Activity and Rumination Monitoring for Calving Times

A Senior Project
Dairy Science Department
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In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science

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ABSTRACT

The objective of this study is to determine if monitoring rumination, with the use of a rumination monitoring system, can effectively predict the time of parturition. This rumination monitor is the MICRO Dairy Logic HR-Tags. They are part of the Heatime™ collars, which also work with estrus detection. A protocol was created for the dry cows for placing the collars on to establish a baseline. The collar has a microphone which is used to monitor the rumination of the cow. Once the baseline is established the cow is moved to the close-ups. In the close-ups rumination is monitored as the cow reaches time of parturition. The collars are read through a system of sensors located in the exit alley of the milk barn and above the water troughs in the maturity pen. The data is transferred to the computer to determine if a rumination drop occurs prior to calving. In addition to monitoring drops rumination was related to calving scores and data was used to make comparisons to postpartum diseases. The rumination data was sorted and demonstrated a drop in rumination at calving time. During the next few days, rumination rose to the normal rumination time of the cow. There were a total of twenty two cows used. There were seven Holsteins and fifteen Jerseys. The observation seen is there is a drop of rumination almost down to zero in the two hour block at calving time. In summary, the system showed consistent drops in rumination at calving but did not accumulate enough data points to create comparisons or contrasts consequently results were inconclusive and difficult to extrapolate conclusions without a large subjective inference.
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INTRODUCTION

Technological advances are being made in all aspects of the dairy operation; rumination monitoring with SCR HR-TAGS is one of these advances. The initial development of these collars was to monitor specific movements that indicate estrus; these collars did not have the rumination microphone in them. The HR-Tags now have a microphone that will monitor the rumination activity. With rumination monitoring there is the possibility to use it for parturition predictability, postpartum disease detection, assistance in postpartum disease recovery time and there is potential for many other possibilities. However, there are very few studies done in the field of rumination monitoring systems. By doing this study, it may increase the possible use of rumination monitoring. These new ways of monitoring rumination activity will aid in the dairy operation as a whole. These emerging monitoring systems will decrease the down time of cows after calving by preventing diseases like ketosis, displaced abomasums and milk fever. The cows are able to get back into the herd, producing more quickly, and generally are in better health. Optimizing production is always the key goal in today’s successful dairy economy.
LITERATURE REVIEW

*Heatime™ benefits over other methods*

Every year technology is advancing for the dairy industry. Breeding cattle went from using a bull to the implementation of artificial insemination. As the times change the systems for monitoring estrus keep advancing. These systems, such as accelerometers which measure cow movement, estrus synchronization programs and even tail calking have seen advancements (Nutcher 2010). There is also the use of gomer bulls, patches that show mounting activity, and pedometers which attach to the leg of the animal to measure movements which determine if there is an increase in activity (Nutcher 2010). As new ideas and more advanced systems become available, dairymen are using them to improve estrus detection rates in their dairy operation. Once the dairyman determines how to use these systems or is shown how to use them, they obtain the associated benefits. They may increase productivity of their operation as a whole. When using a system like the MICRO Dairy Logic Heatime™ there needs to be a standard operating procedure. Following these standard operating procedures will determine if this system will run and operate correctly. Nutcher (2010) established and implemented the Cal Poly Dairy’s breeding protocol when using the Heatime™ collars. It is a voluntary waiting period of fifty days and when the animal is over fifty days and are on the high activity list they are breed. In a study on economic consequences the determination is the voluntary waiting period reduces the animals’ milk production (Inchaisri et al 2010). Getting the first breeding to conceive is important because getting the animal pregnant at the earliest possible time can save the dairyman money. This is done by increasing the milk production and not having to breed for a second time. This saves the cost of A.I. using a
heat detection system which can increase the possibilities for dairymen to obtain benefits such as a decrease in the number of breeding and rebreeding animals which did not conceive, saving money on semen and supplies and associated labor costs.

**Role of Rumination**

At birth, a cow is a non-functioning ruminate and has only one functioning stomach. As the calf gets older the rumen develops and begins operating, turning the calf into a functioning ruminant animal. As a ruminant they are able to digest cellulose in plants due to the presence of a particular bacteria found in ruminant stomachs. Consequently, cows need plant material to be able to ruminate. The process of rumination begins with the cow or ruminate animal consumes plant material. The plant material travels down the esophagus into the reticulum. From there it goes into the rumen then regurgitated for chewing. During mastication the feed particles are broken into smaller pieces with the addition of saliva which acts as a buffer. Then it goes back to the rumen where it passes to the omasum and abomasum where it is further broke down by enzymes. This whole process is crucial and if the animal is fed a poor rumination diet it can alter the volatile fatty acids which reduce butter fat percentages (Welch 1982). These are critical in the process during and after rumination.

