Automated Heat Detection: AI with No Observation and No Injections?

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Introduction

Over the last 30 years, people have searched for alternatives to traditional observation of cows to detect estrus. Injections to synchronize estrus/ovulation have replaced observations and are now a common tool in many dairy farms. A major benefit of controlling ovulation with injections is that with little or no observation the number of cows inseminated is high. However, injections may not be so popular with some dairy producers and employees and are especially unpopular with the cows. Getting cows pregnant is critical to subsequently initiate lactation and for revenue generation in commercial dairies. To get cows inseminated are there alternatives to observation and injections?

This article provides a general description of alternatives to hormone injections to manage reproduction in dairy cows. It is not meant to judge programs for ovulation synchronization or to compare programs or systems.

Reproduction and Cow Behavior

Almost 100 years ago and before we knew about hormones, physical activity of rats was linked to functional status of ovaries. Since those early studies, status of ovaries was linked to physical activity in virtually every mammal.

When animals experience estrus, ovaries secrete mostly estrogen and little or no progesterone. This hormonal environment -- high estrogen and low progesterone -- makes the brain stimulate physical activity of the animal. In females there are three phases of the complex behavior associated with estrus: attractivity, proceptivity, and receptivity.

Attractivity occurs early in estrus and includes changes in posture, vocalizations, pheromones that attract males through smell, and increased physical activity. Increased activity or locomotion includes seemingly random milling around, exploration, and aggressive action to other females. Collectively, these behaviors during attractivity are interpreted to occur for one purpose, to attract a mate. Unfortunately, many people do not observe cows enough to detect these earliest signs of estrus.

Proceptivity phase is behavior of females that stimulates males to mate. This includes head butting, females mounting other females, various courtship behaviors, and diverse touching and contact. Mounting or standing to be mounted usually is an obvious behavior. Receptivity phase of estrus is actual mating.

Increased activity. As cows approach estrus and ovulation, a profound increase in physical activity occurs before the overt mounting and standing. However, people encounter several problems in detecting estrus of cows.

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Even among healthy cows, duration and intensity of estrus vary widely. Note that activity can vary due to number of cows in estrus, hot or cold ambient temperature, stocking rate, number of non-pregnant cows, lameness or illness. If visual observations for estrus are twice daily, successful estrus detection is typically less than 50%. This is not acceptable and has led to extensive use of synchronization programs.

Note that time from beginning of estrus to ovulation is quite consistent --- about 24 hours. Detecting the beginning of standing estrus best predicts when ovulation will occur and leads to highest accuracy of when to time AI. Artificial insemination should always occur before ovulation. This means that AI should occur about 12 to 16 hours after onset of estrus. There are two challenges: detecting estrus to have opportunity for AI and detecting the start of estrus to best schedule AI.

**Systems to Monitor Cow Activity**

Can monitoring physical activity of cows help detect estrus and be used to schedule AI? In fact, in 1977, pedometers were first used to detect estrus in dairy cows. Technology to detect motion and software to analyze data have progressed enormously in the last 30 years. Currently at least four systems have been designed to detect variations in physical activities of cows. Below is a brief description of each with website addresses for additional information.

**Heatwatch II** (www.cowchips.net) monitors when a cow is mounted.
Heatwatch involves gluing a radiotransmitter to the tailhead which is activated with pressure of mounting. This system depends on classic mounting behavior of cows in estrus (during the proceptivity phase). Heatwatch provides continuous monitoring of mounting behavior. Duration and intensity of mounting vary widely among cows. This system does not work well when cows are not mounted. In concert with the software, managers must decide the number and duration of mounts that designate estrus for individual cows.

**Afimilk** (www.afimilk.com) monitors general movement of cows with a pedometer. A baseline of activity for each cow is established. Then, deviations above or below the baseline indicate events like estrus, illness, or lameness. Pedometers accumulate information and are read at milking.

**ai24** (www.semex.com, click the ai24 link) or **Heatime system** (www.healthycow24.com) monitors movement with a motion detector in a collar. This system counts number of steps and other motions associated with estrus. Activity can be recorded every 2 hr. But, as availability of antennae decreases, activity is recorded fewer times per day. As cows approach an antenna, data are transferred to a Control Box with infrared technology. The system will handle up to 600 cows with four antennae.

**SelectDetect** (www.selectsires.com/select-detect.aspx) is the most recent system available. All SelectDetect® systems include three basic components: monitors, base station, and a computer. Monitors or accelerometers are attached to cows with neck collars and detect movement in three different planes: up and down, front to back, and side to side. Monitors collect data continuously. The monitor on each cow transmits data to one or more Base Stations located in the barn. Base Stations merely receive data from cows and transfer to the computer usually in an office. Depending on distances, Base Stations can connect to the computer with a cable or Bluetooth wireless. Overall the software examines mathematically the data from each cow to identify high or low activity relative to her baseline. Herd managers determine how often to collect and review the data.

**General Discussion**

After detecting increased physical activity, the best time to inseminate is still under review and may vary among systems and herds. However, it appears that about 16 hours after the system detects onset of estrus is the best time for AI. Frequent examination of data increases success to detect onset of estrus. Except for Heatwatch, these systems detect the attractiveness of estrus. This is earlier than mounting occurs. Therefore after detection of increased activity, scheduling of AI will occur later to coincide with ovulation. Depending on availability of data, consider at least four different insemination periods during a day to really maximize accuracy to time insemination for maximal fertilization. This idea may appear not practical but will increase pregnancy rate compared with just one or even two AI periods per day.

The data from these systems are available for individual cows and lead to three possible conclusions: cows in estrus, cows need examination directly, or no action needed.

There is a cost to install any of these systems to monitor changes in activity. However, consider this as an investment to improve heat...
detection, enhance accuracy to time insemination, reduce or eliminate injections for synchronization, and reduce costs for hormones and labor. Systems to monitor physical activity of cows allow people to assess cows constantly without visual observation. For many dairy managers these systems will reestablish the priority to detect estrus and inseminate accordingly.

Before you actually purchase a system to monitor activity, you need to answer these questions.

- How frequently do I need to collect data from cows to detect onset of estrus?
- What is the total equipment required for cows, collection of data, transfer to office, and for analysis of data?
- What type of computer, if any, is required?
- How many cows will the system accommodate?
- What are the features of the software? Highly technical or user-friendly?
- What is the opportunity to interface with other software used for herd management? Does this affect the computer selected?

**The Big Question**
The big question is: will these systems improve reproductive performance of dairy cows? The answer is unknown because results of controlled studies are not published in the scientific literature. Thus, a partial budget is not really constructive. However, for every system there certainly are positive testimonials.

Consider a worst case in which systems to monitor activity have similar reproductive success as traditional observation or synchronization. Benefits of monitoring activity are that cows do not have to be injected or observed. Thus, there are savings in costs for hormones and labor. With increased accuracy to detect onset of estrus at various times of day, timing AI should occur according to onset of estrus for each cow. Note that the “AM-PM Rule” is based on twice daily observations for estrus so there are only two daily periods for AI. So, with monitoring activity there should be multiple times for AI per day not just morning and evening. Alternatively, it is likely that these systems will increase detection of estrus, increase conception rates, increase service rates, and consequently increase pregnancy rates of dairy cows with vastly reduced observations or injections. If true, that certainly will be a win-win.

Author notes: There may be additional systems that monitor activity of cows. Omission here is simply failure to identify them during the search process and is not intentional. Much information regarding these technologies is proprietary. Thus, details of how these systems work and actual impacts on reproductive success in controlled studies are not available in the scientific literature.

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Bibliographical citations for all articles are available only in the online version at www.msu.edu/user/mdr/.
As human populations increase and available arable land decreases, agricultural systems are under pressure to produce more food more efficiently.

Michigan State University researchers believe that breeding dairy cows that produce milk with less feed can help meet this goal. “We already know how to get cows to produce more than 100 pounds of milk a day - we have the science to be able to do that,” said Mike VandeHaar, animal science professor and MSU AgBioResearch faculty member. “Our question now is whether some cows are genetically predisposed to produce that milk with less feed. If we find that feed efficiency is inherent in a cow’s DNA, it will improve our ability to sustainably produce the milk and dairy products that our growing population consumes.”

