A PROPOSED INFORMATION MANAGEMENT AND DISEASE MONITORING SYSTEM FOR DAIRY HERDS

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Introduction

Farmers today have access to many advisory services. However, all too often farm management advisors disregard disease control when considering methods of increasing the efficiency of production (11).

Veterinary directed herd health programs fall short of their objectives to control diseases and to increase profits because attention is primarily directed towards the individual animal rather than the herd or flock. To overcome this shortcoming, the computerized health monitoring system described in this paper was designed to collect, store and analyze data relating to the health of each herd under study. To demonstrate the capability of the system, special attention was given to the reproductive data collected from the herds studied.

In general, studies of dairy herd health data indicate that two groups of diseases are the most significant in terms of their frequency of occurrence and economic loss. For example, records from ten farms studied by Morris (12) revealed that 65.8% of the 2081 clinical disease incidents recorded in adult dairy cattle were associated with the udder and genital system. McClure and Dowell (9) pointed out that approximately three-quarters of the disease occurrences of adult cattle in their survey were those of reproduction and lactation. Data presented by Priester (14) reveal that 54.9% of the disease occurrences commonly diagnosed by members of the 12 veterinary schools on the Veterinary Medical Data Programme were related to the reproductive system and the mammary gland. Morris (12) stated that "although a variety of other diseases affect adult dairy cattle most of these are limited to specific farms or geographical areas."

The major benefit of reducing the intercalving interval (an index of efficient reproduction) is that the average annual production per cow is increased (8). They estimated an average decrease of 2.40 ± 1.09 kg of milk and 0.112 ± 0.040 kg of fat loss for each additional day open and concluded by using this result that the optimum intercalving interval was 13 months for heifers and 12 months for second or further calvers. Barfoot (1) utilized 100 days open as the maximum allowable interval in his economic analysis of reproductive efficiency and calculated each additional day open until conception as a $1.00 loss. Morris (13) stressed, however, that although the mean interval expressed in days for a herd is important, the standard deviation must also be reduced in order to achieve the greatest financial benefit.

Clinical mastitis was reported by Janzen (6) to result in a 30–35% loss in production. A subclinically infected quarter was estimated by Morris (13) to lose from 30 to 35% of its productive capacity. Morris went on to point out that these effects are further increased when one considers the decreased productive life of the herd.

Fisher (4) found that 48.5% of the cows he studied had bacteriologically positive mammary glands and estimated the resultant economic loss at $189.00 per cow per year. Kingwill *et al* (7) found that 55% of the cows and 25% of the quarters in their study were infected. Daniel *et al* (2) determined that for an increase of one unit in the California Mastititis Test (C.M.T.) there was a monthly milk production decrease of 49 lbs per cow.

The above mentioned examples illustrate the need for a system to monitor diseases in dairy herds, in particular those which affect the reproductive systems and mammary glands and lead to economic loss.

Desdaers (3) pointed out that two major tasks of farm management made easier by the assistance of the computer are: 1) record keeping and 2) analysis of records. Several schemes used for these purposes were re-

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viewed by Smaile (15). However, only one of these, the Melbread Plan, made provision for health monitoring of dairy herds. Smaile (15) stated that such a scheme "imposes a discipline on a farmer of collecting data regularly and receiving a report each month, which will automatically improve the farmer's ability to criticize his own decisions and provided the information is well presented, he will see the consequence of his decisions".

Data Collection, Processing and Storage

For the purposes of this project six dairy farmers presently participating in the Herd Health Plan of the Clinical Studies Department of the Ontario Veterinary College agreed to cooperate.

An inventory of the animals in each herd was required and was taken by the herdsman. This information was then coded on the cow and diary coding forms (Figures 1 and 2), key punched onto standard 80 column computer cards and processed in separate steps, referred to as the cow and diary subsystems in Figure 3, of one computer program. This program was written in the Mark IV[1] computer language, and was run on an IBM 370/155 computer. It is documented at the University of Guelph.

As can be seen from Figure 3, correct cow and diary records were listed and merged onto the master tape files. Incorrect records were listed with the appropriate editing (error) message(s). These were then recoded, keypunched and processed.

The table subsystem (Figure 3) consists of tables of names and codes which serve to cross reference the other two subsystems and as such must be updated, when necessary, prior to either of the other subsystems. Information entered into this subsystem was analyzed by the Mark IV computer program and was entered, after computer editing, onto a direct access device.

Information submitted by the farmer after the initial inventory was provided through a diary, which was designed to be carried by the farmer at all times and was therefore readily available for recording.

At each interval herd visit, the clinician removed a copy of the information recorded in the farmer's diary, which along with the Herd Health visit summary sheet, provided the data which was coded, keypunched and updated on the master files as previously described.

[1]Informatics Incorporated.

Information Retrieval

The retrieval system (at present) produces one computer generated report. This, the interval report, was designed to take into account and analyze data recorded during any specified time interval. The computer program required to generate this report was written in PL/1[2] and is documented and available for reference at the University of Guelph. The program may be used in two ways: 1) to provide a report following a regular herd examination which can then be interpreted by the veterinarian and discussed with the dairyman and/or 2) to provide the veterinarian with an up-to-date report prior to his regular visit to the herd.

