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Reproduction: Economics of reproductive efficiency

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Abstract

Greater pregnancy rates are always more profitable when they can be accomplished free. The gain in profit is decreasing with greater pregnancy rates. Therefore, less can be spend to further increase pregnancy rate. However, the published benefits of greater pregnancy rates (improved reproductive efficiency) are incomplete and are underestimated. The benefits from greater pregnancy rates depend on the strategy followed, such as use of sexed semen and of selling surplus heifers. Genomic testing of females on the farm can be profitable, depending on the fraction surplus heifers that can be created, and on smart breeding decisions regarding the use of sexed and beef semen. The value of these options increases with better reproductive efficiency.

Introduction

Pregnancy rate is a standard measure of the success of a dairy reproductive program (De Vries, 2016). The optimal pregnancy rate (PR) is the one that best meets the farm's objectives, for example maximized profitability. In the dairy industry, PR is defined as the percentage of females eligible to become pregnant in a 21-d period that actually do become pregnant. First, this paper describes some characteristics of high PR herds based on DHIA data. Second, a review of published research literature is given, which shows that greater PR have been associated with greater profitability, but the gain is lower when PR are already high. Third, the ability to achieve greater PR creates options for farms, for example to use sexed semen and genomic testing, which may add to the economic value of increased reproductive efficiency. An example is given. This paper is limited to cows.

Characteristics of dairy herds with varying pregnancy rates

Table 1 lists characteristics of 7,032 dairy herds that participate in the DHIA program with records processed by DRMS (2016) in Raleigh, NC. All are Holstein herds and have at least 50 cows. The herds are sorted by their annual PR as of September 8, 2016. The trend lines show the pattern in the nine columns with different PR. The right most column is the average of all herds with valid PR records. Average herd size was 239 cows with an average PR of 19%, 23,239 pounds/year (10,551 Kg/year) milk yield and a 37% annual cow cull rate. Eleven percent of the herds had PR between 28 and 39% and these herds accounted for 21% of the cows. There is a tendency that the greater PR are observed in the bigger herds.

Herds with greater PR also had shorter days in milk, longer voluntary waiting periods but shorter days to first service, greater service rates and greater PR, shorter days open, shorter actual calving intervals, and more calvings/present cow. The number of heifers/cow was similar at 94% across the PR categories, but age at first calving was a little lower in herds with greater PR.

Although herds with greater PR had good overall reproductive performance, the annual cull rate was surprisingly constant at 37% across most PR categories. One question that comes up when evaluating the economics of different PR is how cow cull rates are effected. In Table 1, the greater number of

Table 1. Characteristics of 7,032 dairy herds (Holsteins, ≥ 50 cows) that participate in the DHIA program, sorted by pregnancy rate[1].