Through a $5 million grant from the U.S. Department of Agriculture’s National Institute of Food and Agriculture, VandeHaar and his fellow MSU researchers have set goals to increase the efficiency and sustainability of milk production by:

- Educating future leaders, voters and consumers about key practices in dairy husbandry that promote feed efficiency and sustainability.
- Developing a feed-efficiency database on 8,000 genomically characterized Holstein cows.
- Determining the genetic architecture of feed efficiency and building a foundation for genomic selection of more efficient animals.
- Developing and implementing genomic breeding tools to produce cows with enhanced feed efficiency.
- Developing and implementing practical support tools to improve whole-herd feed efficiency.

“We are excited about this USDA grant program,” VandeHaar said. “Improving stewardship of resources in the dairy industry has been a lifelong passion of mine. If we’re going to eat animal products and feed more people, we have to do it more efficiently.”

The goal is not just increasing the amount of milk a cow produces, but increasing efficiency of milk production can help improve stewardship of the planet, VandeHaar said.

“Projects like this are critically important to our planet,” he said. “If we can’t figure out efficient ways to feed 9 billion people in the next 40 years, we will have hungry people, political unrest and no place left for native ecosystems because we’ll be using those lands to grow food.”

Additional MSU team members include Rob Tempelman, Dave Beede, Richard Pursley and Miriam Weber Nielsen. Also contributing to the
Review of Local Disasters: Motivation to Prepare

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Disaster Management

Most people are aware of the national and regional scale animal catastrophes in North America in the last decade: avian influenza outbreaks in Virginia, British Columbia, Maryland, and Delaware; hurricanes Katrina and Rita; flooding in the Midwest; and oil spills in the Gulf of Mexico and the Kalamazoo River, to name a few. These have resulted in mass disposal of poultry, livestock and wildlife.

Other Disaster Types
Equally massive, but less familiar to most people, are the more frequent and more numerous farm-scale catastrophes: facility fires, rangeland wildfires, power outages, ventilation failure, prolonged heat stress, blizzards, feed poisoning, manure gas poisoning, and building collapse. We searched the World Wide Web in order to find news stories about “local” animal emergencies in the U.S. since the beginning of 2011. We wanted to learn about how often farm-scale disasters happen (see Table 1 on Page 6) and how people and communities managed or handled the emergencies.

Granted, this list is not comprehensive, as some incidences of animal death never make public news sources. Manure pump-out is an example here. Farmers may lose small numbers of animals as gases are emitted from the manure being removed from below floor storage.

What We Found
How effectively animal emergencies are managed is frequently not well-known. Typically, news stories give time, place, animal type, and immediate responses. Few other details about animal euthanasia, depopulation, carcass disposal, and clean-up are found in popular press. We could not find any follow-up articles about the effectiveness of responders or costs of clean-up.

We found one article about how the mortalities were managed. In the case of the Goodhue, Minnesota swine barn fire, the farmer worked with county authorities, staff from the Minnesota Pollution Control Agency and the Minnesota Board of Animal Health and agreed to compost the carcasses.

Composting was done on a concrete slab adjacent to the farm’s current composting site and large enough to contain the compost pile. Bulking agent was hauled

$5 Million Grant …

The project are researchers from the University of Wisconsin, Iowa State University, Wageningen UR in The Netherlands, the University of Florida, Virginia Polytechnic Institute and State University, and North Carolina Agricultural & Technical State University.

The grant was awarded through USDA’s Agriculture and Food Research Initiative and administered through the National Institute of Food and Agriculture.

AFRI’s global food security challenge area focuses on two intertwined issues: Food availability and food accessibility. Adequate food availability implies that the population has a reliable source of food from domestic or international production. For adequate food accessibility, the population must have sufficient resources to purchase food for a nutritious diet. The long-term goal of this program is to increase global food availability through increased and sustainable food production with reduced losses.

“Projects like this are critically important to our planet. If we can’t figure out efficient ways to feed 9 billion people in the next 40 years, we will have hungry people, political unrest and no place left for native ecosystems because we’ll be using those lands to grow food.”
in and the finished compost was applied to the cropland of the farm. Remains of the building were recycled and placed in a landfill.

**Something to Note**

Responsibility for disaster management and the resources available for animal emergencies depend on the scale and the cause. Local level catastrophic animal losses almost always are managed locally by the farmer and surrounding community, utilizing their knowledge, capabilities, and resources. These disasters can overwhelm the farm if planning for such a problem is lacking and if people involved do not know where to access physical and information resources.

Preparation for and prompt response to emergencies decrease the time taken to solve problems, increase the speed of purposeful reactions, quickly connect local farmers and responders, and provide them with access to resources to improve the effectiveness of their response in protecting themselves, other animals, the environment (e.g., ground water from mass graves), and neighborly relationships. Meeting with local and state agencies to develop plans also can provide a working framework to execute plans. Emergencies cannot be predicted, and therefore, farmers with animals ought to take time to prepare.

**Table 1. Partial list of local-level U.S. animal emergencies in 2011.**

<table>
<thead>
<tr>
<th>Event</th>
<th>Mortality</th>
<th>Location</th>
<th>Date</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barn fire</td>
<td>83,000 layers</td>
<td>Versailles, Ohio</td>
<td>May, 2011</td>
<td>The Washington Post, 2011</td>
</tr>
<tr>
<td>Barn fire</td>
<td>3 million layers</td>
<td>Marseilles, Ohio</td>
<td>March, 2011</td>
<td>UPI.com</td>
</tr>
<tr>
<td>Barn fire</td>
<td>285,000 layers</td>
<td>Cecil County, Maryland</td>
<td>April, 2011</td>
<td>MiddletownTranscript.com</td>
</tr>
<tr>
<td>Barn fire</td>
<td>300 sows</td>
<td>Goodhue, Minnesota</td>
<td>April, 2011</td>
<td>Goodhue-Bellechester Messenger</td>
</tr>
<tr>
<td>Barn fire</td>
<td>100 cows</td>
<td>Rome, New York</td>
<td>February, 2011</td>
<td>WNEP, 2011</td>
</tr>
<tr>
<td>Barn fire</td>
<td>100 chickens, ducks, peacocks</td>
<td>Paw Paw, Illinois</td>
<td>February, 2011</td>
<td>WHBF, 2011</td>
</tr>
<tr>
<td>Snow load barn collapse</td>
<td>100 cows</td>
<td>Northumberland, New York</td>
<td>February, 2011</td>
<td>WPTZ, 2011</td>
</tr>
<tr>
<td>Snow load barn collapse</td>
<td>159 dairy cows</td>
<td>Morris, Minnesota</td>
<td>February, 2011</td>
<td>Morris Sun Tribune, 2011</td>
</tr>
<tr>
<td>Barn fire</td>
<td>300 hogs</td>
<td>Wakeshma Township, Michigan</td>
<td>January, 2011</td>
<td>WWMT, 2011</td>
</tr>
<tr>
<td>Snow load barn collapse</td>
<td>85,000 layers</td>
<td>Hartford, Connecticut</td>
<td>January, 2011</td>
<td>MSNBC, 2011</td>
</tr>
<tr>
<td>Barn fire</td>
<td>17,000 chickens</td>
<td>Harrisonburg, Virginia</td>
<td>January, 2011</td>
<td>AGWEEK, 2011</td>
</tr>
<tr>
<td>Barn fire</td>
<td>1,800 pigs</td>
<td>Melvin, Iowa</td>
<td>January, 2011</td>
<td>Hayworth, 2011</td>
</tr>
<tr>
<td>Barn fire</td>
<td>6,000 pigs</td>
<td>Dwight Township, Michigan</td>
<td>January, 2011</td>
<td>Hessling, 2011</td>
</tr>
</tbody>
</table>

Note: Work with your local MSU Extension Educators to get help regarding about disaster management, animal emergencies, and mortality composting needs. For more information feel free to contact Dale Rozeboom, Department of Animal Science, E-mail: rozeboom@msu.edu, or Phone: +1-517-355-8398.
MSU Dairy Nutrition Roundtable Meetings: 2010-11

Faith Cullens  
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Dairy Nutrition

Introduction
Each winter the team of MSU Extension dairy nutritionists hosts a series of Nutrition Roundtable meetings for dairy nutritionists practicing in Michigan and northern Indiana. During December 2010 and January 2011, five meetings were held across the state. At the Roundtables we discussed a variety of current topics, new products, and new nutrition research. This article highlights three areas that were especially ‘hot topics’ at the last series of meetings.

