EVALUATION OF CHROMIUM PROPIONATE (KEMTRACE®) ON REPRODUCTIVE PERFORMANCE OF HOLSTEIN COWS IN A PENNSYLVANIA DAIRY HERD.

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INTRODUCTION

Reproductive management influences farm profitability through effects on milk produced per cow per day, calves born per year, and herd replacement (Ferguson and Galligan, 2000). Reproductive efficiency is best measured as pregnancy rate (PR), the rate at which cows become pregnant from the voluntary waiting period (VWP), days in milk insemination begins post-calving (Ferguson and Galligan, 2000). Since cows have an average inter-estrus interval of 21-d, even in herds employing synchronized, timed artificial insemination programs (TAI), pregnancies in open cows occur in 21-d event clusters from the VWP. Survival curves or event time curves of pregnancy by days in milk reflect the 21-d PR and may be referred to as a PR curve. Herds using Presynch-OvSynch and Postsynch OvSynch (Pursley et al. 1997) programs have PR curves which decline in steps, reflecting the pattern of synchronization in groups of cows. Herds inseminating cows on visual estrus typically have PR curves that have a regular decline over sequential 21-d periods, whereas in synchronized herds they are clustered in 7-d or 14-d events within 21-d (first insemination) and 42-d periods (repeat inseminations).

Since insemination rate (IR) and conception rate (CR) influence PR, a change in either of these rates can alter the slope of the PR curve within the period of change, creating an inflection in the rate at which the curve declines. In many herds, CR to first insemination (FSTCR) is greater than CR to second, third, or fourth and higher services (repeat CR, RPTCR), due to infertile cows concentrating as service number progresses. This change in CR from FSTCR to RPTCR causes a slower decline in the PR curve following first insemination and can decrease the potential efficiency of reproductive programs.

In herds using a post-synchronization program, PR may decline for repeat inseminations due to a delay in reinsemination to 42-d periods from the prior insemination. The sequencing of GnRH-PGF-GnRH injections cannot occur until open status is confirmed, which may not be possible until 28 to 42 days postinsemination depending on method and frequency of pregnancy diagnosis. Some herd managers employ visual estrus detection to maintain inseminations at 21-d post prior inseminations and only synchronize cows not seen in estrus by 28 to 32 days following a prior insemination. Management programs influence the periodicity of repeat inseminations.

However, PR at repeat insemination may also be reduced due to the reduction in CR with increasing service number. Reduction in CR at repeat services may be due to cows that had health problems post-calving (retained placenta, metritis, ketosis, displaced abomasum, lameness, or mastitis among other conditions), or may be those cows which have experienced greater metabolic stress and lost more body condition, or may be cows that experienced later first ovulation post-calving. Greater milk production has also been identified as a risk factor for reduced CR, and higher producing cows may have lower FSTCR and become a greater proportion of cows inseminated at higher services, thus lowering CR to these services. There is not one reason which can be linked to reducing CR to increasing service number in dairy herds and analysis of risk factors needs to be undertaken to identify the potential factors.

The result is that PR curves in a dairy herd can take altered shapes and may not decline uniformly following the VWP. Overall mean PR can be very misleading as an index of overall reproductive efficiency due to alterations in the shape of the PR curve by 21-d periods due to the above mentioned factors. PR and CR should be examined for first insemination and repeat inseminations to gain a sense of fertility patterns in a dairy herd.

HISTORY

An 819 (lactating and dry cows) Holstein dairy herd (28,386 lbs milk rolling herd average, 3.8% fat and 3.2% protein) had been monitored for production and reproductive performance for a number of years (Figure 1). Herd size and rolling herd average (RHA) had increased from 645 cows and 24,203 lb in May, 2006 to 806 cows and 29,280 lb by May, 2011 (Figure 1).

