Measuring Dairy Herd Reproductive Performance

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Reproductive performance is
1. determined by
   A. length of voluntary waiting period
   B. heat detection efficiency
   C. conception rate among fertile cows
   D. percent of infertile and aborting cows
2. modified by
   A. environmental factors
   B. nutritional management
   C. infectious agents

Inherent Problems with Reproductive Statistics
1. crude measurements that attempt to infer the physiologic status of a dynamic group of animals.
2. lack of standardization of the numerators and denominators used in their calculation.
3. record systems that fail to record all pertinent reproductive events.
4. occurrence of "data management" by
   A. dairy personnel - an attempt to increase perceived herd performance.
   B. herd testing personnel - "shortcut" in transcribing information.

Reproductive statistics can be divided into those that estimate:
1. Overall herd reproductive performance
2. Heat detection efficiency
3. Conception efficiency
4. Reproductive diseases

Overall Herd Reproductive Performance

1. Calving Interval
A. can be estimated from either past or projected performance.
B. values from most well managed herds range from 12.5 to 13.5 months.
C. **Past Calving Interval**
   1. average interval between 2 most recent calvings and therefore excludes first lactation cows.
   2. usually a rolling average for the last 12 months
      a. advantage - short temporal fluctuations not reflected.
      b. disadvantage - recent changes not reflected.
   3. possible populations measured
      a. all cows calving in last 12 mos.
         1. would include all cows culled that calved in last 12 mos.
         2. would exclude a portion of cows for all herds with a calving interval >12 mos. i.e. 15% of cows in herd with a 14 mos. calving interval.
      b. only those cows currently in herd.
         1. would not reflect actual performance since culled cows usually have a longer calving interval.
      c. cows currently in herd in addition to cows culled during last 12 mos.
         1. would increase the period of historical information included in the statistic.
   4. Conclusions
      a. measures historical performance usually 9 to 28 mos. previously.
      b. does not include first lactation cows.
      c. may be affected by culling rate depending on population measured.
D. **Projected Minimum Calving Interval**
   1. designed to overcome shortcomings of past calving interval.
      a. contains recent and prospective information.
      b. includes first lactation cows.
      c. affected by infertile cows present.
   2. average calving interval is projected for
      a. pregnant cows in herd.
      b. cows with breeding dates, but not confirmed assuming cows are pregnant at last breeding.
      c. cows past voluntary waiting period, but open, are assumed to be seen in estrus, bred, and conceive 10 days from present date.
   3. optimistic "best" estimate of future performance.

2. Average Days Open
A. average days from calving to conception

B. period of time examined varies from previous gestation to current gestation and may include estimates of future conception.
C. values from most well managed herds range from 100 to 125 days.

B. **Past Average Days Open**
1. measures performance from previous gestation.
2. obtained by subtracting 280 days from Past Calving Interval.
3. populations measured can vary as in Past Calving Interval calculations.
4. has same characteristics as Past Calving Interval.
   a. measures historical performance - usually 9 to 28 mos. previously.
   b. does not include first lactation cows.
   c. may be affected by culling rate depending on population measured.

C. **Calving to Conception Interval**
1. measures performance from current gestation.
2. considers the population of all pregnant cows currently in herd.
   a. calculated as average days from calving to conception for all cows in herd confirmed pregnant.
   b. includes first lactation cows.
   c. does not include open and infertile cows and therefore requires knowledge of % open cows in herd to evaluate.
   d. measures performance 2 to 9 mos. previous.

D. **Projected Minimum Average Days Open**
1. measures performance from current gestation in addition to an "estimate" for future conception.
2. considers the population of pregnant cows currently in herd as well as open and infertile cows.
3. average days open is projected for
   a. pregnant cows in herd.
   b. cows with breeding dates, but not confirmed assuming cows are pregnant at last breeding.
   c. cows past voluntary waiting period, but open, are assumed to be seen in estrus, bred, and conceive 10 days from present date.
4. differs from Projected Minimum Calving Interval by 280 days.

3. **Percent of Herd Confirmed Pregnant**
A. statistic originated by dividing the gestational period by calving interval to determine the percent of time an average cow would be pregnant.
1. 280 day gestation / 380 day calving interval -> average cow pregnant 75% of time.
2. Assuming 60 day dry period in a 380 day calving interval -> cow will be dry about 16% of time.

B. not reliable with seasonal calving.
C. related to calving interval.
1. Longer calving interval results in a smaller % dry, smaller % milking and pregnant, and a larger % milking and open.
2. Shorter calving interval results in a larger % dry, larger % milking and pregnant, and smaller % milking and open.