Optimal Body Condition Score through Transition
Optimal body condition score (BCS) at calving was discussed extensively in the Roundtables. This topic also was addressed by Dr. Phil Garnsworthy (University of Nottingham, UK) at the American Dairy Science Association Discover Conference on Transition Cow Biology and Management in September 2010. He said that a BCS loss of 0.5 unit (1 to 5 scale) is acceptable for fresh cows and that cows should calve with “BCS between 2.5 and 3.0 to optimize health, fertility and lifetime performance”.

This is lower than the commonly recommended range of 3.0 to 3.5. We know that cows that are excessively fat at calving are more prone to develop health disorders and have an extended period of negative energy balance, reducing reproductive performance. We also know that inadequate BCS at calving can result in lower milk yield and decrease reproductive performance. It is clear that there is an optimum for the range among cows within a management group. And, variation among cows should be minimized by focusing attention on cows in late lactation.

Garnsworthy’s recommendation is consistent with the theory that feed intake of cows in the transition period is controlled by hepatic oxidation of fatty acids. Cows with greater BCS will mobilize more fat and have greater plasma non-esterified fatty acid (NEFA) concentrations for a longer period of time. According to the hepatic oxidation theory, uptake and oxidation of this mobilized fat in liver suppresses feed intake decreasing energy intake and extending the period of negative energy balance.

A couple of decades ago we thought that cows needed more condition at calving to provide energy while feed intake was suppressed postpartum. So, a BCS of 3.5 to 4.0 was often recommended. Since then we have realized that fat mobilization is the main reason that feed intake is suppressed and we have recommended lower BCS at calving. As more information becomes available, recommendations for optimal BCS at calving may be fine-tuned further.

2010-11 Corn Silage and Grain: Milk Yield and Fat Content
In contrast to summer 2010 milk fat was low across the country, by late 2010 dairy producers and nutritionists in Michigan reported that with the new corn crop, milk fat percent was more normal and milk production was lower than expected.

Much of the 2010 corn silage crop was harvested too dry and mature. Dry mature corn silage can result in lower fiber and starch digestibilities, which significantly affect milk production and milk fat test. Corn silage neutral detergent fiber (NDF) digestibility can vary by more than 20 percentage units. Each unit of forage NDF digestibility lost results in about 0.5 lb loss of 4% fat-corrected milk yield. Fiber digestibility cannot be compensated for by replacing it or supplementing other ingredients so it is important to select corn silage hybrids with high NDF digestibility and harvest at proper moisture content. Lower starch digestibility in corn silage can be compensated for by adding additional starch to the diet or generally by grinding available corn grain finer.

It was noted that corn crop harvested in fall 2010 may be beneficial for fresh cows and maintenance cows (to maintain BCS at target values given level of milk production). They do not need much highly fermentable dietary starch sources. When making nutritional changes to the milking herd ration with the goal of increasing milk components or milk yield do so gradually so that...
rumen microbes have time to adapt. Although reaching your target may take several weeks, movement in the right direction may be detectable within the first week of implementation.

The higher than usual milk fat concentration seen this past winter is in stark contrast to the issue of low butterfat test seen during most of 2010 across the country. Figure 1 (below) illustrates the low milk fat test during 2010 that was observed not only in Michigan, but in the whole United States. From February through October 2010, monthly butterfat percentage averages in the Mideast Federal Milk Marketing Order ranged from 0.4 to 0.9% below the 10-year average for those same months. Although the exact reason for the struggle has not been pinpointed, it probably has to do with poor forage growing conditions in 2009.

Iron in Drinking Water
Concerns about high iron concentrations in drinking water were raised in some Roundtables. Higher concentrations [such as 2 to 10 parts per million, (ppm)] may be a problem by reducing water and feed intake, milk yield, immune function, reproductive performance, and absorption of copper and zinc. These problems can be magnified during stress associated with transition of fresh cows. Additionally, high iron is implicated in reduced water intake. When stumped by the reason for lower than expected milk yield and health problems, dairy nutritionists and producers are sampling and checking water to see if high iron might be a contributing factor.

Unfortunately, we don’t know the upper threshold at which iron in drinking water is likely to be a problem. Recommended maximum tolerable concentration generally listed by analytical laboratories is 0.3 ppm. This apparently was derived as an acceptable level for palatability in humans. However, the actionable negative iron threshold in drinking water for dairy cattle is unknown. Typically, in most rations plenty of iron is present to meet cows’ requirement, even though the form of iron (ferric: Fe³⁺) is only about 10% absorbable. In contrast, iron (ferrous: Fe²⁺) in drinking water is highly soluble and presumed to be nearly 100% absorbable, probably increasing the risk for problems.

Experience in field cases in the last several years suggests improvements in milk yield and cow health when excess iron is removed from drinking water or a different water source with low iron is used.

Fortunately, excess iron in drinking water is relatively easy to detect with a standard laboratory analysis and corrective action can then be taken relatively easily. Options are: 1) find a different drinking water source with lower iron; or, 2) treat drinking water to oxidize ferrous iron to ferric and then remove it from the system by filtration.

The simplest way to oxidize ferrous iron is by exposure to air (oxygen) such as with an ‘iron curtain’. Cost-effective water treatments include hydrogen peroxide or chlorination to oxidize ferrous iron to ferric iron followed by mechanical filtration. Other methods (such as ozonation, reverse osmosis, or an oxidizing filter) or really fancy water treatment systems can react and remove iron also, but careful assessment of installation and operating costs are very highly recommended. Guidelines on how to take a drinking water sample and standard water analysis are provided at: http://www.msu.edu/~beede/, click on “Extension” and then “Taking a Water Sample”.

Figure 1: Monthly changes in milk fat % of fluid milk in 2010 compared with the previous 10-year average (2000 to 2009). Data and information supplied by Livestock Marketing Information Center, Denver, CO.

Are you a nutritionist who missed the MSU Dairy Nutrition Roundtable in December 2010 - January 2011? If so, email Dr. Mike Allen at allenm@msu.edu to receive information in November 2011 about the upcoming 2011-12 Dairy Nutrition Roundtable meetings.
Thumb H₂O Project: Part 3, Water Delivery*

Craig Thomas
Extension Dairy Educator

In the previous two parts of this series (January, 2011 and April, 2011), the extreme importance of drinking water for dairy cattle was emphasized. By weight, water is the most important nutrient for milking cows. The previous articles focused on the chemical and mineral composition of dairy cattle drinking water and the steps to take if your cow’s drinking water contains high levels of undesirable constituents. It is recommended that you test your farm’s water for the constituents most often leading to water quality issues (total dissolved solids (TDS), sulfate (SO₄²⁻), chloride (Cl), iron (Fe), and nitrate-nitrogen (NO₃⁻-N)) and take action if any of these constituents are consistently above actionable levels.

A cow’s water intake can be influenced by many factors including: 1) dry matter intake (DMI), 2) milk production, 3) sodium (Na) intake, and 4) air temperature (2). This leads to wide variations in water requirements among milking cows. For example, at 60°F a cow milking 40 lb/day will eat an estimated 42 lb/day of DM and drink about 10.1 gal/day less water than her herdmate producing 100 lb milk/day and eating 60 lb/day of DM (3). Both cows will increase their water consumption by about 3.5 gal/day when the temperature increases from 60 to 80°F (3). These intake figures assume water quality is satisfactory and no other factors are interfering with water consumption.

