Reproductive Records: Monitoring and Compliance

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Abstract

Reproductive performance of a dairy herd is a function of certain management policies and how well these are implemented in daily herd management. It has long been known that there is an important economic advantage to be gained by efficient reproduction in dairy herds. The ability to use records effectively is a cornerstone of reproductive management. Accurate records are necessary to obtain the history of past performance and determine if changes or adjustments need to be made in current management policies. However, one must use good judgment with monitoring to avoid changing something that is not really a problem. Change should occur as needed or warranted, and not just for the sake of change. Many parameters can be used to monitor reproductive status and trends on the dairy herd, but every parameter monitored should be proactive, measurable and result in profit to the dairy.

Benchmarks are standards by which performance can be measured or compared, and are not synonymous with goals. Benchmarks are simply the averages for different monitoring parameters and may be derived by grouping together herds that represent specific categories (herd size, production level, geographic location). Goals are target levels of performance toward which managers are striving. Complete herd records should provide the necessary tools to define herd performance historically, assist in establishing goals for monitored parameters and assist in determining the impact of the plan developed to reach the established goals.

What is compliance on the dairy? It will be defined here as the administration of treatments or actions according to a prescribed protocol. The more complicated a protocol, the greater the chances for procedural failure. Protocol compliance is critical for success. There are two types of monitoring points for compliance: the execution of the event itself, or the resulting outcome from that action that is related to the process. Most reproductive monitoring is performed on the resulting action which is indicated by the day in milk at first service (DIMFS), serum progesterone levels at time of injection or insemination, and finally, pregnancy rates in the subsequent 21-day cycles.

Résumé

La performance reproductrice d'un troupeau laitier dépend de certaines politiques de régie et du soin avec lesquelles elles sont appliquées chaque jour. On sait depuis longtemps qu'une reproduction efficace donne un avantage économique important à l'élevage laitier. Or, le bon usage de registres du troupeau est la pierre angulaire d'une gestion efficace de la reproduction. Il faut y consigner avec précision l'historique des performances du troupeau pour déterminer les changements ou les ajustements à apporter à sa régie. Toutefois, on doit faire preuve de jugement dans son suivi, pour éviter d'appliquer un changement inutilement. Le changement doit être nécessaire ou justifié, et non pas se faire pour le plaisir de changer. Plusieurs paramètres ou indices peuvent servir à suivre le statut et les tendances reproductrices du troupeau, mais chacun de ces paramètres doit décrire une caractéristique mesurable et que l'on peut améliorer, au bénéfice de la rentabilité de la ferme laitière.

Les repères sont des normes à partir desquelles on peut mesurer ou comparer ses performances et on ne doit pas les confondre avec les objectifs. Les repères sont simplement des moyennes de différents paramètres de suivi, que l'on peut calculer en regroupant les troupeaux sous diverses catégories (taille du troupeau, niveau de production, lieu géographique). Quant aux objectifs, ce sont des niveaux-cibles de performance que tout gestionnaire s'efforce d'atteindre. Et justement, pour être complets, les registres doivent permettre de définir les performances passées du troupeau et les buts à atteindre selon les paramètres choisis, et de vérifier l'impact du plan élaboré en conséquence.

Qu'est-ce que la conformité sur une ferme laitière? Nous la décrirons ici comme l'administration des traitements nécessaires ou les actions effectuées, conformément au protocole retenu. Cependant, plus le protocole est complexe, moins on a de chances de le suivre. Mais la conformité à son protocole est cruciale pour réussir. Il y a deux façons de garantir et de surveiller cette conformité : l'action effectuée et l'observation du résultat de cette action. Pour suivre les performances reproductrices, on observe principalement le nombre de jours en lait à la première saillie, le niveau de progestérone dans le sérum sanguin au moment de l'injection ou de l'insémination et, finalement, le taux de gestation dans les cycles de 21 jours qui suivent.

Terminology

Monitoring: regular and organized collection and evaluation of information from a dairy in an attempt to detect change in a parameter or process. To review dairy

records in order to ensure expected performance is maintained or to detect change that is usually unintended or undesirable. Monitoring may also be used to measure the effect of implementing a new process, protocol, or intervention.

