POTENTIAL SOURCES OF BIASES IN A POPULATION-BASED SURVEY OF DAIRY REPRODUCTIVE MANAGEMENT PRACTICES

By

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Abstract

In a questionnaire survey of dairy reproductive management practices among 234 dairy farmers of Tulare County, California, a response rate of 93.16% was achieved. Based on the forms of contact with the farmers, three groups of respondents, early, middle and late, were identified. Comparisons among the groups indicated the three were different on several management variables. These differences are potential sources of biased variable estimates for the Tulare general population of 234 dairy farms if the results from only a subset of respondents were utilized.

DEDICATION

With love and admiration, I dedicate this work to PAUL K. KYULE
for keeping my presence at home alive among my relatives and friends.

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INTRODUCTION

In response to evolving requirements for improving livestock industries, baseline data on health parameters and management practices are needed for planning and evaluating herd health programs. Due to this prime need, veterinary researchers and practitioners are tending more and more to complement results of laboratory-based research by scientifically-pursued field studies (Schwabe, 1984). As part of this change, investigators are resorting to greater use of survey methods. These methods possess well-documented advantages over most other research methods for gathering data on multiple variables as these variables may affect health, reproduction or production outcomes in populations of animals (Ruppaner, 1972; Sollod and Knight, 1983).

Many surveys are conducted either by interview (face to face and telephone) or by self-administered questionnaires (mail surveys) alone or in conjunction with administration of various tests or measurements (Babbie, 1973). Even though interviews or questionnaires are cost-effective and can be carried out in a relatively short time period, it has been difficult to achieve 100% cooperation from the members of the targeted sample (or total population) (Criqui et al., 1978; Cox and Cohen, 1985).

Non-cooperation results in estimates of unknown reliability and may lead to possible biased inferences. The most common potential biases encountered in survey results are response and non-response biases, although other sources of biases related to survey questionnaires and the interview process have been identified (Murphy, 1976; Vernon et al., 1982; Siemiatycki et al., 1984).

Non-response bias occurs because of possible differences between respondents and non-respondents and it is not limited to surveys only. It is a potential problem also through cases lost to follow-up in longitudinal studies and refusals to participate in cross-sectional studies or in experimental research (Khan, 1983). This bias is a major concern because of unknown differences between respondents and non-respondents.

Response bias occurs because of possible misrepresentation of the target population by the respondents. The situations where this bias is of concern are similar to those of non-response bias (Criqui, 1985).

Non-response and response biases have been explored in data from a few human health surveys with attempts made to determine their effects upon survey results (Criqui et al., 1978; Austin et al., 1981; Forthofer, 1983; Siemiatycki

and Campbell, 1984; Cox and Cohen, 1985).

In this study, the results from a survey of dairy reproductive management practices were examined to elucidate the possible biases due to sequential responses from dairy farmers of Tulare County, California. Such information has generally been lacking for data obtained from animal-based health surveys.

MATERIALS AND METHODS

Data:

The data utilized in this study were derived from dairy farmers in Tulare County, California in a questionnaire survey in 1983 of reproductive dairy management practices (Cowen, 1986). In brief, a questionnaire was mailed in early September to all dairy farmers. This mailing was followed after 39 days by a second mailing plus a telephone reminder to all non-respondents, since by that time, response to the initial mailing had virtually ceased. Dairy farmers who had not responded to this second mail-telephone request within a further period of 40 days were visited at the farm site and requested to fill out the questionnaire. Based on this sequential survey procedure, three groups of respondents were identified.

Group 1 : Dairy farmers who responded to the first mailing (Early respondents)

Group 2 : Additional dairy farmers who responded to the second mail-telephone request (Middle respondents)

Group 3 : Dairy farmers who responded only to farm visits (Late respondents)

The data collected were coded and entered into a computer file. Full description of the mail questionnaire is available in Cowen (1985). Briefly, the dairy farmers were requested to record information on animal numbers, major reproductive problems, estrus detection and breeding practices, record-keeping systems, and physical facilities. The responses were categorized into 93 variables which covered the topics queried.

PROCEDURE OF DATA ANALYSIS

Calculation of the response rate.

The response rate (RR) was calculated as :

$$RR\ (\%) = \frac{\text{Respondents}}{\text{Respondents + Non-respondents}} \times 100$$

Statistical Analysis

Statistical analyses of the 93 variables were performed using the computer programs of the BMDP (Biomedical Programs) packages (BMDP, 1983). Initial data screening using P1D (Simple data description and data management) was carried out and showed that out of the 93 variables, only 81 were well-distributed among the cases (dairy farms). These 81 variables (Table 1a-h) are the subject of the analyses in this report.

Preliminary chi-square tests on the discrete variables and analysis of variance (ANOVA) of the continuous variables were done using the three groups of respondents.

A stepwise discriminant analysis was performed on all the variables which gave significant results fom these initial analyses. This Multivariate technique was applied to determine which variables significantly discriminated among the three respondent groups.

