Use of an Activity Monitoring System as Part of the

Cal Poly Dairy Breeding Protocol

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ABSTRACT

The objective of this study, is to determine the effectiveness of an activity monitoring system as an integral part of the Cal Poly Dairy breeding protocol. Dairy herd reproductive efficiencies have dropped in the past 40 years. Increased milk production, and genetic advancements towards more milk production, have led to reproductive rates declining. An advanced breeding program is needed to become more efficient in this area. The study consisted of the evaluation of one option, Heatime™ by MICRO Dairy Logic, and comparing it to the commonly used programs in dairies today such as synchronization methods, pedometers, and other electronic detection aids. The Heatime™ system was chosen to be installed on the Cal Poly dairy herd. Once installed it was kept up to date with current information; freshenings, pen moves, breedings, heats, and pregnancy checks. The results of this study yielded a well functioning breeding program. The system continuously monitors heats and records daily breeding lists. Charts and graphs are given to aid in determining a heat, or a possible problem cow. The cows are bred and entered in the computer to keep an up-to-date database. A pregnancy check was done to determine the reproductive efficiency over the first month of operation of the system. The result was a pregnancy rate of 9.62%. In conclusion, the data was not enough to make a determination of effectiveness, due to time constraints and due dates, and needs continued study to further evaluate. It did yield a smoothly running new breeding program which will be a springboard for countless other studies and further evaluation.

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INTRODUCTION

Open cows cost money. With highly volatile milk prices, a dairyman must keep efficiencies high, and costs at a minimum, in order to survive in today's dairy business. As seen in the crash of the industry in 2008 and 2009, the dairies that are not able to keep up, are sometimes taken over or sold out. With an effective breeding program, cows are no longer seen at four hundred plus days in milk, and the number of open animals in one's herd decreases. The calving interval decreases, meaning two important things; more calves, and more cows at or near peak milk.

For each estrous cycle that a cow is not spending growing a calf, she is costing the dairyman extra money. She is eating a more expensive ration, for at least 21 more days. It compounds when realizing she wont be back to the high-cow string with a new calf and higher milk production as soon as she would if she were pregnant. These losses due to open cows are further compounded by the current feed price situation. With corn hovering at record averages, and ethanol not slowing down, the other prices are rising as other alternatives are explored. This leads to an overall more expensive ration across the entire herd. The milk price does not compensate for this. Therefore, dairymen must strive to be as efficient as possible.

Pregnant cows bring many benefits. The more pregnant cows, the tighter the calving interval. This puts more baby calves on the ground, more cows milking at or near peak milk, and fewer cows gaining excess weight and clogging up the low cow string at 400+ days in milk. All these benefits point to more milk in the tank, and more animals for the herd. Effective breeding programs allow for these benefits.

Getting cows pregnant takes more effort today than in years past. This stems from problems surrounding advanced genetics and modern practices pushing the cows for higher milking efficiencies and yield, which, most of the time, oppose reproductive efficiencies. Current technologies are used to aid in a dairies reproductive efficiencies. These include, tail chalking, patches, pressure sensors, activity monitors, progesterone tests, synchronization techniques, and the visual heat detection method. These systems are widely used with varying levels of success.

Activity monitoring systems are relatively new and have the possibility of providing reliable data with minimal additional labor. MICRO Dairy's Heatime™ system is one such system. This system will be installed on Cal Poly's Dairy, and the findings will be monitored. This system will be evaluated compared to current alternative systems used in modern dairying to determine relative value amongst the other standard systems.

LITERATURE REVIEW

Reproductive Management

Dairy cattle, due to the added stress of lactation, maintenance, and growth, are predisposed to poor reproductive efficiencies. Reproductive inefficiency of dairy cattle causes great frustration for dairy producers (Stevenson, 2001). The decline of reproductive efficiencies have correlated with the rise in milk production. Conception rates of lactating dairy cows in the United States have declined since the 1950‘s (Butler and Smith, 1989), and milk production rates have risen since then. Due to the inverse relationship of milk production to reproduction, a dairy farmer must put in place an adequate breeding system to help compensate (Stevenson, 2001).

There are many aids in determining estrus in dairy cattle. Typically this is the most logical place for improvement in getting cows pregnant. The factors affecting pregnancy efficiencies are semen quality, inseminator efficiency, heat detection, and overall heard reproductive health. Semen quality, inseminator efficiency, and reproductive health are fairly constant. Professional breeders, bull studs with high standards, and nutritionists cover these areas pretty well. This leaves heat detection rates as the main target for improvement. A good reproductive management system is needed to help in determining and breeding cows in heat. There are many options to choose from: different synchronization programs, tail chalking, pedometers, accelerometers, patches, heat mount detectors, gomer bulls, androgenized heifers, and electronic pressure-sensitive, rump-mounted devices like the Heatime™ system. All of these can be combined, used separately, or picked through for the correct

combination on a particular dairy (Stevenson 2001). Stevenson also notes from Senger, that there are 5 key factors in having a perfect estrus detection system:

- Continuous surveillance of the cow
- Accurate and automatic identification of the cow in estrus
- Operation for the productive lifetime of the cow
- Minimal labor requirements
- Higher accuracy and efficiency (>95%) for identifying the appropriate physiological events that correlate with estrus, ovulation, or both (Senger 1994)

Stevenson went on to say that none of the estrus detection aids or devices were more reliable than visual observation. That is referring to visual observation 100% of the time. This being impossible, help from aids are needed. The devices in Stevenson's study did well, but had room for improvement (Stevenson 2001).

Currently the standard accepted method for breeding cows in the Western style, is tail chalking and some type of synchronization program. One benefit to a synchronization program, is that heat detection may go up to 100%, due to full submission. This means that a herds conception rate now equals the herds pregnancy rate. These synchronization programs range in strategies but all revolve around GnRH and Prostaglandin shots in order to synchronize cows to ovulate in the same window of time (3-4 days), or at a specific time (within 1 day). They have many benefits ranging from convenience of scheduling tasks, controlling the timing of onset of estrus for a group of cows, to knowing the stages of the estrous cycle in a particular

group of cows. Most programs work by giving the cows scheduled and ordered doses of GnRH, Prostaglandin, and Progesterone implants, in order to "reset" her cycle, and induce an estrus event at a time desired (Stevenson 2001).