Benchmarks: standards typically obtained from large data sets, usually from Dairy Records Processing Centers by which reproductive performance can be compared, measured or assessed. A benchmark value should only be the starting point. The distribution of a particular parameter allows for a more factual representation of past performance than simply an average for that particular parameter. Herd benchmarks must be applied with caution and may not be the appropriate alerting levels for management intervention on an individual cow basis. Benchmarks are not the same as goals.

Goals: target levels of performance which management of the dairy are attempting to achieve. The S.M.A.R.T. approached to goal setting should be followed, where goals are: Specific – Measurable – Attainable – Realistic – Timely. This is an important concept, and where benchmarks can assist in avoiding unrealistic goals. Ideally, a practical goal is one that can be obtained within a reasonable time period once the present "bottlenecks" to performance or implementation of a protocol have been identified and corrected.

Variation: the extent of spread or range in measurement of a variable. At the herd level, an example of variation is illustrated by the scatter graph of days to first breeding (Figure 1) that has an average of 83 days and a range of 111 days (38 to 149 days-in-milk).

Lag: the time elapsed between occurrence of an event and measurement of it. Lag is natural in many reproductive parameters. Days open and calving interval are two historical reproductive parameters that are usually not monitored today because of the inherent lag associated with these measurements.

Bias: an incorrect inclusion or exclusion of individuals from calculation of a particular parameter. Bias can also occur if cow records are incomplete or if assumptions are made regarding pregnancy outcome. Calving interval is the classic example for bias in reproductive monitoring, since only cows that have calved twice or more are eligible for inclusion in the calculation.

Momentum: results for a particular parameter are excessively influenced by historical performance. The potential pitfall created by momentum is that recent performance can be masked, making monitoring inaccurate at best.

Conception Rate and Binomial Variation

Conception Rate (CR) is a trait statistically referred to as a binomial variable, or one for which there are only two possible outcomes. A given insemination can only result in one of two possible outcomes: the cow becomes pregnant or she does not become pregnant. The most common analogy used to describe binomial variation is the coin toss. However, most dairy herds have an average CR for lactating cows below 50%, and therefore do not have an equal probability for pregnant or open

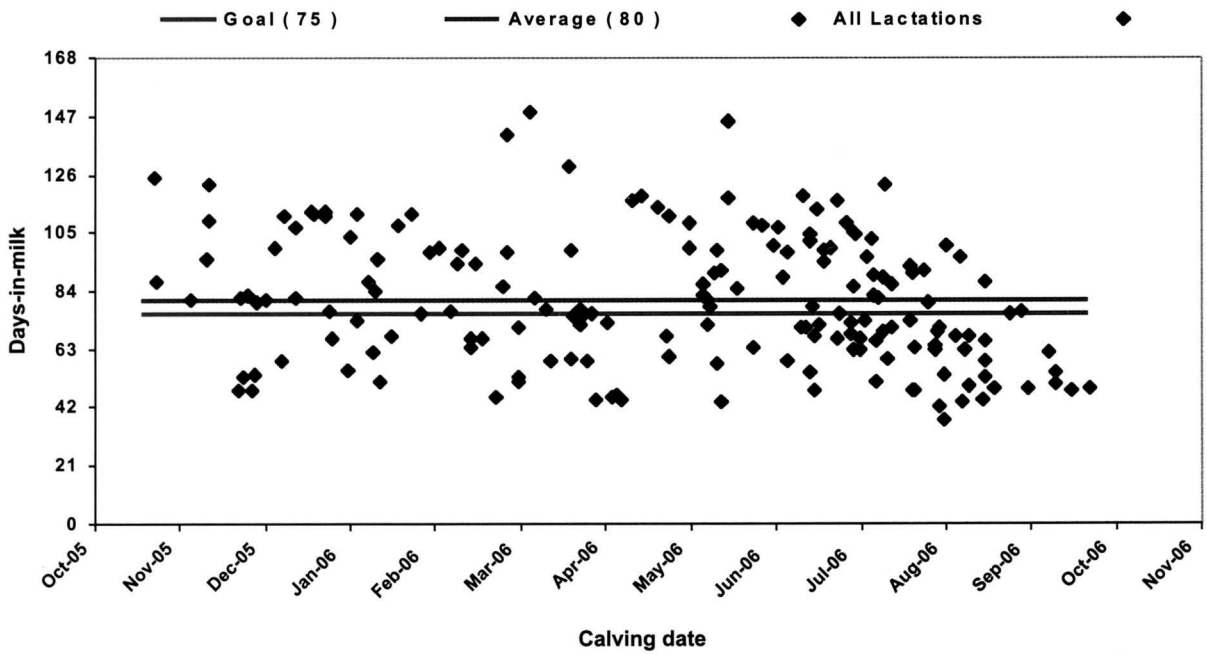


Figure 1. Scatter graph of days-in-milk at first breeding for the last 12 months (each diamond represents a cow).