RESULTS

Among 234 dairy farmers available for study, 218 (93.16%) responded at some time during the study period. These included 103 early, 52 middle and 63 late respondents. A distribution of the respondents based on the forms of contanct and dates of survey returns is shown in Table 2. The sequential response rates indicated in the table show a high response rate (79.75%) which was obtained from the late respondents who filled out the questionnaire when approached face to face at the dairy sites. The response rates netted by the first mailing (44.02%) and the second mailing with telephone reminder (39.7%) were each lower compared to that of late respondents.

Statistical Analyses:

Chi-square Analysis and Analysis of Variance

The results of these analyses are shown in Tables 3a-h and 4. Various management variables differed significantly among the three response groups.

Especially, noteworthy are those variables which showed strongly

significant statistical values at $p < 0.005$. Among these particular variables, "dairy farmers don't use artificial insemination (AI)", "dairy farmers using AI variably", "owner/manager does the breeding", "others (e.g. bulls) do the breeding" showed the greatest differences in breeding practices among the three groups. The dairy men who responded to the early requests were more likely (84%) to use AI for cattle breeding than were middle (61%) and late (42%) respondents. "Dairy farmers using AI variably" followed the same order with the highest proportion in early (39%), middle (17%) and late (2%). The owner/manager was responsible for breeding the cows more often among early (25%) and middle (27%) than among late (2%) respondents. However, the reverse occurred for the use of "others (e.g. natural breeding by bulls) do the breeding". There were 57% of late respondents who used bulls for breeding, as compared to 35% of middle respondents and 18% of early respondents.

In estrus detection, the owner/manager performed this duty more in early (45%) and middle (46%) respondents than in late (18%) respondents. The early respondents relied more on "various signs" as indicators of estrus cows than the middle and late respondents (e.g. "standing to be mounted" was used for estrus detection by 51% of early, 17% of middle and 22% of late respondents; "changes in vulva" by 38% of early, 19% of middle and 13% of late respondents; "tail chalk rubbed off or Kamar patch broken" by 37% of early, 13% of middle and 8% of late respondents and "combination of heat signs" was used by 67% of early, 58% of middle and 35% of late respondents). Heat detection was more likely to be carried out "everywhere" in early respondents (57%) than in middle (40%) and late (20%) respondents. The use of prostaglandins as an aid in estrus detection was most prevalent among early respondents (33%) followed by those in middle (15%) and late (13%) groups.

Seventy one per cent of early respondents were members of the Dairy Herd Improvement Association (DHIA) compared to 33% of middle and 37% of late respondents. Replacement of ear tags once a month was common among respondents in middle (31%) and early (28%) groups and low in the late group (8%).

The results also showed that the groups differed in how they obtained replacement cattle e.g. respondents in the late group were more likely to purchase Springers (45%) than were those in the middle (31%) and early (20%) groups.

"Veterinarian performs fresh checks" was a practice more often followed among the respondents of the early group (59%) than those in the middle (46%) and late (38%) groups. This use of veterinary service paralleled reported

problems with cystic ovaries which showed high occurrence in cows of the early respondents (28%) compared to 19% of the middle respondents and only 7% of the late respondents.

These variables showing strongly significant statistical differences ($p<0.005$) among the three groups, plus all other variables whose differences were statistically significant at $p<0.05$, are summarized in Table 5. These variables were subsequently employed in the discriminant analysis.

Discriminant Analysis (DA)

Prior to performing discrimant analysis using these independent variables (Table 5) and the three response groups, a correlation analysis was carried out. Correlation coefficients equal or greater than 0.500 and those equal or less than -0.500 were regarded as indicative of high co-relation between two variables. Statistical significance of the correlation coefficients values was not determined because: (1) violations of the normality assumption for the use of linear discriminant analyis and (2) many varaibles were dichotomous. Examination of correlation matrix showed that:

(a) "Tail-chalking (crayon) was highly related with tail chalk rubbed off or Kamar patch broken" ($r = 0.6652$)

(b) "Dairy farmers don't use AI" was highly associated with:

(i) "Combination of heat signs" ($r = 0.5087$)

(ii) "Others (e.g. bulls) do the breeding" ($r = 0.7932$)

(c) Correlation coefficients of the dependent variables (i.e. membership in the three respondent groups) with the independent variables were not high ($-0.3832 < r < 0.3802$).

The results of the discriminant analysis are summarized in Table 6. When all the variables in Table 5 were subjected to DA eight variables entered into discriminant function which correctly classified 84.8% of the early group, 15.4% of the middle group and 56.7% of the late group. The overall percentage of the correct classification was 59.7% which exceeded the 33.3% one would expect by chance.

The F matrix part of the table gives F statistics for testing the equality of the means for each pair of groups. The F value (1.80) for the early group and the middle group is not significant ($p>0.05$). The other F values indicate significant differences between the late group and early group ($F=14.06$, $p<0.05$) as well as between the late group and the middle group ($F=12.01$, $p<0.05$).