Alternative Methods of Heat Detection

Activity monitoring systems have been utilized in the past. One such example is the trial published in 1976 by Charles A. Kiddy. A study was done using pedometers attached to the rear legs of cows, read manually at each milking, and compared to previous data. This data was then correlated to a breeding program. The pedometers used and their setup and attachment seems primitive by today's standards, but at the time it was a very innovative and groudbreaking study (Kiddy 1976).

In another study, Løvendahl and Chagund† looked at electronic pedometers or activity tags. These items use changes in behavior to detect estrus in dairy cows and heifers. General increased activity, curiosity, restlessness, and both primary and secondary signs of estrus are monitored as increased activity. These are known as signs of estrus to watch for in visual heat detection methods, and can be correlated into electronic data via electronic activity monitors. "The efficiency of the various types of devices in terms of estrus detection rate has been reported to be between 50 and 100%, depending on criteria of success and methods of determining the signal and its interpretation" (Løvendahl and Chagund† 2010). Their published article also talks about an idea activity monitoring system having the total package; equipped with a dedicated software system as an integral part of an on-farm management system. Wireless sending and a dedicated computer system allow the unit to stand

alone without constant supervision and recording of data (Løvendahl and Chagund† 2010).

Rumination

According to a study done by Walker et al., titled "Lameness, Activity Time-Budgets, and Estrus Expression in Dairy Cattle", they monitored rumination rates in dairy cattle. They noted that there was reduced estrus expression in lame cows which was attributed to the lameness of the cow. The animals still exhibited the same behaviors, just less frequently than cows with no lameness problems. The intensity of the observable heat was reduced. This was attributed to lame cows dedicating less time out of their daily routine to expression of estrus (Walker et al. 2008).

This correlates to the rumination rates of all cows. The study done by Walker et al., compared bite rates and rumination rates between lame cows and not lame cows. They found that lame cows had a lower bite rate during grazing than the not lame cows. However there was no difference found in rumination chewing rates between the two groups (Walker et al. 2008).

Erika Lindgren did a study concerning the effectiveness and validation of rumination as a measurement to determine estrus. She monitored the SCR tags and found near identical results when comparing the tag and actual observed data. Figure 1 shows this correlation. The rumination itself was taken into consideration as she cited Grant and Albright, "During estrus a marked decline in rumination time can be observed as well as prior and after parturition. . ." (Grant & Albright 2001)(Lindgren 2009). This shows that we can count on rumination as a secondary sign of estrus.

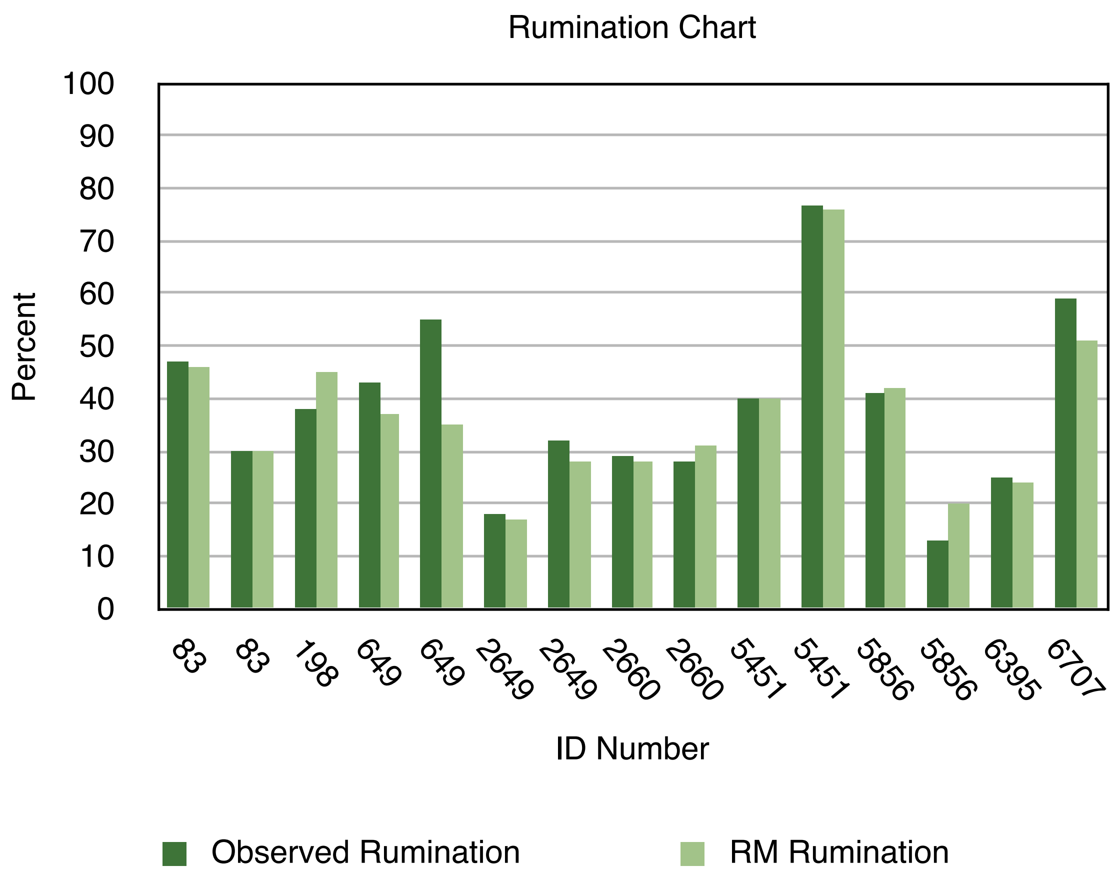


Figure 1. Shows correlation between Observed and data derived from SCR rumination tags (Lindgren 2009).

