Reproductive Status of Dairy Herds in Alberta: A Closer Look

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Take Home Messages

- Reproductive status of 637 dairy cows from 23 dairy herds in Alberta was closely monitored, based on milk progesterone concentrations, from calving until about 125 days postpartum. Whole herd DHI records were also analyzed to evaluate the reproductive performance of 21 herds.
- Although 75% of the cows had reinitiated their estrous cycles by 6 weeks after calving, and 90% by 9 weeks, more than 50% of the cows had not been inseminated for over 11 weeks after calving.
- The overall conception rate to first insemination in the 637-cow population was 38.4%, and cows that had their first ovulation within 3 weeks of calving had the highest conception rate to first insemination.
- Only 43% of the eligible cows were pregnant by 125 days after calving.
- Anestrus (cows not returning to heat after calving) does not appear to be a major problem in Alberta herds as the incidence was only 4%.
- Based on whole-herd DHI data analysis of 21 herds, the 21-day AI submission rate was only about 37%.
- The inter-breeding interval (between 1st and 2nd AI) averaged 42 days.
- Thus, undetected heats, poor AI submission rates, and long inter-breeding intervals are significant problems that contribute to poor reproductive efficiency.
- Aggressive heat detection, implementation of a systematic Ovsynch/ timed AI program, close monitoring of cows during the early postpartum period, and increased frequency of reproductive examinations are all strategies to increase pregnancy rates.

▪ Introduction

Much has been said and written about the issue of declining fertility in dairy cows, not only in North America (Lucy, 2001; Westwood et al., 2002) but also in other parts of the world (Macmillan et al., 1996; Royal et al., 2000). While conception rate to the first service after calving has decreased by 0.4% per year in the 20 years since the mid 70's in the USA (Beam and Butler, 1999), in Europe, the decline in conception rate appears to be of a greater magnitude (Hoekstra et al., 1994; Jorritsma and Jorritsma, 2000). One report indicates that the conception rate to first service has declined by about 1% per year, from 56% between 1975 and 1982, to about 40% between 1995 and 1998 (Royal et al., 2000). According to a recent Canadian report (Bousquet et al., 2004), the fertility in Eastern Canadian dairy herds has declined by approximately 5% in the 10 years between 1990 and 2000, which is very similar to what has been reported in the USA.

In herds using artificial insemination, accurate heat detection is very important for reproductive success. One Canadian study (Kinsel and Etherington, 1998) found that the heat detection rate (HDR) in Ontario herds during the early 1990's was only 48%. More recently, Dr. Stephen Leblanc (University of Guelph) reported, at this seminar, that the average Canadian dairy herd has a HDR of only 33% and a conception rate of 38% (Leblanc, 2005). Although calving interval and average days open are commonly used reproductive indices to compare herd performances, both of these indices are not highly reliable (Leblanc, 2005; Stewart et al., 1994). However, pregnancy rate is considered to be a reliable index of overall reproductive performance on a whole herd basis (Leblanc, 2005). Pregnancy rates for Canadian dairy herds over the 6-yr period of 1999 to 2004 have remained relatively constant at about 13% (Leblanc, 2005).

In the late 1980's one study conducted in British Columbia involving 27 dairy herds found that fertilization failure and early embryo mortality were the most probable causes of reproductive losses (Rajamahendran et al., 1993). Though no study has been conducted in Alberta using objective measures of reproductive status, a mail-in survey conducted in Alberta over 13 years ago identified inadequate estrus detection as a possible reason for poor reproductive efficiency (Spicer et al., 1994) in Alberta dairy herds.

Major changes have occurred in the dairy industry in the past 10-15 years. The number of herds has declined dramatically over the past decade, resulting in significantly larger herds. For example, the number of dairy farms in Alberta has declined from over 1100 in 1997 to about 700 in 2006. Over the same period, the average herd size has increased from about 65 to over 100 cows. As dairy herd sizes increase, the cow-to-person ratio also increases considerably, in most instances. This trend will only further compromise the reproductive efficiency of dairy herds as fewer people are available to perform important chores like heat detection. Considering that dairy cow fertility continues to decline, it is important to determine the current status of reproduction and identify the key contributors to poor reproductive efficiency, so that suitable remedial measures could be initiated. Although a reasonable evaluation of reproductive status could be made from DHI records, it is often difficult to identify the underlying problems. An objective evaluation of reproductive status, on the other hand, will provide valuable insights to address the problem of poor reproductive efficiency.

With this in mind, we evaluated the reproductive status of Alberta dairy herds adopting three different approaches. A description of the research, its main findings, and potential strategies to address the issues identified, are presented in this paper.

■ Description of the Research

Reproductive Status Evaluation Using Milk Progesterone

The first approach was to determine reproductive status of dairy herds through the evaluation of milk progesterone concentrations. Progesterone is an important reproductive hormone, which can be measured to evaluate reproductive status of individual cows. Approximately 200 dairy producers across the province of Alberta were contacted by telephone/fax, requesting their participation. Twenty-three producers agreed to participate in the study that was conducted between October 2004 and April 2006. Approximately 30 cows from each herd were included in the study over 3 consecutive periods (clusters of 10 cows during each period) extending over a calendar year. In this manner, milk samples, and health and reproductive records from a total of 637 lactating dairy cows were obtained and used in the analysis.