Overlaps among these three groups are shown by the scatter plot in Figure

1. whose axes are formed by canonical variables 1 and 2. These canonical variables are linear combinations of the eight variables entered that best discriminated among the three groups. The positions of the mean values (labelled 1, 2 and 3) of the canonical variables for each of the three groups are indicated. These means show that the main variation is exhibited in canonical variable 1 between late group (3) and the other two groups (1 and 2). As for groups 1 (early) and 2 (middle), canonical variable 1 shows insignificant variation between the two groups. The plot further shows major overlap between the respondents in early and middle groups while less overlap is evident with late group points.

When the clearly co-related variables were succesively removed from the analysis, the results (proportions correctly classified) remained the same. However, removal of the variable "number of days set for pregnancy checks" (had high F to enter=24.21) from the discriminant function caused some changes (Table 7). The variable "others (e.g. bulls) do the breeding" was replaced by "observe estrus cows in other places". With seven variables in the discriminant function 55.6% of early group, 15.4% of middle group and 83.3% of late group were correctly classified. The overall percentage of correct classification was lowered to 53.6%. The F values of the F matrix still remained significant although the values were reduced. The scatter plot remained unchanged.

When the two variables with largest F values (i.e. "number of days set for pregnancy checks variable" (F=24.21) and "owner/manager does the breeding" (F=12.36) were removed, the latter variable was replaced in the function by the variable "owner/manager detects the estrus cows". The results of these analyses are shown in Tables 7 and 8 which show overall percentage of correct classification was 53.6% and 55.5% respectively.

These additional discriminant analyses indicate that several variables may have been measuring the same thing: e.g. "owner/manager does the breeding" and "owner/manager detects the estrus cows".

DISCUSSION

In response to evolving needs for improving livestock production, both in developed and developing countries, survey data are increasingly being utilized for planning and evaluating herd health services (Perry and McCauley, 1984). In order for these health programs to be successful, baseline survey data must

reflect true features of the livestock industries involved. Thus the data have to be gathered from the whole population or from a representative random sample of the population. Since most survey data in the past have been obtained from livestock owners willing (volunteering) to participate in a particular study, the problem of biased survey results is of considerable concern (Cox and Cohen, 1985).

Studies using data from several human health surveys have shown that differences may exist between respondents and non-respondents which cause biased estimates of variables to be inferred to the general population. Such biased estimates have been consistently demonstrated in surveys studied which recorded response rates of less than 80% (Criqui et al., 1978; Criqui, 1985). These developments are encouraging efforts in more and more human health surveys to actively pursue non-respondents.

Overall, a high (93.16%) response rate was achieved in the parent survey (Cowen, 1986) to this study. This response rate was attained because of active pursuit of non-respondents by both mail and telephone, as well as visiting the dairy farms to request that farmers fill out the questionnaire. The high response rate justified the generalization of the several outcomes of the parent study (Cowen, 1986) to the dairy farmers of Tulare County.

In the present investigation, the major objective was to see if possible biases may occur in such studies based upon animal surveys, if non-respondents to initial questionnaire (and a single follow-up) are not actively pursued.

The three groups studied here portrayed a picture of continuous follow-up trend in survey data collection. The patterns of some management variables exhibiting differences among these three response groups, early, middle and late (e.g. "dairy farmers don't use AI", "dairy farmers use AI variably", "DHIA", "number of days set for pregnancy checks variable") show that, if the data collection survey had been stopped in its early stages, the results inferred to the whole population of Tulare dairy farmers may have displayed response biases. This indicates that the non-respondents (late group especially) were a different group of dairymen in management regards also from those who more readily responded. Thus the systematic differences observed among the three groups in a number of management variables (e.g. in breeding practices, estrus detection signs, record-keeping systems, major reproductive problems) indicate probable non-response biases related to differences in overall managemental "philosophy" or practice of subsets of the dairymen population.

However, the extent to which these observed differences can be attributed solely to such real differences between respondents and non-respondents is obscured slightly by another possible source of bias introduced in this survey follow-up itself. That is, the same form of contact between the dairy farmers and the interviewer was not applied throughout in administering the questionnaire. This resulted in respondents dividing themselves into three groups on the basis of the forms of contact with the interviewer during the process of interview. Thus administration of the questionnaire in this study might have contributed to these observed differences. While this cannot be verified, the discriminant analysis results provided some possible insights. The DA results showed it was more difficult to separate early and middle groups than late group from these other two. It need be noted that the early and middle respondents self-administered the questionnaire while late respondents filled out the questionnaire in the presence of the interviewer, signaling a possible interviewer impact. In addition, the farmers who responded late might have had opportunity to have any ambiguous questions clarified, hence causing more possible differences between the late group and the other two groups.

Further, the differences among the three groups might have been caused by the type of information queried as well as the questionnaire's length. Information regarding, for example, percent purebred cows, major reproductive problems, number of corrals, source of replacements, frequency of replacement of eartags, cattle numbers, required record keeping for accurate or reasonable answers. Thus, only dairy farmers with detailed records could easily fill out their questionnaire and respond promptly. This was possibly the case because 71% of the early respondents were DHIA members who necessarily keep detailed records of certain management practices. This case of response advantage would be unavailable to many non-DHIA members who did not keep such detailed records. Again, however, this in itself also suggests an actual difference on overall management "philosophy" and practice between late respondents and the others. The majority of non-DHIA members occurred in the middle group (67%) and the late group (60%).