outcomes from a given insemination. Rather, the probability that a single given insemination from an average-fertility bull will result in a pregnancy is equal to the respective CR of the herd. The effects of binomial variation are best illustrated in an analogy of blindly selecting a white marble from a bag of 100 marbles with the number of white marbles in the bag equal to the average CR of the herd. A herd with a 30% CR would then be equivalent to a bag of 30 white marbles and 70 black marbles. Now, let's consider what binomial probabilities predict will happen to 10 "average fertility" inseminations in a herd with a 30% CR. With 10 inseminations, there are 11 possible outcomes ranging from 0 to 100% pregnant, but there are 100 possible combinations (10 x 10) to achieve these 11 results. The outcome of each insemination is independent of all others and is equivalent to taking your chances of picking a white marble rather than black one with 70:30 odds stacked against you in each selection. As illustrated in Figure 2, the greatest probability of any single answer is three pregnancies (white marbles); however, this is only expected to occur 26.7% of the time. This means that 73.3% of the time, the result will be something other than a CR of 30%. It could be more or could be less, but the observed answer has nothing to do with the "fertility" of the insemination event.

It is also very important to note in this example that the probability of an answer that is < 30% is greater than the probability of an answer that is > 30%. As illustrated in Figure 2, the cumulative probability of all combinations of < 3 pregnancies (0, 1 and 2 pregnancies) is 38.2%, whereas the seven potential outcomes > 3 pregnancies (4 thru 10 pregnancies) only add up to a 35.1% probability. It should not be surprising if we sometimes go through 10 "average" inseminations and achieve 0 or only one pregnancy, as binomial probabilities predict this will occur 2.8% and 12.1% of the time, respectively.

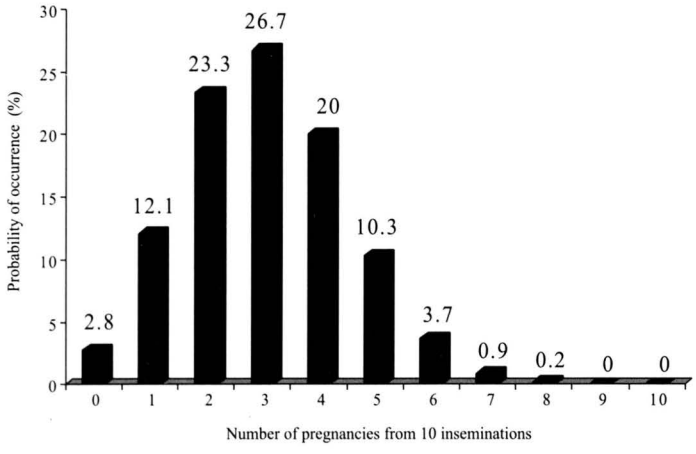


Figure 2. The probability of achieving various numbers of pregnancies as a result of 10 inseminations in a herd with a 30% conception rate.

The only way to overcome the effects of extreme deviations from random chance is to take lots of chances. However, with each successive attempt another potential outcome is added to the matrix, which proportionately reduces the probability of occurrence of each individual outcome. If we expand the example to 100 services (marble selections), there are now 10,000 possible combinations of outcomes with 101 possible answers. The probability that the observed result for this average fertility insemination will be "close" to 30% increases with increasing numbers of services, but the probability that the answer will be "exactly" 30% decreases to only 8.7% probability.

The point of this extensive discussion of binomial variation is to emphasize that any given "observed value" for a binomial variable is most likely not the "real value". Even with very large numbers of services, we cannot always say with confidence that numeric differences are real differences. The effects of numbers of observations on binomial confidence intervals in a herd with a 30% CR are presented in Table 1. With only 10 services the confidence interval is ±41%, making it all but impossible to say that any CR is different than average, no matter what the result. To confidently say that an observed 7% difference in CR is truly different from average, we must have 300 or more services to the treatments which may be technician, sire, lactation group, breeding trigger, day of the week, or calendar month. Even large herds seldom have a sufficient number of services to a given treatment to detect meaningful differences in conception potential.