Milk samples were collected twice a week (Mon/Thu or Tues/Fri) starting approximately 7 d after calving until 120 d. Samples (hand-stripped) were collected by the milker / herdsperson, just prior to attaching the milking unit, into pre-labeled containers provided by the project staff. Samples were kept frozen until picked up or shipped to the laboratory. Milk samples from 7 to 90 days after calving (approximately 15,000 samples) were analyzed for progesterone concentrations. Milk samples were also obtained on the day of insemination from 266 cows to determine the accuracy of heat detection.

Complete data were available for 569 of the 637 cows. Data were missing for 20 cows, 20 cows were culled during the project, 4 cows were dried-off, 18 cows were sold, and 6 cows died. Interval from calving to first rise in progesterone (indicative of the first ovulation after calving, and the initiation of cyclicity) was calculated. Also, length of the first estrous cycle and number of estrous cycles before first insemination occurred were also determined and incorporated in the statistical analysis.

Reproductive Status Evaluation Based On DHI Data:

In the second approach, in addition to the information relating to the 30 cows from each herd, production, health, and reproduction-related data for the whole herd were obtained through CanWest DHI, with the consent of the participating producers, for the Years 2004, 2005 and 2006.

DHI data were downloaded electronically, from CanWest DHI, into a DairyComp 305 Advisor software package. For the purpose of this paper, reports were generated using various BREDSUM commands only. Heat detection rate, conception rate, and pregnancy rate by 21-day intervals were generated for each herd using the BREDSUM\E command. The effects of the month of insemination (BREDSUM\C), number of inseminations (BREDSUM\B) and lactation were also generated and analyzed statistically.

Reproductive Status Evaluation by Ultrasonography:

In the third approach, we closely monitored the reproductive tracts of 72 cows by transrectal ultrasonography in one dairy herd. Ultrasound examinations were performed three times each week starting 7 days after calving until the confirmation of two consecutive ovulations.

The ultrasound data were used to determine the interval to first ovulation, interval between first and second ovulation, and the size of the preovulatory follicle. Other data gathered included the interval from calving to uterine involution (return of the previously pregnant uterus to its normal size), and the outcome of the first insemination.

Throughout this paper, data are reported as means ± SE. Probability values $\leq$ 0.05 were considered significant. A tendency toward significance was indicated if $P \leq 0.1$ but > 0.05.

▪ Findings Based On Milk Progesterone Analysis (23 Herds; 637 Cows)

Onset of Cyclicity after Calving

The overall interval from calving to first rise in progesterone (indicative of ovulation and reinitiation of cyclicity) was 32.0 $\pm$ 0.7 days; however this interval varied from 5 to 113 days. The cumulative percentages of cows initiating cyclicity by 3 wk, 6 wk, 9 wk, and $>$ 9 wk after calving were 27, 75, 90, and 96%, respectively (Figure 1). Only a small proportion of cows (28/637 or 4.4%) did not show cyclic activity during the study and were considered anestrus.

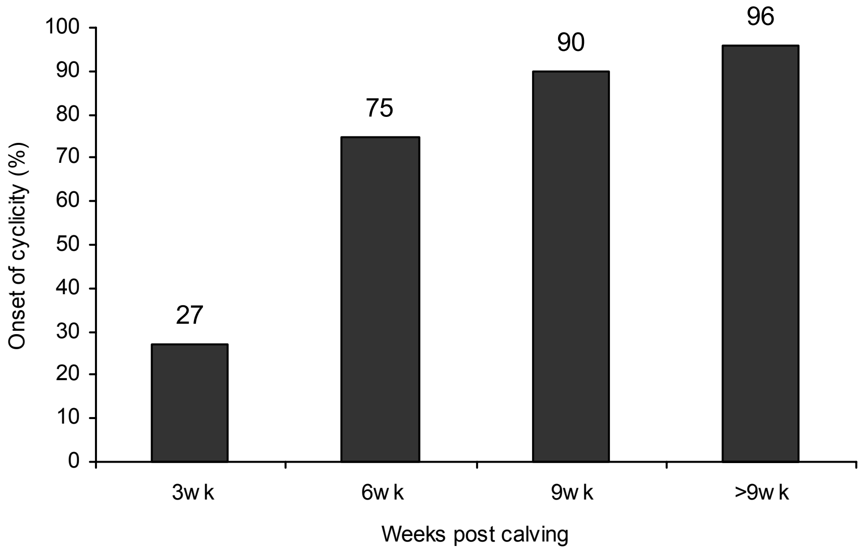

Figure 1. Onset of cyclicity in dairy cows by 3, 6, 9, and >9 weeks. Data presented as cumulative percentages.

Length of Estrous Cycles

In 42% of the cows, the first estrous cycle was of short (<17 d) duration; 45% of the cows had estrous cycles of normal (17 to 24 d) duration, and 13% of the cows had prolonged (> 24 d) estrous cycles.