Although the DHIA variable showed significant X^2 value ($p<0.001$), it never entered into the discriminant function probably because of other possible proxy variables (e.g. replacement of eartags once a month).

The discriminant analysis scatter plot indicated that early and middle respondents generally resembled each other in spite of differences reported in a preliminary study of non-response bias using the same data (Cowen et al.,

1985). However, this plot showed that the late group was to a greater extent different from these other groups. Although the use of this scatter plot technique assumes a multivariate normal distribution of variables, its use in this analysis was considered justified in view of the study objective, and since the discriminant analysis is statistically robust and can withstand extensive use of dichotomous data (Vandegraaff, 1980). The difference between the mean value 3 and the mean values 1 and 2 (Figure 1) highlights the different information on various management practices contained in the late group.

Thus, inferences about the general population using information from the early and middle groups only would have biased the overall study results. Therefore, a survey designed to obtain population information should incorporate a plan of pursuing non-respondents as thoroughly as possible. In addition, the same procedure of questionnaire administration to all interviewers should be followed so as to clearly define and determine the extent of any biases in total survey results.

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TABLE 1a

Description of general independent variables used in the statistical analysis for the survey data from dairy farmers in Tulare County, California, 1983

Variable	Mean (SD)[a]	Median	Range	No. of dairies
Days set for pregnancy check variable[D]	0.34 (0.48)	0.00	0.0 - 1.0	218
Veterinarian performs postpartum checks[D]	0.66 (0.48)	1.00	0.0 - 1.0	217
Veterinarian performs pregnancy diagnosis[D]	0.49 (0.50)	0.29	0.0 - 1.0	217
Average days dry[C]	62.70 (10.14)	60.00	0.0 - 150.0	213
Number of milking cows[C]	461.50 (303.92)	400.00	35.0 -1900.0	217
Number of dry cows[C]	101.00 (90.76)	80.00	5.0 - 650.0	215
Number of breeding bulls[C]	8.49 (8.40)	6.00	0.0 - 60.0	217
Percent of pure-bred cows[C]	5.93 (19.56)	0.00	0.0 - 100.0	214
Dairy farmers using artificial insemination variably (AI)[D]	0.23 (0.42)	0.00	0.0 - 1.0	218
Dairy farmers don't use AI[D]	0.34 (0.48)	0.00	0.0 - 1.0	218

[a] Standard deviation

[D] Dichotomous variable; [C] Continous variable

TABLE 1b

Description of independent variables used in the statistical analysis for reproductive problems in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairies
Long calving intervals	0.20	(0.40)	0.00	0.0 - 1.0	218
High number of services per conception	0.11	(0.31)	0.00	0.0 - 1.0	218
Repeat breeders	0.50	(0.50)	0.00	0.0 - 1.0	218
Cows don't shows heat	0.20	(0.40)	0.00	0.0 - 1.0	218
Low heat detection	0.09	(0.28)	0.00	0.0 - 1.0	218
Abortions	0.22	(0.41)	0.00	0.0 - 1.0	218
Dirty cows (metritis)	0.20	(0.40)	0.00	0.0 - 1.0	218
Retained placentas	0.17	(0.38)	0.00	0.0 - 1.0	218
Cystic ovaries	0.19	(0.40)	0.00	0.0 - 1.0	218
Calving problems	0.05	(0.22)	0.00	0.0 - 1.0	218
No major problems	0.37	(0.48)	0.00	0.0 - 1.0	218
Other problems	0.03	(0.16)	0.00	0.0 - 1.0	218

[a] Standard deviation

[D] Dichotomous variable

TABLE 1c

Description of independent variables used in the statistical analysis for estrus detection in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairies
Estrus detection personnel					
Owner/manager	0.38	(0.49)	0.00	0.0 - 1.0	218
Herdsmen	0.27	(0.45)	0.00	0.0 - 1.0	218
Assistant herdsmen	0.08	(0.27)	0.00	0.0 - 1.0	218
Milkers	0.25	(0.43)	0.00	0.0 - 1.0	218
Hot cow man	0.02	(0.15)	0.00	0.0 - 1.0	218
Other employees	0.07	(0.26)	0.00	0.0 - 1.0	218
Everyone looks for heat	0.28	(0.50)	0.00	0.0 - 1.0	218
Estrus detection aids					
Visual only	0.41	(0.50)	0.00	0.0 - 1.0	218
Tail chalking (crayon)	0.37	(0.48)	0.00	0.0 - 1.0	218
Kamar patches	0.07	(0.25)	0.00	0.0 - 1.0	218
Prostaglandins	0.23	(0.42)	0.00	0.0 - 1.0	218
Synchromate B	0.01	(0.10)	0.00	0.0 - 1.0	218
Teaser animals	0.04	(0.20)	0.00	0.0 - 1.0	218
Other aids	0.05	(0.22)	0.00	0.0 - 1.0	218
Signs used for estrus determination:					
Changes in vulva	0.26	(0.44)	0.00	0.0 - 1.0	218
Standing to be mounted	0.34	(0.47)	0.00	0.0 - 1.0	218
Chalk worn off or kamar patch broken	0.23	(0.42)	0.00	0.0 - 1.0	218