Synch Programs

Table 1, derived from Stevenson's work, shows the costs associated with each method. "Assessing the costs of using programmed AI-breeding is not easy. Furthermore, most producers assume that it is more costly because of the extra labor, semen, and hormones" (Stevenson 2001). However, the additional cost is overshadowed by the realized economic benefit. A table in Stevenson's article shows the net profit of using a timed breeding program depends on heat detection rates of traditional systems. If heat detection rates are at 70%, the realized net economic effect is +$53 per additional pregnancy. If heat detection is 40%, which is closer to

most herds, then the net economic impact is +$134 per additional pregnancy. Ovsynch has been shown to give from 20 - 12 more pregnancies per 100 cows, depending on heat detection rates; respectively at 40% - 70% (Stevenson 2001). So on the low side, 20 x $53 = $1,060 more per 100 cows. The high side is 12 x $134 = $1,608 more per 100 cows. The prices per additional pregnancy included all costs of breeding, value of additional pregnancy, and cost of additional days open (Stevenson 2001). This shows that a program like this, with high heat detection rates, will easily pay for the extra cost and is economically a viable decision.

Table 1. Compares the costs associated with Traditional tail chalking methods vs. Ovsynch (Stevenson 2001).

Per Cow	Traditional	Ovsynch
Horemones	$0	$13
Labor	$0	$5
Semen + AI	$20	$20

MATERIALS AND METHODS

MICRO Dairy Logic's Heat Time

The product implemented for use as a new breeding protocol was provided by MICRO Dairy Logic. MICRO Dairy Logic donated and helped set up the SCR Heat Time Collars. Mr. Tony Timmons initiated contact concerning the collars, after suggestion by Dr. Stan Henderson and dairyman Cornel Kasbergen.

The Heatime™ tags utilize an accelerometer correctly positioned on a cow, to be able to recognize movements the animal makes. They are located on her neck, just posterior to the jaw bone on her neck. They must be positioned a certain way to interpret the animals movements correctly. The accelerometer collects the data in relation to its position on the animal, so if it were backwards or flipped, and a cow was mounting, it would not interpret this data correctly. They are a "smart" device in that they know where they are supposed to be positioned, and transmit data based on this parameter. The information is filtered to not detect all movements, as a pedometer would, but to detect only estrus related movements. For example, a cow mounting another would move in a different fashion than one running to the milk barn. These movements are all filtered and analyzed to only flag those which are of true importance in determining an estrus event.

These tags also have a rumination monitoring system in them. The method in which rumination is monitored is by sounds. A microphone placed against the back wall of the tag which is held snug against the cows neck by the collar, listens for teeth grinding and constant rhythmic chewing sounds for more than a few seconds,

followed by a short rest, then more rhythmic chewing. This is indicative of rumination and is recorded as such, in minutes, until it stops. The tags also hold a battery. This battery, on the activity tags, has approximately a 10 year life. With the additional rumination function, the 10 year life may be impacted slightly, but still a long effective life without repair or replacement.

These movements and rumination minutes are recorded and stored for up to 24 hours. This information is uploaded to the sending units, via two infrared scanners on either exit lane of the milking parlor. They are read twice a day on the milk cows, as Cal Poly milks twice a day. The tags have the ability to hold information for up to 24 hours in prevention of data loss in the event of a power outage or a skipped milking. The tags require a seven day period in which they develop a baseline standard deviation for each individual cow. The activity information is displayed in a raw data bar graph with the standard deviation line on this same graph. Dairy cattle exhibit drastically increased activity during estrus. When an animal comes into estrus, she spikes in activity, and she drops in rumination. A baseline for flagging the cow is set to anything above 4.7 standard deviations above the normal activity. Typically when a cow spikes, 30+ standard deviations are displayed.

Mr. Andrew Young, a technical support advisor for MICRO Dairy Logic, helped set up MICRO's program. The herd management program is available both as a computer program or a completely stand alone system. For this study, MICRO Dairy's program, Data Flow, will be used in conjunction with Cal Poly's programs, DHI Plus and Dairy Comp 305. The system is fairly straight forward, and allows

monitoring of the herd alongside the original dairy's program. The biggest issue in having this much data is assuring that it gets entered correctly. Input of the dairy's information will keep the dairy up to date and current with all the breedings, pen moves, freshenings, and vet checks. This will ensure the program is setup to run optimally and give the best results.

Figure 2. A new HR Tag out of the box, and in position it would be on the cow, as if she were looking at the reader.

Heatime™ Collars

The Heatime™ collars consist of a band, weight, tag, and a clasp to allow for adjusting. The clasp is designed to breakaway to prevent the cow from strangling herself in the event of a hang-up on something. They use a metal weight encased in rubber to provide proper placement of the HR-TAG on the cow. Figure 2 shows the HR-TAG, which is what was used in this study, new out of the box. The tags allow for movement measurement; including all head movement types, intensity, and duration. This is done using a proprietary motion intensity sensor housed in the tag. This is linked with a specific, six digit, tag number, which is assigned to a cow in the Data Flow program; similarly to an EID tag number in Dairy Comp 305 or DHI Plus.