Even though water quality may be fine, other issues may prevent cows from satisfying their water needs. Thus, analyzing cows’ drinking water is only the first step to ensure that “water nutrition” and water intake are satisfactory. Remember, drinking water should receive attention in two regards: 1) water quality (“Is your water fit to drink based on its chemical and mineral composition?”); and 2) water delivery (“Are you providing an ample supply of good quality, fresh, clean water to your cattle?”). Water quality is addressed by the chemical/mineral analysis. Water delivery concerns such issues as numbers of waterers per group and waterer location, size, and cleanliness. The most common waterer problems on dairy farms are: 1) inadequate number of waterers; 2) inadequate watering space; 3) poorly designed watering spaces; and 4) dirty waterers.

Parlor Area
Provide about 2.0 linear ft of watering space per milking parlor stall in return alleys from the milking parlor (e.g., 40 ft of watering space for a double-20 parlor). Warm plate cooler water is a good source for this water since cows prefer to drink warm water. This is true even in warm weather and warm climates. Remember, milk is about 87% water and cows may drink as much as 50 to 60% of their total daily water intake immediately after milking if given the opportunity (1, 2, 3).

Waterers in Cow Housing Areas
Provide a minimum of two waterers/group and cows should not have to walk more than 50 ft to get a drink of water. Waterers should be located close to feed bunks and protected from direct sunlight. Direct sunlight promotes algae growth which decreases water palatability. It is crucial to provide adequate open space around waterers. This is particularly important for waterers located in cross-over alleys. Cross-over alleys should be at least 13.5 ft wide to allow adequate watering and walking space. There should be approximately 4 inches of linear waterer space per cow in every group. It is critical to provide adequate waterer space and locate waterers properly to keep boss cows from preventing other cows from obtaining adequate water (1, 2, 3).

Waterer Cleanliness
Waterer cleanliness is the final, but very important, critical link in water nutrition. How clean? Would you be willing to drink from it? If “no,” then clean it. Water trough cleaning should be a regular chore that receives high priority (1, 2, 3).

Thumb Water Project
The Thumb H₂O Project involved 36 dairy farms in Huron, Sanilac, St. Clair, and Tuscola Counties. Milking cow drinking water was sampled on each farm and then analyzed using the services of a certified commercial laboratory (2, 3). These results were presented in the first article of this series (January, 2011). In addition, data were collected from milking parlors and milking cow housing facilities on these farms concerning waterer numbers, space, location, and cleanliness. Results of this aspect of the Thumb H₂O Project are presented in Tables 1 through 5 following.
Parlor Area
Table 1 presents the data concerning waterers in the parlor area. Only 40.5% of the farms provided drinking water in the parlor holding pen and only 19.3% provided drinking water in the parlor exit alleys.

All the farms supplying drinking water in the parlor holding pen used recycled plate cooler water while only 50% of the farms providing drinking water in the parlor exit alleys used recycled plate cooler water. The water offered in parlor holding pens was usually offered using an oval drinking tub. In each case of water offered in the parlor exit alleys, water trough linear space met, or exceeded, minimum recommendations. These data indicate that opportunities exist on many farms for increasing drinking water availability to milking cows. It should be noted, however, that waterers in these areas were, on average, quite dirty. The average cleanliness rating was only about 1.5 (1=very dirty, 5=very clean). One would naturally expect these waterers to be dirtier since all milking cows have access to them at least twice per day and cows drink more water immediately after milking. These drinking water sources probably should be cleaned at least daily, and preferably after or before every milking. Also, some of these waterers were nearly empty. Granted, most farms were evaluated during times cows were not being milked. But, be sure waterers in these areas remain nearly full when cows are present. This may require supplemental sources of water if plate cooler water is unable to fully meet the demand.

Table 1: Waterers in the parlor area.

<table>
<thead>
<tr>
<th>Location</th>
<th>Water provided</th>
<th>Recommended linear inches/cow</th>
<th>Average linear inches/cow</th>
<th>Water provided comes from plate cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding Pen</td>
<td>40.5%</td>
<td>N/A</td>
<td>7.3 inches</td>
<td>100%</td>
</tr>
<tr>
<td>Exit Alleys</td>
<td>19.3%</td>
<td>24.4 inches/parlor stall</td>
<td>24.4 inches</td>
<td>50%</td>
</tr>
</tbody>
</table>

1Statistics calculated only from the subset of farms on the study providing water in these locations.
2Percentage represents only the subset of farms providing water in either location.

Cow Housing Areas
Table 2 indicates that every farm in the study met the minimum recommendation of two waterers per group. In some respects I question the full importance of this criterion, since total linear waterer space may be the more important indicator of whether or not cows are exposed to adequate amounts of drinking water.

Table 2: Waterers in cow housing (numbers of waterers per group).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Farms meeting criteria</th>
<th>Average maximum walking distance</th>
<th>Highest number of waterers/group</th>
<th>Lowest number of waterers/group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum of 2 waterers/group</td>
<td>100%</td>
<td>3.6</td>
<td>4.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 3 (page 11) shows that only about one in five farms met the recommendation (50’ or less) for maximum walking distance to water. The average maximum walking distance was over the limit by 22.5 ft (72.5 ft), the longest distance was over double the recommended maximum (109.3 ft) and the shortest was about 10 ft below the maximum (40.5 ft). As I collected these data it became obvious that the larger and newer free stall barns were clearly those barns that most often exceeded the recommended maximum walking distance to water. However, these barns also tended to have the greatest linear feet of waterer space. Perhaps exceeding the walking distance maximum is less critical as long as adequate linear space is provided.

Table 4 (page 11) presents waterer data in cross-over alleys. Only slightly over half (57%) of the farms had waterers in cross-over alleys. Most of these farms tended to have older free stall barns. Less than 25% of farms with cross-over alleys met the recommended minimum width of 13.5 ft. The barns meeting this recommendation also tended to be newer free stall barns. Many older barns have cross-over alleys only 8 to 10 ft in width. Waterers in these narrow cross-over alleys are difficult for large cows to access and easy for boss cows to defend, keeping more submissive cows from drinking. It should be remembered that when these older barns were built they met the standards existing at the time.
Table 5 presents the data on waterer linear space and cleanliness. There were wide variations in waterer linear space per group. The average linear space was 2.2 inch/cow, about half of the recommendation (4 inch/cow). The highest linear space was well above the recommendation at 5.8 inch/cow; and the low was a meager 0.7 inch/cow. Once again, the farms with lower linear waterer space tended to have older free stall barns; while those providing adequate space tended to be newer facilities. Some of the older barns were equipped with dual waterers providing only 2-10 inch watering spaces per waterer. This appears to be very deficient, especially when these waterers are often located in narrow cross-over alleys.

Table 3: Waterers in cow housing (maximum walking distance to water).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Farms meeting criteria</th>
<th>Average maximum walking distance</th>
<th>Longest maximum walking distance</th>
<th>Shortest maximum walking distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum walking distance (&lt;50 ft)</td>
<td>20.8%</td>
<td>72.5 ft</td>
<td>109.3 ft</td>
<td>40.2 ft</td>
</tr>
</tbody>
</table>

Table 4: Waterers in cow housing (waterers located in cross-over alleys).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Farms with waterers in cross-over alleys</th>
<th>Farms meeting minimum cross-over width</th>
<th>Farms not meeting minimum cross-over width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum cross-over alley width of 13.5 ft</td>
<td>57.0%</td>
<td>24.6%</td>
<td>75.4%</td>
</tr>
</tbody>
</table>

Table 5: Linear waterer space and cleanliness in barns.

<table>
<thead>
<tr>
<th>Waterer criteria</th>
<th>Met minimum¹</th>
<th>High²</th>
<th>Average²</th>
<th>Low²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear space recommendation (4 inch/cow)</td>
<td>19.6%</td>
<td>5.8 inch</td>
<td>2.2 inch</td>
<td>0.7 inch</td>
</tr>
<tr>
<td>Waterer cleanliness³</td>
<td>N/A</td>
<td>3.0</td>
<td>2.3</td>
<td>1.6</td>
</tr>
</tbody>
</table>

¹Percentage of farms with waterers in cross-over alleys.  
²Linear waterer space measured in inches per cow.  
³Waterer cleanliness scale of 1-5 (1= very dirty, 5=very clean).