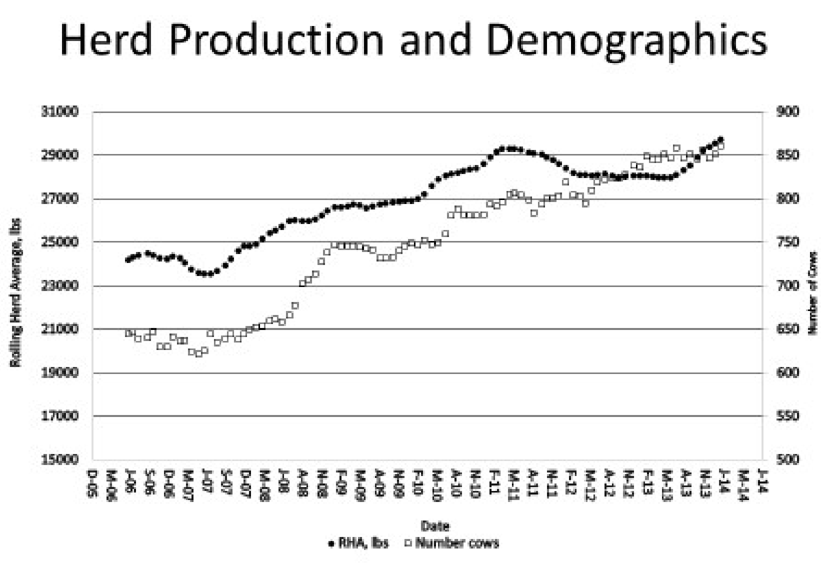

Figure 1. Herd demographics and production from May, 2006 to May, 2011. Rolling Herd Average, RHA, lb/cow/year, ●; Number of lactating and dry cows, Number cows, o.

Pregnancy rate (PR) had generally been below 20% in 2005 and 2006 but had increased in 2008 to 21% (Figure 2). This increase in PR was associated with an increase in first service CR (FSTCR) over this time period from 30% and lower to around 40%. Second service CR also improved in 2008 but was typically around 33% in 2008 and 2009.

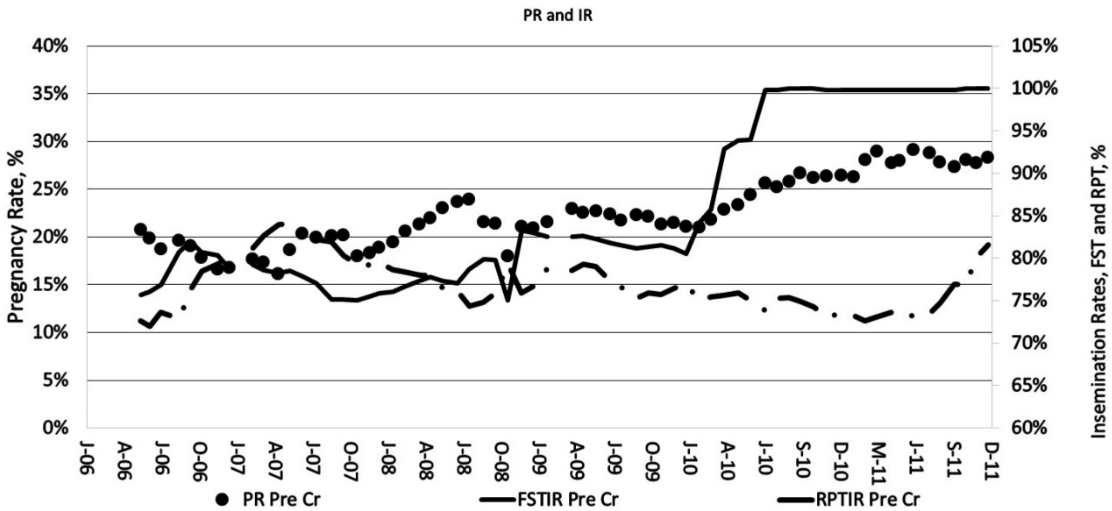

Figure 2. Pregnancy rate, first insemination rate, and repeat insemination rate prior to chromium supplementation from May, 2006 through December, 2011. Pregnancy rate, PR, pre supplementation with chromium, PR Pre Cr, ●; First insemination rate pre chromium supplementation, FSTIR Pre Cr ▬; Repeat insemination rate pre chromium supplementation, RPTIR Pre Cr, ▬ ● ▬.

In 2010 the farm management committed fully to a Pre-Synch OvSynch timed artificial insemination program (TAI) which increased first service insemination rate from just under 80% to 100% (Figure 2). Associated with this change was a change in voluntary waiting period from 57 days to 72 days. Coincident to the increase in FSTIR, PR increased to 28% and FSTCR began to increase in 2010 and reached a plateau of 45% in 2011. However, second service CR began to decline and dipped below 30% in 2010 and remained below 30% in 2011 (Figure 3). Repeat inseminations had been controlled using a post synchronization program since 2006 in combination with rectal palpation for pregnancy examination at 39 days post-insemination. This program had not changed during this time period.

Examining CR across 2, 3, and 4 services during 2010 and 2011 indicated that these rates were significantly lower than FSTCR and had declined from 2008 and 2009 values (Table 1, Conception rate at first service and second service, Figure 3). The binomial trend across service number from first to fourth service was significantly negative (Rosner, 2006). The difference in CR for first and second service (Figure 3) was seen to be diverging to a greater difference beginning in 2010. This suggested the herd was experiencing two different fertility populations: very fertile cows that conceived to first service and a group of cows with lower fertility at 2, 3, and 4 or more services. Segregating cows by transition problems, such as metritis, ketosis, displaced abomasum, parity (first, second, third and greater), production, and by season of calving failed to yield any associated conditions with the lower fertility in cows which failed to conceive at first service. In addition, it was not apparent that cows that failed to conceive at first service were in thinner body condition or had lost more body condition than cows which conceived at first service.