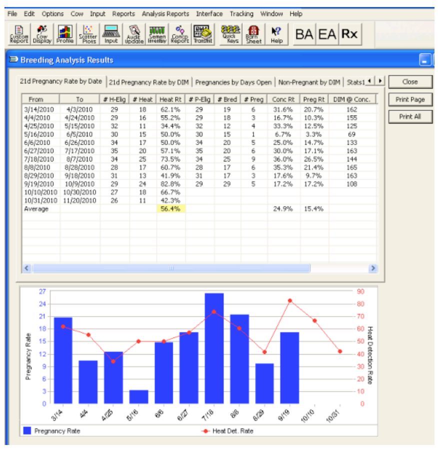
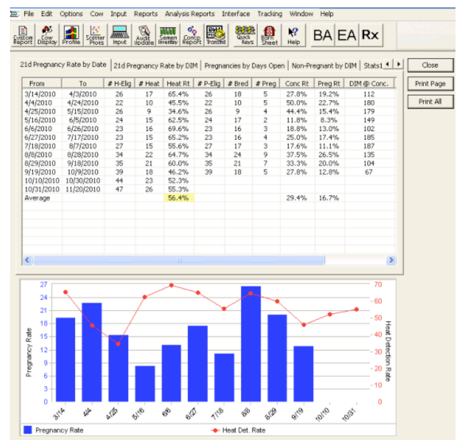
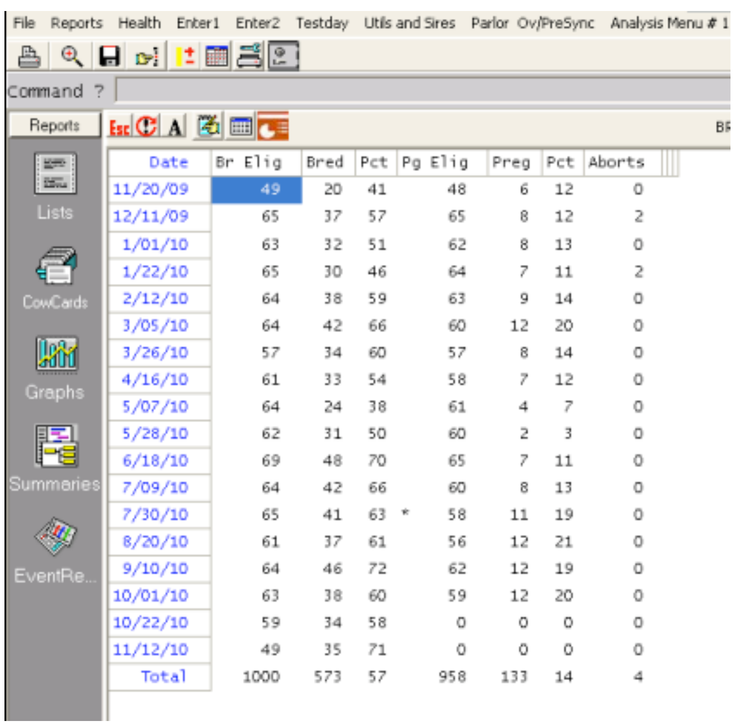
21 Day Pregnancy Rates

A good way to monitor heard reproductive efficiency is in a 21 day pregnancy rate. Pregnancy rate is suggested to be one of the best measurements of a herds breeding program (Stevenson et al. 1996). It is calculated by taking the number of animals pregnant divided by the number of eligible animals (PR = # Pregnant / # Eligible). Depending on the definition of eligible animals, different rates are acquired. For example, if “Do Not Breed” cows were included, the rate would be different than if they were excluded. DHI Plus and Dairy Comp 305 both kick out numbers for these rates, which differ slightly due to different parameters. The Cal Poly Dairy pregnancy rates are shown in Table 2 as of 12/3/2010.

It is interesting to note the difference in rates between the two programs. A pregnancy rate of 16.7% for the Jerseys and 15.4% for the Holsteins from DHI Plus

compared to 14% combined on Dairy Comp 305. This gives us a baseline for which to compare the results of the Heatime™ system to.

Table 2. Shows each of the originally used systems at the Cal Poly Dairy and screen shots of their breeding analysis. DHI Plus split the herd into Jerseys and Holsteins, but Dairy Comp 305 had them all in one.

System	Holsteins	Jerseys
DHI Plus		
Dairy Comp 305		

Date	Br Elig	Bred	Pct	Pg Elig	Preg	Pct	Aborts
11/20/09	49	20	41	48	6	12	0
12/11/09	65	37	57	65	8	12	2
1/01/10	63	32	51	62	8	13	0
1/22/10	65	30	46	64	7	11	2
2/12/10	64	38	59	63	9	14	0
3/05/10	64	42	66	60	12	20	0
3/26/10	57	34	60	57	8	14	0
4/16/10	61	33	54	58	7	12	0
5/07/10	64	24	38	61	4	7	0
5/28/10	62	31	50	60	2	3	0
6/18/10	69	48	70	65	7	11	0
7/09/10	64	42	66	60	8	13	0
7/30/10	65	41	63 *	58	11	19	0
8/20/10	61	37	61	56	12	21	0
9/10/10	64	46	72	62	12	19	0
10/01/10	63	38	60	59	12	20	0
10/22/10	59	34	58	0	0	0	0
11/12/10	49	35	71	0	0	0	0
Total	1000	573	57	958	133	14	4

These numbers are low compared to the industry goal of >20% for the pregnancy rates. The rates tend to rise in the summer and winter, but are lower in the spring and fall, likely due to time conflicts with classes and less time devoted to the dairy. This is not the typical trend seen, but trends do appear on all herds, and will be worth comparing the old trends with the new ones from the Data Flow system. The Data Flow system kicks out numbers on the Fertility Report. This will be a good indicator of the effects of the Heatime™ system on Cal Poly's heard. Currently more data needs to be acquired, and then a viable comparison will be made between the herds old, and new, reproductive efficiencies.

Specific Breeding Protocol

Breeding at the Cal Poly Dairy is currently done using a 50 day voluntary waiting period (VWP). Animals showing signs of heat post 50 days in milk will be inseminated. Furthermore, the animals were enrolled on an Ovsynch program. This all in conjunction with tail chalking was the protocol standard, prior to the installation of the Heat Time system.

Receiving a Collar

Cows at the dairy were collared if they met certain protocol. On breeding animals, they are all open and not on the "Do Not Breed" list. The readers in the hospital and close up pens allow for collars to be put on other cows to monitor rumination and to establish a baseline activity earlier. This is where extra collars are placed. The main objective is to use this as a breeding program, for now. The tags

Table 3. Shows scanners installed and an up close of the scanners in their respective locations

Milk Lane Scanners	Up Close of Milk Lane
	
Hospital and Close up Scanners	**Up Close of Hospital and Close up**
	

are limited and are used on breeding cows first, the extras are put on transition cows. Once diagnosed pregnant, and no additional heats by the system are found, the collars are removed and recycled to incoming fresh cows; approximately 50 days since last breeding. This ensures that the pregnancy check did not disturb and abort the fetus in its early stages.