**Rumination Pattern**

Some studies suggest that rumination occurs at a higher rate during the night than during the day. In a study by (Beauchemin et al., 1990) a pattern in rumination between feedings and a peak in rumination during the night is shown. The time that a cow normally ruminates is around 450-500 minutes per day (SCR Engineers LTD). Micro
Heatime™ rumination monitoring can be used to determine rumination times and tell when they occur.

**Rumination Monitoring Systems**

A study on a dairy in Israel is one of the few that have been done with a rumination activity monitoring system. Rumination collars have a potential in aiding the dairyman’s management system. These collars can potentially help in preventing calving disease, predicting calving times, detection of sick cows, and monitoring the recovery of the sick cows. The main finding in a study done by SCR engineers was a decrease in the rumination two weeks before calving (Bar and Solomon). This suggests that there is an association of rumination and calving times. Bar and Solomon also stated, that at calving, there is a significant drop in rumination. In the days following calving the rumination gradually increases. If the cow gets sick the rumination will take longer to get back to the normal range. Preventing and monitoring sickness is a key element in the usefulness of rumination systems. SCR researchers and engineers are looking into how rumination time relates to calving diseases. Another study shows a sudden decrease of rumination after calving and in the subsequent week rumination will recover and returns to normal around seven days postpartum (Bar) (Figure 1). Knowing the normal rumination activity of a cow leading up to calving, during and following calving will greatly aid in the process of determining if the cow is getting sick. This study shows that early treatment can be achieved based on the rumination activity times. When doing this right there can be a lower amount of medicine used on these cows. Early treatment will also affect the production and reproduction of the cow and overall production of the dairy (SCR
Engineers LTD). By keeping the cow out of the hospital pen she will be back in the milking strings producing more milk and increase the income of the dairyman.

Figure 1. Showing the drop in rumination at calving and the climb back to normal rumination (Bar 2010).
MATERIALS AND METHODS

Micro Dairy’s Heatime™ monitoring system

MICRO Dairy Logic provides the system to Cal Poly, and they helped set up and get the system running, along with the help of Trevor Nutcher a former student at Cal Poly. Nutcher set up the Heatime™ system with Micro Dairy Logic and used this system for his senior project. After Nutcher completed his senior project myself and other farm personal took over with putting collars on and entering the breeding information into the computer. This system includes the following:

1) Entering the data which needed to be done at least once a week to ensure all the information was accurate and up to date.
2) Putting collars on in the breeding pens and in the dry cow pen.
3) The information entered was the day of breeding, the A.I. technician, the date the cow calved and the calf sets male or female.

In addition every two weeks an off campus veterinarian comes to the dairy to check for pregnant cows at thirty one days. The veterinarian confirms a fifty day pregnancy. If confirmed pregnant at this stage in the pregnancy the collars are taken off. Then, these collars are put on cows that have calved and are now over their voluntary waiting period and ready to breed. After the base line for the collars is set, the animal can be breed when she comes in heat and the systems records her for high activity.

Collars

The Heatime collars work by using an accelerometer that is positioned on the left side of the neck. It has to be on the correct side and positioned correctly (Figure 2). If it is on the opposite side or if it is upside down the data will not be read thus rendering the
data invalid. This makes attaching the collar in the correct location an important step of the process. The collar reads the movements the cow makes. Unlike a pedometer, it reads the movements that are related to estrus however, does not interpret non estrus information.

Figure 2: The SCR HR-TAG collar and an example of its positioning on the cow.

The rumination collar HR-TAG are the same collars used for estrus detection (Figure 2). However, Micro dairy logic incorporate an internal microphone. The rumination tags are to be placed on the animal at least fourteen days before the dry cow is projected to calve to establish a baseline. Since the microphone is inside the Heatime collars, the collar is placed on the cow in the same manner as the collars without the rumination microphone. The microphone works by listening for the rumination and tabulates the number of times the cow ruminates in two hours blocks. It then compares that data from the previous two hour block recordings. Then, the system compares all of the two hour blocks in that time period to determine if and when she will make the high activity list or if there is a drop in rumination. It is key to have an established baseline of seven to fourteen days. Without having a baseline the information gathered for those fourteen days is not accurate.
Protocols for Breeding and Close-ups