The report provides three areas of information: the first being a list of all adult cows in the herd. These animals are divided into those that are open and those that are pregnant. Open animals may then be subdivided into groups as follows:

1) Preservice anestrus – cows which have been open 60 days and have not had a recorded heat.
2) Postpartum check – cows which calved subsequent to the last herd health visit and therefore have not had a postpartum examination.
3) Pregnancy diagnosis – cows which have been bred 45 days without subsequent return to heat.
4) Remaining cows open less than 100 days – animals open less than 100 days and not already classified.
5) Remaining problem cows – animals open greater than 100 days and not already classified.

Beside each cow's name (Figure 4), whether open or pregnant, are printed: 1) the date of her last calving (heifers are marked xxxxxxxx) 2) the number of days open, 3) the dates of all breedings since last calving, 4) the dates of all recorded heats (animal not bred) since last calving, and 5) the date(s) and respective comment(s) e.g. diagnoses, treatments and/or observations, since and including last calving.

An example computer print out of the second area of information, herd reproductive statistics, is presented in Figure 5. These data will be discussed under the heading "Field Application" of the system.

[2]International Business Machines Corporation, Program Language One.

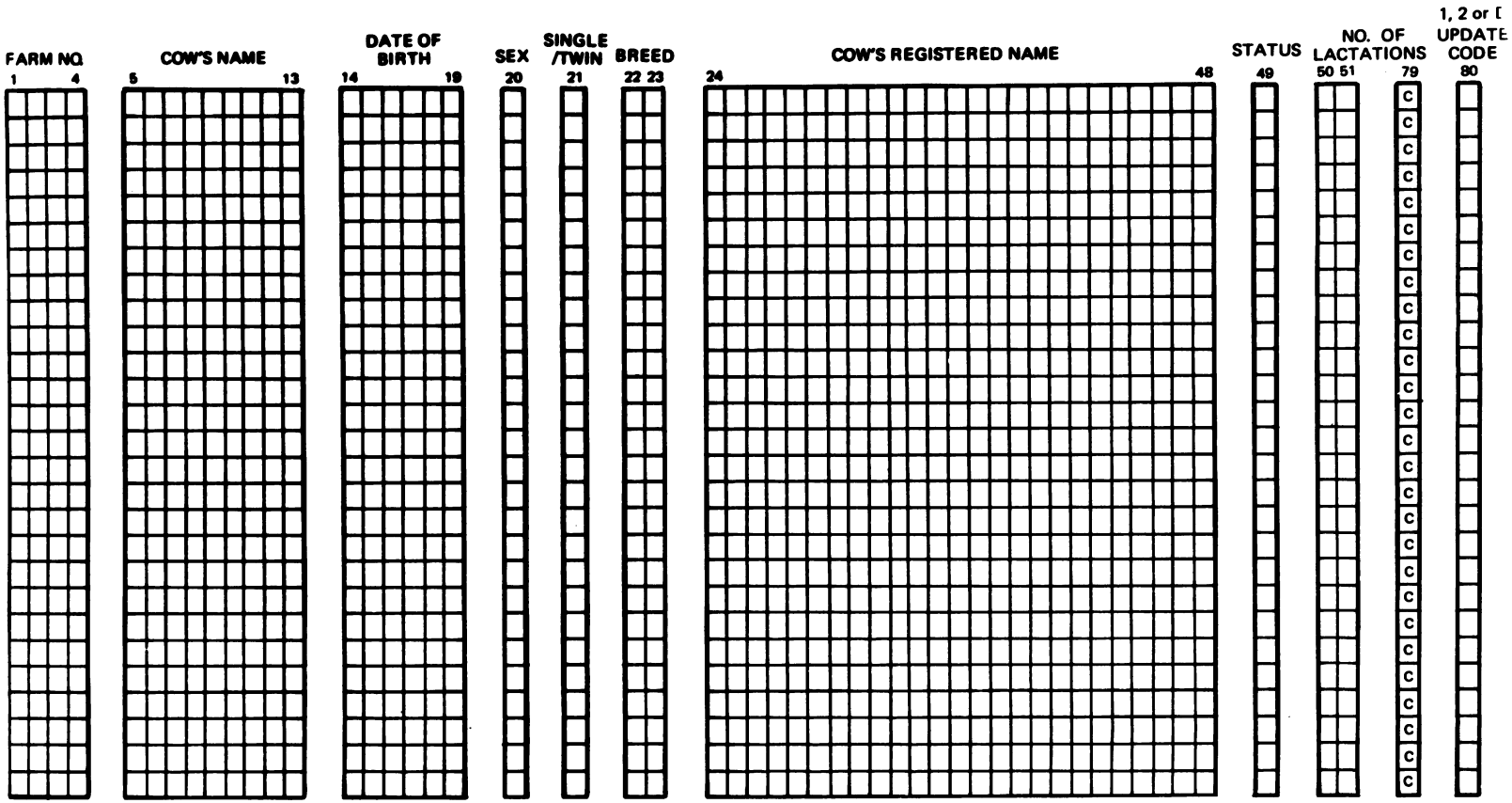

FIGURE 1. Coding form for cow information.