In my opinion, nearly every farm evaluated could do a better job to keep waterers clean. Admittedly, waterer cleanliness is a subjective measure. I used a scale of 1 to 5 with 1 being “very dirty,” and 5 being “very clean.” On average, most water troughs were very dirty (2.3). The best farm scored an average cleanliness rating of 3.6 and the worst farm scored only 1.6. Most producers indicated they routinely clean water troughs every 1 to 2 weeks. Clearly, water troughs should be cleaned at least weekly, and possibly twice weekly. It should be a high priority routine chore.

Conclusion

These data clearly indicate that only a few (about 30%) farms provide water in the parlor area. I recommend that every dairy farm should give serious consideration to offering water in one or both parlor locations (holding pen, exit alleys). This is especially true if the housing area is: 1) below the recommended waterer linear space, 2) exceeds the maximum walking distance recommendation, and/or, 3) has numerous waterers located in narrow cross-over alleys.

Correction of waterer deficiencies in housing areas is problematic. Many farms’ waterer linear spaces were less than half the recommendation. In those instances additional waterer space in the barn should be a high priority. Many of those barns could be easily retrofitted with larger waterers. Those farms with adequate waterer space and longer walking distances would require more extensive remodeling to decrease walking distance to water.

I question any benefit of more waterers as long as waterer linear space meets or exceeds the recommendation. However, those farms exceeding the minimum walking distance or with numerous waterers in cross-over alleys may be good candidates for offering water in the parlor area. In new construction or major renovations, the number of waterers, maximum walking distance to water, waterer linear space, water trough design, and location should receive more attention.
Productivity and Economics of Nurse Trucks for Manure Transport

Tim Harrigan
Dept. of Biosystems and Agricultural Engineering

Manure Management

The profitability of livestock operations depends upon the ability to efficiently recycle manure nutrients and reduce commercial fertilizer use. Record high fertilizer prices have created an incentive for crop producers to use manure as a crop nutrient source, thereby expanding the land base available for manure application. A larger land base provides flexibility in timing manure applications and reduces the tendency to over-apply on a limited amount of land. Recent technological improvements have increased manure handling efficiency. Large spreader tanks and transport vehicles have been developed, and in-field relay tanks and nurse trucks with boom extensions have improved the effectiveness of over-the-road hauling.

New Study
Farm managers need information about equipment capacity and cost to select machinery to complete field operations within the time available. We recently completed a study of the productivity of 13 manure hauling systems used by custom applicators in 10 farms in Michigan, Ohio and Ontario. Custom applicators used tractors designed for rapid (25 mph and greater) over-the-road transport, or nurse trucks ranging in size from 6,000 to 9,000 gal for over-the-road transport to tank spreaders in the field.

Compared with tank spreader/nurse truck systems, tractor-drawn tank spreaders alone are more productive when fields are close to storage because there is no in-field nurse tank-to-spreader transfer, but the hauling rate of tank spreaders declines rapidly as the hauling distance increases. Tank spreader productivity drops by 50% with a 3-mile haul (Figure 1). Nurse trucks have an advantage with longer hauls because of faster travel speed. Nurse trucks over-the-road typically average about 10 mph faster than high-speed tractors.

What We Found
When hauling from nearby storage, two 7,000 gal tank spreaders were twice as productive as one 7,000 gal tank spreader working with two 7,000 gal nurse trucks. When the hauling distance was three miles or more the productivity of each system was nearly equal (Figure 1). When the nurse trucks and spreader tank were the same size the spreader worked at full capacity and had no idle time within 1.7 miles of the pit. The hauling capacity was about 27,600 gal/hr. Beyond 1.7 miles the productivity dropped because the tractor-spreaders applied manure faster than the nurse trucks delivered it. Additional nurse trucks, about one per mile of distance hauled in this case, were needed to keep the tank spreader working near full capacity as the hauling distance increased.

Tank spreaders with one-half the volume of the nurse trucks were used to reduce the potential for soil compaction and improve in-field maneuverability. When one 3,500 gal spreader was used with two 7,000 gal nurse trucks the tank spreader had no idle time within 2.6 miles of the pit and the hauling capacity was about 20,200 gal/hour. Compared with a 7,000 gal spreader, the 3,500 gal spreader reduced the hauling capacity by 17% with a 3-mile haul.
Economics of Manure Transport with Nurse Trucks

We evaluated the costs for manure pumping and agitation, transport and application for a 1,400-cow dairy using either surface broadcast with tillage incorporation or subsurface injection with a 6-point injector. The dairy applied 12.2 million gal/yr on fields from 1 to 4 miles from the pit. The average hauling distance was 2.5 miles. Two hauling systems were evaluated. One system used four 9,000 gal tank spreaders with 6-pt injectors and 240 hp tractors. Two large lagoon pumps were used for pit pumping and agitation. The farm's average hauling rate was 58,600 gal/hr but field-average rate ranged from 71,000 gal/hr within 1 mile of the pit to 42,800 gal/hr with a 4-mile haul. Twenty-six 10-hr days were needed for transport and injection with the 4 tank spreaders.

An alternative hauling system used two 9,000 gal tank spreaders with four 9,000 gal nurse trucks. The tank spreaders were used for hauling to fields less than 3 miles from the pit and the nurse trucks were used with the tank spreaders when hauling to fields 3 or more miles from storage. When hauling to fields near the pit this system cut productivity by one-half, but it improved productivity when hauling to fields 3 to 4 miles away. Compared with four tank spreaders the farm-average hauling rate with the nurse trucks decreased 26% to 43,100 gal/hr. Thirty-one 10-hour days were needed for transport and injection compared with 26, 10-hour days for four tank spreaders.

The cost for pumping and agitation was 0.17 cents/gal for each system. Transport and injection was 1.31 cents/gal with four tank spreaders and 1.55 cents/gal with two tank spreaders and four nurse trucks. The total cost for injection with the four tank spreaders was 1.48 cents/gal, $129/cow/yr. The total cost with four nurse trucks was 1.72 cents/gal, $152/cow/yr. Transport and land application accounted for about 90% of the total cost. The cost of injection was about 10% greater than surface broadcast with tillage incorporation.

We evaluated the effect of distance on labor and hauling cost by increasing the farm-average hauling distance by 50% to 4 miles with fields ranging from 1.5 to 6 miles from storage. The longer hauling distance reduced the productivity of four tank spreaders by 13% and reduced the productivity of two tank spreaders with four nurse trucks by 11%. The labor requirement increased from 26 to 31 days with four tractor-drawn spreaders, and from 31 to 37 days for the spreaders with nurse trucks. The total cost for pumping, agitation, transport and injection for four tank spreaders with the extended hauling distance was 1.64 cents/gal ($143/cow/yr) and 1.91 cents/gal ($169/cow/yr) for the spreader/nurse truck system.

Summary
Manure generally is applied to cropland either in the spring before planting or in the fall after harvest. Manure hauling operations must align with other field work to make efficient use of equipment and labor and prevent delays in field operations.

Semi-tractor-drawn nurse tanks for over-the-road transport can provide flexibility in scheduling field operations and increase the productivity of tractor-drawn tank spreaders when applying manure to fields more than three miles from storage. Nurse tanks are less costly than tank spreaders. A large nurse tank with hydraulics and a boom extension costs about $25,000 compared with $90,000 for a large tank spreader with an injection unit. Custom applicators have access to the large and specialized equipment needed for timely and cost-effective manure application. A typical hourly charge for custom hire of a large nurse truck is about $100/hr. Custom hire of manure hauling services may be a good business decision for livestock producers.