Table 1. CR by service number for first, second, third and fourth service in December, 2011. Data represent cows with service number and if confirmed pregnant or unknown (either open or pregnancy status not yet confirmed) to that service number.

Service Number	Number Cows	Number Pregnant	Number Unknown	CR %
1	396	304	92	44.8
2	139	88	51	27.2
3	96	52	44	27.2
4	60	36	24	31.3
Total inseminated	770	510	260	35.9
Binomial trend[1]	slope -66.52	$\chi^2 = 15.04$	$P<0.0001$	

Example calculation: CR first service = 100 x (304/(770 – 92)) = 44.8
[1] Binomial trend for CR from first through fourth service calculated based on Rosner

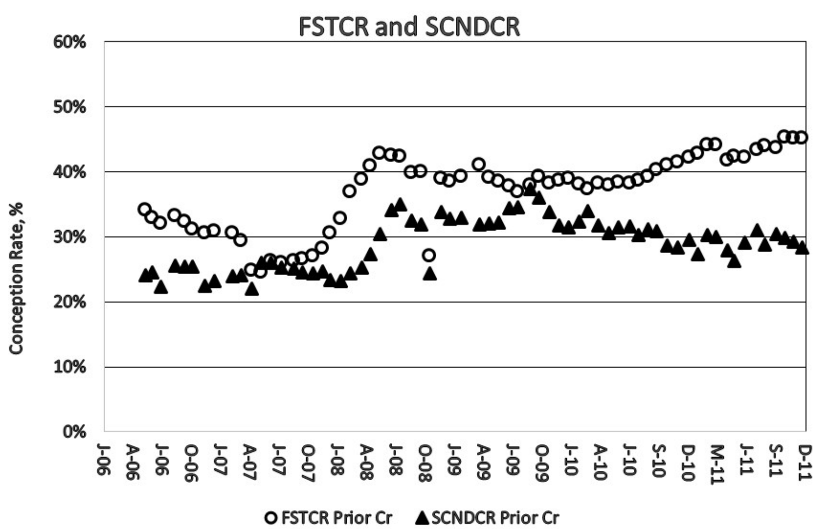

Figure 3. Conception rate at first service and second service from May, 2006 through December, 2011. First service conception rate prior to chromium supplementation, FSTCR Prior Cr, o; Second service conception rate prior to chromium supplementation, SCNDCR Prior Cr, ▲.

Pregnancy rate by days in milk reflected the change in CR with increasing service number (Figure 4). The slope for PR for first services was 38.5% whereas for second service it was 16.5% (Figure 4). Our goal is for PR to be greater than 20 to 25% for all days in milk.

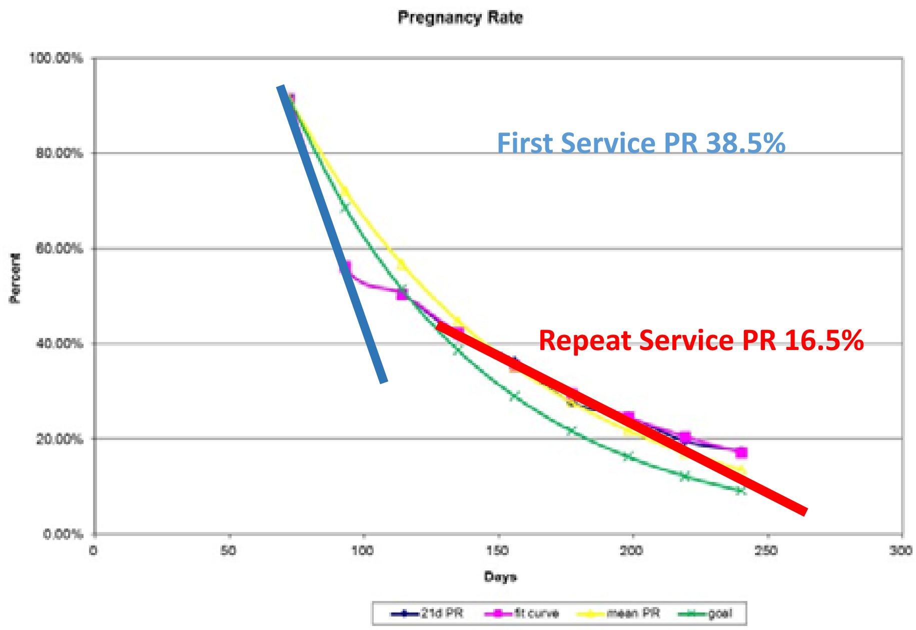

Figure 4. Pregnancy rate (PR) for the herd in December, 2011. Notice the change in PR for first service and for repeat services. The lower PR for repeat services reflects both a 42-d postsynchronization program and lower CR at 2, 3, 4 and later services.

