Reproductive management in dairy herds

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Abstract

Reproduction influences farm profitability. Cows should become pregnant between 55 and 115 days postcalving to optimize milk production, calves born per year and minimize culls for reproductive failure. Pregnancy rate, heat (estrus) detection rate times conception, is the critical driver of reproductive efficiency. Economic returns associated with reproduction are optimal when pregnancy rate is > 25%. To achieve a pregnancy rate > 25%, conception rate needs to be > 33% and first insemination heat detection needs to be > 70%. Herd managers should select a voluntary wait period between 50 - 70 days that optimizes conception rate and use a management program to control first insemination intensity. Pregnancy examination should be scheduled to control days between inseminations.

Keywords: Cattle, reproductive management, pregnancy rate

Introduction

Milk sales account for 80 - 90% of income on dairy farms and sale of calves and cull cows account for 10 - 20% of income.[1] Milk sales are a function of the number of cows milking, parity, average days in milk, management, and genetic merit. However, milk production is dependent on the successful birth of a calf, that makes reproduction an essential component of a successful dairy operation. Due to the shape of the lactation curve, peak production is reached by 30 - 50 days postcalving and then declines at a consistent rate; therefore, cows produce milk most efficiently when they calve every 11 - 13 months. Since pregnancy gestation averages ~ 280 days, the goal of reproductive programs on dairy farms should be for pregnancy to occur between 55 - 115 days postcalving. Since uterine involution and resumption of ovarian cycling are not complete until 30 - 50 days postcalving, management programs should begin insemination 50 - 70 days postcalving to achieve optimal intervals between successive calving.

To become pregnant, cows must be inseminated in estrus, that occurs every 21 days in a cow (range; 18 - 24 day).[2] Standing estrus is relatively short, lasting 5.1 - 10.6 hours.[3] Depending on the number of cows around estrus, the number of mounts per estrus period may range from 6.2 - 12.8 mounts per cow.[4] A mount may last for < 20 seconds, so observation to detect a cow in estrus needs to be committed for at least 15 minutes at a time and occur 3 - 4 times in a day.

Various factors influence the intensity of expressed estrus by a cow such as number of cows around estrus, flooring, and level of milk production.[2,3] Having more than 2 cows in estrus increases activity and the probability of observing estrus. Cows with greater milk production have lower serum estrogen, shorter periods of estrus expression, and fewer estrus mounts.[4,5,6]

A major challenge in reproductive management is observing cows in estrus. Average heat (estrus) detection rate for 9,480 herds in the Dairy Records Management Service (DRMS, Raleigh, NC) in the NE is 45.1%. Multiple factors influence efficiency of estrus detection. Housing, flooring, cattle grouping, number of cows in and around estrus, level of milk production, parity, and frequency and intensity of observation all contribute to the probability of observing cows in estrus.[6] However, the major factor in low estrus detection is failure to commit sufficient time throughout the day to detect cows in estrus. Particularly as herds have increased in size and cows are spread across multiple groups, committing labor to just watch for estrus is a low priority on many farms. Many approaches may be employed to improve estrus detection on dairy farms. There is visual observation, heat detection aids, radio telemetry, activity monitors, progesterone biosensors, and estrus synchronization programs.[8-11]

Evaluating the efficiency of estrus detection is important. Estrus detection needs to be quantitated to evaluate the efficiency of a reproductive program. Days open and calving interval are outcomes of management and are not critical control points for reproductive control. Heat detection is the dominant management control point of reproduction and it must be quantitated to assess a program on a dairy farm. Various methods have been used to estimate heat detection rates (HDR) from herd records.[12] A simple method is to distribute first inseminations from the VWP by 21-day periods and calculate the number of animals inseminated within each 21-day period by the number of available animals to inseminate. This will give a value for first insemination heat detection rate (FSTHDR). Distributing days between sequential inseminations by periods < 10, 10 - 17, 18 - 24, 25 - 35, 36 - 48 and > 48 days gives an estimate of estrus detection for repeat inseminations (18 - 24 and 36 - 48 days), heat detection errors (< 10 and 10 - 17 days), early pregnancy losses (25 - 35 days), and gross inefficiency in repeat insemination efficiency (RPTHDR) (> 48 days).

Management has direct control of detecting cows in estrus for insemination. Since pregnancy depends on insemination, cows have to be observed in estrus to initiate reproductive outcomes. Conception, establishing a pregnancy, is the second critical component of a herd program. Conception rate (CR) to first service for 9,480 herds in the DRMS in the NE is 42%. With an HDR of 45% and a CR of 42%, pregnancy rate would be 18.9%. The question is how well does this approach a reproductive optimum?

Ultimately, herd reproductive performance is a function of heat detection rate (HDR) and CR. Since estrus is a periodic event, occurring every 21 days, the combination of HDR and CR define the pregnancy rate (PR), that is the proportion of open cows that become pregnant every 21 days.[13,14] The reported PR from the 9,480 herds in the DRMS records is 19.4%. This is slightly higher than the prior estimate of 18.9%, as culling cows with reproductive problems would result in a slightly higher PR than HDR x CR.

Pregnancy rate determines the economic value of reproduction.[1,14,15] The proportion of cows pregnant every 21 days following the voluntary wait period (VWP) determines the average milk produced per day (due to the shape of the lactation curve and period of recalving), the number of calves born per year, and the number of animals culled for reproductive failure. These contribute to the value of getting a cow pregnant within each 21-day period from the VWP. The proportion of open cows pregnant with each 21-day window sums to determine the overall herd value of reproduction.

Figures 1a and 1b display income over feed cost for PR from 7.5 - 100% for five milk production classes (305 day production): 21,000, 23,000, 26,000, 28,500, and 33,000 lb. Milk price was $20/CWT, calf value was $175/head; heifer rearing cost was $1500/head and cull cow value was $750/head. Lactating cow feed cost was $0.12/lb of dry matter and dry cow feed cost was $0.06/lb of dry matter. Income is higher with greater milk production and pregnancy rate (Figure 1a). Marginal value decreases more steeply when PR is < 25%, whereas the change in value above 25% is less (Figure 1c). Therefore, economically, the goal for herd management is to achieve a 25% PR or greater. Furthermore, with a PR of 19.4%, the average DRMS herd is losing $165 a year due to low reproductive efficiency.