For more information about the on-farm study and economic evaluation involving custom manure applicators please refer to: Tim Harrigan, Biosystems and Agricultural Engineering, E-mail: harriga1@msu.edu or Phone: 517-353-0767.
What is Reactive N and Why Should I Care?

Gerald May, Extension Air Quality Educator
Natalie Rector, Extension Manure Nutrient and Water Quality Educator

Nitrogen is an important component for all plant and animal growth, essential for the development of proteins and important in other living functions. In our environment, N exists in many forms. In its inert gaseous state, N\textsubscript{2}, it is very stable and makes up over 78% of the earth’s atmosphere but is unavailable for plant and animal growth.

Reactive N includes the biological and chemically active forms of N in the environment. The inorganic forms of N ammonia (NH\textsubscript{3}), ammonium (NH\textsubscript{4}), nitrite (NO\textsubscript{2}), nitrate (NO\textsubscript{3}), nitric oxide (NO) and nitrous oxide (N\textsubscript{2}O) included in the N cycle are all forms of reactive N (Figure 1). These forms of N are all interrelated and are constantly in flux in the environment. Learning to recognize and manage reactive N has future implications for agriculture.

Through the conversion of N\textsubscript{2} to NH\textsubscript{3} and NH\textsubscript{4} (ammonia and ammonium), N becomes available for life uses. This conversion of N\textsubscript{2} to its ammonia forms takes place through two natural processes: 1) N\textsubscript{2} is converted to NH\textsubscript{4} by bacteria living in the nodules of legume plants (clovers, alfalfa, beans, peas); and, 2) a burst of energy from a bolt of lightning converts N\textsubscript{2} to NH\textsubscript{3} (Vitousek et al., 1997). In the early 20\textsuperscript{th} century the advent of the Haber (or Haber-Bosch) process for converting N\textsubscript{2} to NH\textsubscript{3} was commercially adopted and the manufacture of commercial N fertilizers began. Each process requires significant inputs, either bacterial or energy, to complete the conversion.

The Nitrogen Cycle

Prior to adopting the use of commercial N fertilizers, farmers depended on lightning storms, crop residue, animal manure and N fixation by legumes to produce the N needed for plant growth (Figure 1). A portion of the N fixed by legumes is removed in harvested crops for use by animals and humans. The remainder is left in the field either as organic N in crop residue or in the soil as nitrate and nitrite. Denitrifying bacteria that live in anaerobic conditions in soil, riparian areas and wetlands, convert a portion of the NO\textsubscript{2} and NO\textsubscript{3} back to their inert state (N\textsubscript{2}) and to a lesser extent N\textsubscript{2}O (Vitousek et al., 1997; Killpack and Bucholtz, 1993).

Increased human activity, including burning of fossil fuels, clearing land and manufacturing commercial N fertilizers, have made significant contributions to the reactive N in the environment. Prior to the increased release of reactive N associated with human activity the amount of reactive N in the environment was held in balance by the denitrification process. Human activity has had both positive and negative impacts on the denitrification process but to what extent is not well understood (Vitousek et al., 1997). The net effect has been a significant increase in the reactive forms of N in our environment.

Adapted from “Utilization of Nitrogen by Plants”, Dept. of Horticulture and Landscape Architecture, Purdue University. Available: http://www.hort.purdue.edu/rhodcv/hort640c/.
Increased use of N Fertilizer

Figure 2 shows the growth in commercial fertilizer use in the U.S. from 1960 to 2008. Phosphorus as $P_2O_5$ and potash as $K_2O$ use has stayed constant since the mid 1990’s or earlier. These two components of soil fertility are chemically bound to soil particles (phosphorus more so than potassium) and, if not used by one year’s crop, remain in the root zone and available for the following year’s crop.

In contrast, from 1960 to 2008 N use increased nearly 5-fold (Figure 2). Unlike $P_2O_5$ and $K_2O$, if N is supplied beyond crop needs for a single growing season the N not utilized by the crop may be bound by organic matter, leach from the root zone, be lost through surface water runoff or it may volatilize into the air prior to the next year’s crop. Fertilizer use in the U.S. is indicative of other growing regions throughout the world. This annual input of commercial fertilizer worldwide is a significant contributor to the reactive N in our environment.

Why is the Increasing Amount of Reactive N a Concern?

The increasing release and conversion of N has positively impacted all of our daily lives. The nitrogen used in agriculture has made it possible for farmers to meet the world wide demands of a growing population’s daily needs for food, fiber and shelter. Fossil fuels create energy for virtually all of our daily processes that we consider routine but are often as basic to others as warming their homes. Limiting reactive N in the environment becomes more challenging when the importance of these daily activities is considered. The increasing levels of reactive N are leading to major environmental concerns.

Nitrate ($NO_3^-$), has long been a concern in ground water. High levels of nitrates in ground water have been directly linked to increased cases of blue baby syndrome, a health concern in infants under 6 months old. It also causes health concerns for the elderly. The U.S. Environmental Protection Agency (EPA) has an established safe drinking water standard of 10 mg NO$_3^-$ per liter water (EPA, 2009). In 1998, EPA reported finding NO$_3^-$ levels exceeding the 10 mg/L standard in 40% of the reporting hydrogeologic sites, but only 1% of the tested drinking water sources exceeded the limit (EPA, 1998). Excess reactive N ends up in streams, rivers and lakes through tile line flows, inorganic matter, top soil erosion. It contributes to eutrophication and algae blooms in lakes and coastal areas that receive waters from nutrient enriched rivers (EPA, 2011).

Nitric oxide (NO), and nitrogen dioxide ($NO_2$), collectively referred to as NO$_x$, contribute to smog and haze and have been linked with asthma in children and adults (EPA, 2011). Nitrous oxide ($N_2O$), is a greenhouse gas that also contributes to acid rain (EPA, 2010). Ammonia deposition has been associated with the undesirable changes in forest growth (Pitcairn et al., 1998). The EPA is studying the positive and negative impacts of reactive N on a national and regional basis. The agency has contributed to the development of a National Ecosystems Services Atlas. This atlas, due out later this year, is intended to identify the ecosystem systems, and drivers, impacted by reactive N (EPA, 2011).

What is Agriculture’s Role?

Agriculture is considered a major contributor of excess reactive N and therefore the industry will be looked to for solutions. When one considers the increasing cost of N inputs, contributing to the solution may actually be a win-win situation for producers, agriculture and the environment. Practices that may reduce reactive N associated with agricultural production include:
Feeding dairy steers from birth to weaning can result in highly variable profits. A positive profit margin becomes increasingly difficult to attain as feed prices increase. As a result, the value of dairy steer calves can be highly variable. Also, the sale of dairy steer calves frequently totals only one percent of gross sales on a dairy operation. It becomes understandable that dairy steer calves may not receive top priority from management and labor in dairy operations.

Feeding adequate quantities of high quality colostrum shortly after birth to newborn calves is critical to achieving passive immunoglobulin (Ig) transfer from dam to calf. The transfer of Ig from dam to calf through the colostrum is important for calf health during the first 2 months of age. Dr. Sam Leadley, Calf and Heifer Specialist with Attica Veterinarian Associates, presented his recommendations to Optimizing Newborn Calf Health Management at the 2011 Great Lakes Regional Dairy Conference:

- Cows should be vaccinated with scours vaccines to ensure colostrum antibodies will be present for immunity transfer.
- Care should be taken to reduce manure buildup on cows and maternity areas should be kept clean to reduce risk of contaminating newborn calves with manure from mature cows. Reducing exposure to manure from mature cows greatly reduces mortality and morbidity.
- Colostrum should be harvested within 2 hr of birth. Delay of colostrum collection reduces Ig concentration in the colostrum. As compared with 2 hr post-calving collection of colostrum, Ig concentration decreased by 17, 27 and 33% at 6, 10 and 14 hr post calving collection, respectively.
- Colostrum also should be kept clean and cooled immediately if not fed directly. Bacterial growth in colostrum increases exponentially if not cooled to 40°F soon after milking.
- Ideally, newborn calves should receive 4 quarts of high quality colostrum within the first few hours of birth. Calves should be encouraged to suckle from a bottle as much of the four quarts as possible and then use an esophageal tube feeder to administer the remaining colostrum.
- Producers are encouraged to set a goal to feed 80% of calves within 4 hr of birth with 4 quarts of colostrum.