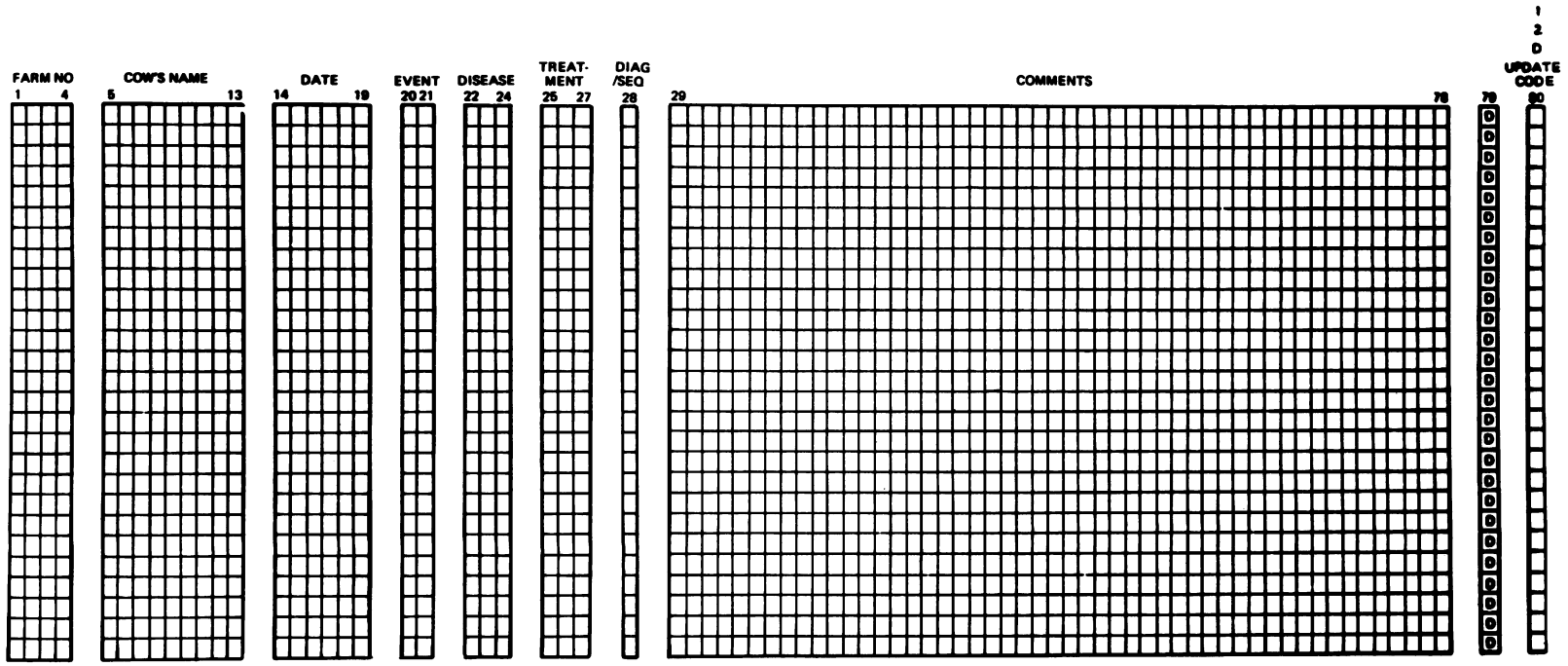

FIGURE 2. Coding form for diary entries.

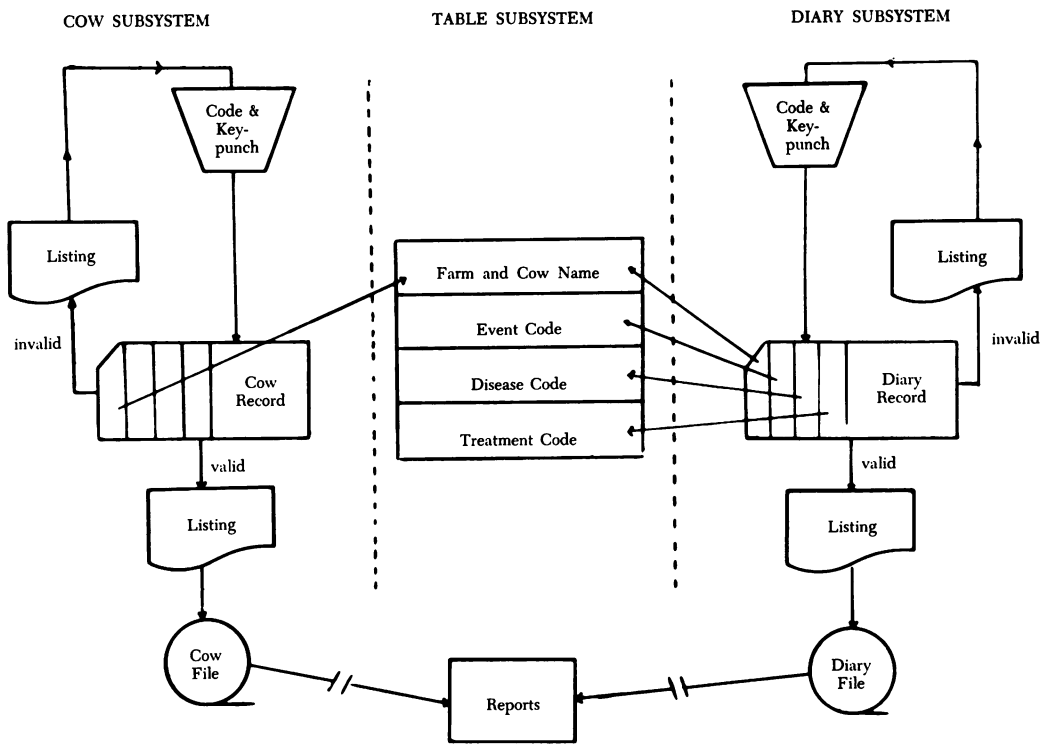

FIGURE 3. A schematic of the computer systems.