Assessing Reproductive Performance

The majority of cows in the North American dairy herd are managed using some form of computer-based

Table 1. Effect of sample size on minimum detectable difference (2-tail test, P = 0.05, 80% power) for a herd with a 30% conception rate.

Number of services per treatment[1]	Minimum detectable difference from average
10	±41%
50	±18%
100	±13%
300	±7%
500	±6%
1000	±4%

[1] Treatment may be technician, sire, lactation group, breeding trigger, day of the week, or calendar month.

record system such as Afi Farm, DairyComp 305, Dairy Plan, Dairy Quest, DHI-Plus, or PCDART. A solid reproductive management program begins with dedicated and knowledgeable managers who are motivated to implement and maintain a system that defines what has to be done, by whom, why must it be done, how it will be done, and what is not acceptable. Many times managers rely on instinct and perceptions when analyzing herd reproduction. However, relying solely on those factors can lead to an inaccurate view of the reproductive performance of the herd. The first step in record analysis is to identify the key components of reproductive performance that affect the desired outcome or goals. Evaluation of reproductive records should answer three important questions: 1) Historically, how has the herd performed? 2) How is current pregnancy production? and 3) What does the near future hold for generation of pregnancies? Every consultant has a unique method of assessing reproductive performance using dairy records. The approach outlined here is simply the approach that was developed by the authors for use across North America by Select Reproductive Solution ™ Specialist in dairy herds using various on-farm record systems.

The initial consultation should determined the objectives of the reproductive program. It may not merely be to maximize pregnancy production, which would be stated by most as the underlying aspiration. The consultant must assess how aggressively and reliably management will implement such strategies as timed AI protocols, resynchronization and such systematic heat detection systems as tail chalking or activity pedometers. There is no need to monitor if change will not occur, no matter how conclusive the outcome dictates adjustments are essential. Verifying completeness of the data is important, but somewhat difficult because you are looking for something that is not there. Screening data for accuracy and completeness may involve reviewing lists of cows, such as number fresh, sold or died by month, cows with gestation >300 days, and cows with times bred ≥1 and days-in-milk at first breeding = 0.

When reviewing reproductive performance of all parameters examined, management has the most control over when first breeding will occur. The true voluntary waiting period (VWP) must be determined to accurately start the calendar for when eligible cows are available for calculation of 21-day pregnancy rates. The default VWP used by DairyComp305 is 50 days, but by using the V switch one can set the VWP for the BREDSUM pregnancy rate option (BREDSUM\V65 set the VWP at 65 days). The PCDART system has a VWP default of 60 days and requires the VWP input be performed prior to record processing, and cannot be altered by a consultant after record processing. The Select RePRO Analysis™ system estimates the actual VWP based on when 10% of the cows have received a first service.

Select RePRO Analysis Goals Worksheet (Figure 3)

Suggested Goals are listed (national and regional) as a starting point for management to set herd goals.

Current Status is the herd's status calculated from the imported file.

Herd Goals are set by herd management and are used to compare to current status.

Pregnant cows required to obtain desired calving interval: Using the days-in-milk at last entry date and the desired calving interval selected by management, this worksheet calculates the percent of herd that must be confirmed pregnant to achieve the desired calving interval and is listed under Percent of Herd Confirmed Pregnant for National SRS Goals. The actual number of cows confirmed pregnant is listed under Current Status.