TABLE 1c (continue)

Variable [D]	Mean	(SD) [a]	Median	Range	No. of dairies
Tail head rough and messed up	0.20	(0.40)	0.00	0.0 - 1.0	218
Mounting other cows	0.13	(0.34)	0.00	0.0 - 1.0	218
Expected heat dates	0.09	(0.29)	0.00	0.0 - 1.0	218
Combination of heat signs	0.55	(0.50)	1.00	0.0 - 1.0	218
Place of estrus detection:					
Milking parlor	0.13	(0.34)	0.00	0.0 - 1.0	217
Wash pens	0.11	(0.31)	0.00	0.0 - 1.0	217
Corrals	0.56	(0.50)	1.00	0.0 - 1.0	217
Lanes	0.12	(0.32)	0.00	0.0 - 1.0	217
Lock ups	0.16	(0.36)	0.00	0.0 - 1.0	217
Everywhere	0.42	(0.49)	0.00	0.0 - 1.0	217
Other places	0.03	(0.18)	0.00	0.0 - 1.0	217

[a] Standard deviation

[D] Dichotomous variable

TABLE 1d

Description of independent variables used in the statistical analysis for breeding personnel reported in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairies
Inseminator	0.32	(0.47)	0.00	0.0 - 1.0	218
Owner/manager	0.19	(0.39)	0.00	0.0 - 1.0	218
Herdsmen	0.21	(0.41)	0.00	0.0 - 1.0	218
Assistant herdsmen	0.06	(0.24)	0.00	0.0 - 1.0	218
More than two people	0.03	(0.16)	0.00	0.0 - 1.0	218
Other(e.g bulls)	0.34	(0.47)	0.00	0.0 - 1.0	218

[a] Standard deviation

[D] Dichotomous variable

TABLE 1e

Description of independent variables used in the statistical analysis for record keeping reported in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairie
Computers	0.09	(0.28)	0.00	0.0 - 1.0	218
DHIA	0.52	(0.81)	0.00	0.0 - 1.0	218
Individual cow cards	0.79	(0.75)	1.00	0.0 - 1.0	218
Cow to breed list	0.17	(0.77)	1.00	0.0 - 1.0	218
Veterinarian keeps the records	0.01	(0.01)	0.00	0.0 - 1.0	218
No specific record system	0.06	(0.23)	0.00	0.0 - 1.0	218
Other system	0.03	(0.18)	0.00	0.0 - 1.0	218

[a] Standard deviation

[D] Dichotomous variable

TABLE 1f

Description of independent variables used in the statistical analysis for source of replacements reported in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairies
Raise own	0.87	(0.34)	1.00	0.0 - 1.0	217
Buy heifer calves	0.00	(0.00)	0.00	0.0 - 1.0	217
Buy springers	0.30	(0.46)	0.00	0.0 - 1.0	217
Buy fresh cows	0.14	(0.35)	0.00	0.0 - 1.0	217
Other sources	0.02	(0.13)	0.00	0.0 - 1.0	217

[a] Standard deviation

[D] Dichotomous variable

TABLE 1g

Description of independent variables used in the statistical analysis for ear tags replacements reported in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairies
Every two months	0.08	(0.29)	0.00	0.0 - 1.0	217
Once a month	0.23	(0.42)	0.00	0.0 - 1.0	217
Twice a month	0.05	(0.22)	0.00	0.0 - 1.0	217
Every week	0.01	(0.30)	0.00	0.0 - 1.0	217
Every day	0.09	(0.28)	0.00	0.0 - 1.0	217
Other	0.37	(0.47)	0.00	0.0 - 1.0	217
Farmers don't use ear tags	0.09	(0.29)	0.00	0.0 - 1.0	217

[a] Standard deviation

[D] Dichotomous variable

TABLE 1h

Description of independent variables used in the statistical analysis for physical facilities reported in the survey data from dairy farmers in Tulare County, California, 1983

Variable[D]	Mean	(SD)[a]	Median	Range	No. of dairies
Lockups	0.54	(0.50)	1.00	0.0 - 1.0	218
Close up pens	0.67	(0.47)	1.00	0.0 - 1.0	218
Hospital cow pens	0.82	(0.38)	1.00	0.0 - 1.0	218
Maternity pens	0.55	(0.50)	1.00	0.0 - 1.0	218
Fresh cow pens	0.53	(0.50)	1.00	0.0 - 1.0	218

[a] Standard deviation

[D] Dichotomous variable

TABLE 3a

Comparison of the proportional distributions of variables[b] among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Days set for pregnancy check variable	31.081	0.000
Veterinarian performs postpartum checks	1.257	0.533
Veterinarian performs pregnancy diagnosis	6.349	0.042
Dairy farmers using AI variably	30.570	0.000
Dairy farmers don't use AI	29.978	0.000