D. usual distribution is listed in literature:

Dry and Pregnant	12-15%
Milking and Confirmed Pregnant	40-44%
Milking and Not Confirmed Pregnant	40-44%

E. distribution affected by
1. both culling rate and stage of lactation at culling.
   a. cull cows do not have a dry period.
   b. replacement heifers will usually be at the start of their lactation.
   i.e. if the culling rate is 30% with ⅔ of cows culled at the end of lactation, there will be a decrease in the % dry from 16% to 12.8% in a herd with a 12.5 mos. calving interval.
2. stage of gestation at pregnancy exam.
   i.e. average days at pregnancy exam of 40 days will result in a decrease of 5 to 6% in the % milking and not confirmed pregnant compared to an average days at pregnancy exam of 60 days.

4. **Percent Days in Milk**
A. determined by dividing the sum of cow days milked in a period by the sum of all cow days in the period.
B. not reliable with seasonal calving.
C. affected by calving interval.
1. Longer calving intervals result in higher percent days in milk.
2. Shorter calving intervals result in lower percent days in milk.

D. affected by culling rate.
1. High culling rates increase percent days in milk, since culled cows do not have a dry period.
2. Low culling rates decrease percent days in milk, since a higher percentage of cows are dry.

E. values for Percent Days in Milk should be 86 to 87%.

5. **Average Days in Milk**
   A. average of days since calving for all milking cows in herd.
   B. not reliable with seasonal calving.
   C. related to calving interval.
      i.e. 12 mos C.I. = 150 average DIM
      13 mos C.I. = 165 average DIM
      14 mos C.I. = 180 average DIM
   D. affected by culling rates.
      1. Low culling rates result in retention of subfertile cows which have longer days in milk.
      2. High culling rates increases number of cows in early lactation.
   E. herd performance.
      1. Average DIM >175 days -> seasonal calving, reproductive inefficiency or lack of culling.
      2. Average DIM <160 days -> seasonal calving or excessive culling.

6. **Herd Reproductive Status (HRS)**
   A. index used to reflect excessive days open in open cows in relation to herd size.
   B. calculated by
      DO = sum of DIM of cows not confirmed pregnant and >100 DIM
      TC = total cows in herd (milking and dry)
      HRS = 100 - [(DO/TC) x 1.75]
   C. index negatively affected by both the number of days open >100 days and the number of cows with days open >100 days.
   C. affected by stage of gestation at time of pregnancy exam.
   D. index of 60 to 65 acceptable for herd practicing early pregnancy diagnosis.

7. **Percent Cows Open >150 Days**
   A. indication of the number of functionally infertile cows in the herd.
   B. defined as the number of cows open >150 days DIM shifted back 60 days to allow for pregnancy determination divided by total number of cows in herd.
   C. should be <15% of the herd.

8. **Culling Rates**
   A. are usually 30% of the herd per year.
   B. have profound effects on reproductive statistics.
   C. classification of removal reasons has been used to indicate reproductive performance.
      1. stated in literature that culling due to reproductive reasons should not exceed 33% of all cows culled. (10% of herd removed for reproductive reasons.)
      2. common misclassification reduces the % of cows removed for reproductive reasons.
         a. cows >300 DIM and culled for low production usually conceived after 150 DIM.
         b. all cows failing to conceive by 150 DIM should be removed for reproductive reasons when culling occurs regardless of pregnancy status.
      3. Percent of cows culled for reproductive reasons should be evaluated with caution without understanding of removal classification criteria.

9. **Barr's Model**
   A. partitioned Calving to Conception Interval into
      1. days lost due to voluntary waiting period.
      2. days lost due to cows' failure to conceive.
      3. days lost due to missed heats.
   B. average Calving to Conception Interval = voluntary waiting period + 10.5 + days lost due to failure to conceive + days lost due to missed heats.
   C. days lost due to failure to conceive = (services per pregnancy, pregnant cows - 1) x 21 days
   D. model only considers cows that became pregnant and does not consider the portion of herd that is functionally infertile.
   E. may provide indication of problem areas in herd.

Heat Detection Efficiency

1. Heat detection efficiency can be estimated in terms of intensity and accuracy.
   A. **Heat Detection Intensity** is estimating the specificity of heat detection on a diary. Specificity refers to the proportion of cows seen as not being in heat that are truly not in heat. This directly related to the amount of time spent at heat detection.
   B. **Heat Detection Accuracy** is a term used to indicate the sensitivity involved in heat detection. Sensitivity refers to the proportion of cows detected in heat that are truly in heat.
   C. As **Heat Detection Intensity** increases, Heat Detection Accuracy decreases. i.e. if heat detection intensity >85%, heat detection sharply decreases.