The Heatime™ collars breeding protocol at the Cal Poly Dairy is to place the collars on early enough to establish a baseline of fourteen days. At that point, the collars
will be ready to capture and record the heats and rumination detected from the cows on the high activity list. These collars are recognized by the readers in the exit lanes of the milk barn (Table 1). Every morning the herdsman prints out the high activity list. The cows with high activity are checked to confirm their heat and then bred. The breeding information is then entered into the computer. When the cow is confirmed fifty days pregnant the collar is removed. It is placed on a cow after her fifty day voluntary waiting period. This is done every other week when the vet comes and does a pregnancy check. The Heatime™ rumination collars are placed on the dry cows before they are moved to the close-up pen and once in the close-ups they establish a baseline. In the close-ups the collars are recognized by the readers above the water troughs (Table 1). All the data is relayed to the computer in the office, where it can be monitored to determine rumination activity leading up to calving time (Figure 4). The data was then interpreted and cows that have calved in the past year were selected. This was done by going through every rumination chart to determine whether it is viable data to be a benefit for this project. There were both Jerseys and Holsteins used in this study. A total of twenty-two cows were used.

Figure 4. The office computer where the readers send the collar information.
RESULTS AND DISCUSSION

Analysis of rumination data of the calving estimates

The rumination data taken from the microphone readings in the collar of each cow was recorded and evaluated. Collection of the data had many obstacles. The rumination graphs can only be seen in three month increments. To see the data from a later date one must change the dates of the graph. Another issue with the data in the system is when the calving times where entered into the computer at Cal Poly Dairy. The date and not time of day was the only information entered. When a cow calves the date is only entered in the computer as the day and not the actual time when the calf is born which may affect the data of this study. Because of this, the data collected for this study has results that vary because of unknown and uncertain calving times. Both Jersey and Holstein cows are used for the study and each breed had the same procedures. The information taken was the day of calving, rumination time at calving, rumination time twenty-four hours before and after calving, and rumination time twelve hour before and after calving (Table 2). It also shows the averages of both the Jerseys and Holsteins twenty-four hours and twelve hours before and twenty-four and twelve hours after calving time. Another problem is that there is not enough data on cows that had collars on at calving time. The decreased number of cows is due to the time of putting collars on cows. This was often done after cows calved when the collars were used only for estrus predictions.
The rumination time is recorded and sent to the computer in the office where it is shown in two hours blocks on a rumination graph (Figure 5). Each block is the rumination time for the two hours of the allotted time. The suggestion is that rumination drops prior to calving time. As is shown in Table 2 the rumination time at calving drops almost to zero. It is an average of one point fourteen. Also seen in the table above the rumination drops leading up to caving and it increases again after calving. The drop twelve hours before calving is much less for the Jerseys. In Figure 5 you can see that at
calving time rumination drops substantially and in most cases in this study drops down to zero in the two hour block. The average rumination time for twenty two cows at calving time was a minute and fourteen seconds in the two hour increment. It is seen that the major drop in rumination is a four hour block where the cow is not ruminating. Then she starts ruminating again but shortly after for some reason she stops ruminating for another four hour block. The reason for the drop is unknown.

The health report of cow 405 was checked and she was not recorded in the records for being treated with anything. Thus the reason for the second rumination drop is unknown. The averages of both Jersey and Holstein breeds are shown in Table 2. The combination average of the two breeds is also depicted on Table 2. Table 3 shows screen shots of the system at work with views of different cow’s rumination charts.

Table 3. Shows screen shots of the rumination graphs with a description

<table>
<thead>
<tr>
<th>Screen Shot</th>
<th>Description</th>
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<tr>
<td><img src="image" alt="Example of a rumination chart. This is showing the collar almost did not get on the cow in time to establish a base line before calving." /></td>
<td>Example of a rumination chart. This is showing the collar almost did not get on the cow in time to establish a base line before calving.</td>
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Example of another rumination chart. This shows that this cow 2083 dropped her rumination time prior to calving.

Example of another rumination chart. This one shows that cow 375 has a longer time of no rumination at calving.

Example of a rumination chart. This chart shows cow 340 rumination leading up to calving did not drop or vary much.
Example of rumination chart. This chart shows cow 323 is ruminating right after calving and it slowly increases.