The collars required scanners to be put up in the exit lanes of the milk barn, and also above the water troughs in the close-up and hospital pens, as the hospital are milked into a bucket at the pen. Table 3 shows the locations of the scanners and an up close of each at their respective positions. They are triggered by motion sensors, then flash infrared, scanning for the collars. The installation of the system went well and was very professionally done. Figure 3 shows the computer system and data center.

There are other benefits to using and monitoring rumination. The transition period is a critical zone for the dairy cow, and being able to monitor rumination rates could show which animals might be predisposed to a number of complications, indicated by a low dry matter intake. These would include complications in the transitional period such as retained placentas, linked also to endometritis, metritis, and pyometria; along with ketosis, linked with displaced abomasum; and milk fever. This information can later be monitored and correlated with disease in the transition cows with collars, to determine if there is a strong link, or if the collars will be able to distinguish such a link.

Figure 3. Shows the installation in the office of the computer, data acquisition system, and printer which MICRO Dairy Logic donated and installed.

The seven days that it takes to recognize an animals normal activity, is only for monitoring activity. Rumination, however, does not need this adjustment period. It is an instant reading from the moment the collar is put on the cow. This data comes in as rumination per day in minutes. It is graphed in two hour blocks. The data is compiled in the same way as activity; it is given a standard deviation line which better allows us to see a drop as an actual drop, rather than just a period of rest. This

deviation is compared to an eight hour window around the time, one week ago. This helps correlate with temperature and weather changes due to seasons changing.

RESULTS AND DISCUSSION

Synchronization

There are many benefits to using a synchronization program. It is convenient to give the cow vaccinations coinciding with shots, also it works well as most facilities will have their cattle locked up in self locking stanchions for the breeder or for the veterinarian for pregnancy checks. The system works well and has been proven by repeated use in a large number of dairies in California and other states. It was show to be profitable, factoring all the costs of injections, labor, feed, pregnancies, semen, open cows etc. . . when compared to not using a synchronization program at all, and simply artificial insemination of natural observed heats.

Hormone injection tends to be a labor intensive process and the public may see this as a negative to the dairy industry. The public has been growing more involved in the way animals are handled. This is seen in Proposition 2 which passed in California in 2008, setting pen size limits for laying hens, farrowing sows, and veal calves. Dairy farmers have also been put under the spotlight with incidents and videos posted online, such as the Ohio dairyman - Mercy for Animals video, or the infamous "fork lift driver" video. Furthermore, the public has become involved in the way we produce our milk, with concern about using recombinant bovine somatotropin injections to stimulate feed conversion rates in dairy cows. Most creameries, as a result, require that dairymen sign a contract stating no rBST will be used on that particular dairy. To the publics, steroids or hormones used in conjunction with food supply is a taboo. One more thing which may pose an issue, is

the injecting of hormones into dairy cattle to induce estrus. All of these factors promote the idea of moving to something different; being proactive to prevent negative attention from the general public.

Activity Monitoring for Estrus

Activity monitoring to catch more cows in estrus may be one such way. In Kiddy's study, he stated: "Our results suggest that estrus can be detected in cattle through the continuous monitoring of physical activity. The pedometer appears to be a useful device for this purpose, particularly in loose housing situations where cows are milked in milking parlors." He also talked about trials with electronic methods of monitoring being a viable option in the future (Kiddy 1976).

Reviewing the results from a similar study done by Liu and Spahr, on the automated electronic activity measurements in dairy cows, they found that "The results of this experiment show a promising future for use of electronic activity tags to detect estrus" (Liu and Spahr 1993).

Both of these studies were pointing to what is now a reality with the Heatime™ system. It collects "smart" data wirelessly, and presents it rather simply with only management decisions left to be made. Furthermore, it satisfies the 5 key factors in a perfect estrus detection system as outlined by Senger:

- Continuous surveillance of the cow
- Accurate and automatic identification of the cow in estrus
- Operation for the productive lifetime of the cow
- Minimal labor requirements

- Higher accuracy and efficiency (>95%) for identifying the appropriate physiological events that correlate with estrus, ovulation, or both (Senger 1994)

These factors are all met by the Heatime™ program. There is continuous surveillance. Minimal labor requirements; only upkeep of data and ensuring proper entry into the system. Furthermore, the identification of the cow in estrus is automatically pulled up each time she is scanned. The system even gives the best *time* to inseminate - on the decline of activity. This correlates with inseminating in correct correlation to ovulation, in order to get the highest possible conception rates.

Rumination was also shown to be a valid identifier in estrus monitoring. As viewed in Walker, et al.'s study, rumination rates were the same for both lame and not lame cows (Walker et al. 2008). This correlates with the study done by Erika Lindgren looked at earlier. Estrus was marked by a significant decline in rumination time. This also happened before and after parturition. Furthermore, the SCR tags proved effective at gathering all of the rumination data, as seen in Figure 1 (Lindgren 2009).