In December, 2011 a discussion was undertaken to explore adding chromium (Cr) to the post-calving and high group rations. Literature suggested that Cr supplementation in the periparturient period reduced nonesterified fatty acid (NEFA) mobilization from body fat and increased tissue insulin, sensitivity, possibly improving glucose availability to peripheral tissues (Bryan et al., 2004; McNamara and Valdez, 2005). It was hypothesized that Cr may improve the energy status of cows and improve fertility of cows at 2nd, 3rd and 4th services (Rockwell and Allen, 2011). It was decided to include Cr propionate (0.4%) in a pre-mix to be included in lactating diets beginning in January, 2012. No other changes to the ration or reproductive management was made.

Animals, Facilities and Management

Cows were housed in modern 6-row, drive through free-stall barns with deep-bedded sand stalls. Alleys were cleaned with recirculated flush water when cows were milked. Ventilation fans were located over feed bunks and free-stalls with water sprinklers at the feed bunks. Barns were equipped for long day lighting on a cycle of 16-h light and 8-h darkness. Cows were fed once a day to 3 to 5% refusals with multiple feed “push-ups” throughout the day, and water was available free choice from troughs. Cows were milked 3x per day in a double-12 parallel parlor. Milk volume per cow was automatically recorded at each milking with monthly DHIA testing for volume and milk components. For the year prior to the trial, monthly average days in milk (DIM) ranged from 169 to 201 DIM with a mean of 185 DIM across the year. Monthly mean milk production per cow ranged from 81.7 to 95.6 lbs/cow with an average production of 89.1 lb/cow across all months with a mean milk fat content of 3.4% and milk protein content of 3.0%.

There were a total of seven lactating groups: a post-fresh pen for cows 14 to 21 d post-calving, two mature high production groups for cows 14-21 DIM to 200 DIM, a first lactation group, two mid-lactation pens (first lactation and 2+ lactation groups), and a low production pen prior to dry-off. All feed ingredients were mixed daily and offered to each group. Ration ingredients and composition are presented in Table 2 and 3. Daily mean dry matter intakes were calculated for each pen. In January, 2012, Cr supplementation was initiated using KemTrace® brand Chromium Propionate 0.4% which was added at 1.72 lb/ton of a protein mix which was incorporated into the lactating TMR (Protein mix in Table 1, 2). This inclusion rate was calculated to provide 8 mg of Cr/head/day at a mean DMI of 55 lbs/head/day. Rations offered to the post-fresh, high, mid, and early first lactation and late first lactation groups are in Table 3. Rations offered to late and pre-dry off groups are not presented as these cows were not in breeding groups. Nutrient content of the TMR's was very similar over the last two years; there was no major difference in nutrient content.

Table 2. Ingredient composition and nutrient content of lactating protein mix (%, DM basis).

Ingredient	% DM	Nutrient	% DM
Amino Plus®[1]	50.08	CP	35.80
Distillers Dried Grains & Solubles	19.46	SP, % of CP	8.48
Limestone, ground	10.70	NDF	15.94
Blood meal, ring dried	5.02	ADF	6.89
SQ-810[1]	7.86	Lignin	1.63
Salt, white	3.89	Starch	2.54
Magnesium oxide	0.78	Sugar	9.46
MFP[2]	0.58	Ether extract	3.07
Vitamin ADE premix	0.41	Ash	31.74
Vitamin E-20	0.41	Ca	4.61
PSU #4[1]	0.33	P	0.51
Se Premix 0.06%	0.31	K	1.37
Rumensin 90	0.078	Mg	0.94
KemTRACE® Chromium 0.4%	0.086	S	0.50

[1]Amino Plus, AGP Inc. Omaha, NE; SQ-810; Sodium Sesquicarbonate, Arm and Hammer, Princeton, NJ; MFP, methionine supplement, Novus International, St. Charles, MO; PSU #4, trace mineral supplement, Sporting Valley Feeds, Manheim, PA.

Table 3. Ingredients and nutrient compositions of TMRs fed to lactating groups (%DM).