2. **Heat Detection Intensity, Heat Detection Accuracy,** and **Conception Rates** interact.
   A. Low heat detection accuracy results in low conception rates at any intensity.
   B. High conception rates indicate high heat detection accuracy but does not measure heat detection intensity.
   C. Excellent conception rates and heat detection in-

tensity eliminate heat detection efficiency as a source of herd infertility.

3. **Portion of Cows in Heat by 60 Days**
   A. indicates heat detection intensity.
   B. requires recording of all heats during the Voluntary Waiting Period. This may not be done routinely on diary.
   C. calculated as:

number of cows with at least 1 heat recorded that reached 60 DIM during a period
---
number of cows that reach 60 DIM during period

   D. goal is 75% of cows in heat by 60 DIM

4. **Average Interval to First Heat**
   A. indication of heat detection intensity.
   B. requires recording of all heats during the Voluntary Waiting Perod.
   C. calculated as:

sum of days to first heat for all cows exhibiting a first heat during period
---
number of cows exhibiting a first heat in period

   D. goal is <45 days to first heat.

5. **Days to First Service**
   A. indication of heat detection intensity.
   B. calculated as:

sum of intervals from calving to first service for all cows receiving a first service during period
---
total number of cows receiving a first service during period

   C. more reliable statistic since most dairyman will record more breedings than heats alone.
   D. performance depends on Voluntary Waiting Period.
      i.e. if heat detection intensity is 100% - > days to first service should be VWP + 10.5 days.
      1. good heat detection intensity - > VWP + 18 days
      2. marginal heat detection intensity - > VWP + 19 to 26 days
      3. poor heat detection intensity - > VWP + > 26 days

6. **Percent of Cows Inseminated by 90 DIM**
   A. indication of heat detection intensity.
   B. calculated as:

number of cows inseminated at least once & reaching 90 DIM during period
---x 100
total number of cows reaching 90 DIM during period

   C. performance should be > 80%.

7. **Percent of Possible Heats Detected**
   A. measures heat detection intensity.
   B. calculated as:

all breedings & reported heats in eligible cows in period
---x 100
estrous days in period in eligible cows / 21 days

      eligible cows are all cows past the voluntary waiting period contributing estrous days in cycle.
      1. unbred & known open cows.
      2. bred cows not confirmed pregnant: days in period up to last breeding + (days after last breeding x conception rate) [conception rate estimated by 1/services per pregnancy, all cows]
      3. days in period up to date cows turned with bull.
      4. add 7 estrous days for each use of PGF.
   C. goal is > 70% of possible heats detected.

8. **Average Interestrus Interval**
   A. indication of heat detection intensity.
   B. two methods of determination
      1. Direct method
         a. indicates recent heat detection intensity in cycling open cows currently in herd.
         b. requires two recorded heats to be included in statistic.
         c. calculated as:

sum of all interestrus intervals ending in period
---
total number of interestrus intervals ending in period

      2. Indirect method
         a. uses reproductive statistics from different cohorts of cows to determine crude estimate of heat detection intensity.
         b. calculated as:

Calving to Conception Interval - Average Days to First Service

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Services per Pregnancy for Pregnant Cows - 1

c. excludes open cows from statistic
d. if Services per Pregnancy for All Cows is used, the number of interestrus intervals is overestimated which reduces the average interestrus interval.

C. goal should be < 30 days.

9. **Heat Detection Rate**
   A. Measures heat detection intensity.
   B. calculated as:

$$\frac{21}{\text{average interestrus interval ending in period}} \times 100$$

   C. goal should be >70%.

10. **Distribution of Interestrus Intervals**
   A. indication of both heat detection accuracy & intensity.
   B. interestrus intervals division and targets

Intervals	Expected Performance
<3 days	< 5%
3-17 days	<10%
18-24 days	60%
25-35 days	<10%
36-48 days	10%
>48 days	< 5%

   C. increases in the percent of interestrus intervals in the 3-17 day and 25-35 day ranges indicate low heat detection accuracy or the possibility of early embryonic death.
   D. **Ratio of 21 to 42 Day Cycles**
      1. indication of heat detection intensity.
      2. acceptable heat detection intensity will result in ratios between 6 to 1 and 4 to 1. Performance below 4 to 1 indicates lack of heat detection intensity.