	Preg Rate min:	4	8	12	16	20	24	28	32	36	1
Characteristic	Preg Rate max:	7	11	15	19	23	27	31	35	39	46
Preg Rate-Year Ave		**6**	**10**	**14**	**18**	**21**	**25**	**29**	**33**	**37**	**19**
Herds (N)		171	660	1305	1629	1395	919	473	222	64	**7032**
Herds (%)		3%	10%	19%	24%	20%	13%	7%	3%	1%	**100%**
Cows (N)		132	138	150	206	251	361	477	397	430	**239**
Cows (%)		1%	5%	12%	20%	21%	20%	14%	5%	2%	**100%**
Change in Herd Size (%)		1.5	1.2	2.4	3.6	3.9	4.6	4.4	3.6	3.6	**3.2**
Rolling Milk Yield (lbs/year)		18,987	20,888	22,397	23,175	24,168	24,979	25,491	26,187	25,725	**23,239**
SCC Actual (x 1000)		364	327	294	268	239	214	199	179	177	**265**
Days in Milk		221	208	193	180	174	168	165	163	159	**183**
Cows Left Herd per Year (%)		37	37	37	37	37	37	37	38	39	**37**
%Cows-1st Lact		38	41	38	38	38	39	38	40	39	**38**
Calvings/Cow Present (%)		103	97	103	105	109	109	110	112	114	**107**
Heifers/cow (%)		103	94	95	94	93	95	94	94	95	**94**
Age of 1st Lact Cows (Months)		28.1	27.3	26.4	25.7	25.0	24.4	24.0	23.5	23.3	**25.6**
Voluntary Waiting Period(VWP)		58	57	58	59	59	60	62	63	65	**59**
Days to 1st Serv-Total Herd		122	108	95	85	79	76	74	72	72	**88**
Heats Observed for Year %		25	33	40	48	54	60	65	69	72	**48**
Con Rate for Past 12M-1st Serv		38	37	39	40	41	42	44	45	48	**41**
Con Rate for Past 12M-2nd Serv		33	37	40	41	41	42	43	44	46	**41**
Con Rate for Past 12M-3rd+ Serv		30	33	36	38	39	40	41	42	42	**39**
Days Open-Proj Min-Total Herd		205	181	157	139	127	118	111	107	103	**142**
Actual Calving Interval (Months)		14.8	14.5	14.0	13.5	13.2	13.0	12.8	12.7	12.6	**13.6**
Net Merit $ for All Cows		-32	0	17	30	50	73	91	113	126	**36**
Net Merit $ for Heifer		89	114	141	157	186	213	238	261	263	**168**

[1]The right most column is the average of 7,032 herds. One pound = 0.454 Kg. Source: DRMS (2016).

calvings/cow did not result in noticeably more raised heifers that could have increased cull rates. On the other hand, cull rates were also not reduced as might be expected when fewer cows are culled because of failure to get pregnant on time. Table 1 also shows that herds with greater PR had both cows and heifers with greater genetic merit as measured by the average predicted transmitting ability of Net Merit. Average annual milk yield/cow increased slightly.

Review of published profitability of greater pregnancy rates

Herds with greater PR in Table 1 generally show better technical performances in many characteristics, but financial data for these herds are not available. A problem with using actual financial data is that greater profitability may not only be a result of greater reproductive performance, but a result of overall good management that also leads to improved cow health, more milk production, etc, that contributed to profitability. Studies that investigate how greater PR improve financial performance use advanced calculations (modeling) to overcome the lack of actual financial farm data.

Figure 1 shows how greater PR are associated with increased profit/cow/year for the six American modeling studies that are summarized in Overton and Cabrera (2017). Net return gain is set at $0 at 10% PR for all studies. The studies vary in most of the many inputs that are needed to calculate these results, but it is not always clear to point to the main drivers of the differences between the studies. For example, differences exist in the assumed risk of culling, prices for heifers, milk, feed, calves, reproduction program costs (drugs, labor, semen), voluntary waiting period and end of breeding periods.

Each study reported profit at several different PR. To move from one PR to the next within a study, the studies used a different technology (for example greater conception rates with a timed-AI program than with estrus detection, with associated costs), or assumed greater estrus detection efficiency or conception rate with the same technology free. The gains in profit in figure 1 therefore are a mixture of net gains that include the cost of the technology to achieve that change in PR, and gross gains that do not include the cost to obtain the change in PR.