Submission Rate

The average interval from calving to submission for first insemination was 88.5 ± 1.4 d (range 32 to 267 d). The percentage of animals submitted for breeding by 80, 100 and 125 d after calving were 42, 62 and 77%, respectively. Twenty-three percent of the cows (n=143) were not submitted for breeding during the period of the study (i.e., for up to 125 days after calving). Of these, 108 cows (76%) were eligible to be bred and stayed in the herd until the end of the project; yet, they had not been inseminated even once during that period. Looking more closely at the milk progesterone profiles of these 108 cows, we found that 50% of the cows had normal estrous cycles, 32 % had irregular estrous cycles, and 18% were not cycling.

Accuracy of Heat Detection

Two-hundred-and-sixty-six samples of milk were obtained on the day of insemination to determine the accuracy of heat detection. Progesterone concentration is very low when a cow is in heat, and gradually increases following ovulation. If the progesterone concentration is higher than 1.0 ng/mL at the time of insemination, the probability of a cow conceiving to that insemination is very low. Of the 266 samples collected on the day of insemination, only 11% had progesterone concentrations higher than 1 ng/mL suggesting that 89% of the cows submitted for insemination were in a stage conducive for conception to occur. Thus, even though only a small percentage of cows eligible for breeding were detected in heat, about 90% of the cows detected in heat (or otherwise submitted for insemination; i.e. timed insemination) were truly in heat or in a physiological state conducive for conception.

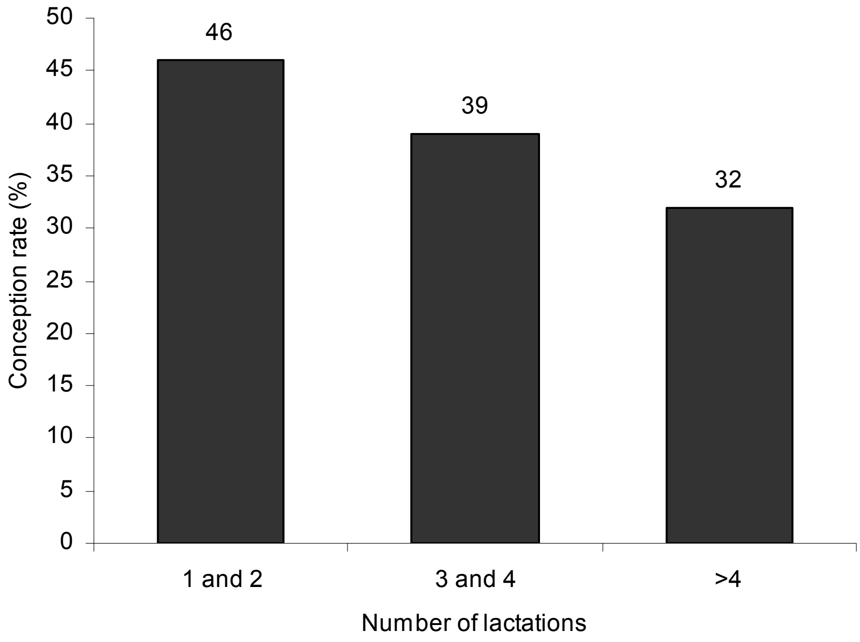

Figure 2. Percentage of cows that conceived to the first breeding by number of lactations. Cows with more than 4 lactations had the lowest (P < 0.03) conception rate to first breeding.

Conception Rate

For the cows that were followed closely (through milk progesterone analysis), the overall conception rate to first service was 38.4%. The conception rate to first service was influenced by parity (P<0.03; Figure 2), with higher conception rates in younger cows compared to more mature cows. The conception rate to first service was also influenced by the interval from calving to first ovulation and cyclic activity (P<0.03; Figure 3), and progesterone concentration at insemination. Cows with reproductive disorders or mastitis during the postpartum period tended (P<0.1) to have lower conception rate to first breeding (Figure 4).

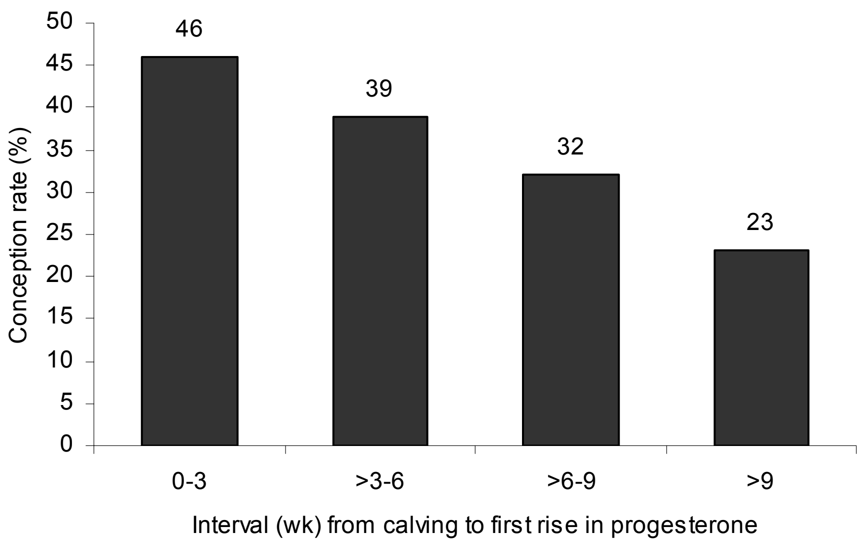

Figure 3. Percentage of cows that conceived to the first breeding, by interval (wk) from calving to first rise in progesterone. The first noted rise in progesterone is an indication that the cow had been in heat and ovulated. Cows that had the first rise in progesterone within 3 weeks after calving had the highest (P < 0.03) conception rate to first breeding.