11. **Percent of Cows Pregnant at Pregnancy Exam**
   A. measures heat detection intensity. (Not a measure of conception success.)
   B. easy statistic to determine at the end of reproductive visit.
   C. calculated as:

$$\frac{\text{number of cows diagnosed pregnant at pregnancy exam}}{\text{number of cows examined for pregnancy}} \times 100$$

   D. goal affected by stage of gestation at pregnancy exam.
      1. 35 days of gestation - >75%
      2. > 42 days of gestation - >95%

12. **Percent of Cows Pregnant to Previous Breeding**
   A. indication of both heat detection accuracy & intensity.
   B. calculated as:

$$\frac{\text{number of cows conceiving to a previous breeding \& were diagnosed pregnant during period}}{\text{total number of cows diagnosed pregnant during period}} \times 100$$

   C. performance
      if >3% - > poor heat detection accuracy.
      if 0% - >associated with poor heat detection intensity.

13. **Milk Progesterone Levels at Insemination**
   A. indicates heat detection accuracy.
   B. milk progesterone values obtained at insemination.
   C. obtain a minimum of 20 samples. Large sample sizes can be interpreted with greater confidence.
   D. elevated milk progesterone occurs during non-estrus periods of the cycle.
   E. interpretation
      1. should be done with caution using small sample sizes
      2. good heat detection accuracy reflected with 10% or less samples with high milk progesterone values.
      3. poor heat detection accuracy may be occurring with >20% of samples with high milk progesterone values.

Conception Efficiency

1. **Services per Pregnancy, All Cows**
   A. also has been reported as Services per Conception.
   B. calculated as:

$$\frac{\text{number of AI breedings shifted back 60 days to allow for pregnancy determination}}{\text{number of breedings that resulted in confirmed pregnancy}}$$

C. may be expressed as a rolling average from 2-14 months previous.
D. includes both fertile and infertile cows by including all cows receiving an insemination.
E. reciprocal of Services per Pregnancy, All Cows is good estimate of Overall Conception Rate.
F. in small herds, one or two infertile cows with a large number of inseminations can significantly increase Services per Pregnancy, All Cows. If a significant difference appears between First Service Conception Rate with the reciprocal of Services per Pregnancy, All Cows, examine all individual cow records for a few cows contributing excessive services to statistic.
G. performance should be < 2.5 Services per Pregnancy, All Cows
H. some Dairy Records Processing Centers (DRPC) include one additional service to this statistic for cows conceiving to bull without also considering any services by bull prior to conception. This results in lower than actual Services per Pregnancy.

2. **Services per Pregnancy, Pregnant Cows**
A. calculated as:

$$\frac{\text{sum of AI breedings used for all cows confirmed pregnant during period}}{\text{number of cows confirmed pregnant during period}}$$

B. measures conception efficiency in fertile cows since only those cows that conceive are included.
C. reciprocal of Services per Pregnancy, Pregnant Cows is estimate of conception rate in fertile cows.
D. performance should be < 2.25 Services per Pregnancy, Pregnant Cows.
E. some DRPC include one additional service to this statistic for cows conceiving to bull without also considering any services by bull prior to conception. This results in lower than actual Services per Pregnancy.

3. **First Service Conception Rate**
A. calculated as:

$$\frac{\text{number of successful first services shifted back 60 days to allow for pregnancy determination}}{\text{total number of first services in shifted period}}$$

B. conception statistic not influenced by a disproportion of infertile cows.
1. excellent outcome variable for studies examing effects on cow fertility.
2. least biased estimate of bull fertility, semen handling, or breeding technique.
C. affected by the Voluntary Waiting Period and therefore the Days to First Service.
1. first services occurring between 40 to 50 days postpartum are usually 5 to 10% lower than first services occurring between 60 to 70 days postpartum.
2. if Voluntary Waiting Perod is affecting First Service Conception Rate, the Conception Rate at Second Service will be 5 to 10% higher than first service.
3. must be controlled for when using First Service Conception Rate as an outcome variable in epidemiologic studies.
D. performance usually ranges between 40 to 45% successful on first srvice.
E. some sources have reported First Service Conception Rates calculated as:

$$\frac{\text{number of successful first services}}{\text{number of pregnant cows}}$$

1. excludes a significant portion of herd since open cows are not included.
2. performance using this calculation should be > 55%.