The third area of information is a list of management aids. These are self-explanatory and are merely listed:

1) Changes in herd size (including reason, if any) since the last herd health visit.
2) Name, age and average age of heifers calving since the last herd health visit.
3) Cow names and dates of heats expected before the next herd health visit.
4) Cows expected to calve before the next herd health visit.

The fourth area of information is entitled "Sequential Analysis" (see Figure 6), the intent of which is to indicate herd reproductive trends. The term sequential analysis was used for two reasons: 1) the last fifty cows found to be pregnant by physical examination are considered sequentially by the date of their confirming examination and 2) each column of dots represents the same cow in each of the four curves: days open (DO), services per conception (S/C), calving to first heat (C-H1) and heat to heat (H-H). The position of each dot is relative to that of the preceding dot. This is however, not sequential analysis in the statistical sense of the term.

Days open (DO) will be used as an example to explain the concept. The page may be viewed as a grid. An arbitrary value of 100 days open is selected and a reference point picked on the grid. The number of days open for the first cow (Figure 6) is calculated. When the figure for days open is less than the arbitrary values, the dot is placed one position above the reference point but if greater than or equal to it, the dot is placed below. This latter dot now becomes the reference point. The number of days open for the next cow is calculated and the dot placed horizontally one column further along on the imaginary grid and either above or below the reference point as described above. The process is continued until the last fifty cows diagnosed pregnant have been considered. This analysis provides, due to the small size of the herds in the Guelph, Ontario area, a running trend covering the 12 to 18 month period preceding the last date of the interval.

The same procedure is used to produce graphs for S/C, C-H1 and H-H. The arbitrary value for the proportion S/C is two (because the analysis is done on an individual cow basis, whole numbers must be used), for C-H1 60 days and H-H 18–24 days. If a cow is bred and conceives on her first recorded heat, she is arbitrarily assigned a value of 21.

The interpretation of the sequential analysis will be illustrated with reference to Figure 6.

UNIVERSITY OF GUELPH D.V.C. HERD HEALTH PLAN — PAGE: 1

INTERVAL REPORT — OWNER:

INTERVAL: 04/03/74 TO 05/13/74 — ADDRESS :

CATEGORY NAME	DATE LAST CALVING	DAYS OPEN TO DATE	HEATS	DATE OF ASSOCIATED BREEDINGS	COMMENT	EVENT	COMMENT--->	
PRESERVICE ANESTRUS								
COLLIE	09/30/73	225		10/29/73	VT	BUCKET SAMPLE CMT 0		
				<		>	<NO TREATMENT	>
				10/29/73	VT			
				<CYSTIC GRAFFIAN FOLLICLE		>	<FSH	>
				12/13/73	VT			
				<CYSTIC GRAFFIAN FOLLICLE		>	<DRAIN OVARIAN CYST	>
MARGE	10/06/73	150		10/06/73	CALVED	FEMALE		
				<		>	<NO TREATMENT	>
				10/07/73	FTMD	36 CC TEMP 105		
				<RETAINED PLACENTA		>	<PEN-STREP	>
				12/13/73	VT	BUCKET SAMPLE CMT 3		
				<		>	<NO TREATMENT	>
				12/13/73	VT			
				<PYOMETRA		>	<CHLOPSULFONE IU INFUSION	>
PREGNANCY CHECK								
JEAN	XXXXXXX	48	02/12/74	03/26/74				
REMAINING COWS OPEN < 100 DAYS								
AGNES	05/05/74	8		05/05/74	CALVED	FEMALE		
				<		>	<NO TREATMENT	>
AMY	03/10/74	64	03/29/74	05/02/74	03/10/74	CALVED	MALE	
			04/07/74		<	>	<NO TREATMENT	>
					03/10/74	VT		
					<HYPOCALCEMIA	>	<CALCIUM SUDEXTROSE	>
					04/09/74	VT	NORMAL CHLD CERVIX ENLARGED	
					<	>	<NO TREATMENT	>
ELEANOR	02/28/74	74	04/09/74		02/28/74	CALVED	MALE & FEMALE	
					<	>	<NO TREATMENT	>
					03/03/74	FT	CLEANED	
					<	>	<NO TREATMENT	>
					04/09/74	VT	NORMAL FRO RUPTURED ON PALPATION	
					<	>	<NO TREATMENT	>
ISABEL	02/18/74	84	03/31/74	04/18/74	02/18/74	CALVED	FEMALE	
				05/08/74	<	>	<NO TREATMENT	>
					02/18/74	VT		
					<HYPOCALCEMIA	>	<CALCIUM SOLUTION	>
					04/09/74	VT	NORMAL CLERD	

FIGURE 4. An example computer printout of the cow check list.

