wide ranging. The dates involved in the various surveys of the data can be chosen by the user, as can the way in which the reports are listed. Often the choice is between screen and paper output, and between pocket-sized lists or wide-printed detailed analysis. The reports can comprise individual cow lists or herd analyses so the whole-herd information for a year or more may be summarized on a single page.

The reports include:

1. *Action lists*
   Cows due to dry off
   Cows due to calve
   Cows due for service
   Cows due for P.D.
   Cows P.D. negative and not reserved
   Cows P.D. positive and seen in heat service
   Cows for veterinarian to see
   Herdsmans Action List for the Week.
2. *Recent Review Lists*
   Cows calved
   Cows served
   Cows Dried Off
   Cows culled
   Cows pregnancy diagnosed
   Cows with reproductive examinations
3. *DAISY Brinkmanship Reporter*
   Yield Averages by month of calving
   Weekly management report
   Feed list - individual cow concentrate allocations
   Group averages
4. *Recording sheets*
   for health and fertility events
   for milk yield records
5. 1. *Potential Cull Sorter* - (identified cows with combinations of or absolute levels of a range of conditions)
   2. Cow Sorter
6. *DAISY/SIBYL*
   Financial performance and forecasting program for herd or group, which minimizes purchased feed requirement.
7. Ration Calculation and Planning package.
8. Herd Milk Production Analysis
9. Herd Fertility Performance Analysis
10. Conception Rate Analysis Program (including Q-Sum)
11. Oestrus Detection Efficiency Analysis Programs (including Q-Sum and Histograms)
12. Monthly Pyhsical "stock-check" with yield indices.
13. Culling Analysis
14. Treatment Analysis P.D. Negative treatments
    Oestrus not observed treatments
    Endometritis treatments
    Use of Prostaglandins heat detectors etc.

Panel Discussion

Question: Firstly, what was the cost of writing this type of program and on the other side of the coin what is the average computer service cost per head on a monthly basis for an average of 60 cows? So if you have any information on the development in the writing of the program we will start with that.

Answer: Well the cost of writing the program I think can best be expressed in man hours or man years. I agree with Dr. Esselmont that a good programmer is worth twice his weight in gold and it took two years from a very good programmer and two of my years which are a lot less valuable than the programmers. So about four man years of work. The cost of running the system on a per cow basis will really depend upon the individual veterinarian. I envision this going into the veterinarian's office and him supplying it as service to his clients. If he has 1000 cows on the service it is going to cost so much, if he has 10,000 cows on the system it is going to be a lot less. So, I think that the computer is around 6-8,000 dollars or 6-10,000 dollars and maintenance costs are about 1% per year of the purchase price of the computer. I think you can figure it out on a per cow basis. I think you can get it down to 2 or 3 or 4 dollars per cow per year as a service to your clients.

Dr. Esselmont, did you want to add something on economics?