If these management practices are followed, high rates of Ig transfer to the calf should occur and will help to ensure healthy vigorous calves. Immunoglobulin G represents 90% of all Ig transferred to calves. Immunoglobulin G concentrations in blood serum greater than 10mg/ml indicate adequate Ig transfer. Calves with serum concentrations less than 10mg/ml are at greater risk of diseases such as scours and pneumonia and exhibit mortality rates twice those of calves receiving IgG transfer greater than 10mg/ml.

Summary
Understanding the highly negative impact of calves receiving insufficient quantities of high quality colostrum at birth is the most important management decision affecting profitability of feeding Holstein steers. Dairy producers can aid in producing vigorous calves by ensuring calves receive adequate quantities of high quality colostrum. Producers that develop a reputation for doing so should receive higher prices for healthy calves.

“ If [good] management practices are followed, high rates of Ig transfer to the calf should occur and will help to ensure healthy, vigorous calves. Understanding the highly negative impact of calves receiving insufficient quantities of high quality colostrum at birth is the most important management decision affecting profitability of feeding Holstein steers.”
Innovative Calf Warming Boxes Reduce Disease Transmission

Dan Grooms  
Dept. of Large Animal Clinical Sciences  
Bob Kreft, Rob West and Adam Blumerich  
Dairy Cattle Teaching and Research Center  
Phil Durst  
Extension Dairy Educator

Introduction

For the last 6 years, the Michigan State University Dairy Cattle Teaching and Research Center (MSU Dairy Herd) has actively engaged in a Johne’s disease (JD) control program. The ultimate goal is to eliminate the disease from the herd. Johne’s disease is a chronic disease caused by the bacteria *Mycobacterium avium* subspecies *paratuberculosis* (MAP). The disease is transmitted from adult to young animals primarily through feces, colostrum and milk. Control of the disease requires long-term diligence in maintaining management changes designed to slow down the risk of disease transmission.

Recently, a team from Michigan State University completed a multi-year research study looking at control and prevention of JD in cattle herds. One of the key findings from this study was the need to stop the transmission of the disease in the maternity pen. Anything that can be done to reduce calf exposure to MAP in the maternity pen is highly beneficial to preventing the spread of the disease.

Key to Controlling MAP

An environmental study of farms enrolled in the Michigan Johne’s Disease Control Project showed that 17% of cultures taken from maternity floors were positive for MAP. In addition, another study in which swab cultures from the skin of cows in maternity or close-up dry cow pens showed that MAP could be cultured from 6 of the 7 animals tested, even though only one of those cows was test-positive (fecal and blood) for MAP. Therefore, the risk of exposure in the maternity pen is high; the longer time spent by the newborn calf in that pen increases the risk of JD infection. A key management strategy for controlling MAP transmission in dairy operations is to remove the calf from its dam as soon as possible after birth.

To facilitate rapid removal of calves from their dam at birth, the Dairy Cattle Teaching and Research Center staff designed and built neonatal calf warming boxes to provide a means to care for newborns and reduce the opportunity for pathogen exposure. Essentially, these “calf incubators” allow for rapid removal of calves from their dams immediately after birth, even when they are still wet. This protected environment allows for the calf to dry rapidly while protecting it from pathogens that often are transmitted in the maternity pen. The boxes are located immediately next to the maternity pens to facilitate the rapid movement of calves into them.

Each box is built to hold one calf. Dimensionally, they are 2 ft W x 4 ft H x 4 ft D (see Figures 1 and 3 on page 18 and 19). They are completely made of plastic material to allow for easy cleaning and disinfecting between calves. The floor is made of rubber coated expanded metal grating to facilitate drainage of urine and feces. The front panel is clear Plexiglas which allows for easy observation. Each box has its own thermostatically controlled heater to maintain an air temperature of 72° F. The list of construction materials is in Table 1 on page 18.

At birth, calves are towel-dried and moved to the warming boxes using a calf sled (available from www.foxworthysupply.com). While in the boxes, calves receive 1 gal of high quality colostrum and other neonatal health procedures. Calves remain in the boxes for approximately 24 hr at which point they are moved to outside calf hutches. The number of boxes needed may vary depending on breeding programs, but roughly, 1 box/25 cows is a starting place.

While it may not be practical, to remove every calf this soon, consider times and situations where the importance of this option is increased; such as the case when calving into a pen with more than one cow or when JD test-positive dams calve. In these instances, the risks are higher and the need to protect the calf is greater.

Advantages of Warming Boxes

Farm personnel and veterinarians have identified several advantages
with the warming boxes. First, a significant drop in the incidence of calf scours has occurred. This is likely a result of the rapid removal of the calf from an environment where it could become exposed to a multitude of pathogens (E. coli, cryptosporidium, salmonella, etc.) that cause calf diarrhea.

Personnel also have noticed that calves from dystocia occurrences seem to respond better when put into the boxes, presumably because of the added warmth provided. Although it is too early to tell if the calf boxes are advantageous in the JD control program, our understanding of the biology of the disease has convinced us that early removal of calves from adult cow environments, including the maternity pen, will reduce the risk of MAP transmission. The major disadvantage of the boxes is that they need to be cleaned and disinfected which obviously requires added labor. The staff estimates that 30 to 60 minutes is needed to clean all four boxes.

Protecting the health of the next generation of replacement animal is critical. The use of calf warming boxes is another tool in what should be a comprehensive control program on farms. No one practice can substitute for improperly maintained maternity pens or failure to implement other key strategies such as not feeding the colostrum of test positive dams. However, innovative solutions such as the one described here helps to ensure early calf health which can translate into superior health and performance as adults.

<table>
<thead>
<tr>
<th>Material</th>
<th>Source</th>
<th>Cost Estimate (January 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 4 ft x 8 ft x ½ inch plastic wood</td>
<td>Plastic Lumber Yard <a href="http://www.plasticlumbaryard.com">www.plasticlumbaryard.com</a></td>
<td>$318.00</td>
</tr>
<tr>
<td>1 - 2 ft x 4 ft x ½ inch clear acrylic sheets - Item # 44386</td>
<td>US Plastics <a href="http://www.usplastic.com/">http://www.usplastic.com/</a></td>
<td>$124.63</td>
</tr>
<tr>
<td>4 - 2 inch x 4 inch x 8 inch plastic dimensional wood</td>
<td>Plastic Lumber Yard <a href="http://www.plasticlumbaryard.com">www.plasticlumbaryard.com</a></td>
<td>$70.40</td>
</tr>
<tr>
<td>1 - 2 inch x 6 inch x 10 inch plastic dimensional wood</td>
<td>Plastic Lumber Yard <a href="http://www.plasticlumbaryard.com">www.plasticlumbaryard.com</a></td>
<td>$35.20</td>
</tr>
<tr>
<td>Rubber coated expanded metal grating</td>
<td>Foxworthy Supply <a href="http://www.foxworthysupply.com/">www.foxworthysupply.com/</a></td>
<td>$105.70</td>
</tr>
<tr>
<td>1500 Watt Heater - Item # PD 95-92</td>
<td>Foxworthy Supply <a href="http://www.foxworthysupply.com/">www.foxworthysupply.com/</a></td>
<td>$105.70</td>
</tr>
<tr>
<td>Thermostatically controlled extension cord - Item # 2E535</td>
<td>Grainger Supply <a href="http://www.grainger.com">www.grainger.com</a></td>
<td>$91.50</td>
</tr>
<tr>
<td>Galvanized pan head bolts</td>
<td>Local hardware</td>
<td>--</td>
</tr>
<tr>
<td>Door handle - Item # 1WAE9</td>
<td>Local hardware</td>
<td>--</td>
</tr>
<tr>
<td>2 - Safety hasp - Item # 1RBP7</td>
<td>Local hardware</td>
<td>--</td>
</tr>
</tbody>
</table>
What is N? ...
Continued from Page 15

- Applying the N source close to the time of crop uptake.
- Avoiding surface applied N fertilizers, especially on high pH soils and hot/dry conditions.
- Avoiding nitrogen fertilizer applications in the fall for next season’s crops.
- Taking all reasonable N credits from past cropping practices, reducing purchased N accordingly.
- Increasing use of cover crops to maintain nutrients in the root zone during the non-cropping season.
- Reducing ammonia losses from manure storage.
- Exploring new technologies that hold and retain N in the soil.
- Increasing use of conservation measures to reduce topsoil losses and retain nutrients in the root zone.
- Formulating non-ruminant diets based on amino acid requirements rather than total protein content coupled with increased use of synthetic amino acids.