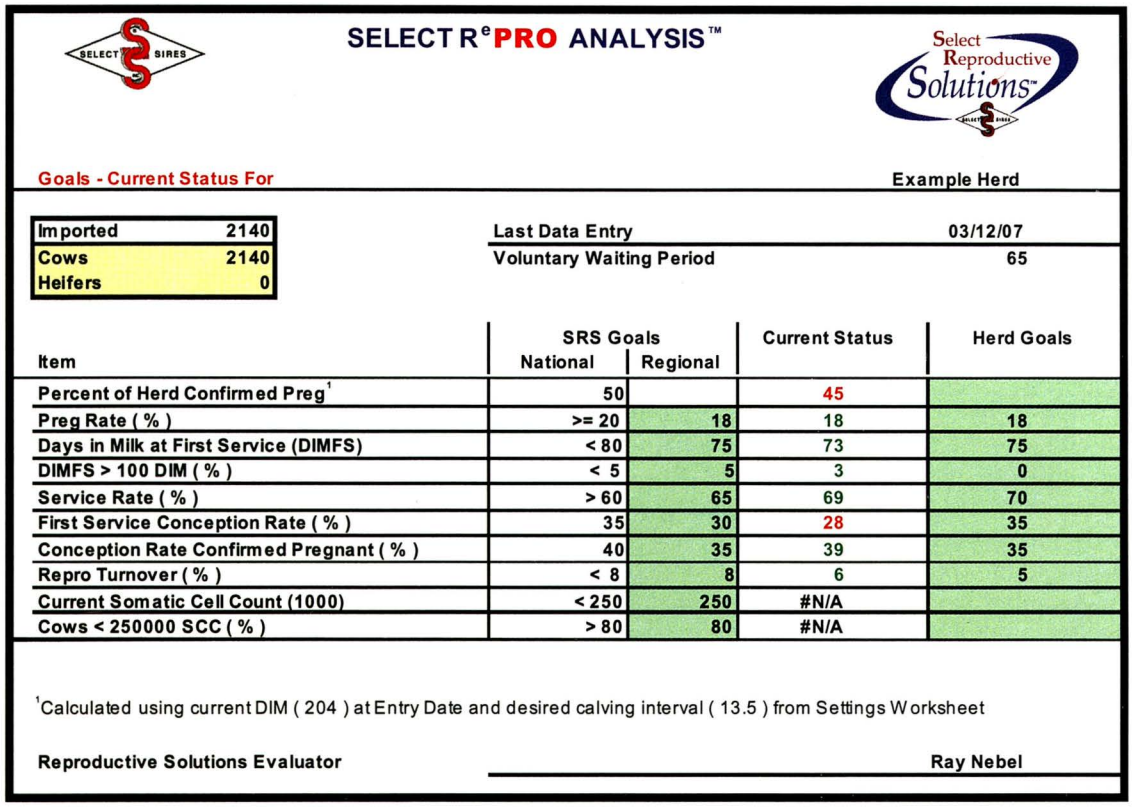
Cumulative 21-day Pregnancy Rate (%): While no single parameter is perfect, it is our opinion that 21-day pregnancy rate (%) is the single best tool for assessing both historical and present reproductive performance. Pregnancy rate is the reproductive performance benchmark that incorporates service rate and conception rate in a timely fashion, and should be the cornerstone of performance evaluation. Pregnancy rate is defined as the probability that an eligible cow will become pregnant within a given 21-day period. Pregnancy rate can be summarized by parity and days-in-milk using VWP as the starting point, or using trend analysis by date. Pregnancy rate can be calculated regardless of whether AI, natural service, or a combination is used. If pregnancy rate is lower than desired, either CR or service rate or both need improvement.

Days-in-Milk at First Service (DIMFS): Is the average DIM at first service, and should be combined with a scatter graph (Figure 1) that displays the variation in DIMFS.

DIMFS > 100 DIM (%): Allows for assessment of number of cows that were usually exceptions to the first-service protocol.

Service Rate (%): Percent of eligible cows inseminated in a defined period of time, typically 21 days.

First-Service Conception Rate (%): First-service CR is a measurement that combines the effects of semen quality, fertility of the cow, AI technique and timing of insemination, as well as such factors as high environmental temperatures and cow comfort. First-service CR contains all cows, problem breeders and reproductively normal cows. Most dairy record systems allow CR to be stratified by parity, service number, technician, sire, days-in-milk, breeding trigger, day of the week, or calendar month.



SELECT R[e]PRO ANALYSIS™

Select Reproductive Solutions

Goals - Current Status For: Example Herd

Imported	2140
Cows	2140
Heifers	0

Last Data Entry: 03/12/07
Voluntary Waiting Period: 65

Item	SRS Goals National	SRS Goals Regional	Current Status	Herd Goals
Percent of Herd Confirmed Preg[1]	50		45	
Preg Rate (%)	>= 20	18	18	18
Days in Milk at First Service (DIMFS)	< 80	75	73	75
DIMFS > 100 DIM (%)	< 5	5	3	0
Service Rate (%)	> 60	65	69	70
First Service Conception Rate (%)	35	30	28	35
Conception Rate Confirmed Pregnant (%)	40	35	39	35
Repro Turnover (%)	< 8	8	6	5
Current Somatic Cell Count (1000)	< 250	250	#N/A	
Cows < 250000 SCC (%)	> 80	80	#N/A	

[1]Calculated using current DIM (204) at Entry Date and desired calving interval (13.5) from Settings Worksheet

Reproductive Solutions Evaluator: Ray Nebel

Figure 3. A representative Goal Sheet containing Current Reproductive Status and various goals utilized in the Select RePRO Analysis ™ program, with data from a 2140-cow herd.