The percentage of animals pregnant by 80, 100 and 125 d after calving were 18.0, 31.0 and 42.6%, respectively. The proportion of cows pregnant by 125 d postpartum was affected by lactation number (Figure 5) and reproductive disorders during the postpartum period (Figure 6).

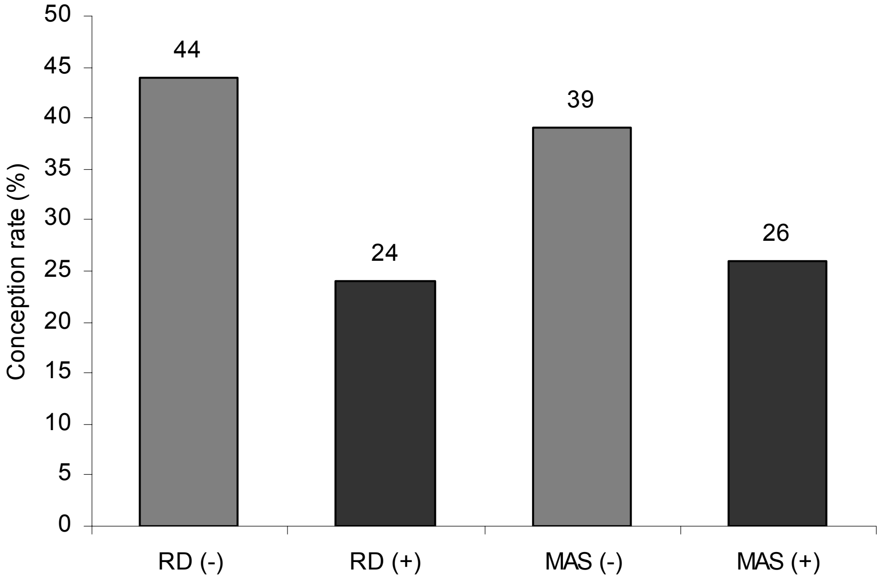

Figure 4. Percentage of cows that conceived to the first breeding by incidence of reproductive disorders or mastitis during the postpartum period. Cows that had reproductive disorders [RD (+)] or mastitis [MAS (+)] during the postpartum period tended (P = 0.1) to have lower conception rate than those that did not have reproductive disorders [RD (-)] or mastitis [MAS (-)].

Inter-Breeding Interval

A total of 259 cows were bred either two (n = 205) or three (n = 54) times during the study. The interval from first breeding to second breeding was on average 41.6 ± 1.7 d (range 1 to 147 d). Only 58 (28.3%) cows were rebred within 17 to 24 d after first breeding. Conversely, 65.0% of cows were rebred beyond 24 d after first breeding. The average interval from second to third breeding was 34.2 ± 2.9 d (range 1 to 97 d). The percentage of cows rebred within 17 to 24 d after second breeding was 27.7%.

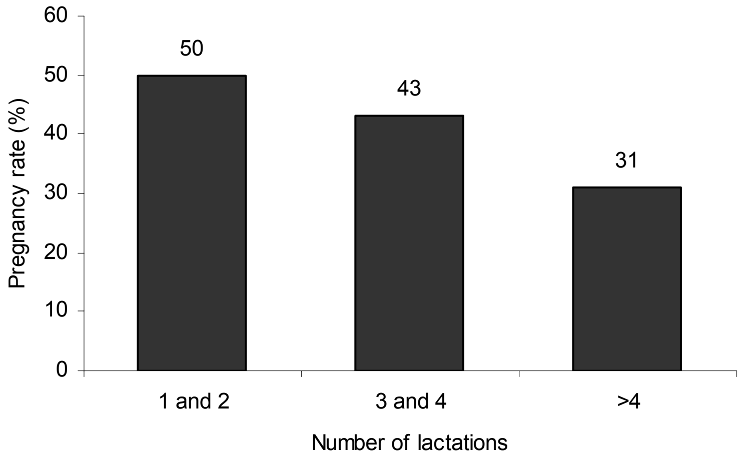

Figure 5. Percentage of pregnant cows at Day 125 after calving by number of lactations. Cows with more than 4 lactations had the lowest pregnancy ($P < 0.01$) rate by 125 days after calving.