[a] $P<0.05$ is the level of significance

[D] Dichotomous variable

TABLE 3b

Comparison of the proportional distributions of variables[b] among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Long calving intervals	5.854	0.054
High number of services per conception	4.217	0.121
Repeat breeders	1.743	0.418
Cows don't shows heat	9.958	0.007
Low heat detection	7.171	0.027
Abortions	1.513	0.469
Dirty cows (metritis)	3.964	0.138
Retained placentas	0.077	0.962
Cystic ovaries	10.910	0.004
Calving problems	7.891	0.019
No major problems	4.456	0.103
Other problems	6.777	0.033

[a] $P<0.05$ is the level of significance

[D] Dichotomous variable

TABLE 3c

Comparison of the proportional distributions of variables among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable	Pearson chi-square value	P (value)
Estrus detection personnel		
Owner/manager	15.342	0.001
Herdsmen	2.546	0.280
Assistant herdsmen	4.808	0.090
Milkers	1.521	0.468
Hot cow man	5.714	0.058
Other employees	0.128	0.938
Everyone looks for heat	8.276	0.016
Estrus detection aids		
Visual only	3.573	0.168
Tail chalking (crayon)	9.107	0,011
Kamar patches	1.096	0.578
Prostaglandins	11.327	0.004
Synchromate B	0.796	0.672
Teaser animals	4.519	0.104
Other aids	0.571	0.752
Signs used for estrus determination:		
Changes in vulva	12.038	0.002
Standing to be mounted	20.185	0.000
Chalk worn off or kamar patch broken	20.756	0.000

TABLE 3c (continue)

Variable[D]	Pearson chi-square value	P (value)[a]
Tail head rough and messed up	7.952	0.019
Mounting other cows	3.340	0.188
Expected heat dates	3.222	0.200
Combination of heat signs	15.471	0.000
Place of estrus detection:		
Milking parlor	1.782	0.410
Wash pens	1.673	0.433
Corrals	9.932	0.007
Lanes	8.940	0.011
Lock ups	5.729	0.057
Everywhere	18.874	0.000
Other places	6.875	0.032

[a] $P<0.05$ is the level of significance

[D] Dichotomous variable

TABLE 3d

Comparison of the proportional distributions of variales among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Inseminator	1.149	0.563
Owner/manager	17.270	0.000
Herdsmen	4.497	0.106
Assistant herdsmen	5.144	0.076
More than two people	3.617	0.164
Other(e.g bulls)	24.825	0.000

[a] P<0.05 is the level of significance

[D] Dichotomous variable

TABLE 3e
Comparison of the proportional distributions of variales among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Computers	5.980	0.340
DHIA	24.268	0.000
Individual cow cards	2.160	0.340
Cow to breed list	9.713	0.008
Veterinarian keeps the records	1.161	0.560
No specific record system	8.966	0.011
Other system	3.082	0.214

[a] P<0.05 is the level of significance
[D] Dichotomous variable

TABLE 3f

Comparison of the proportional distributions of variales among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Raise own	2.614	0.271
Buy heifer calves	-----	-----
Buy springers	11.917	0.003
Buy fresh cows	9.996	0.007
Other sources	0.032	0.984

[a] P<0.05 is the level of significance

[D] Dichotomous variable

TABLE 3g

Comparison of the proportional distributions of variales among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Every two months	2.195	0.334
Once a month	11.528	0.003
Twice a month	0.547	0.761
Every week	0.004	0.998
Every day	5.712	0.058
Other	3.210	0.201
Farmers don't use ear tags	13.879	0.001

[a] P<0.05 is the level of significance

[D] Dichotomous variable

TABLE 3h

Comparison of the proportional distributions of variales among the three respondent groups of dairy farmers in Tulare County, California, (1983) using chi-square test

Variable[D]	Pearson chi-square value	P (value)[a]
Lockups	3.292	0.193
Close up pens	1.467	0.480
Hospital cow pens	10.133	0.006
Maternity pens	2.621	0.270
Fresh cow pens	9.804	0.007

[a] P<0.05 is the level of significance

[D] Dichotomous variable

TABLE 4

Analysis of variance for the continuous variables in the survey data from dairy farmers in Tulare county, California,1983

Variable	F value	P value[a]
Average days dry	3.960	0.048
Number of milking cows	1.020	0.314
Number of dry cows	1.500	0.222
Percent purebred cows	4.147	0.043
Number of corrals	3.014	0.088
Number of breeding bulls	0.000	0.997

[a] P <0.05 is the level of significance

TABLE 5

Variables employed in the discriminant analysis for the survey data from dairy farmers in Tulare County, California,1983