Conception Rate Confirmed Pregnant Cows: are the most fertile cows on the farm, and should be higher than CR at first service.

Repro Turnover (%): is the percent of DNB in the herd. Excessive turnover can influence or mask many of the reproductive parameters used in evaluating reproductive performance. It is important to know if cows removed from the herd are included in the calculations of a parameter, such as days to first service and conception rate. It is also important that all cows removed from the herd are designated in the correct category (mastitis/udder, disease/injury, reproduction, low production, lameness of feet/legs and others).

Current Somatic Cell Count (SCC) (%): Takes an average for cows in their second and third DHI test periods, which usually correspond to the first four breeding cycles.

Cows < 250,000 SCC (%): Identifies the percent of "normal" cows in the herd.

Pregnancy Inventory or Pregnancy "Hard Count"

A popular monitoring scheme is the concept of hard counts of pregnancy inventory (Figure 4). The basis for this approach is that for a herd to maintain its size, a minimum number of calvings per week (or period used for pregnancy determination) is necessary. For non-seasonal herds with stable cow numbers, simply divide the number of cows by either the current calving interval or desired calving interval to obtain the number required. To obtain a weekly number for herds that examine cows weekly, divide the monthly total by 30 (average days in a month) and multiply this number by 7 to receive a weekly figure. If the culling of the lactating herd is 33%, then 33% of the herd replacements must be supplied by heifer calvings. Pregnancy hard count does consider the number of eligible cows, and many herds do not maintain a stable number of calvings or herd size. Twenty-one-day pregnancy rate is a superior monitor; however, many managers and herdsman like a target number for comparison during pregnancy exams.

Compliance

By definition, compliance is satisfying requirements. Compliance on the dairy will be defined here as the administration of treatments or actions according to a prescribed protocol. The more complicated a proto-