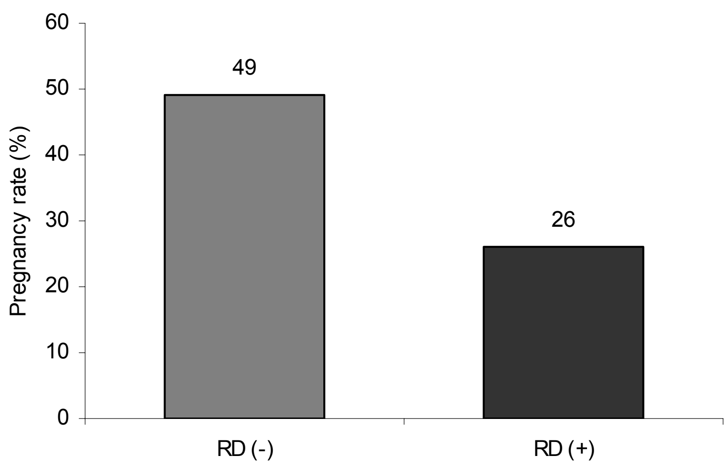

Figure 6. Percentage of pregnant cows at day 125 after calving by incidence of reproductive disorders or mastitis during the postpartum period. Cows that had reproductive disorders [RD (+)] during the postpartum period had ($P < 0.01$) lower pregnancy rate than those that did not have reproductive disorders [RD (-)].

▪ Findings Based On DHI Data Analysis (21 Herds; 3 Years)

21-Day Submission Rate, Conception Rate, and Pregnancy Rate

The 21-day submission rate, conception rate, and pregnancy rate all differed significantly among dairy herds. The submission rate ranged from 18.2 to 49.6%. Even though the overall submission rate of 34.7% for Year 2004 was lower (P<0.01) than the mean submission rate of 37.9% for Years 2005 and 2006, conception rates and pregnancy rates were not different for the 3 years.

The 21-day conception rates ranged from a low of 18.5% to a high of 46.5%. The mean 21-day pregnancy rates ranged from 3.8% to 19.9%. Conception rate by month differed significantly, ranging from 33.4 to 47.5% (Figure 7). The mean conception rate was highest during the winter months of December, January and February (45.7%) and was the lowest (35.5%) during the fall months of September, October and November. We recently reported (Ambrose et al., 2006) that conception rates were lower during the summer months in one herd in Alberta, after analyzing insemination records over a period of 5 years. However, in the present study conception rates were not significantly affected during the summer months, but the lowest conception rates were recorded for the months of September through November. It is possible that cows that were exposed to higher ambient temperature in the summer months manifest a carry over effect. Typically, ovarian follicles grow over a period of several weeks. Exposure to elevated temperatures during this phase may lead to the lower fertility in the fall months, as follicles that were developing during the warm season will be the ones that ovulate during the fall months.

The number of inseminations had no bearing on the conception rate. That is, the probability of conception did not differ regardless of whether it was the first insemination or the eighth insemination.

Abortions

Abortions were influenced by season. A greater proportion of cows aborted in the cooler months of the year (December through April) whereas the lowest proportion of abortions occurred in the months of September and October (Figure 7). While parity (# of lactations) did not influence conception rates, it affected abortion rate. Cows in their second lactation had a lower rate of abortion than cows in their third lactation (Figure 8).

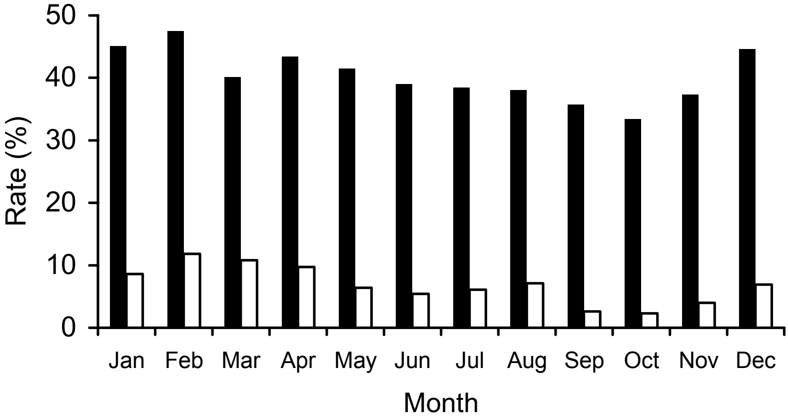

Figure 7. The mean conception (black bars) and abortion rate (white bars) of cows within herds distributed by month, based on CanWest DHI data from 21 herds. Conception rates were lower (P < 0.05) in the fall months (Sep, Oct, Nov) relative to the winter months (Dec, Jan, Feb). A higher proportion of cows aborted in the cooler months of the year (Dec, Jan, Feb, Mar, Apr) whereas the lowest proportion of abortions occurred in September and October.

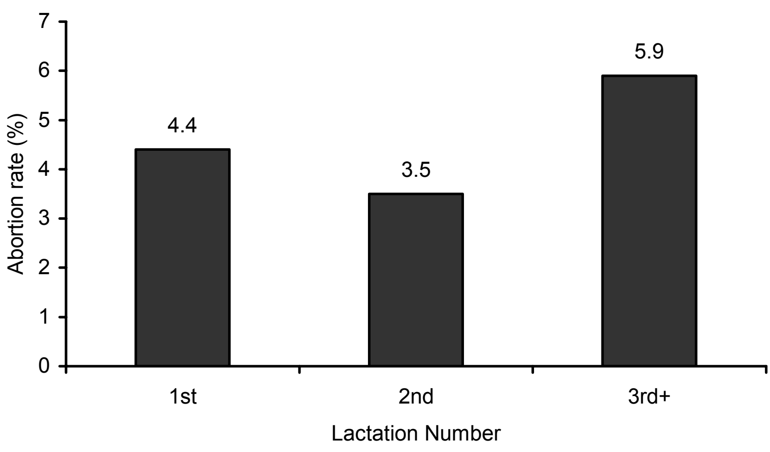

Figure 8. The mean proportion of abortions as distributed by lactation number, based on CanWest DHI data from 21 herds over a 3-year period. Mature cows (i.e., 3 or more lactations) had an increased risk of abortion compared to cows in their 2nd lactation (P<0.02).