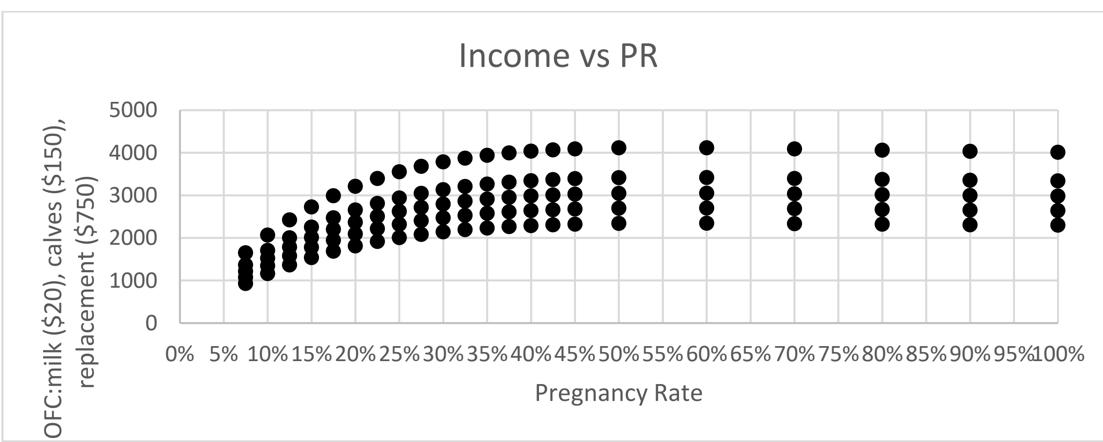


Figure 1a. Income over feed cost for five levels of milk production for pregnancy rates varying from 7.5 to 100%. Milk price is $20/CWT, calf value is $175/head; heifer rear cost is $1500/head and cull cow value is $750/head. Lactating feed cost is $0.12/lb of dry matter and dry cow feed cost is $0.06/lb of dry matter. Milk production M305 is 21,000, 23,000, 26,000, 28,500, or 33,000 lb per 305 days of production.

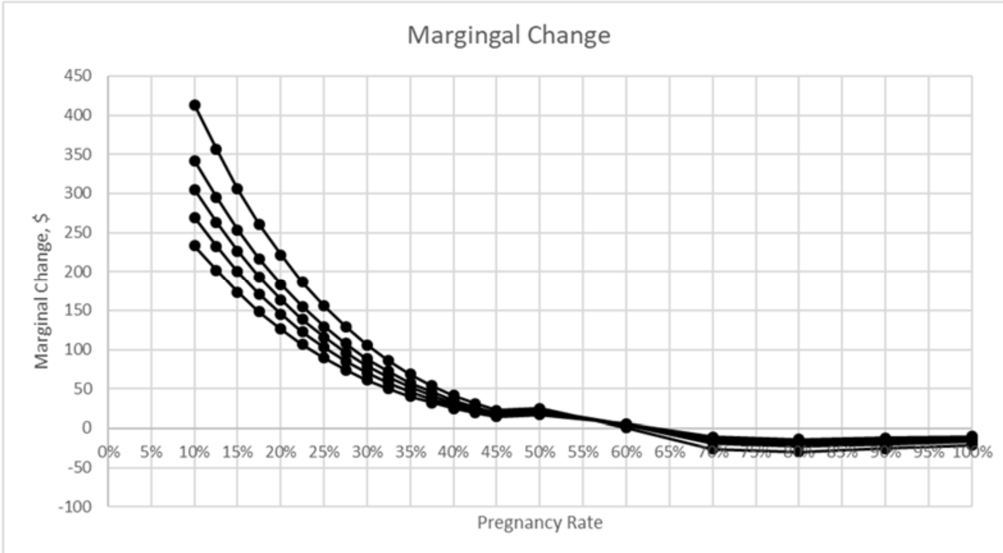


Figure 1b. Marginal change in income over feed cost as a function of pregnancy rate (same assumptions as Figure 1a).

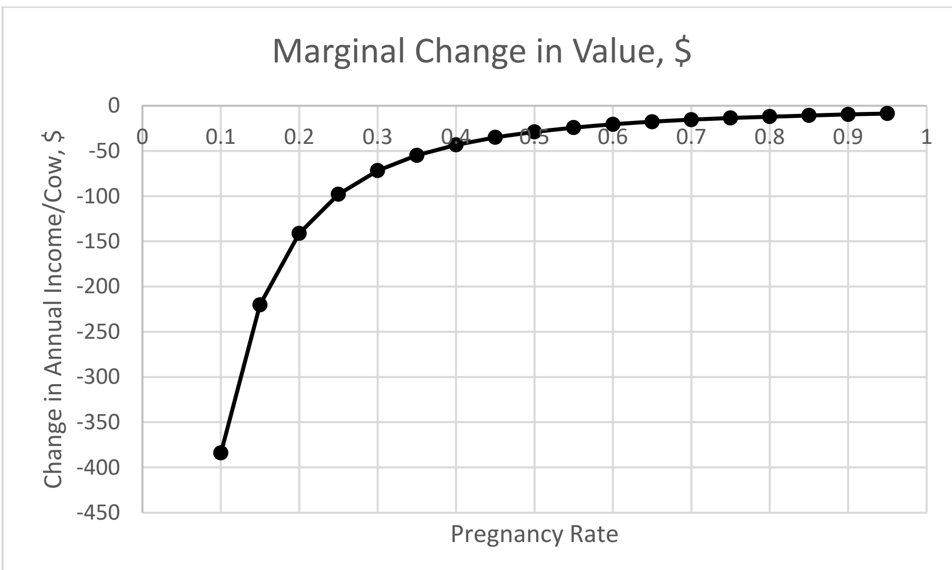


Figure1c. Marginal change in value as pregnancy rate declines from 100%. Losses below a pregnancy rate of 25% are six-fold the losses above a pregnancy rate of 25%.