Ingredient	Lactating Group				
	Post-fresh	High 2+ Lactation	Mid 2+ Lactation	High 1st 1st Lactation	Mid 1st 1st Lactation
Corn Silage	34.29	36.80	37.95	37.99	42.49
Alfalfa Silage	13.49	12.58	15.81	13.60	17.16
Hay, mixed	4.66	---	---	----	----
Corn, fine	15.36	15.00	15.22	15.98	11.44
Protein Mix[1]	9.01	9.30	9.23	9.39	8.58
Topdress[2]	8.07	9.75	3.40	5.19	----
Canola Meal	4.65	4.86	4.92	5.01	5.53
Soybean meal, 48%	4.46	3.23	3.39	3.27	4.60
Wheat midds	3.54	6.88	8.39	7.85	8.99
Molasses	1.47	1.60	1.68	1.71	1.23
Energy Booster 100[3]	0.98	----	----	----	-----
Composition (% DM)					
CP	17.74	17.56	17.57	17.41	17.84
SP, % of CP	33.58	33.75	36.08	34.97	37.90
NDF	31.53	31.36	31.65	31.31	33.01
ADF	19.60	18.86	19.12	18.71	20.06
Starch	25.96	27.51	26.83	27.71	24.73
Sugar	4.55	4.36	4.46	4.47	4.24
Ether Extract	4.95	4.16	3.82	3.91	3.65
Ash	7.27	7.06	7.16	7.08	7.20
Ca	0.80	0.77	0.80	0.78	0.81
P	0.40	0.42	0.44	0.43	0.45
Mg	0.30	0.31	0.32	0.31	0.32
S	0.25	0.25	0.25	0.25	0.25
Vitamin A, KIU/lb	1.55	1.60	1.58	1.61	1.54
Vitamin D, KIU/lb	0.39	0.40	0.40	0.40	0.38
Vitamin E, IU/lb	11.60	11.97	11.88	12.09	11.53
DCAD[6]	26.20	24.80	24.30	24.00	24.70

[1] Protein Mix presented in Table 2.
[2] Contained (% DM): Soy Hulls, 42.42; Corn grain, 33.93; Soy bean meal, 48%, 11.88; Energy Booster 100, 5.94; Blood meal, ring dried, 4.24; SQ-810[4], 1.44; Smartamine M[5], 0.16; Composition (% DM): CP, 18.91; NDF, 32.50; Starch, 25.39; Sugar, 2.09; Ether extract, 9.33.
[3] Energy Booster 100; Milk Specialties Global Animal Nutrition, Eden Prairie, MN
[4] SQ-810, Sodium Sesquicarbonate, Arm and Hammer, Princeton, NJ
[5] Smartamine M, rumen-protected methionine; Adesso, Alpharetta, GA
[6] DCAD = dietary cation-anion difference, mEq/100 g DM; (Na + K) – (Cl + S)

Reproductive Management

All cows were enrolled in a Pre-Synch OvSynch program (Pursley et al. 1997). The program was as follows: cows were given prostaglandin F-2α (PGF, 25 mg IM) at 39 to 45 d which was repeated at 53 to 59 d post-calving; cows were then given GnRH (10 ug) at 64 to 70 d post-calving followed by PGF at 70 to 76 d postcalving. A second GnRH injection was given 72 to 78 d post-calving and cows were artificially inseminated on appointment (TAI) at 12 hours after the second GnRH injection, 73 to 79 d post-calving. The mean days to first breeding was 74 days on this program. This first service program had been implemented in 2010, as evident in Figure 2 with first insemination rates of 100% of cows inseminated within 21 d of VWP.

Estrus detection was employed for repeat insemination, but not aggressively. Only 24% of repeat inseminations occurred based on observed estrous. The majority of repeat inseminations were managed with a post-synchronization program (76%) which was combined with weekly veterinary visits for pregnancy diagnosis. When cows were 32 to 38 d post-insemination they were given a GnRH injection (10 ug) and were assigned for pregnancy examination at 39 to 45 d post-insemination. If cows were diagnosed as not pregnant they were given a PGF injection, followed by GnRH on day 41 to 47 post-insemination and then TAI on day 42 to 48 days post-insemination. The post-synchronization program was initiated in 2006.

Historical Trends

As seen in figure 2, pregnancy rate (PR) improved in 2007 and 2008 with the implementation of the post-synchronization program from approximately a mean rate of 18% in 2006 to a mean rate of 22% to 23% in 2007 through 2009. Part of the improvement in PR over this time period was an improvement in first service conception rate (FSTCR, Figure 2) from 25% to 32% in 2006 and 2007 to around 40% in 2008 through 2010. A major improvement in PR occurred in 2010 through 2011 with the application of the Pre-synch Ov-Synch program on all cows beginning in January of 2010 (Figure 2). It can be seen in Figure 2 that first insemination intensity (FSTIR) increased to 100% in 2010, with a resulting increase in PR (Figure 1) and an increase in FSTCR (Figure 2) to approximately 45%.