UNIVERSITY OF GUELPH O.M.C. HERD HEALTH PLAN

REPRODUCTIVE SUMMARY

INTERVAL REPORT

INTERVAL: 04/09/74 TO 05/13/74

PARAMETER	NUMBER OF ANIMALS	AVERAGE	STANDARD DEVIATION
DAYS OPEN FOR COWS PREGNANCY DIAGNOSED THIS INTERVAL	10	128.70	79.850
SERVICES/CONCEPTION FOR COWS PREGNANCY DIAGNOSED THIS INTERVAL	10	2.40	1.744
CALVING TO FIRST HEAT FOR COWS IN FIRST HEAT THIS INTERVAL	4	82.25	36.383
CALVING TO FIRST SERVICE FOR COWS SERVICED FIRST TIME THIS INTERVAL	7	90.57	36.823

HERD REPRODUCTIVE STATUS

TOTAL NUMBER OF PROBLEM COWS:	14
TOTAL DAYS OPEN FOR PROBLEM COWS:	2446
TOTAL NUMBER OF ADULT COWS IN HERD:	53
HERD REPRODUCTIVE STATUS:	19.24

PROBLEM BREEDERS

TOTAL DAYS LOST TO PROBLEM BREEDERS THAT CONCEIVED LAST INTERVAL: 423

DAYS LOST EXPRESSED AS AVERAGE PER ADULT COW: 7.981

NUMBER AND PERCENTAGE OF COWS IN EACH REPRODUCTIVE GROUP

GROUP	NUMBER	PERCENTAGE
OPEN	23	43.396
PREGNANT	30	56.604

NUMBER AND % OF ADULT HERD CURRENTLY DRY	14	26.415

FIGURE 5. An example computer printout of the reproductive summary.

The first line (that of DO) has a slight upward tendency but is much reduced from the maximum of 45 degrees indicating that the herd had a high proportion of problem cows.

The second line (S/C) has an overall upward tendency. The first half of the line has a slope of 45 degrees (the maximum possible); however, these dots represent cows that were pregnant at the time of inventory and therefore only one breeding (the one resulting in pregnancy) was recorded. For this reason the first part of the last three lines is meaningless. The last part of the second line (S/C) is slightly inclined, indicating that on the average less than two breedings were necessary to achieve pregnancy.

The last half of the third line (C-H1) has a slight upward tendency indicating that the greater proportion of the cows considered had their first observed heat prior to the sixtieth postpartum day.

The last half of the fourth line (H-H) has an overall downward tendency indicating that the cows considered had very irregular heat periods.

This example suggests a herd problem of either irregular reproductive cycling of cows or poor heat detection by the farmer.

FIELD APPLICATION

The system was designed to concentrate on the information necessary to monitor reproductive efficiency in dairy herds. The following system generated parameters were selected to illustrate the capability of the system: 1) days open (DO), 2) calving to first recorded heat interval (C-H1), 3) calving to first ser-