Factors influencing pregnancy

Pregnancy rate is a function of HDR and CR.[13,14] Heat detection rate has different attributes, depending whether detecting estrus in cows for first insemination versus detecting cows in estrus postinsemination. Cows for first insemination are not pregnant and therefore may be induced into estrus using prostaglandin or combinations of prostaglandin ($PGF_{2\alpha}$) and gonadotrophin releasing hormone (GnRH). Therefore, first inseminations may be clustered in groups of cows within a 21-day window from the VWP. However, once inseminated, a cow cannot be induced into estrus until the farm manager is certain the cow is not pregnant. Return to estrus at 21 days postinsemination must be based on visual observation or an analysis of hormonal indicators of nonpregnancy status, such as declines in progesterone or bovine pregnancy glycoproteins. Most pregnancy tests are not accurate until 28 - 35 days postinsemination. Therefore, clustering of open cows for reinsemination cannot be done until they are confirmed not pregnant. First insemination HDR (FSTHDR) can be clustered in a 21-day window from the VWP; repeat HDR (RPTHDR) for reinsemination cannot be clustered in a 21-day period, but at best at a 42 - 48 day period. In addition 100% of cows are available for first insemination whereas only (1-FSTCR)*100% of cows are available for second insemination, with a declining proportion at each sequential service.

Figures 2a, b, c present pregnancy rate as a function of conception rate across all services (2a), of first insemination heat detection rate (2b), and of repeat heat detection rate (2c) for 534 observations from 325 herds, largely in Pennsylvania. To achieve a PR of 25% or greater, CR needs to be > 33 - 35%. Conception may be greater than this and not achieve a 25% PR, due to low rates of heat detection. To achieve a PR of 25%, FSTHDR needs to be > 70% (Figure 2b) and a higher proportion of herds achieve a PR of 25% when FSTHDR is 100%; that occurs when a synchronized first insemination program is employed. To achieve a PR of 25%, RPTHDR needs to be > 50% (Figure 2c); however, RPTHDR has a lower association with PR than FSTHDR and CR.

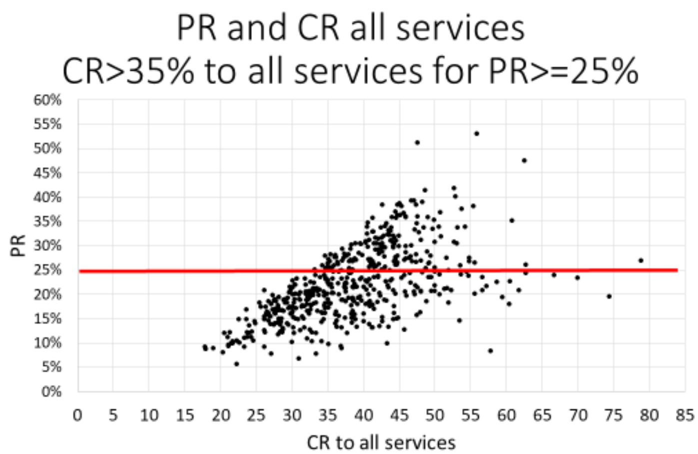


Figure 2a. Pregnancy rate for conception rate across all services for 539 herds. For a pregnancy rate of 25%, conception rate needs to be at least 33% or more. However, conception rates greater than 35% may not achieve 25% pregnancy rates due to low heat detection rates.

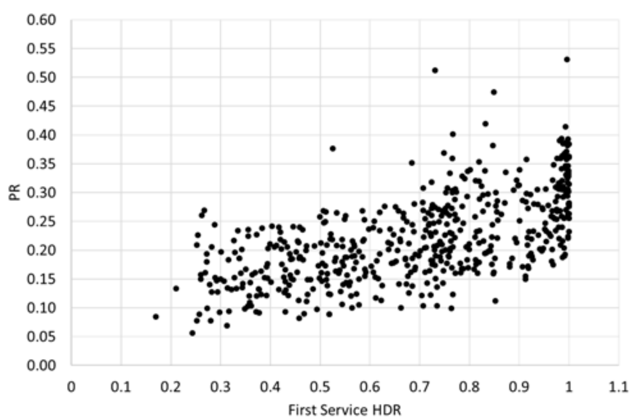


Figure 2b. Pregnancy rate for first service heat detection for 539 herds. First insemination heat detection rate has to be above 70% to achieve a 25% pregnancy rate.