▪ Findings Based On Ultrasonography (1 Herd; 72 Cows)

The interval from calving to the completion of uterine involution (return of the uterus to its normal size after calving; Figure 9) was determined by ultrasonography (US). If uterine involution was not completed by day 45 after calving, cows were treated with prostaglandin F2α (PGF). In total, 6 (8.3%) cows received PGF, 3 of those had retained placenta (RP). In the cows that had RP or uterine infections, the interval from calving to uterine involution was 32.0 days versus 24.6 days in cows that had no RP or uterine infections. Mastitis and metabolic disorders did not influence the interval to uterine involution. The incidence of RP or uterine infections, mastitis, and metabolic disorders were 18.0, 9.7 and 6.9%, respectively.

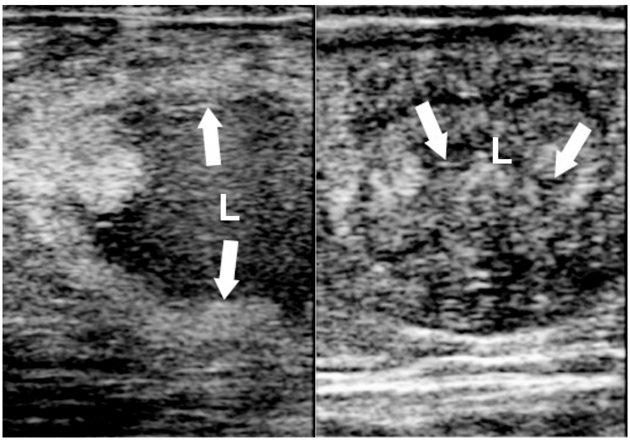

Figure 9. Ultrasound images of the postpartum cow uterus. Both pictures represent the uterus 23 days after calving. The panel at the left shows an enlarged uterus with the uterine cavity or lumen (L) filled with pus. The panel at the right shows an involuted uterus. The arrows indicate the lumen of the uterus in both panels.

Overall mean ± SE for interval from calving to first ovulation was 30.5 ± 1.9 d (range 10 to 81 d). Retained placenta or uterine infections did not affect the interval from calving to first ovulation. However, first ovulation occurred 12 d earlier ($P < 0.05$) in cows that had a dominant follicle of ≥ 10 mm diameter at first US examination (i.e., 7 ± 1 d after calving). Cows with RP or uterine infections tended to have a smaller follicle at first US examination than those without postpartum reproductive disorders ($P < 0.1$; 7.0 *vs.* 8.7 mm in diameter, respectively).

Conception rate at first insemination was significantly influenced by parity, with first lactation cows having higher ($P < 0.02$) conception rates (55%) than other categories (18.7 and 25.6 for 2^{nd} and $\geq 3^{rd}$ lactation cows, respectively). In cows that had RP or uterine infections the conception rate was 46.2% *vs.* 22.3% in cows that had no RP or uterine infections ($P < 0.1$). Though we expected that RP or uterine infections would have a significant detrimental effect on conception rate, in this particular study, we did not see such an effect, possibly due to the small population size (note: only 18% of the 72 cows had RP or uterine infections).

Also, the conception rate in cows ovulating during the first 4 weeks after calving (42.3%) tended to be higher ($P < 0.10$) than in those that had the first ovulation later in the postpartum period (26.2%).

▪ So What? Can Something Be Done To Address These Issues?

Submission (To AI) Rate Can Be Improved

Many of our findings are not new. The poor 21-day submission (to AI) rate of 35-38%, though not a big surprise, must be improved to the 50-60% range if we are serious about improving the reproductive efficiency of our dairy herds. The fewer cows we detect and breed, the lower will be the herd pregnancy rate. Although submission rate, conception rate, and pregnancy rate varied considerably among herds, in the present study, the mean 21-day conception rates were in the range of 33 to 48%. Because the opportunity to make significant improvements in conception rates is minimal, the only reasonable way of improving pregnancy rates at the herd level is by increasing the submission (to AI) rates. To make this happen, we need to do more aggressive heat detection. Modern high producing lactating cows have shorter duration of estrus (heat); hence methods other than only visual observation should be implemented.

Based on the milk progesterone tests conducted on samples collected on the day of insemination, we can conclude that the accuracy of heat detection is quite acceptable, at nearly 90%. However, there is a huge opportunity to improve heat detection as only less than 40% of all eligible cows are being submitted for insemination at any given 21-day period.