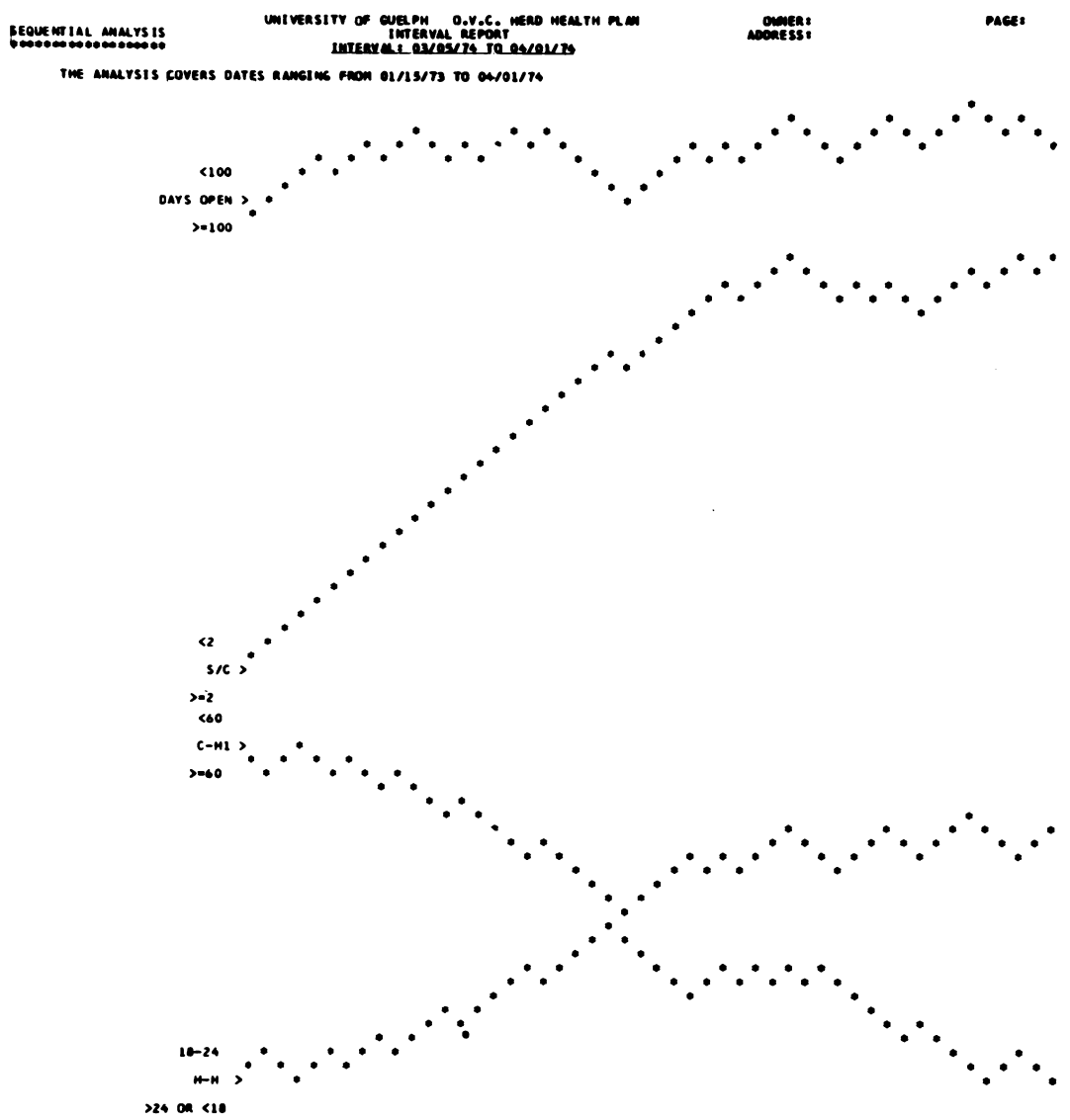

FIGURE 6. An example computer printout of "sequential analysis".

vice interval (C-S1), 4) number of services per conception (S/C), 5) Herd Reproductive Carolina's Evaluation System for Herd Repro- Status (HRS) (Instructional Manual, North Carolina's Evaluation System for Herd Reproductive Status (5), 6) average number of problem breeders per interval (also expressed as a percentage of the adult cow population) and 7) average days open for problem breeders. Values for each parameter, calculated as averages over seven intervals (approximately eight months) are presented in Table I. Due to the limited amount of data, the results must be interpreted with a degree of caution. However, a suggested interpretation of the results in each herd is presented.

Herd 1

The adult herd was composed of approximately 48 animals. Cows were tied, milked and fed in stanchions. The herd had the highest average days open interval (138.08 days) of the six herds considered in this project. This may be partly explained by the following points: 1) cows were not manifesting heat until 89.81 days postpartum and 2) the farmer was not breeding cows until the subsequent heat period. This resulted in eleven cows, at any point in time, open greater than 100 days (average of 246.56 days) and an HRS index of −2.12. These results suggested a problem of either preservice anestrus or poor heat detection by the farmer.

TABLE I

SUMMARY OF THE REPRODUCTIVE DATA OCTOBER 1, 1973 TO JUNE 15, 1974

Farm	1	2	3	4	5	6
Days Open[a]	138.08(33.05)	128.79(30.27)	134.87(20.14)	95.91(18.23)	97.20(25.45)	127.13(11.82)
Calving to first heat interval[b]	89.81(13.65)	80.33(8.39)	83.00(0.55)	59.37(19.36)	68.91(6.34)	56.84(10.9)
Calving to first service interval[c]	108.46(4.82)	94.66(13.27)	109.25(24.52)	80.18(10.19)	68.91(6.34)	94.36(6.39)
Services per conception ratio[a]	1.43(0.18)	1.39(0.18)	2.03(0.27)	1.59(0.14)	1.73(0.13)	2.1(0.07)
Herd Reproductive Status Index	−2.12	−10.02	13.53	10.71	27.14	6.98
Average number of problem cows (percent of open cows in brackets) per interval	11(50%)	12(60%)	14(63%)	13(59%)	12(40%)	26(50%)
Average days open for problem cows per interval	246.56	200.77	176.20	191.94	175.41	173.92
Main Herd Problem	Preservice Anestrus	Preservice Anestrus	Preservice Anestrus	Residual of cows with poor reproductive performance		Delayed Breeding

[a]Calculated for cows that were diagnosed pregnant.
[b]Calculated for cows that manifest a heat for the first time since calving.
[c]Calculated for cows that were bred for the first time since calving.
Standard deviations in brackets.

Herd 2

This herd, the smallest of the six, was composed of 42 adult cows. Management practices were similar to those of Herd 1 with the exception of bunk feed corn silage.

The problem on this farm appeared similar to that of Herd 1. Cows on the average manifest their first postpartum heat at 80.33 days (nine days earlier than Herd 1) and conceived earlier, as compared to Herd 1, by a similar length of time. There were, on the average, 12 cows with an average days open period of 200.77 days in the herd, which represented 60% of the open cow population. This fact was reflected by an HRS index of −10.02.

Herd 3

This herd was composed of 40 milk cows, and was comparable to Herd 1 with regard to management and feeding practices.