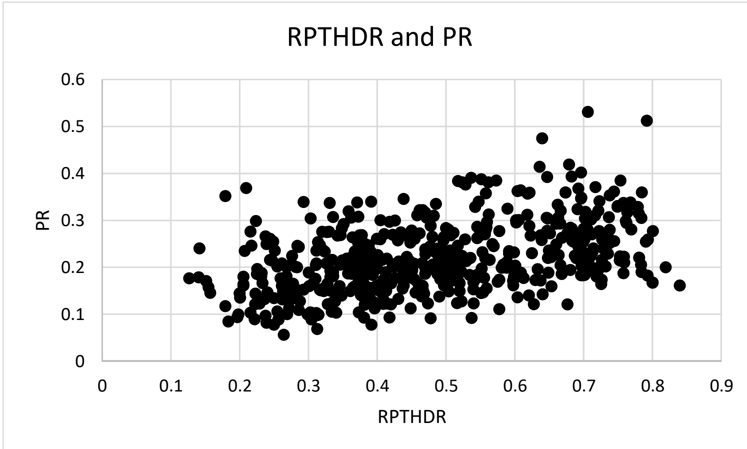


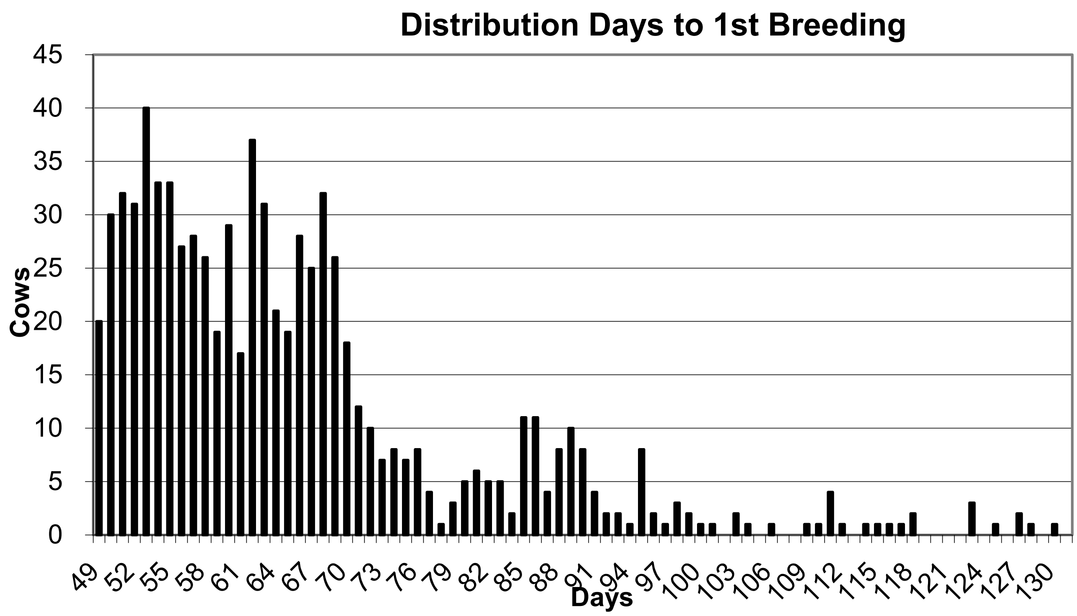
Figure 2c. Pregnancy rate for repeat heat detection rate for services after first service for 539 herds. Repeat heat detection rate needs to be greater than 50% to have a greater probability of achieving a pregnancy rate of 25%.

Mean values for herd observations with PR ≥ 25% and for herd observations with PR < 25% are shown (Table 1). Except for mean days to first insemination, the proportion of interbreeding intervals less than 10 days and between 25 to 35 days and the percent of annual culls, all reproductive indices are superior for herds with PR ≥ 25%. Herds with a pregnancy rate of ≥ 25% realized $333/cow more income if milk price was $20/CWT, calves had a value of $150/head, replacement cost minus cull cow value was $750/cow, lactation feed cost was $0.12/lb of dry matter and dry cow feed cost was $0.08/lb of dry matter. Although the lower pregnancy rate group produced more total milk, it occurred over a longer period of time, reducing the efficiency of milk produced per day, reducing calves born annually, and increasing replacement costs due to fewer pregnancies over a 126-day breeding period.

Table 1. Mean values for 325 herds and 534 observations for mean reproductive indices for herds with pregnancy rates equal to and > 25% and herds with < 25% pregnancy rate

Item	PR < 0.25 Mean ± SEM		PR ≥ 0.25 Mean ± SEM		P value
Number observations	359		175		<.0001
Voluntary Wait Period, d	52.38	0.68	61.53	0.82	<.0001
Days to first insemination, d	78.97	0.70	77.56	0.83	0.0718
Proportion First Insemination Rate	0.638	0.011	0.825	0.014	<.0001
Proportion Conception Rate All Services	0.351	0.005	0.436	0.005	<.0001
Proportion Repeat Insemination Rate	0.479	0.009	0.560	0.011	<.0001
Pregnancy Rate	0.185	0.003	0.305	0.004	<.0001
Interval Between Inseminations	43.76	0.56	37.86	0.63	<.0001
Proportion of Inseminations < 10 days	0.026	0.003	0.034	0.003	0.0152
Proportion of Inseminations 10 - 17 days	0.038	0.002	0.036	0.002	0.4491
Proportion of inseminations 18 - 24 days	0.237	0.007	0.256	0.008	0.04
Proportion of inseminations 25 - 35 days	0.128	0.004	0.120	0.005	0.1875
Proportion of inseminations 36 - 48 days	0.280	0.012	0.353	0.015	<.0001
Proportion of inseminations ≥ 49 days	0.294	0.009	0.218	0.011	<.0001
Pregnant after 126 days breeding period	0.693	0.004	0.880	0.005	<.0001
Calving interval, days	457.0	1.4	415.2	1.5	<.0001
Mean lactation age of herd, years	2.37	0.02	2.48	0.020	<.0001
Proportion of active cows culled	0.229	0.010	0.243	0.012	0.2952
Total milk produced/cow, kg/cow	12,490	14.9	12,044	15.0	<.0001
Milk produced per day, kg/cow	27.40	0.05	29.01	0.06	<.0001
Annual value of income /cow, $	1,833.0	9.2	2,166.0	10.5	<.0001

Good reproductive performance is possible using visual heat detection. Figure 3 presents data from a farm for first insemination and repeat insemination using visual observation to manage insemination. Heat detection rates are >70% and PR is >25% on this farm. Good reproductive management may be achieved with visual observation. It will be reflected in first insemination and repeat insemination frequencies.First insemination frequencies will be spread somewhat uniformly over 21 day periods. Frequency distribution of first insemination by days in milk from the voluntary wait period of 48 days is shown in Figure 3 with corresponding Tables.