Variable	group means			means of all groups	*SD of all groups
	early	middle	late		
Hospital cow pens	0.828	0.692	0.917	0.820	0.378
DHIA	0.707	0.327	0.367	0.517	0.470
Low heat detection	0.141	0.077	0.017	0.090	0.283
Cystic ovaries	0.283	0.192	0.067	0.199	0.392
Cows don't show heat	0.293	0.192	0.067	0.204	0.394
Calving problems	0.040	0.000	0.117	0.052	0.220
Other reproductive problems	0.020	0.077	0.000	0.028	0.165
Tail chalking (crayon)	0.485	0.269	0.300	0.379	0.478
Prostaglandins	0.333	0.154	0.133	0.232	0.414
Dairy farmers don't use AI	0.162	0.385	0.583	0.337	0.440
Dairy farmers use AI variably	0.394	0.173	0.017	0.232	0.393
Changes in vulva	0.384	0.192	0.133	0.265	0.430
Standing to be mounted	0.505	0.173	0.217	0.341	0.451
Chalk worn off or kamar patch broken	0.374	0.135	0.083	0.232	0.403
Tail head rough and messed up	0.283	0.173	0.083	0.199	0.393
Mounting other cows	0.162	0.154	0.067	0.133	0.339

TABLE 5 (continue)

Variable	group means			means of all groups	*SD of all groups
	early	middle	late		
Combination of heat signs	0.667	0.577	0.350	0.555	0.482
Days set for pregnancy checks variable	0.434	0.481	0.067	0.327	0.482
Everyone looks for the estrus cows	0.354	0.327	0.133	0.284	0.444
Owner/manager detects the estrus cows	0.455	0.462	0.183	0.379	0.473
Owner/manager does the breeding	0.253	0.269	0.017	0.190	0.379
Others (e.g bulls) do the breeding	0.182	0.346	0.567	0.332	0.445
Cows to breed list	0.253	0.058	0.133	0.171	0.370
Observe estrus cows in the corrals	0.636	0.615	0.400	0.564	0.488
Observe estrus cows in the lanes	0.172	0.135	0.0167	0.119	0.319
Observe estrus cows everywhere	0.566	0.404	0.200	0.422	0.473
Observe estrus cows in other places	0.020	0.000	0.083	0.033	0.177
Buy heifers	0.051	0.096	0.183	0.100	0.296
Buy springers	0.202	0.308	0.450	0.299	0.449

TABLE 5 (continue)

Variable	group means			means of all groups	*SD of all groups
	early	middle	late		
Buy fresh cows	0.091	0.096	0.233	0.133	0.336
Veterinarian performs fresh checks	0.586	0.462	0.383	0.498	0.496
Replacement of ear tags once a month	0.283	0.308	0.083	0.232	0.415
Average days dry	64.232	60.654	61.967	62.706	0.122

*SD stands for standard deviation.

TABLE 6
Summary results from the stepwise discriminant analysis for classification into three groups of the survey respondents from dairy farmers in Tulare County, California,1983

F--matrix: degrees of freedom 7 202

		Respondents	
		early	middle
Respondents	middle	1.80	
	late	14.06	12.01

	classification functions		
	Group		
Variable	early	middle	late
1.Days set for pregnancy checks variable	2.8404	2.2442	0.5279
2.Owner/manager does the breeding	1.5325	1.9714	0.2680
3.Other reproductive problems	2.8863	5.0238	0.5064
4.Replacement of ear tags once a month	1.6591	1.9327	0.1005
5.Calving problems	0.0633	-0.6799	1.5865
6.Others (e.g bulls) do the breeding	1.3044	2.0770	3.5084
7.Hospital cow pens	6.1342	5.3230	7.0384
8.Observe estrus cows in the lanes	0.9756	0.9596	-0.7508
Constant	-4.5838	-5.1118	-5.5855

TABLE 6 (continue)

Jackknifed classification matrix:

Group	actual respondents	classified as early	middle	late	percent correct
Early	99	84	11	4	84.8
Middle	52	37	8	7	15.4
Late	60	26	0	34	56.7
Total	211	147	19	45	59.7

TABLE 7

Summary results from the stepwise discriminant analysis for classification into three groups of the survey respondents from dairy farmers in Tulare County, California,1983

F--matrix: degrees of freedom 7 202

		Respondents	
		early	middle
Respondents	middle	1.43	
	late	6.93	8.94

	classification functions		
	Group		
Variable	early	middle	late
1.Owner/manager does the breeding	1.1731	1.4389	- 0.4153
2.Observe estrus cows in other places*	1.5325	1.9714	0.2680
3.Other reproductive problems	1.9530	4.0769	0.3981
4.Replacement of ear tags once a month	1.6591	2.1758	0.2512
5.Calving problems	-0.2201	-1.0065	1.7534
6.Hospital cow pens	5.60017	4.7106	6.4921
7.Observe estrus cows in the lanes	0.9756	0.9596	-0.7508
Constant	-3.5551	-3.7330	-4.4116

*Removal of "days set for pregnancy diagnosis variable" led to the loss of "others (e.g bulls) do the breeding" and entry of "observe estrus cows in other places".