Treatments with PGF and heat detection aids may improve submission rate but require additional management and heat detection is still needed. Where increasing the heat detection efficiency is not possible, alternative approaches such as fixed timed insemination (e.g. Ovsynch/timed AI) can be adopted to improve the submission rate. Although Ovsynch/timed AI programs will not improve the conception rate (actually, in some cases conception rates to

Ovsynch/timed AI are slightly lower than that following AI at detected estrus; Ambrose et al., 2006), a systematic implementation of Ovsynch/timed AI program will greatly improve submission rates. As more cows are inseminated, overall herd pregnancy rates will improve, assuming that conception rates remain relatively constant within a herd, and within an acceptable range.

Inter-Breeding Interval Can Be Reduced

The intervals between 1st and 2nd breeding, and between 2nd and 3rd breedings were 42 days and 34 days, respectively, with a range of 1 to 147 days. A cow that is assumed to be pregnant, but not actually pregnant, is an economic liability to the dairy producer. The Australians call this type of cow "phantom cows". What can we do to reduce the interval between breedings so that there are fewer "phantom cows" in the herd?

One approach is to do early pregnancy diagnosis. Unfortunately, we do not have any reliable cow-side milk or blood test for early pregnancy diagnosis at the present time. However, the use of ultrasound can provide an accurate diagnosis of pregnancy around 28 days after insemination. Though not many veterinarians presently use ultrasound, it certainly is a very useful diagnostic tool for detection of early pregnancy. Not only that, an ultrasound examination, which usually takes no longer than 2 or 3 minutes, can also tell if the embryo is alive or dead (based on visualization of the embryo's beating heart). Such an approach would greatly help in quickly identifying cows that are open so that they can be given prostaglandin or placed on an Ovsynch/timed AI program and rebred in a timely manner.

If ultrasonography is not an available option, scheduling more frequent (e.g. weekly) herd health visits with your veterinarian is an alternative. Most practitioners can accurately diagnose pregnancies by palpation per rectum at 35 days after insemination. Thus, increasing the visit-frequency of your veterinarian to perform reproductive examinations can reduce the inter-breeding intervals through early identification of non-pregnant cows.

In dairies where cows are loose-housed or kept in free-stall barns, even simple measures such as the application of tail-chalk / tail-paint / Kamar-type device to cows that were inseminated approximately 2-3 weeks earlier can greatly assist in catching cows that may be returning to heat.

The use of systematic resynchronization protocols for timed AI combined with early pregnancy diagnosis would significantly reduce the inter-breeding interval. A resynchronization program involving the use of an intravaginal progesterone device (CIDR) within an Ovsynch-type protocol is being recommended in the United States, but at the present time this protocol is unavailable for use in Canada as the use of CIDR in lactating dairy cows is presently not approved. The development of a dependable protocol to resynchronize second breeding is an area of current research.

Cows Must Be Monitored Closely During the Early Postpartum Period

As reported by several researchers in the past, we found that reproductive disorders (e.g. retained placenta, uterine infections) and mastitis have a negative effect on conception rate at the first insemination. Also, uterine involution was significantly delayed in cows that suffered from retained placenta or uterine infections. Considering these, it is important to observe cows more closely during the early postpartum period. Any suspected cases of reproductive disorders / mastitis should be brought to the attention of the herd veterinarian to allow treatment interventions (if necessary) at the earliest. Again, if more frequent herd visits can be arranged with your veterinarian, it can offer advantages in this aspect as well.

Cows that start cycling early after calving have a greater likelihood of conceiving sooner. Therefore, any means of inducing early cyclicity (e.g. PGF, GnRH treatments, etc.) should be considered by consulting your veterinarian.

Mature Cows Need More Attention

It is clear from the findings of this study that parity (number of lactations) has a definite effect on conception and abortion rates. As reported by others (Balendran et al., 2006; Grimard et al., 2006) conception rates were lower in mature cows compared to those in their 1st lactation. Thus, reproductive evaluations during the early postpartum period must be improved for mature cows. The probability of abortion was significantly higher in mature cows compared to younger (first or second lactation) cows, which calls for more frequent monitoring of established pregnancies in this group of cows. A more aggressive approach to improve the AI submission rate of the mature cows should also improve overall reproductive efficiency at the whole herd level.

Nutritional Management Strategies

As discussed above, recent studies indicate that first lactation cows have higher conception rates than mature cows. What could be the reason for this? In general, it seems logical to expect lower fertility in younger cows as they would have greater energy demands than older cows; the available energy must be partitioned not only for maintenance and milk production, but also for growth as young cows are still in a growing phase. A consequence of this is a deeper state of negative energy balance. It is widely reported that a state of negative energy balance is detrimental to reproductive function. While this may still be the case, clearly, the reproductive processes in the first lactation cows do not appear to be affected as badly as in mature cows. This brings us to think about the transition period, which is the period that immediately precedes and follows calving. Is there anything different in the diets between heifers and cows during the transition period that may be influencing the postpartum reproductive events? Are there things that we can do during the transition period that may be beneficial for reproduction? These are areas of current research at the Dairy Research and Technology Centre.