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Distribution by 21-day periods of first inseminations from the voluntary wait period:

Heat Detection		Cows bred:	838		Total cows:	1101		
			All Lactations					
Wait Period	1-48	49-69	70-90	91-111	112-132	≥ 133		Total
Number of cows:	41	584	153	37	16	7		838
Cumulative %:	4.9%	74.6%	92.8%	97.3%	99.2%	100.0%		
Heat detection:	4.9%	73.3%	71.8%	61.7%	69.6%	100.0%		
Mean HDE:	72.4%	95% CI:	3.1%	Range:	69.3%	<---->	75.5%	

Distribution of days between inseminations by category intervals:

Interval Analysis: Distribution of Days between Breeding Services Sum of 1 - 2, 2 - 3 and 3 - 4							
			All Lactations				
Interval	< 10	10 - 17	18 - 24	25 - 35	36 - 48	≥ 49	N
# Cows:	37	55	476	75	102	72	
% Cows:	4.5%	6.7%	58.3%	9.2%	12.5%	8.8%	817
Long:	8.8%	Abnormal:	17.4%	Ratio:	4.7	PostHDR:	70.8

Figure 3. The graph is the frequency distribution of first insemination by days in milk from the voluntary wait period of 48 days. Grouping by 21-day periods from the VWP allows calculation of first insemination rates. The first insemination intensity (first insemination heat detection rate, FSTHDR) was 72.4%. Pregnancy rate in this herd was 31.3%. Conception rate to all services was 44.3%. Next is the frequency distribution of days between inseminations grouped by <10, 10 - 17, 18 - 24, 25 - 35 and > 48 days.

Figures 4a, b, c presents the same graphics for pregnancy rate but from a group of herds with superior reproductive performance (149 herds). A subset of these herds was reported.[15] Conception rate is strongly associated with PR, and almost all these herds have a CR > 35%. Pregnancy rate is also strongly associated with FSTHDR. Repeat heat detection rate (RPTHDR) is not strongly associated with PR, but all these herds have RPTHDR greater than 50%. These herds averaged a PR of 36.0% (SD 6.0%), CR of 48.0% (SD 7.5%), FSTHDR of 91.4% (SD 9.8%), and a RPTHDR of 64.8% (SD 9.3%). These herds were large (mean size, 1530 cows) but ranged in size from 81 to 21,000 cows. Herd size does not inhibit good reproductive performance. Conception rate in these superior herds is not significantly better than CR in DRMS records. What makes these herds superior in reproductive performance is high rates of first insemination efficiency

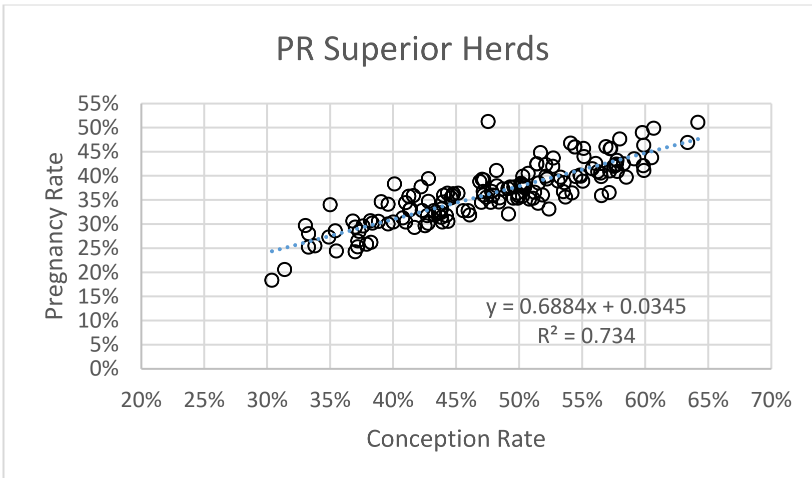

Figure 4a. Pregnancy rate and conception rate to all services for 149 herds with excellent reproductive performance from across the US. If conception rate is greater than 35%, no herd has a PR less than 25%.

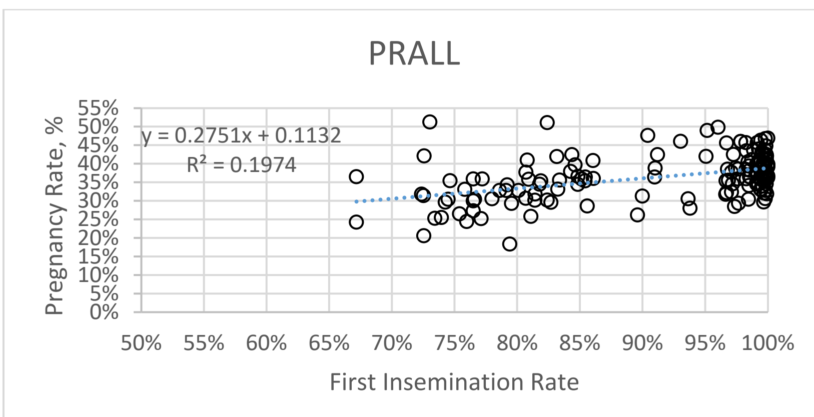

Figure 4b. Pregnancy rate for first insemination rates for 149 herds with excellent reproductive performance across the US. Only one herd with a first insemination rate greater than 75% has a pregnancy rate less than 25%.

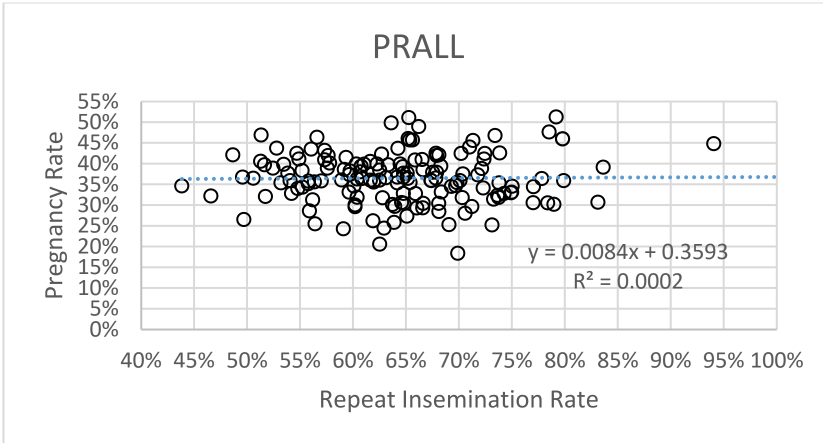

Figure 4c. Pregnancy rate for repeat insemination for 149 herds with excellent reproductive performance from across the US. There is no strong relationship between repeat insemination rates and pregnancy rate, but all most all these herds have repeat insemination rates > 50%.