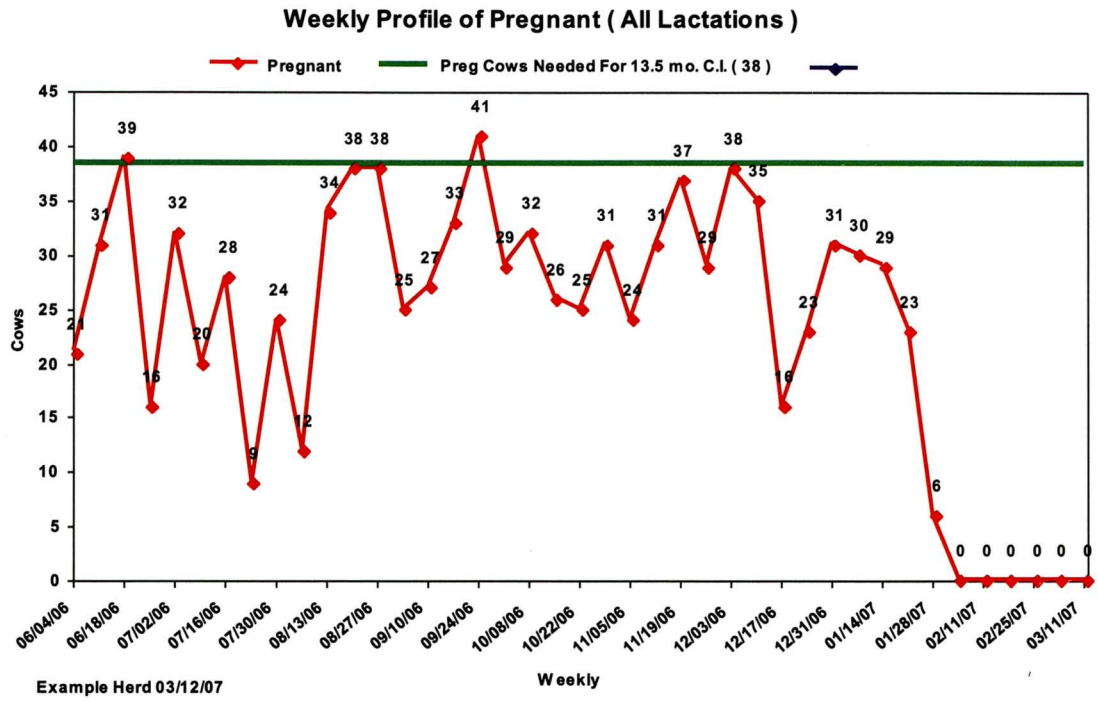


Figure 4. Weekly count of new pregnant cows required to maintain a stable herd size on a 2140-cow herd that has a 13.5-month calving interval.

col, the greater are the chances for procedural failure. Protocol compliance is critical for success. For example, the standard Presynch + Ovsynch protocol requires that each cow receive five hormone injections at appropriate days-in-milk, and in the correct sequence. Failure to administer any one of these five hormones, or administration in an incorrect sequence, will result in a failure of the protocol to deliver an ovulated ova following insemination. There are two types of monitoring points for compliance: execution of the event itself, or the resulting outcome from that action that is related to the process. Most reproductive monitoring is performed on the resulting action, which is indicated by the DIMFS, serum progesterone levels at time of injection or insemination, and finally pregnancy rates in the subsequent 21-day cycles. The scatter plot of DIMFS versus calving date (Figure 1) is a great tool, as it has no statistical lag but it examines a secondary event, which is the endpoint of insemination.

The Dairy Wellness Plan Manager software created by Pfizer Animal Health contains a metric called "compliance", which is defined as percent of eligible cows that have been inseminated within 10 days following the VWP of the herd. For a herd that utilizes visual observations for detection of estrus, this would equate to a 100% service rate. The metric is really designed to evaluate performance of a herd using a 100% timed AI (TAI) program. This metric of compliance allows for seven days of enrollment of eligible cows (weekly cohort groups) and adds three days for "early heat cow."

Serum samples systematically collected from individual cows have been proposed as a method to determine synchronization compliance. If a herd is using a presynchronization protocol, which consists of two sequential prostaglandin administrations 12 to 14 days apart, theoretically 90% or more of the cows should have an active corpus luteum (thus, "high" progesterone) at the initiation of the Ovsynch or Cosynch portion of the protocol using gonadotropin releasing hormone. A cow with "low" progesterone would indicate either anestrus or failure of prostaglandin injection compliance. Additional blood sampling should be performed if >15% of the samples reveal low progesterone levels. Paired sampling for progesterone analysis at the start of Ovsynch protocol, combined with serum harvested at time of insemination, should result in a "high – low" progesterone profile if injections were given in correct sequence and interval, and if the cow responded as expected.

Records and progesterone assays monitor secondary signs of compliance to determine compliance level. Radio Frequency ID (RFID) has the capability to provide real-time monitoring of compliance for synchronization protocols. Currently, RFID technology using a Bluetooth wand that transmits to a pocket PC can store an entire herd's database. The device can access each individual cow record and provide an audible command

for the next action or required hormone injection according to the specific protocol. RFID technology may well represent the next major break through in dairy management.

Conclusion

While there is no one reproductive parameter that "tells the whole story", average 21-day pregnancy rate provides the most information regarding overall performance, and should be the starting point when evaluating dairy herd reproductive efficiency. The 21-day pregnancy rate calculation allows an appraisal of not only how well cows are conceiving, but also how quickly. Optimizing rather than maximizing CR should be the focus and because of binominal variation, sufficient numbers of inseminations should be required prior to changes in procedures and protocols. The management of a particular dairy must decide the specific protocols to be used to meet their established goals. Together, the protocols selected by management will become the planned reproductive program. The objective of monitoring reproductive records is to look for opportunities to improve the level of herd performance, either by accomplishing tasks better or more efficiently. Evaluation of reproductive records should answer three important questions: 1) Historically, how has the herd performed? 2) How is current pregnancy production? and 3) What does the near future hold for generation of pregnancies? Managing a dairy is entirely about compliance to protocols, and applies to all areas such as feeding, milking, fresh cow and transition group management, as well as reproduction.

Suggested Reading

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