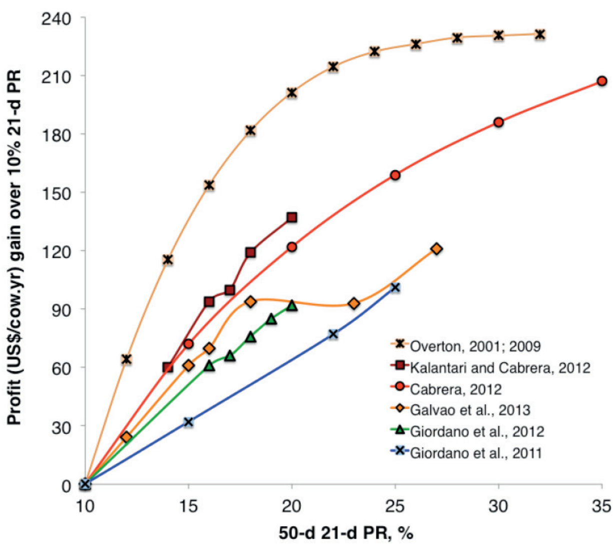

Figure 1. Profit gain of increasing 21-d pregnancy rate (PR) at a 50-d voluntary waiting period reported in 6 different studies. Profit was standardized at 0 at 10% PR. The Overton values were modified from the original published values to reflect current economic conditions. The costs to obtain the increased PR are included within some studies but not in others. Authorized source: Overton and Cabrera (2017).

In all six studies, a greater PR leads to a greater profit. Even in the two studies that report PR over 30%, profit keeps increasing. There is no economic optimal PR in Figure 1. The value of increasing PR is diminishing in at least two of the seven studies, however. These lower marginal returns at greater PR are expected. The average value of a 1-percentage point increase in PR ranges from more than $40/cow/year (low PR) to less than $10/cow/year (high PR).

The assumption often is that the number of cows is fixed. Getting a cow pregnant earlier means that she is going to spend more time being dry and less time producing milk in a year. Thus, these studies assume that better reproductive performance decreases the size of the milking herd. In herds where milking capacity (parlor size or robots) is limited, it is likely that the number of milking cows stays constant. Better reproduction then leads to more dry cows but the same number of milking cows. In this scenario, the value of greater PR is actually greater than in the situation where the number of cows (milking and dry) is kept constant.

Strategies with greater pregnancy rates

With improved reproductive performance, there is a greater potential to generate more dairy heifer calves. One question then is how to best use this option, for example by raising all heifers and increasing cow cull rate, delay breeding, selling surplus dairy heifer calves, or primarily focus on maintaining a constant cull rate as Table 1 suggests happens. When surplus dairy heifer calves are sold, genomic testing might aid with deciding which animals to keep and which to sell, thereby capturing additional genetic value. Therefore, the benefits of increasing PR probably depend on what is being done with the heifer calves.

At the University of Florida, we put together a herd budget model to evaluate combinations of genomics, semen type, and culling given all kinds of herd specific data and prices (De Vries, 2017). The bottom line is profit/milking cow/year. In this model, kept dairy calves were valued based on their genetic merit. This genetic merit depends on the genetic merit of the dams and sires of the calves and on the sale of surplus dairy heifer calves. A greater surplus of dairy calves can be created with sexed semen, but at a higher cost than conventional semen breeding and at lower conception rates. Sexed, conventional and beef semen can be applied to different groups of cattle.

Figure 2 shows the effect of greater pregnancy rates (≈14%, ≈20%, ≈28%) on the profitability and optimal breeding schemes. The top part has a user-defined breeding scheme where the top 50% of heifers were bred with sexed semen (se). All other breedings in heifers and cows were with conventional semen (co). Beef semen (be) was not used, but could be an option if crossbred calves are valuable. The pregnancy rates changed some when more or less sexed semen was used.

The user-defined schemes showed increases in profitability with greater pregnancy rates, as might be expected. Genomic testing was not profitable when pregnancy rate was ≈14% but generated $38 more profit/milking cow/year when pregnancy rate is ≈28%. At the low pregnancy rate, no surplus calves were available so genomic testing results were only used to select the top 50% of heifers. At the high pregnancy rate, genomic testing was used to select the surplus calves (26% surplus when pregnancy rate is ≈28%) and again to identify the top heifers to breed with sexed semen. There was clearly a strong interaction between the value of genomic testing and the level of reproduction in the herd.