Over this time period from 2009 through 2011 PR and FSTCR had improved, but second service conception rate (SCNDCR, Figure 2) actually declined from 32 to 33% to just below 30% over this same period. Binomial trend analysis of the pattern of CR from FSTCR through second, third and fourth services indicated there was a significant negative trend in CR across these services (Rosner, 2006). Conception rates for first lactation cows were greater than for second and third lactation cows, but the same negative trend was apparent from first through fourth service in each of the age groups.

Application of Chromium Supplementation

Cows in the post-fresh and high production groups were body condition scored in January, 2012 with initiation of the chromium feeding. It was expected that it would take at least four months to observe any apparent trends in fertility. Cows would need to calve, be consuming the chromium supplement and move into the breeding groups, which began at 70 days postcalving. Monthly RepMon analysis was done for the herd and data compiled. Cows pregnant previously to January 2012 create a lag in the data and mitigate any improvement but are removed as they calve and enter a new lactation.

In Figure 5 it can be seen that as data progressed in 2012, second service CR increased to 38% by the third quarter of 2012. First service CR was not significantly changed over 2012. Conception rate to third and fourth services also increased during this period, increasing CR to all services (data not shown). Pregnancy rate increased to 32% with the improvement in CR to repeat services. Since 2012 the farm has continued to feed Cr and PR remains above 30% and second service and repeat service CR remains in the high 30%, with FSTCR around 45%. The improvement in fertility with the chromium supplementation has continued.

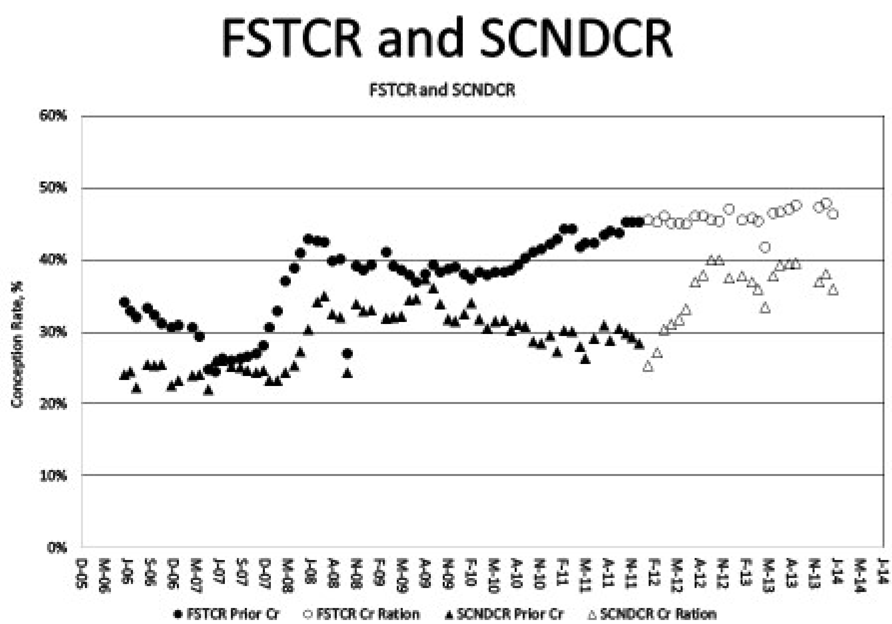

Figure 5. First service conception rate prior to Chromium supplementation (●) and after chromium added to herd TMR beginning in January, 2012 (o). Second service conception rate prior to chromium supplementation (▲) and after chromium supplementation began in December, 2012 (△). Data continue until July, 2014.

Table 3 presents data for CR by service number and month from November, 2011 through October, 2012, encompassing the main period of the trial. Binomial trend analysis was used to examine the trend in CR across monthly means over this period (Rosner, 2006). First service CR did not significantly change over this period (X^2 =

0.928, P<0.335, Table 3), although the coefficient for trend was positive. Conception rate for second, third, and fourth services all significantly increased over this period (Table 3), indicating an improvement in fertility for cows inseminated at these services.