Specific breeding protocol

As the data comes in from the scanners and tags, the computer analyzes it. It uses the raw data to come up with graphs showing both the raw data in two hour blocks and a standard deviation line to compare to the cows average activity. The normal activity during heat increases, but not quite drastically enough to notice. The standard deviation line really exaggerates this change because of the drastic change

Table 4. shows varying screen shots and their descriptions - from the computer running the system and collecting data

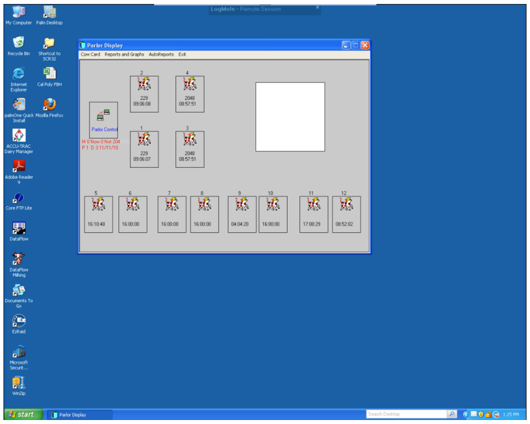
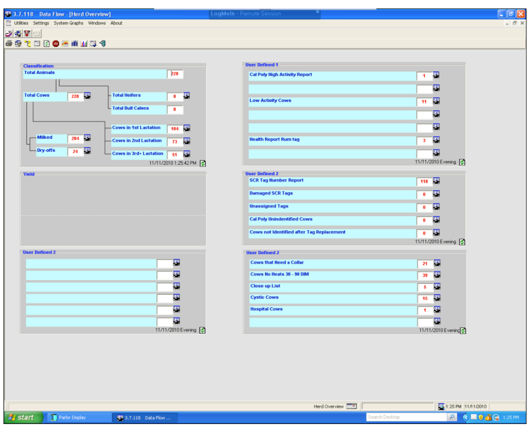
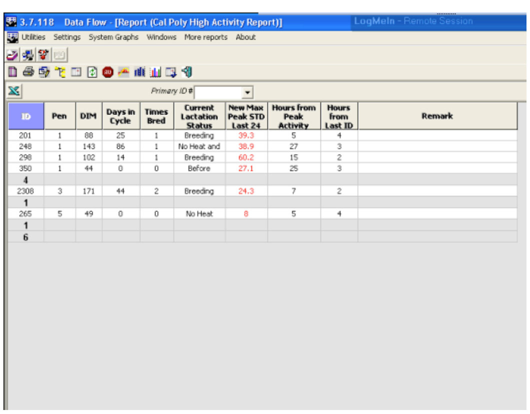
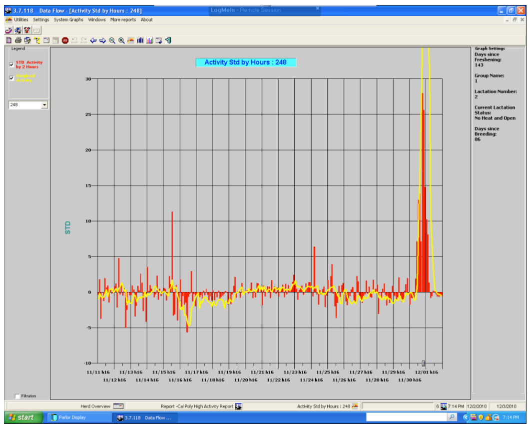
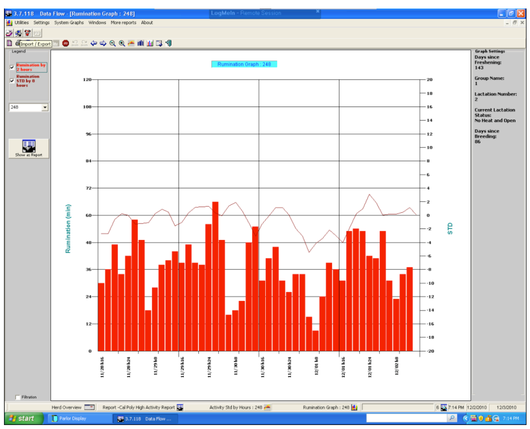
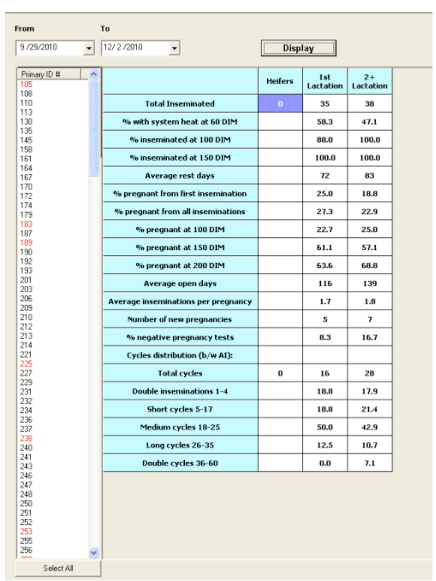
Screen Shot	Description
	Main screen always running - Shows scanners and last cows ran through each scanner
	Home page of reports and general information about number of cows in a report at a glance
	Example of a report. They are customizable and the user is able to put many reports on the home page

Table 5. Shows screen shots of graphs and also the fertility report - also from the computer running the system

Screen Shot	Description
	Example of one of the activity charts. The sharp peak in activity is seen on 12/1/10, this is a marked heat and the animal was bred after the peak.
	Example of one of the rumination charts. This is the same animal as the above chart. There is a marked dip in minutes per day on the date 12/1/10. This also is indicative of a heat.
	This is the Fertility Report. This can be generated for any desired dates. The report shows reproductive efficiency rates and allows the user to compare different time periods to see trends

From 9 /29/2010 To 12/ 2 /2010 Display

Primary ID #: 105, 108, 110, 113, 130, 135, 145, 158, 161, 164, 167, 170, 172, 174, 179, 183, 187, 189, 190, 192, 193, 201, 203, 206, 209, 210, 212, 213, 214, 221, 225, 227, 229, 231, 232, 234, 236, 237, 238, 240, 241, 243, 246, 247, 248, 250, 251, 252, 253, 255, 256