4. **Percent Pregnant in 3 Services**
A. calculated as:

$$\frac{\text{number of cows conceiving within 3 services}}{\text{number of cows receiving one, two or three services}} \times 100$$

B. ease of calculation varies with calving pattern.
1. seasonal calving
a. easily calculated since a defined calving season allows the performance of the same cohort to be evaluated at the end of the breeding season.
2. non-seasonal calving
a. difficult to calculate since continual calving results in multiple cohorts receiving their first, second, and third service at the same point in time.
C. can be estimated in non-seasonal calving herds by using the first service (R1), second service (R2), and third service conception rates (R3) occurring during the same period.
D. estimated calculated as:

$$R1 + [(1-R1) \times R2] + (1 - \{R1 + [(1-R1) \times R2]\} \times R3)$$

E. performance should be > 80% pregnant within 3 services.

5. **Q-Sum Graph (Cumulative Sum Graph)**
   A. services placed on Y-axis in chronological order while the outcome in terms of success or failure placed on x-axis.
   B. very useful for evaluating temporal changes in conception rates, especially in small herds.

6. **Average Days Open with Bull**
   A. indicates conception efficiency in bull bred herds or bull bred strings.
   B. calculated as:

$$\frac{\text{sum of days between Turned with Bull Date \& estimated date of conception for cows confirmed in bull breeding}}{\text{number of cows confirmed to bull breeding}}$$

   C. performance values should:
      1. range between 40 to 50 days.
      2. be evaluated on a string basis in addition to a herd basis.
   D. elevated values may be due to:
      1. low cow ferility
      2. low bull fertility
         a. lack of inherent reproductive capacity.
         b. large **Cow to Bull Ratio.**
            1. calculated as:

$$\frac{\text{cows Turned with Bull \& not confirmed pregnant}}{\text{number of bulls with access to cows}}$$

            2. ratios should vary between 20 to 30, depending on age of bulls used.

7. **Bull Services per Pregnancy**
   A. method of measuring conception efficiency with bull breeding.
   B. calculated as:

$$\frac{\text{average of (conception date-[turned with bull date + 10]) for all cows confirmed pregnant to bull during period}}{21}$$

   C. excludes open exposed cows till diagnosed pregnant.
   D. reciprocal estimates conception rate.

Reproductive Diseases

1. **Abortion Rate**
   A. abortions are defined as cows diagnosed open after being confirmed pregnant in addition to visible abortions.
   B. calculation of abortion rates vary in terms of:
      1. cows considered at risk
         a. all cows in herd
         b. cows confirmed pregnant
      2. time period considered
         a. monthly or yearly basis
         b. period of known pregnancy
   C. specific calculations
      1. all cows in herd

$$\frac{\text{number of abortions in period}}{\text{total number of cows in herd}} \times 100$$

         a. expect rates between 7 to 14% per year.
         b. monthly rates can be annualized by multiplying by 12.
      2. cows confirmed pregnant

$$\frac{\text{number of abortions in period}}{\text{number of confirmed pregnant cows in herd}} \times 100$$

         a. expect rates between 12 to 24% per year.
         b. monthly rates can be annualized by multiplying by 12.
      3. period of known pregnancy

$$\frac{\text{number of abortions in one month}}{\text{number of confirmed pregnant cows in herd}} \times 7.5 \times 100$$

         a. estimates the risk of abortion for a cow during time of confirmed pregnancy status.
         b. period of confirmed pregnancy status is determined by subtracting average stage of gestation at pregnancy diagnosis from gestation length.
         c. values of 7.5 months are commonly used since 50 days of gestation are common stages for pregnancy diagnosis.

2. **Incidence Rates for specific Reproductive Diseases**
   A. specific conditions may include **Dystocia, Retained Placenta, Milk Fever, Metritis, and Follicular Cysts.**

B. these indicence rates can serve as early indicators of impending infertility since their occurrence has been associated with reduced reproductive performance.
C. calculated as:

$$\frac{\text{number of cases of the specific condition}}{\text{number of cows at risk}} \times \text{time} \times 100$$

D. difficult to interpret since the definition of a case, the cows considered at risk, and time period considered may vary between herds or individuals.
E. definitions i.e. follicular cysts
   1. case
      a. fluid filled structure greater than some diameter
      b. fluid filled structure that persists for a minimum number of days
   2. cows considered at risk
      a. all cows in herd
      b. all open cows in herd
      c. all known open cows examined
      d. all cows diagnosed open in addition all known open cows examined
   3. time period considered
      a. reproductive visit
      b. month
      c. year

Related References

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Buiatrics is the study of cattle diseases.