Table 3. Binomial trends[1] across service number (first to fourth) from November, 2011 through October, 2012

	Service Number CR, %			
Month	First	Second	Third	Fourth
Mean Num.	749	334	182	107
Nov. 2011	45.2	29.3	25.5	30.4
Dec. 2011	45.5	28.4	28.7	32.5
Jan. 2012	40.8	23.5	24.3	29.6
Feb. 2012	45.3	27.1	31.9	33.3
Mar. 2012	41.0	26.9	26.3	28.8
Apr. 2012	45.2	30.8	27.9	33.1
May 2012	41.5	28.4	27.0	28.5
Jun. 2012	44.7	33.5	31.4	40.5
Jul. 2012	45.7	37.2	31.4	40.5
Aug. 2012	46.0	37.9	35.5	43.1
Sep. 2012	45.0	40.3	34.8	42.9
Oct. 2012	45.3	39.9	34.0	37.9
Trend	increasing	increasing	increasing	increasing
X^2	0.928	41.36	8.65	10.91
P<	0.335	0.0001	0.003	0.0009

[1] Rosner, 2006

The improvement in repeat service CR is apparent in comparing herd PR curves from December, 2011 and December, 2012 (Figure 6). Pregnancy rate for first service did not change, but the PR for repeat services improved to encompass the 25% PR curve (Figure 6, December, 2012). The initial decline in PR at first service is similar in both curves. The decline in the PR curve in December, 2012 is steeper and represents the improvement in CR at repeat services, as RPTIR was not different between the years. This increase in PR was associated with a gain of $66/cow/year with the same inputs in milk price, calf and cull cow value for December, 2011 and December, 2012 (RepMon calculation). At a cost of $0.04/cow/day for Cr, it would cost $8/cow to feed Cr through 200 days for a return of $56/cow.

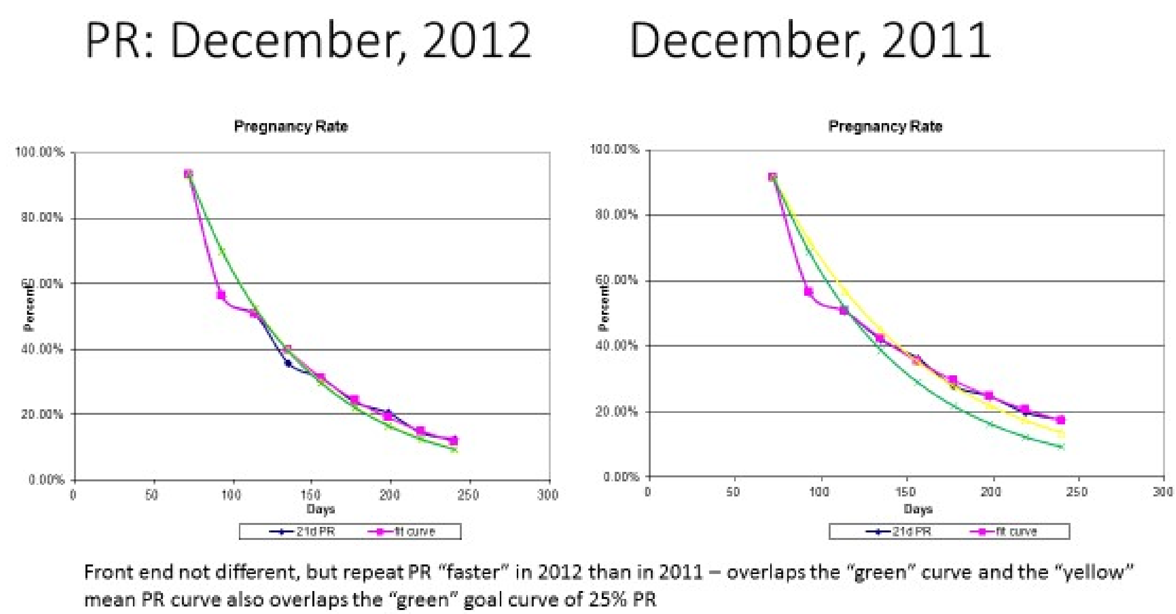

Figure 6. Pregnancy rate curves for December, 2011 (prior to chromium supplementation) and December 2012, after chromium supplementation began in January, 2012.

Body condition score was taken in the post-fresh and high groups in May, 2012. There was a significant improvement in the distribution of body condition between January and May. Over this time period, temperatures in the barn were largely within the thermal neutral zone of cattle (40 ^{o}F to 70 ^{o}F) and not often between 20 to 40 ^{o}F (Figure 4). Thus, temperature likely had little influence on body condition between these dates, but other factors may have contributed to the improvement. Milk production over this time period was steady.

DISCUSSION

An issue with this type of field observation is that the improvement in fertility after the chromium supplementation began may be related to some other unidentified factors. However in this herd we had good, solid data for years prior to the feeding period with good data on transition health and reproductive management. There was no change in postpartum problems nor was there a significant change in milk production per day or in the age distribution of the herd over this time period. The same people were inseminating cows and managing reproduction as over the previous several years. Thus, we concluded the change in CR was probably related to the Cr supplementation.