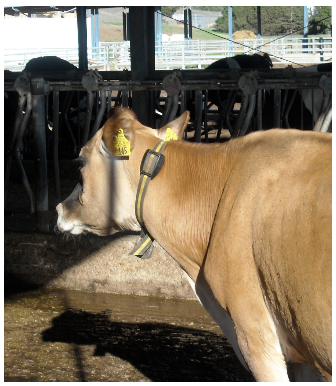
Select All

	Heifers	1st Lactation	2+ Lactation
Total Inseminated	0	35	38
% with system heat at 60 DIM		58.3	47.1
% inseminated at 100 DIM		88.0	100.0
% inseminated at 150 DIM		100.0	100.0
Average rest days		72	83
% pregnant from first insemination		25.0	18.8
% pregnant from all inseminations		27.3	22.9
% pregnant at 100 DIM		22.7	25.0
% pregnant at 150 DIM		61.1	57.1
% pregnant at 200 DIM		63.6	68.8
Average open days		116	139
Average inseminations per pregnancy		1.7	1.8
Number of new pregnancies		5	7
% negative pregnancy tests		8.3	16.7
Cycles distribution (b/w AI):			
Total cycles	0	16	28
Double inseminations 1-4		18.8	17.9
Short cycles 5-17		18.8	21.4
Medium cycles 18-25		50.0	42.9
Long cycles 26-35		12.5	10.7
Double cycles 36-60		0.0	7.1

from her normal daily routine. When the standard deviation goes above 4.7 units above normal, the computer flags the animal as in heat. Examples of these and other screen shots from the program are shown in Table 4 and Table 5. Drastic numbers are definitely heats, while numbers close to the cutoff may be pen moves or due to cows being let outside after a change in weather. For example, the cows got out on October 10 early in the morning; this triggered more animals to be flagged as in heat. The animals are not all in heat, so one must go through the data to determine who to breed. Days in milk and days since last heat are looked at in conjunction with the magnitude of the recorded activity spike. Questionable animals should be palpated, if obvious signs of heat are not present, to determine whether to be bred or not. These results will determine who should be inseminated based on period in estrous cycle.

Once a cow comes up as in an eligible heat, she is inseminated within the correct time frame designated by the system. Ideally, breeding should be done anywhere from 8 - 16 hours past the peak activity spike. This is not always possible, especially breeding only once a day, however, the ovum and sperm are both viable for long enough periods of time to allow for fertility ratings to not be compromised by only breeding one time per day. Rather than doing AM/PM breedings, the simpler route of only AM breeding seemed more applicable in the interest of time and to be more applicable to most dairy farms with modern breeding norms.

Table 6. Shows collar in relation to various animal activities.

Collar Placement	Collar while Eating	Entering Stations
		

Collars

The collars fit on the animals snug around the neck. This enables accurate measurement of both rumination and movements. The collars are accepted by the animals and they seem comfortable with them on rather quickly. Events like entering the lock-ups to eat are effortless. Table 6 shows pictures of these activities.

Putting the collars on the animals took less time than expected. It took no more than 5 or 6 hours to put collars on all the eligible cows. This included finding them, marking and putting the collars on, scanning the collars, and entering all of the data into the computer. The original entry went smoothly as the Data Flow program is able to pull records off of Dairy Comp 305 or DHI Plus. From then on, the only needed upkeep is to enter all the changed collars, freshenings, breedings, pen moves, etc. The system is simple and data entry for anything is done with a few clicks and

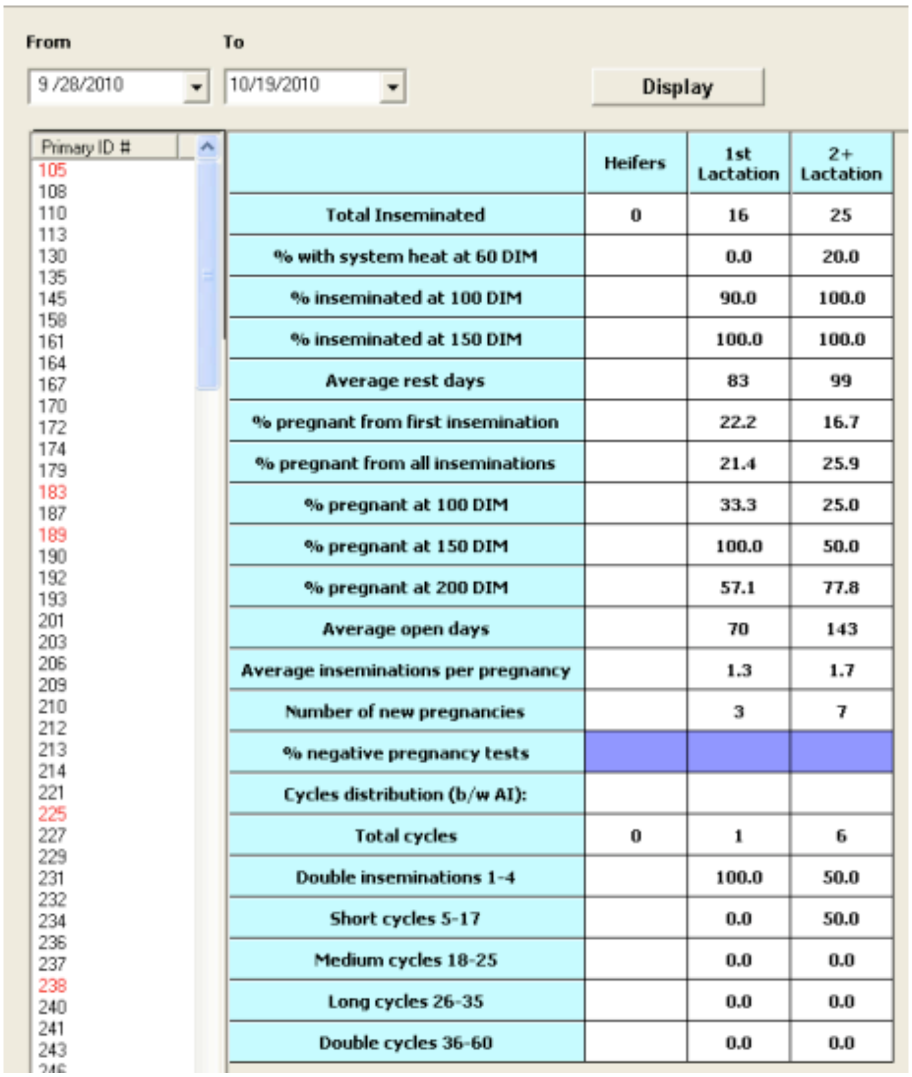
keystrokes. The system also has the ability to follow things such as sicknesses, treatments, milk flows and other special remarks for each individual cow. Overall a very impressive system.