For example, it has been shown that the inclusion of polyunsaturated fatty acids of flaxseed origin in the diets of dairy cows improved fertility by increasing conception rates (Ambrose et al., 2006b) and by reducing pregnancy losses (Ambrose et al., 2006b; Petit and Twagiramungu, 2006). We have also shown that dietary unsaturated fatty acids can enhance embryonic development in dairy cattle (Thangavelu et al., 2006). While these are exciting new findings of considerable practical value, continued research in this important area of nutritional management of reproduction is essential as it holds much promise for the future, and will likely provide the answers we are looking for.

▪ Conclusions

Based on our findings we conclude that undetected estrus, poor AI submission rates, and prolonged inter-breeding intervals are significant contributors to poor reproductive efficiency. However, postpartum anestrus (cows not cycling) was not identified as a major problem. Mature cows had lower conception rates, and also had a greater risk of abortion than younger cows. Retained placenta, uterine infections, and mastitis contributed to poor fertility.

Increased emphasis should be placed on improving the efficiency of estrus detection, and on preventing (or the early detection and treatment of) postpartum infections. Although the scope for a significant increase in conception rate is limited, increasing the insemination (submission) rate through improved estrus detection and implementation of fixed timed insemination programs will improve pregnancy rates in our dairy herds. Increasing the frequency of reproductive examinations can also facilitate the improvement of pregnancy rates.

The potential to develop a new (or to improve on existing) electronic estrus detection tool remains. Likewise, a reliable cow-side test for early detection of open cows would be of considerable value in reducing the inter-breeding interval. These are future research needs.

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References

Ambrose DJ, Govindarajan T, Goonewardene LA. Conception rate and pregnancy loss rate in lactating Holstein cows of a single herd following timed insemination or insemination at detected estrus. J Dairy Sci 2006; 89 (Suppl 1):213-214.

Ambrose DJ, Kastelic JP, Corbett R, Pitney PA, Petit HV, Small JA, Zalkovic P. Lower pregnancy losses in lactating dairy cows fed a diet enriched in α-linolenic acid. J Dairy Sci 2006;89:3066-74 (b).

Balendran A, Nimmo J, Dinn N, Rajamahendran R. Decreased Fertility with Increasing Parity in Lactating Cows. UBC Dairy Education and Research Centre, Research Reports 2005; Vol 5, No 2.

Beam SW and Butler WR. Effects of energy balance on follicular development and first ovulation in post partum dairy cows. J Reprod Fertil 1999; 54:411-424.

Bousquet D, Bouchard E, DuTremblay D. Decreasing fertility in dairy cows: Myth or reality? Proceedings of World Buiatrics Congress, Quebec, Canada 2004.

Grimard B, Freret S, Chevallier A, Pinto A, Ponsart C, Humblot P. Genetic and environmental factors influencing first service conception rate and late embryonic/foetal mortality in low fertility dairy herds. Anim Reprod Sci 2006; 91:31-44

Hoekstra J, Van Der Lught AW, Van Der Werf JH, Ouweltjes W. Genetic and phenotypic parameters for milk production and fertility in upgraded dairy cattle. Livestock Prod Sci 1994; 40:225-232.

Jorritsma H and Jorritsma R. An overview of fertility statistics and milk production data of 15 dairy operations in southeast Friesland. Tijdschr Diergeneeskd 2000; 125:180-184.

Kinsel ML, Etherington WG. Factors affecting reproductive performance in Ontario dairy herds. Theriogenology 1998; 50:1221-1238.

Leblanc S. Overall reproductive performance of Canadian dairy cows: challenges we are facing. Adv Dairy Tech 2005;17:137-147.

Lucy MC. Reproductive loss in high-producing dairy cattle: where will it end? J Dairy Sci 2001; 84:1277-1293.

Macmillan KL, Lean IJ, Westwood CT. The effects of lactation on the fertility of dairy cows. Aust Vet J 1996; 73:141-147.
Petit HV, Twagiramungu H. Conception rate and reproductive function of dairy cows fed different fat sources. Theriogenology 2006;66:1316-24.
Rajamahendran R, Burton B, Shelford J. A field study on the usefulness of milk progesterone determination to confirm estrus and pregnancy of dairy cows in the Fraser Valley area of British Columbia. Can Vet J 1993; 34:349-352.
Royal MD, Darwash AO, Flint APF, Webb R, Woolliams JA, Lamming GE. Declining fertility in dairy cattle: changes in traditional and endocrine parameters on fertility. Anim Sci 2000; 70:487-501.
Spicer HM, Goonewardene LA, McNeil AO, Slack WL. Alberta dairy farm survey response. J Dairy Sci 1994; 77:3460-3472.
Stewart SS, Eicker J, Fetrow J. Analysis of current performance on commercial dairies. Compend Cont Educ 1994; 16:1099-1103.
Thangavelu G, Colazo MG, Ambrose DJ, Oba M, Okine EK & Dyck MK. Early embryonic development in Holstein cows fed diets enriched in saturated or unsaturated fatty acids. Proc 7th Intl Ruminant Reprod Symposium, Wellington NZ, 13-17 Aug 2006; p 50.
Westwood CT, Lean JJ, Garvin JK. Factors influencing fertility of Holstein cows: a multivariate description. J Dairy Sci 2002; 85:3225-3237.