A second issue with collecting monthly summaries from herd reproductive data is that pregnant cows at each service number remain in summary calculations until they re-calve, a period which would take approximately 8 months. This is typically referred to as "momentum" in DHIA data. Each month a proportion of pregnant cows re-calve and are removed from the summary data and replaced with "new" current confirmed pregnancies in the current lactation. Thus, trends may change very little until about eight months post-implementation of a new program by which time all cows initially in the data will have calved and be replaced entirely by cows on the new program. This is apparent in the data in Table 3, where trends are positive across month but show almost “step” improvements from July, 2012 onwards for second, third and fourth inseminations. Although overall CR to repeat inseminations was lower than for FSTCR, the magnitude of the difference was less than that in 2011 and in 2010. Furthermore, trends across monthly CR data by service number in 2010 and 2011 were not significantly different (data not shown), thus the improving trend in monthly means for CR for second, third and fourth services from 2011 to 2012 was thought most likely due to the chromium supplementation.

An additional concern was that the trend to lower CR in repeat services, which began in 2009, may have been due to poorly synchronized ovulation at repeat inseminations on the post-synch program. To address this concern we examined CR for cows at second insemination between 18 to 24 days versus 36 to 48 days following first insemination in 2010 and 2011 inseminations. Cows inseminated between 18 to 24 days following first insemination were inseminated based on observed estrus whereas cows inseminated between 36 to 48 days in this herd were almost entirely from a TAI following a post-synch program. There was no difference in second service CR for these groups of cows, therefore CR at repeat services was not differentiated between observed estrus inseminations versus TAI services. Conception rate at observed estrus and TAI for second service inseminations were equally low in 2010 and 2011.

Chromium has been associated with increases in DMI in cows in early lactation with improvement in milk production and metabolic status (Hayirli et al., 2001, Nikkhah et al., 2010). Metabolic status has been observed as a reduction in serum NEFA concentrations, suggesting less fat mobilization in early lactation and improvement in energy balance. Both a reduction in NEFA serum concentration and an improvement in energy balance would improve CR. The interaction of negative energy balance and reproduction has long been recognized (Butler and Smith, 1989). Although NEFA were not measured, the improvement in body condition would suggest less fat mobilization and an improvement in energy balance. The fact FSTCR were not altered, but second, third and fourth service rates were improved, it suggests that these cows were the cows with improved energy status.

Improved reproduction with Cr supplementation has been reported by Bryan et al. (2004), Lavin-Garza et al. (2007), Rockwell and Allen (2011) and Soltan, 2010. The improvement in reproduction may occur via several mechanisms. Burton et al. observed that Cr improved immune status which may reduce the effects of subacute metritis on CR. We feel this is unlikely in this herd as metritis was not a significant problem. Secondly, Cr has been linked with increases in DMI in the postpartum period (Hayirli et al., 2001, Nikkhah et al. 2010, Yang et al., 1996) reducing NEFA (McNamara and Valez, 2005) and improving glucose utilization (Sumner et al., 2007). All these effects may benefit energy balance and improve fertility. It is possible the repeat breeder cattle in this herd experience more negative energy balance than cows that conceived to first insemination. This was slightly more than half the cows in the herd. In addition, second and older lactation cows, the higher milk producers in the herd, had lower FSTCR than first lactation cows (Dec. 2011, Parity 3+, 41.3%, Parity 2, 41.3%, Parity 1, 51.2%, P<0.04), suggesting more energy stress as a role in reduced in FSTCR. After a year feeding the Cr, FSTCR was not significantly changed in these age groups (Dec., 2012, Parity 3+, 43.2%, Parity 2, 39.0%, and Parity 1, 51.1%, P<0.04), however CR to second service had increased in all lactation groups from 2011 to 2012 (First Parity, 35.9 to 42.1, Second Parity, 18.8 to 43.3, Third+ Parity, 26.6 to 31.5%, respectively). It was felt that Cr may have improved energy status in cows that failed to conceive at FSTCR and was reflected in the improved fertility at 2, 3, and 4th services.

Results of this case study should be interpreted cautiously. Many factors influence CR and chromium may be given credit for some other change within the herd population. As of this writing CR to all services has continued to slightly improve as has milk production. Certainly it is gratifying to see milk production and reproduction improve together. The cost of chromium supplementation was about six cents per cow per day in 2012. Thus, situations of bimodal fertility, as this herd experienced, may benefit from Cr supplementation. First, one should explore associations of effects of postpartum disease within the two populations. If CR is low to all services, then other factors should be explored such as poor semen handling or poor timing of insemination relative to ovulation.

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