A problem of either preservice anestrus or poor heat detection or both was revealed by a calving to first heat interval of 83.00 days. These problems were augmented by a services per conception ratio of 2.03 and resulted in a days open interval for those cows that conceived of 134.87 days. Fourteen problem cows, representing 63% of the open cow population, had an average days open interval of 176.20 days. This, however, was much lower than Herds 1 and 2 and hence the HRS index (13.53) was higher than either of these herds.

Herd 4

The adult cow population of 50 milk cows was managed in much the same manner as Herd 2. Cows manifest a postpartum heat by 60 days and were bred the following heat. This resulted, when combined with a S/C ratio of 1.59, in a days open interval of 95.91 days. During the period of the study, there were 13 problem cows in the herd. The herd therefore appeared to be divided into two groups: 1) cows that were reproducing relatively efficiently and 2) cows with very poor reproductive performance. A more stringent culling program on the second group could increase the overall reproductive performance of this herd and improve the HRS of 10.71.

Herd 5

This herd was composed of 53 adult animals. Husbandry-management practices were conventional with few of the newer practices incorporated into the operation. Cows were bred on their first postpartum heat, which occurred at approximately 70 days. There were 12 problem cows in the herd, but because of the herd's size this represented only 40% of the open cow population. As a result this herd had the highest HRS (27.14) of the six herds. The problem identified in this herd appears to be similar to that in Herd 4. Culling of those cows with poor reproductive performance would improve the efficiency of the herd.

Herd 6

This was the largest of the six herds consisting of 88 adult animals. Cows manifest their first postpartum heat by 60 days but were not bred until their third heat period. This coupled with a S/C ratio of 2.1 resulted in an average days open interval of 127.13 days. Problem cows were open an average of 173.92 days. A management decision on this herd was to delay breeding until at least 90 days postpartum. However, with a S/C ratio of 2.1 (the highest of these six herds) and a relatively low HRS of 6.98, the farmer should reassess this management practice.

General Discussion

The computer system described provides the dairyman with information that 1) has not been so readily available in the past and 2) will monitor health in dairy herds and 3) will identify problem areas. The necessary input to the system by the farmer is minimal and does in fact require no more effort than was used in the past to keep individual cow records.

The system limitations can be divided into three distinct areas: 1) the recording of data, 2) the processing of data and 3) animal identification.

Recording of Data

The system is dependent on the diligence with which farmers and veterinarians record information. If data is not recorded faithfully and accurately, or if important events such as calving dates or pregnancy diagnoses are not noted, the value of the system is lost.

To make more extensive use of the system, an education program directed towards farmers and veterinarians must be initiated. As well, practitioners must be trained to interpret the data generated by the system if they, in turn, are to relate this information to the producer.

Processing of Data

Preparing information for keypunching necessitates two steps. First the data is recorded in the diary and secondly the data is coded. The more steps involved in the processing of information the greater are the chances

of error. A dual purpose recording and coding form would minimize these clerical errors.

Animal Identification

Identifying animals accurately is an essention, but not easily achieved requirement of the system. Animals recorded on the system at birth are often identified, until registration, by a temporary number or name. This necessitates assigning a new identification to these animals by use of the rename event. On the master file, however, these animals are always known by the name assigned at birth, although one can update information using either name. In addition, many farmers wanted to reassign names of cows which were removed from the herd. For this reason a cow's registered name and/or number is recorded on the system. When a cow is removed from the herd, data concerning her is removed (at the end of the year) from the master file and stored on another file under her unique registered name.

To avoid the problems of naming and identifying individual animals, several suggestions are proposed:

a) All animals could be assigned nonrepeatable numbers at birth and all transactions concerning the animal recorded by use of this number. To do this, however, requires that each farmer reidentify all his animals.

b) Each animal could have only one unique name at any point in time. This name could be changed as often as desired by the farmer, but only the latest name stored by the system. Internal to the system and unknown to the farmer, a series of consecutive numbers would be assigned to each animal in the herd and would be used to record information on the master file concerning that animal. All reports would, however, have the numbers translated in terms of the animal's current unique name.

A system to monitor health must be dynamic and hence is never completed. As this particular system evolved, problems such as the ones discussed above arose. These problems can and will be overcome, but for the purposes of this paper the system was documented as it had developed to May 1, 1974 (10).

The future of such a monitoring system is limited only by the ability and imagination of those persons concerned with its development. One must, however, clearly establish the objectives of such a system and review both these objectives and the ability of the system to meet them at regular intervals. The reasons for this are to avoid 1) the generation of reports that do not meet the needs of users and 2) the perpetuation of an outmoded system.

Summary

The system described in this paper, was designed to gather, record, analyze and report data relating to the health of dairy herds. In order to illustrate the application of the system, emphasis was placed on monitoring reproductive efficiency.

Six dairymen in the Guelph, Ontario area agreed to cooperate in this study. Data was recorded in a diary by both the farmer and the veterinarian. This information was then coded, keypunched onto computer cards and stored on magnetic tapes. A computer program designed to print an interval report (every four to six weeks) was written. This report was then interpreted by the veterinarian and discussed with the farmer.

By means of the system, the reproductive problems in each of the six herds were identified and described.