Fertility Report

The fertility report feature on the Data Flow system gives the user many reproductive efficiencies. This allows the user to compare their farm with others, and even track improvements, declines, or over a desired period of time. Items such as "% with system heat at 60 DIM" and "% inseminated at 100 DIM" give the user an idea of how their fresh cow program is doing and how quickly cows are cycling again. The report shows percents pregnant, percent negative pregnancy tests, average open days, inseminations per pregnancy, and other information regarding estrous cycles of the cows. All of these rates are further divided into heifers, 1st lactation, and 2nd + lactation cows. Another fertility report is shown in Figure 4.

The old pregnancy rate from the Cal Poly Dairy was between 14% on Dairy Comp 305 and 16.7% for the Jerseys to 15.4% for the Holsteins. The Data Flow system does not give a pregnancy rate but it can be figured. The dates for evaluating reproductive efficiencies within this project are limited due to the time constraint of due dates. The last pregnancy check was done on 11/20/2010, and the previous was two weeks prior. Pregnancy checks are done every two weeks at the Cal Poly Dairy. Based on checking animals greater than or equal to 32 days since bred for pregnancy, our last possible date eligible for pregnancy check is 10/19/2010. Evaluating a 21 day pregnancy rate requires a 21 day period; 21 days before 10/19/2010 is 9/28/2010.

The program was installed and the dairy was breeding off of it by 9/28/2010. There were a few overlapping ovsynch cows finishing up their protocol in the first few days, but as this was the only time window available, it was used. This data can be seen in Figure 4. Going off of the data shown in this report, the 1st lactation cows had a conception rate of 18.8%, the 2 + lactation cows had 28%, and an overall conception



	Heifers	1st Lactation	2+ Lactation
Total Inseminated	0	16	25
% with system heat at 60 DIM		0.0	20.0
% inseminated at 100 DIM		90.0	100.0
% inseminated at 150 DIM		100.0	100.0
Average rest days		83	99
% pregnant from first insemination		22.2	16.7
% pregnant from all inseminations		21.4	25.9
% pregnant at 100 DIM		33.3	25.0
% pregnant at 150 DIM		100.0	50.0
% pregnant at 200 DIM		57.1	77.8
Average open days		70	143
Average inseminations per pregnancy		1.3	1.7
Number of new pregnancies		3	7
% negative pregnancy tests			
Cycles distribution (b/w AI):			
Total cycles	0	1	6
Double inseminations 1-4		100.0	50.0
Short cycles 5-17		0.0	50.0
Medium cycles 18-25		0.0	0.0
Long cycles 26-35		0.0	0.0
Double cycles 36-60		0.0	0.0

Figure 4. Shows fertility report ran from 9/28 - 10/19. This is the only valid gathered from the system and is also the very first data, as the system was installed only a few days before this time period.

rate of 24.4%. These numbers are a little low as greater than 30% is the benchmark. For the pregnancy rate, if there are 10 new pregnancies, and there are 104 eligible cows, that equals a 9.62% 21 day pregnancy rate on the new system, from 9/28 - 10/19.

Comparison

The comparison between pregnancy rates was found earlier to be one of the best ways to monitor a breeding programs efficiency (Stevenson et al. 1996). The pregnancy rates that are available for evaluation, however, are without sufficient data to make an adequate evaluation of the new and old program. A 9.62% compared to the 14 - 16.7% rage appears to be quite low. However, it should be noted that this data was the very first 21 days of operation with the program. There were multiple factors in effect during the transition. There were ovsynch cows still finishing up their protocol. Furthermore, there was a period of adjustment between the two systems, as expected during periods of transition. Therefore, these two sets of numbers are not reliable as a comparison between the two programs. The numbers are simply the best data attainable within the allotted time for this project.

CONCLUSION

After the system has been installed and the results have been weighed, the information is not enough to make a certain determination of the effectiveness of the system. The system is impressive. All of the breeders working with this program will agree that at least one cow for each of them has come up on the list when she would have been overlooked using the old system. The study needs to continue to get more reliable data for comparison.

An ideal situation would have been to have installed the system earlier over the summer months. This would have allowed for the program to be implemented without the interruption from class schedules. Furthermore the program would have been implemented for a longer period of time, allowing much more data to be considered in evaluating the two systems. Outside factors, however, resulted in the system not being installed until later in September. Therefore, further comparison between the two systems is needed to determine effectiveness in relation to the other. This does not mean, however, that the project failed to recognize other beneficial outcomes.

The system presents a valuable basis for many other experiments, rather than the sole addition of a new breeding program. This is certainly worthwhile and will be an effective tool for many projects at the Cal Poly Dairy. The rumination measurements along with the activity monitoring system allows for the vast data collection needed in nearly any type of reproductive study. Comparisons between the different breeds, as well as between other breeding variables, will be able to be made

using the data from this system. Furthermore, transition cow studies can be done using the collars and the readers in the close-up and hospital pens. This program is a highly effective tool and a great manager of data. The Heatime™ system will certainly serve as an excellent stepping stone to many other projects to be done at the dairy.

In conclusion, though the project did not go as planned originally, and the objective was not accomplished, many other accomplishments were realized. The data for comparison is not enough to make a decision of effectiveness, but it can serve as a baseline for further evaluation of the study. This study will be ongoing to gather more data and make a better comparison. Despite the downfalls of the project, there are benefits. For one, the system is up and running. There is always an adjustment period when switching to a new program, and that has been established and will be able to be excluded from other studies. A second benefit is that all of the bugs have been worked out of the system and it is running smoothly. There seems to be little things that come up, post adjustment, that slightly hinder the use of any new technology. Lastly, the system is set up to serve as a great springboard for countless other projects on anything from reproductive studies to feed trials. So, despite the fact that the study fell short of original expectations, this project did present a great deal of value to the dairy industry.

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