Based on the observations in Figures 2, 3 and 4, CR is the main driver of PR. Herd management must achieve a CR $\geq$ 35% to achieve a PR of 25%. Secondly, management must control FSTHDR and achieve rates greater than 70%. Repeat insemination heat detection rate is less critical, but still should be managed to control days between breeding. The average days between inseminations for herds represented in Figure 4 was 32.9 days (+/- 4.4 days). These herds employed excellent management control of reproduction.

Important control points

Two most important control points to achieve a PR of 25% are herd conception rate and first insemination rate.[1,8] Regressing PR on CR yields an r^2 of 0.70; regressing PR on FSTHDR yields an r^2 of 0.40; regressing PR on RPTHDR yields an r^2 of 0.09. Therefore, priorities are conception, first insemination intensity, then repeat insemination intensity.

Herd conception rate is a function of health postcalving. Cows with any postpartum problem have an odds ratio (OR) of first service conception rate relative to healthy cows of 0.54. Conditions postpartum associated with reduced CR include ovulatory dysfunction, body condition loss of more than ¾ of a unit, and infectious and metabolic diseases. Cows that have more than one problem postpartum have a further reduction in first service CR with an OR of 0.36. Approximately, 20 - 30% of problem cows have more than one condition. The average herd experiences about 50% of cows with some health issue postcalving, whereas well-managed herds can reduce this to 30%. It is difficult to eliminate all health issues postcalving. Good nutrition and management practices are necessary to reduce risk of health problems postcalving.

The fertility in healthy cows will determine the CR in a herd, as they will be the most fertile group in the herd. If 50% of cows have no health problems postcalving and CR in these cows is 45%, then herd CR will be 36% and a PR of 25% is achievable. If healthy cows are 50% of animals calving but have a CR of 40%, then herd CR will be 32%, and a PR of 25% is achievable, but is less likely. If CR in healthy cows is 35%, then more than 80% of cows need to have no health problem to achieve a PR of 25%. The take home point is that farm managers need to do all they can to ensure high rates of conception in healthy cows and reduce the proportion of cows with problems postcalving. In addition to cow health, high rates of conception are also dependent on proper time of insemination relative to estrus, good semen handling and placement, and using bulls with good fertility.

Control of first insemination

Reproductive management programs can be structured as follows: chose a VWP that fits the biology of the herd and maximizes CR. Typically 50 - 70 days provides a reasonable range for establishing a VWP that should be associated with good fertility. Secondly, chose a program to control first insemination intensity. Lastly coordinate veterinary visits and days postinsemination for pregnancy exam to reduce the proportion of cows that are inseminated greater than 48 days from the previous insemination.

Management has some influence on CR. However, management has total control over first insemination intensity and this is the most important management control point for herd reproductive efficiency.[8,13-15] First insemination intensity (FSTHDR), is the proportion of cows first inseminated in 21 days from the VWP. This is totally under the control of management. To achieve a PR of 25%, FSTHDR needs to be greater than 70%. Figure 3 has the frequency distribution of first inseminations by days in milk for a herd with a PR of 31.3%. This herd has a FSTHDR of 73.1%, mainly performed using visual observation, apparent by the uniform frequency distribution across the 21-day periods. The VWP was 48 days. Conception rate across all inseminations is 44.4%. The combination of intense first service insemination and high CR results in the high PR.

Repeat inseminations are important, but do not have the great impact on PR as CR and FSTHDR. Presented in Figure 3 is the distribution of days between inseminations in categories by day: < 10, 10 - 17, 18 - 24, 25 - 35 and > 48 days. This herd inseminated 58.3% of repeat inseminations between 18 to 24 days following a previous insemination; that represents a regular inter-estrus interval. This is more than double the proportion observed for mean values in Table 1 for herds with PR < 25% and herds with PR ≥ 25%. The most critical proportion in this table is the frequency of cows with interval between inseminations ≥ 48 days. This herd is only 8.8%, whereas herds with PR less than 25%, this proportion is 29.4%. A significant delay in reinsemination and timely pregnancy examination can reduce this proportion significantly.

There are many ways to control first insemination.[8] The optimal program for a herd will depend on farm management. Milk progesterone, radio telemetry, and activity monitors require the investment in equipment to improve HDR. Synchronization programs depend on injection of hormones at appropriate timing of the estrus cycle. Visual heat detection requires ancillary aids such as tail paint or pressure sensitive tail patches and 3 - 4 observation periods per day to increase detection to rates greater than 70%. Thus, all programs have some additional cost to control insemination intensity. What is best for any given farm depends on the management structure of the herd.

Synchronization programs

Prostaglandin was first proposed as a program to manage insemination by clustering estruses in cows at specific times.[13-14] However, depending on day of estrous cycle at the time of prostaglandin injection, cows may not respond to the injection, and time to estrus could vary from 1 to 7 days in cows that seemed to respond to the injection. The variation in time to estrus depended on the stage or follicular development on the ovary, and the day of the estrus cycle of the cow. Sequential injections of prostaglandin could synchronize groups of cows in estrus within weekly periods, but could not synchronize follicular waves, so time to estrus following injection was variable. Therefore, although estrus detection could be focused on specific weekly periods, cows had to be inseminated on observed estrus to have good rates of conception. Cows could be inseminated on a schedule following two injections 11 - 14 days apart, but conception was only optimal if inseminated twice, on days 3 and 4 post injection. Additionally, prostaglandin injections had no benefit to induce estrus in anovulatory cows, which could be 10 - 20% of cows following a VWP of 50 days.