Figure 5. Rumination graph of cow 405 that calved, with rumination in two hour blocks.
Calving difficulty score

Calving difficulty score was given to each animal in the study at calving. The rumination graphs of the animals were compared to their calving scores. In a study done by (Maltecca et al., 2006) shows that cows bred to Holstein bulls are more prone to need assistance with calving. This is because Holsteins are generally larger bovines and with a tendency to have bigger calves. While Jerseys are smaller animals and also have a lower caving score thus a smaller calving difficulty (Cole et al., 2005). There were fifteen Jerseys used in the rumination data and of fifteen, one had a calving score of two, while the other fourteen had a calving score of one. With the information collected it is difficult to determine if there was any relation with calving ease and rumination time in the Jersey cows used. The Holstein cows are the numbers greater than 2000. Three of out of the seven Holsteins had a calving ease of two. The difference in rumination between the cows with a calving ease of one and a calving ease of two was such a small difference that it was likely not significant.

Table 4. Cow identification and their calving score

<table>
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<th>Calving Difficulty Scores</th>
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<tr>
<td>Cow ID</td>
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Disease prevention

Calving disease prevention is another issue being addressed with the MICRO Heatime™ rumination collars. The rumination collars will aid in the detection and prevention of calving diseases. We know the transition period from three weeks before parturition to three weeks after parturition is one of the critical times in a productive dairy cow (Gulay et al., 2007). During this period of time the cow will have many influences that will affect their health, performance and time in the herd. There is a drop in rumination that can be seen before there is a drop in production (SCR Engineers LTD, 2011). Being able to earlier identify if a cow that has a postpartum disease, such as displaced abomasums, clinical mastitis, ketosis, milk fever and digestive disorders (Gulay et al., 2007), will greatly aid in the lifespan and the amount of production of the dairy cow. In a project completed by the SCR Engineers, they observed that ketosis is a major cost for a herd. The cost for one hundred cows is $13,000 (SCR Engineers LTD). By determining if the cow has the onset of a disease; it can be treated early and thus preventing losses of production of that dairy cow. This prevention or early detection can save the dairyman money. Additionally, by requiring less medicine for treatment, the cow would decrease its time spent in the hospital pen and ultimately loss of production. Out of the twenty-two animals in this study none had a major post partum disease. If there was, and it was given medication, it was not recorded in dairy computer or DHI Plus. The lack of number of animals decreased the chance of getting a cow that would get a postpartum disease. The next time this is done there needs to be more animals used to have the potential of getting cows with postpartum diseases. There may be a benefit in early
detection by rumination monitoring which may aid in disease prevention. Unfortunately the insufficient data in this study did not aid in this process.
CONCLUSION

In conclusion, this study had numerous variables that need to be addressed before accurate results of rumination activity monitoring can aid in post calving disease prevention. This study revealed that further research needs to be completed in areas of estimation for both calving times and rumination activity over the calving period in order to aid in the prevention of calving diseases. The use of rumination monitoring in detecting and estimating calving times was inconclusive due to the lack of data collected. The main reason that the data was inconclusive was due to the lack of data collected, although data does suggest a significant drop in rumination during the four hour time at calving. It was thought that the data collected from the collars located on the far off dry cows would be used to establish a baseline. However, the collars are only able to hold information for up to twenty four hours and no reader had been put in place to relay the data from the collars to the dairy computer. If the information is not retrieved from the collars within the twenty-four hour times span the information is lost, resulting in the absence of a baseline for comparison. This study revealed the placement of the collars in the far off dry cows has no effect on the establishment a baseline. In order for a baseline to be established, a reader needs to be installed in the far off dry cows’ pen or the collars need to be on the cow’s right to allow data retrieval by the reader in the maturity barn. There is a major drop at calving time but leading up to calving there is inconclusive data showing rumination drop twelve and twenty-four hours prior to calving although there is a slight drop seen. A more complete statistical analysis needs to be evaluated. With the data collected it shows some of the rumination dropping around calving time but the numbers of cows used for the data needed to be increased to show accurate results with
rumination monitoring. To enable a complete analysis, additional statistical data needs to be collected from a larger sample and evaluated.

If this study was done again, numerous changes would be made to ensure a more successful study. The collars would be positioned on the cows at least fourteen days prior to calving and the cow will be housed in the close-up pen. The data collection process would have started sooner so more data points would be collected, given the numbers a more conclusive result. The time the cows calving would be recorded within an hour of her calving. The system did not accumulate enough data points to create comparisons or contrasts consequently results were inconclusive and difficult to extrapolate conclusions without a large subjective inference. Even with the lack of data there is great upside for the dairyman to be using Heatime™ collars for rumination monitoring. It gives them another option to save money and in today’s struggling dairy industry this could be the straw that makes or breaks an operation.
REFERENCES