TABLE 7 (continue)

Jackknifed classification matrix:

Group	actual respondents	classified as early	middle	late	percent correct
Early	99	55	7	37	55.6
Middle	52	33	8	11	15.4
Late	60	9	1	50	83.3
Total	211	97	16	98	53.6

TABLE 8

Summary results from the stepwise discriminant analysis for classification into three groups of the survey respondents from dairy farmers in Tulare County, California, 1983

F--matrix: degrees of freedom 7 202

		Respondents	
		early	middle
Respondents	middle	1.39	
	late	6.62	8.39

	Classification functions		
	Group		
Variable	early	middle	late
1.Observe estrus cows in other places	-0.0699	-0.7266	2.0379
2.Owner/manager detects the estrus cows*	1.7022	1.7860	0.5569
3.Other reproductive problems	1.7433	3.8379	0.4023
4.Replacement of ear tags once a month	1.8429	2.1703	0.2992
5.Calving problems	-0.3181	-1.1383	1.8326
6.Hospital cow pens	5.5861	4.7170	6.3997
7.Observe estrus cows in the lanes	0.4614	0.3886	-1.2280
Constant	-3.7767	-3.9389	-4.4336

* Removal of both "Days set for pregnancy checks" and "owner does the breeding" variables resulted in entry of "owner/manager detects the estrus cows".

TABLE 8 (continue)

Jackknifed classification matrix:

Group	actual respondents	classified as early	middle	late	percent correct
Early	99	64	9	26	64.6
Middle	52	36	8	8	15.4
Late	60	14	1	45	75.0
Total	211	114	18	79	55.5

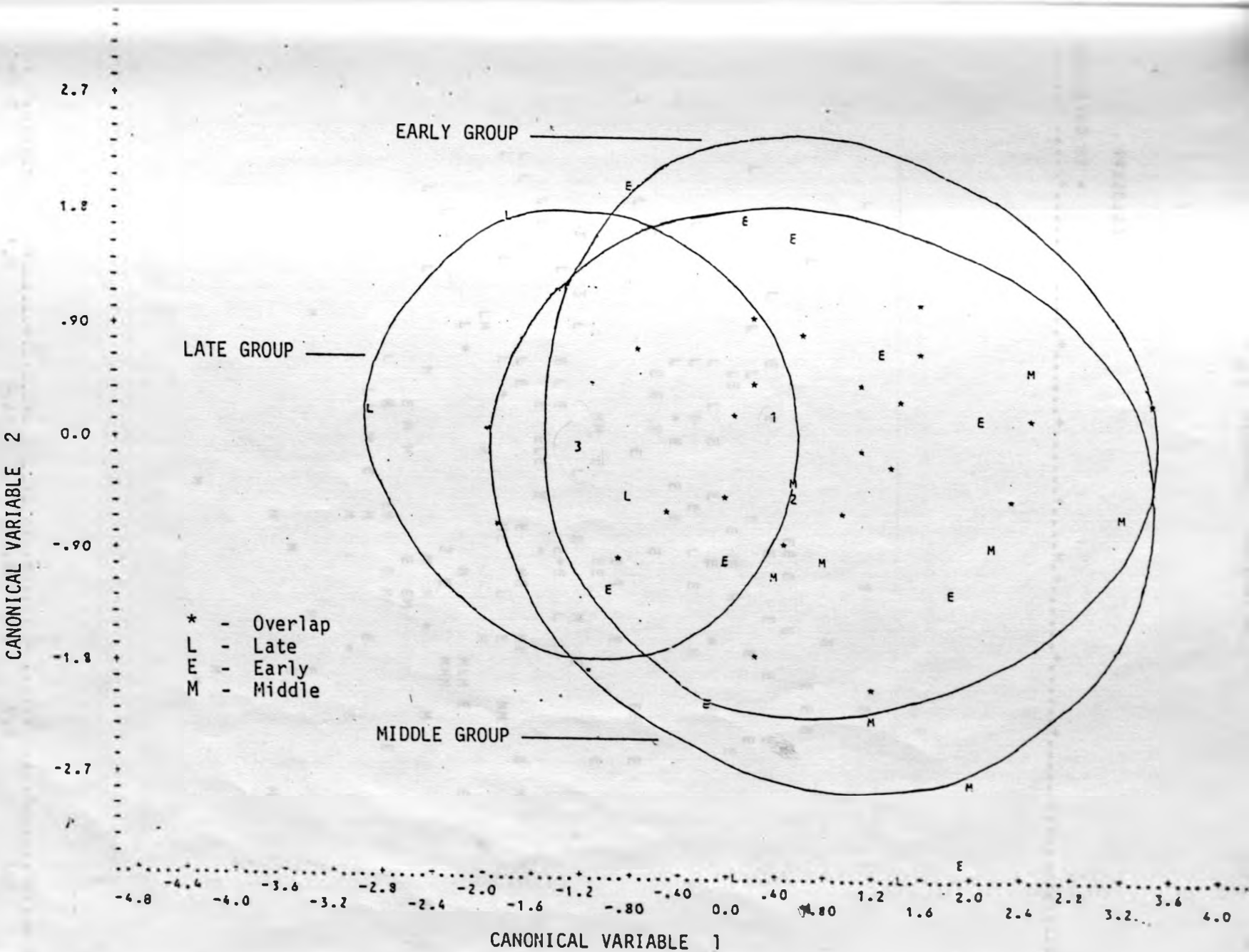

Fig 1. Classification of survey respondents into early, middle, and late groups on the basis of eight variables, Tulare County, California, 1983.

"26 Variables Entered" (67%)

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