A method using GnRH combined with a prostaglandin injection that synchronized luteal regression and ovulation so timed insemination could be managed on a specific appointment (OvSynch) was proposed.[16] The program consisted of an injection of GnRH to induce ovulation and initiate a new follicular wave. Seven days later, a corpus luteum should be responsive to prostaglandin with an emergent dominant follicle. Following the 7-day prostaglandin injection, 2 days later, a GnRH injection should induce ovulation of a new dominant follicle, that 16 hours later should be fertilizable.[16,17] Thus, timed artificial insemination (TAI) could be scheduled following the OvSynch program. Initial application in a commercial herd demonstrated the benefit of using this program compared to typical herd management.[18]

The OvSynch program induced ovulation in anovular cows. However, fertility in these cows was typically poor. Conception rates are typically 20% in cows entering an OvSynch program that have not previously ovulated. Since anovulatory cows have low serum progesterone, although they may have ovulatory follicles on the ovary, follicles induced to ovulate tend to be more mature and produce lower concentrations of progesterone.[17,19] Both poorer quality follicles and lower progesterone production reduce fertility in anovular cows.[19] Alternative methods to improve CR in anovular cows have been proposed.

Furthermore, as OvSynch programs were evaluated, it was observed that only 65 to 70% of cows were synchronized, due to several problems with initiating the program in a random group of cows. [20] The first GnRH injection of the OvSynch protocol may not induce ovulation due to a regressing or immature follicle on the ovary. When these cows received prostaglandin and GnRH for ovulation and insemination, they tended to have a larger and less fertile follicle than cows that ovulated to the first GnRH injection.[21] In addition 5 - 15% of cows had only partial luteolysis after the prostaglandin injection, disrupting sperm transport due to elevations in progesterone. Other problems include smaller follicles in a subgroup of cows with insufficient progesterone output postinsemination, in addition to the problem with cows with larger, over-mature follicles. Various additional methods were proposed to improve stage of follicular development and follicular quality prior to the OvSynch schedule. These recommendations included using progesterone intravaginal devices in cows with no CL at the GnRH injection,[22] presynchronization with sequential prostaglandin injections prior to OvSynch to increase optimal stage of estrus cycle for synchronization,[23,24] sequential use of GnRH prior to initiation of OvSynch,[25] and combinations of estrus detection following prostaglandin prior to OvSynch.[26] Various programs used to control first insemination are shown (Table 2) and various programs used on a group of farms to achieve excellent reproductive performance are detailed. [15] There was no difference in outcome for the various approaches used to control FSTHDR.

Table 2. Programs to control first insemination

1. $PGF_{2\alpha}$	$PGF2_{2\alpha}$	$PGF2_{2\alpha}$		
	watch estrus 7 days	14 days, watch estrus 7 days		
2. OvSynch	GnRH	$PGF2_{2\alpha}$	GnRH	TAI
Day	0	7 days	2 days	12 to 16 hours
3. PreSynch-Ovsynch	$PGF_{2\alpha}$	$PGF2_{2\alpha}$	OvSynch	
Day	0	14	14	
5. SelectSynch	GnRH	$PGF2_{2\alpha}$	watch estrus	GnRH/TAI
Day	0	7	72 hours	84 hours after $PGF_{2\alpha}$
6. G6G	$PGF_{2\alpha}$	GnRH	OvSynch	
Day	0	2	8	
7. CIDR7	CIDR	Pull CIDR/$PGF2_{2\alpha}$	Watch Estrus	
Day	0	7	8 - 11	
8. CIDR6	CIDR	$PGF2_{2\alpha}$	Pull CIDR	Watch Estrus
Day	0	6	7	8 - 11
9 Anovulatory cows	GnRH	$PGF2_{2\alpha}$	GnRH	OvSynch
Day	0	7	10	17
10 No CL at GnRH GnRH/2CIDR	Pull2CIDR/$PGF2_{2\alpha}$	$PGF2_{2\alpha}$	GnRH/TAI	
	0 of OvSynch	5	6	8

Figure 5 presents distribution of first inseminations associated with various programs. Figure 5a presents first service distribution for a herd using weekly TAI with a Presynch Ovsynch program. Figure 5b presents first service distribution for a herd using a TAI program every 14 days. Figure 5c presents a herd using estrus detection following prostaglandin in the presynch portion of the program than TAI is cows not inseminated in estrus. Distribution of first service reveals the pattern of FSTHDR control employed within a herd. First insemination needs to be greater than 70% to achieve a PR of 25% or better. Conception rate needs to be ≥ 35% to achieve PR of 25% or better.

After first insemination, cows not pregnant need to be reinseminated in a timely fashion. Cows returning in one estrus interval and observed in estrus will be inseminated between 18 to 24 days following a prior insemination. If that estrus is missed, the next opportunity will be 36 to 48 days. With scheduled regular pregnancy diagnosis, nonpregnant cows should be detected between 30 to 40 days postinsemination. Cows diagnosed open could be scheduled into a resynchronization program.

Effect of GnRH injections at 19, 26, and 33 days were compared following insemination with pregnancy examination at 26 days using ultrasonography. [27] Open cows then were assigned to a prostaglandin and GnRH TAI program beginning at 26, 33 and 39 days following the initial GnRH.[27] The greatest pregnancy at TAI was for cows begun on postsynchronization at 33 days postinsemination. Therefore, resynchronization can be used in cows not re-inseminated by 24 days postinsemination. Double Ovsynch improved synchronization for repeat inseminations compared to 1 OvSynch synchronization.[28]

Figure 6 presents distribution of days to second insemination for herds using various approaches to control reinsemination. Figure 6a presents the frequency distribution for a herd using visual observation to detect estrus. Distribution is spread over many days, since first insemination is also spread over many days (Figure 5a). Figure 6b is the frequency distribution of days in milk for second insemination in a herd using primarily resynchronization. Cows are clustered from 36 to 48 days for rebreeding. Figure 6c presents distribution of days to second insemination for a herd using visual

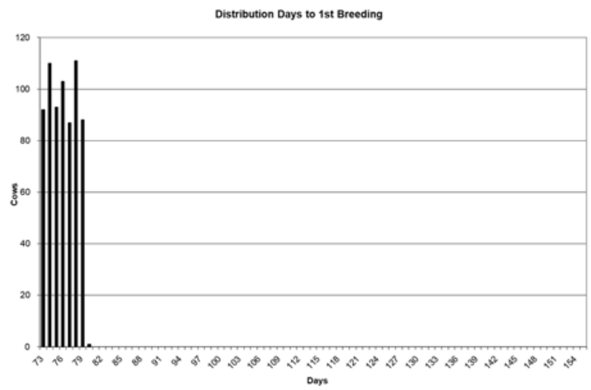

Figure 5a. Distribution of first inseminations in a herd using 100% Presynch Ovsynch every 7 days