Résumé

Les auteurs ont conçu le système qu'ils décrivent dans cet article, afin de recueillir, enregistrer, analyser et rapporter les données relatives à l'état de santé de troupeaux laitiers. Pour illustrer l'application de leur système, ils placèrent l'emphase sur la surveillance de l'efficacité de la reproduction.

Six fermiers de Guelph, Ontario, acceptèrent de coopérer à cette étude. L'enregistrement des données se fit dans un agenda, tant par le fermier que par le vétérinaire. On coda ensuite ces données, on les poinçonna sur des cartes d'ordinateur et on les emmagasina sur des bandes magnétiques. On rédigea un programme d'ordinateur destiné à imprimer un rapport intérimaire, à intervalles de quatre à six semaines. Le vétérinaire interpréta ensuite ce rapport et en discuta avec le fermier.

Ce système permit d'identifier et de décrire les troubles de reproduction qui affectaient chacun des six troupeaux.

Acknowledgments

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REFERENCES

1. BARFOOT, L. E. An economic appraisal of the Preventative Medicine Program for dairy herd health management. M.Sc. Thesis, University of Guelph. 1969.
2. DANIEL, R. C. W., D. A. BIGGS and D. A. BARNUM. The relationship between California mastitis test scores and monthly milk production and composition. Can. vet. J. 7: 99–105. 1966.
3. DESDAERS, N. The electronic computer can help the adviser. Food and Agricultural Technical Information Services (Organization for Economic Cooperation and Development) First Quarter. 1966.
4. FISHER, G. F. Observations on mastitis problems in eastern Ontario. Proceedings of 26th Annual Meeting of the North Eastern Mastitis Conference, Fredericton, New Brunswick. 1973.
5. INSTRUCTIONAL MANUAL, NORTH CAROLINA'S EVALUATION SYSTEM FOR HERD REPRODUCTIVE STATUS. Misc. Extension publ. 43. North Carolina State University, Raleigh. Sept. 1968.
6. JANZEN, J. J. Economic losses resulting from mastitis: A review. J. Dairy Sci. 53: 1151. 1970.
7. KINGWILL, R. G., F. K. NEAVE, F. H. DODD, T. K. GRIFFIN and D. R. WESTGARTH. The effect of a mastitis control system on levels of subclinical and clinical mastitis in two years. Vet. Rec. 87: 94. 1970.
8. LOUCA, A. and J. E. LEGATES. Production losses in dairy cattle due to days open. J. Dairy Sci. 51: 573. 1968.
9. MCCLURE, T. J. and A. E. DOWELL. Survey of dairy herds in the Moss Vale District of New South Wales. Aust. vet. J. 442: 536. 1968.
10. MEEK, A. H. A proposed information management and disease monitoring system for dairy herds. M.Sc. Thesis, University of Guelph. 1974.
11. MORRIS, R. S. Assessing the economic value of veterinary services to primary industries. Aust. vet. J. 45: 295. 1969.
12. MORRIS, R. S. Economic aspects of disease control programmes for dairy cattle. Aust. vet. J. 47: 358. 1971.
13. MORRIS, R. S. Evaluating the economic benefits of specific procedures for control of disease and improvement of productivity on an individual farm. Proceedings of British Veterinary Association Course on Farm Economics and Management for Veterinarians, Reading, July 1972.
14. PRIESTER, W. A. A summary of diagnoses in the ox, horse, dog and cat from 12 veterinary school clinics in the U.S. and Canada. Vet. Rec. 86: 654. 1970.
15. SMAILE, R. A. Developments in the dairy industry in England and Wales with particular reference to the introduction of computerized management aids. B.Sc. Dissertation, University of Reading. 1973.

BOOK REVIEW

Textbook of Meat Hygiene – Sixth Edition. H. Thornton and J. F. Gracey. Published by Baillière Tindall, London. 1974. 599 pages. Price $20.00 approx.

The 6th edition of Thornton's and Gracey's "Textbook of Meat Hygiene" is a result of the expansion of Thornton's 5th edition of Thornton's "Textbook of Meat Inspection".

For the veterinarian totally involved in meat hygiene, or for the interested practitioner the above text will be an excellent reference.

Although distinctly "British" in some terminology, and to a great extent in meat industry practices, the authors have attempted to set forth practices and routines in other parts of the world.

The text is well presented although a change in sequence of content might be helpful. Chapter I deals with Food Animals, chapter II with Abattoirs and chapter III with Post-mortem Inspection. Chapter XI – Meat Hygiene Practice – deals with transportation, resting and ante-mortem inspection. Possibly transportation and resting etc., should be immediately after "Food Animals" and ante-mortem inspection, immediately preceding post-mortem inspection.

The comparative anatomy of tissues and organs is informative and prepares the way for the detailed pathology, diseases and conditions that may be found in meat inspection. The sections on pathology, affections of specific parts, and bacterial and viral diseases, discuss and give judgments on conditions found in the abattoir.

After dealing with rabbit and poultry inspection, the remainder of the book deals with meat hygiene practices, preservation of meat and disposal of by-products and fats. These sections are well presented. The meat hygiene chapter deals with the modern concept of preventive hygiene through to residues in meat. Numerous plates and figures are used to good advantage throughout the text.

This reviewer would recommend the text as a reference for meat inspection and meat hygiene. *G. C. Fleming.*