The bottom part of Figure 2 shows increases in profitability from an optimized breeding scheme

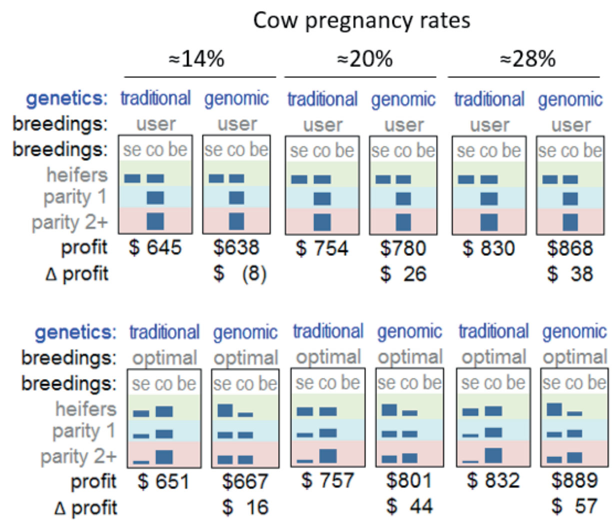

Figure 2. User-defined and optimal breeding schemes and profitability depending on pregnancy rates and the use of genomic testing or traditional genetic reliabilities. The top part has a user-defined breeding scheme where the top 50% of heifers were bred with sexed semen (se). All other breedings in heifers and cows were with conventional semen (co). Beef semen (be) was not allowed to be used. Profit is profit/milking cow/year. Greater pregnancy rates had greater increases in profitability.

over the user-defined scheme in the same situation. Genomic testing results in the use of more sexed semen. Genomic testing is now profitable even at the low pregnancy rate in combination with the use of more sexed semen, which results in a small surplus of dairy calves. At the highest pregnancy rate, genomic testing results in a $57 increase in profit/milking cow/year compared to no genomic testing. It is clear that improved reproductive performance creates options for use of genomic testing and breeding strategies that were not available a decade ago. These options add economic value to improved reproductive efficiency.

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References

Cabrera VE. Economics of fertility in high-yielding dairy cows on confined TMR systems. Animal 2014; 8(s1):211-221.

De Vries A. What is the optimal pregnancy rate? Is being too efficient a benefit or hindrance? Proceedings, 2016 Dairy Cattle Reproduction Council meeting, Columbus, OH. p. 13.

De Vries A. Exploring the best combinations of genomics, semen type, and culling in dairy cattle. DAIReXNET, 2017. URL: http://articles.extension.org/pages/74525/exploring-the-best-combinations-of-genomics-semen-type-and-culling-in-dairy-cattle

DRMS (Dairy Records Management Systems). 2016. Dairy Metrics. URL: http://retro.drms.org/Login.aspx?OrigURL=/DairyMetricsRun.aspx

Galvão KNP, Federico A, De Vries GM Schuenemann. Economic comparison of reproductive programs for dairy herds using estrus detection, timed artificial insemination, or a combination. J Dairy Sci 2013; 96:2681-2693.

Giordano JO, Fricke PM, Wiltbank MC, Cabrera VE. An economic decision-making support system for selection of reproductive management programs on dairy farms. J Dairy Sci 2011; 94:6216-6232.

Giordano JO, Kalantari AS, Fricke PM, Wiltbank MC, Cabrera VE. A daily herd Markov-chain model to study the reproductive and economic impact of reproductive programs combining timed artificial insemination and estrus detection. J Dairy Sci 2012; 95:5442-5460.

Kalantari AS, Cabrera VE. The effect of reproductive performance on the dairy cattle herd value assessed by integrating a daily dynamic programming model with a daily Markov chain model. J Dairy Sci 2012; 95:6160-6170.

Overton MW. Stochastic modeling of different approaches to dairy cattle reproductive management. J Dairy Sci 2001; 84(Sup 1):268.

Overton MW. Modeling the economic impact of reproductive change. J Dairy Sc 2009; 92(Sup 1):541.

Overton MW, Cabrera VE. Monitoring and quantifying value of change in reproductive performance. In: Large Dairy Herd Management. 3rd ed. D. K. Beede, ed. American Dairy Science Association, Champaign, IL. 2017.