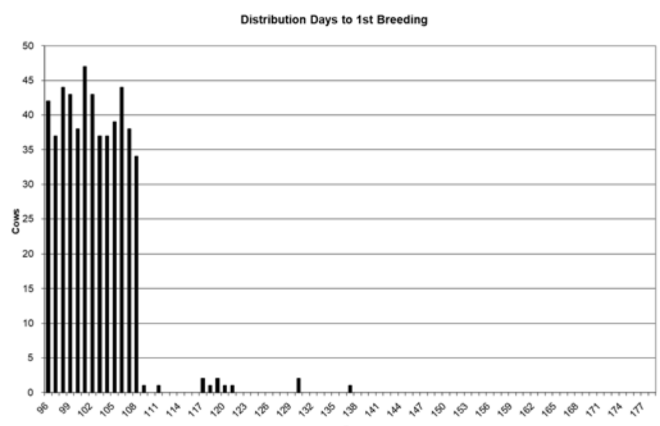

Figure 5b. Distribution of first inseminations in a herd using an OvSynch program every 14 days

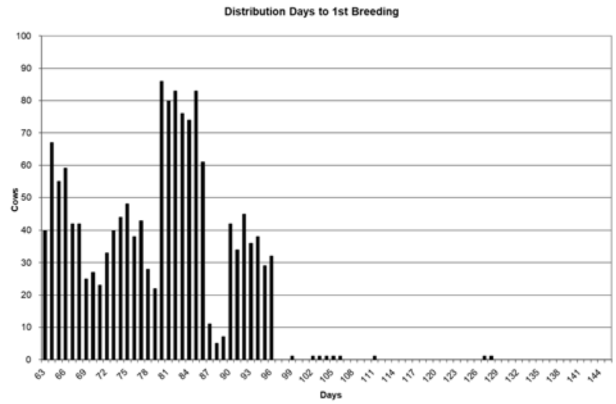

Figure 5c. Herd using estrus detection following prostaglandin Presynch and then applying Ovsynch in cows not inseminated in estrus

observation and then using resynchronization for cows not reinseminated by 30 days postbreeding. Most critical is the herd in Figure 5a has only 8.8% of repeat inseminations over 48 days from the previous service, the herd in Figure 5b has only 4.4% of days between breeding over 48 days, and the herd in Figure 5c has only 7.2% of days between breeding over 48 days. The critical control point for repeat inseminations is a pregnancy diagnosis program to reduce days between breeding over 48 days to less than 10% of inseminations.

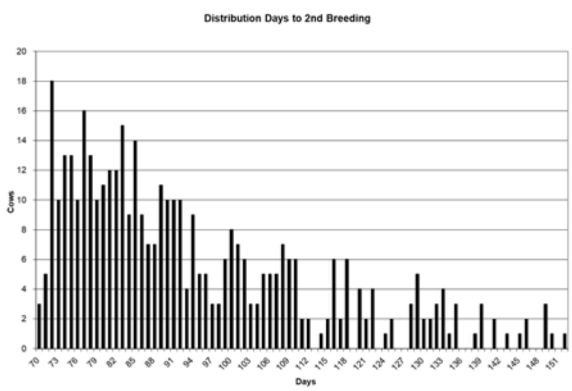

Figure 6a. Herd using visual observation (Herd in figure 3 for firs insemination)

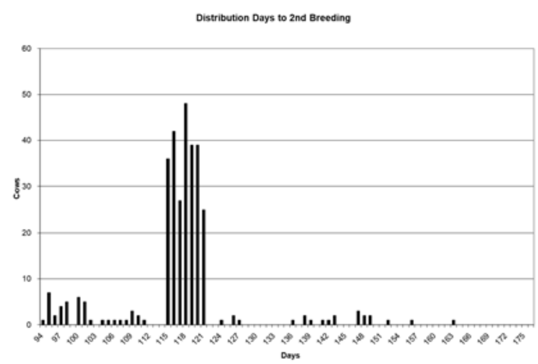

Figure 6b. Herd using resynchronization primarily

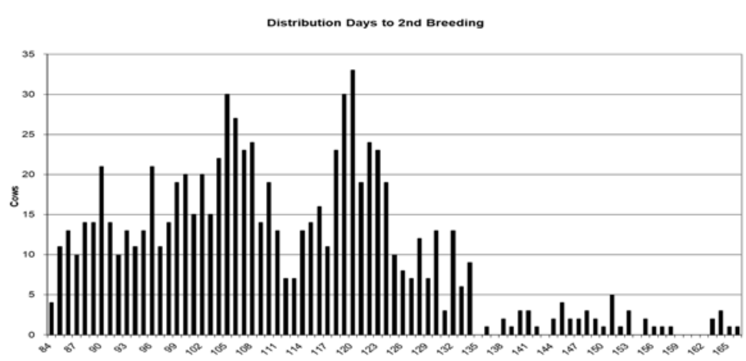

Figure 6c. Herd using heat detection and then re-synchronization

Figure 6. Frequency distribution of days to second insemination for different management programs

Conclusion

Control of first insemination is the critical control point in managing herd reproduction. Monitoring fertility in healthy cows establishes baseline fertility in the herd and provides an estimate of the wellbeing of transition cows and insemination protocols. Healthy cows should have FSTCR greater than 50%. First service intensity needs to be greater than 70% and pregnancy performed on a timely basis before 40 days postinsemination. Many opportunities exist to control first insemination. The best strategy will depend on herd management. Automatic activity monitoring versus synchronized breeding programs could not be generalized, but depended on management within each herd.[29]

Conflict of interest

There are no conflicts of interest to declare.

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