Reactive N in the environment is a major emerging issue. Because of agriculture's dependence on N for continued yield improvements it is an issue the industry will want to monitor as the impact of reactive N in our environment is explored.

In 2006 the EPA convened the Science Advisory Board Reactive Nitrogen Committee. The most recent draft report from that committee, including the committee recommendations were posted in January 2011.

That report can be found at: http://yosemite.epa.gov/sab/SABPRODUCT. NSF/81e39f4c09954fcb85256ead0b406be86e/69B45FA395DAC4AC8525780D006D0D33/$File/INC+Report+Quality+Review+Draft_1_20_11.pdf.
Is It a Good Time to Buy or Sell Agricultural Land?

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A number of factors have come together to provide unique circumstances that may be beneficial to both buyers and sellers of agricultural land: strong demand for land; interest rates at almost all-time lows; and, long term federal capital gains tax rates not seen since 1933, are all involved. Let’s take a look at these factors.

Demand for Land
Interest in farmland is rising globally. Population growth, rising incomes and migration from rural areas to urban locations is driving demand for food products, oilseed and livestock. The world’s population is growing 1.2% annually, fuelling the increased demand for protein at a 2.5% annual rate. Arable land is declining in China, India and the U.S.(1) The world historically held large reserves of food and fiber in storage, but those reserves have been liquidated due to large scale floods, droughts, or other weather events that have occurred. China used to carry a year’s corn crop in reserve, but it is down to 20% of last year’s crop. India used to carry almost a year’s reserve of wheat, but it is down to 35%. China and the U.S. historically carried 50% of a year’s cotton crop, but that is almost all gone (2).

Institutional investors (pension funds, private equity groups) see farmland as a diversification to their portfolio, an inflation hedge, a safe haven and a source of stable returns. Institutional investors seek long-term stable returns of 6 to 8% and that can be done with agricultural land. Since 1970 farmland averaged returns of 12% annually, better than the S&P 500, but with the risk of corporate bonds.(3) The only investment that has shown less volatility than farmland long-term returns has been U.S. Treasuries. (4)

Investors historically have done their best to avoid overpaying for agricultural land. They are looking for a 5% to 6% gross cash return, so if land is priced at $3,000/acre, a cash rent of at least $150/acre is necessary. Recent weather events, increasing demand for food, fiber and protein brought on by higher incomes in developing countries and population growth, have contributed to a significant increase in commodity prices. This in turn, has increased net income levels for farmers, providing the additional cash flows that have contributed to increase the demand for farmland.

Interest Rates
According to Federal Reserve Board statistics that began in 1930, the prime rate (what commercial banks charge their best customers) did not exceed 2% until after 1950. Since then, it has fluctuated from 3% to 20%. The prime rate has been declining since 1980 and during the first week of May, 2011 it was 3.25%. This current historically low prime rate has translated into low mortgage rates that began around 2004. Are we taking these low rates for granted? It is easy to forget historical trends. Between 1976 and 1981, mortgage interest rates ranged from 11% to 21% range.(5) That was a doubling of rates in 5 years. My wife and I bought our first home in 1986 and we were tickled to death to obtain a 13% mortgage rate. It had gone down from 15%.

No one knows how long these low rates will last, but some experts sense they are close to a bottom. Many feel there is a greater chance of rates going up than going down, particularly after 2012, when the economy is predicted to have recovered more from the current recession.

Taxes from Income
We are in a period of historically low long-term federal capital gains tax rates. Rates have historically been at least 20%. The period from 1922 to 1933 is the only period that rates were 12.5% or lower. From 1934 to 1996 the maximum capital gains tax rate exceeded 25% and was in excess of 32% from 1970 to 1978. This increased to as high as 39.9% between 1976 and 1978. For a married couple filing jointly with $69,000 or less of taxable income, the capital gains tax rate will be 0% in 2011.

Capital gain is the profit you make from holding a capital investment
such as land. It is also the price received from the sale of farm raised cull cows. For example, if you buy a parcel of land for $4,000/acre and hold it longer than one year, sell it for $5,000/acre, there is a long-term capital gain of $1,000/acre. There can be deductions to this gain to reduce it slightly, but for the purposes of this article the gain is $1,000/acre. The tax rate applied to the gain is based on the income tax rate bracket of the payor, or in this case the seller of the farmland.

If you sell a 50-head of farm-raised cull cows at $1,300/head, the income of $65,000 receives tax treatment like long-term capital gain. The federal government levies a tax on long-term capital gains based on the taxpayer’s taxable income bracket. Under current law (until the end of 2012), if your adjusted gross income is less than $69,000 for a married couple ($34,500 single), the tax rate for long-term capital gains is 0% (10% and 15% tax bracket). If your income is greater than $69,000, the rate is 15% (25% tax bracket and above). Capital gains tax rates have not been this low since 1933. These rates will continue until the end of 2012. Without changes to the tax law by Congress, the top rate will increase to 20% beginning in 2013 (6).

As an illustration, let’s say that you bought 60 acres of land at $1,000/acre and are considering selling it for $2,000/acre (and you have owned the land for 5 years and your taxable income after deductions and exemptions for income taxes is less than $69,000), the land sale creates a long term capital gain of $1,000/acre. So, there is a total capital gain of $60,000 (60 acres x $1,000/acre). If you sell the land in early 2012 and receive 100% of the proceeds before the end of 2012 and your taxable income for income taxes is less than $69,000, you will pay no federal income tax on the capital gain. If you have $68,000 of taxable income and $60,000 of capital gain you are only paying income tax on the $8,000. How can this happen? That $60,000 of capital gain is tax free because you are in a lower tax bracket (up to the top of the 15% bracket). Keep in mind that this is only effective under current law, which expires at the end of 2012.

**Selling Dairy Business**

These tax rates can be very beneficial to someone considering exiting the dairy business. Let’s use the example of the above mentioned 50-head cull cows sold for a total of $65,000. If that dairy couple has taxable income in 2011 of less than $69,000 (income after exemptions and deductions), they will pay no income tax on the $65,000 of raised cow sales. If they sell raised cows with a total value of $100,000, they will pay 0% tax on the first $69,000 and a tax rate of 15% on the remaining $31,000, or $4,650 in income tax. In this example, they can sell $100,000 of raised cows and pay $4,650 of income tax on that sale. That is an average tax rate of 4.65%.

Unless Congress changes the tax law, the long-term capital gains rate (used for raised, cull cows that are sold, for example) increases to 10% from 0% and to 20% from 15% after 2012. These examples are for educational purposes only. Consult a qualified tax or investment professional before embarking on capital purchases or the sale of capital assets.

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Michigan Milk Market Volatility

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Much publicity has been given to price volatility—both milk and feed price—in recent months and with good reason. Both the Class III and the Michigan mailbox milk price have been quite volatile in the past 10 years. One measure of volatility is the coefficient of variation (CV) calculated as standard deviation divided by mean. That is, it is the amount of variation in that series divided by the average value. For Class III and all milk, the CV was 0.23 and 0.19, respectively. Higher values indicate more volatility. These values are much higher than past decades but are lower than similar measures of volatility in corn and soybean markets over the same time period. Both milk and feed price volatility contribute to margin—and therefore profit—volatility.

Price volatility is not desirable for many reasons. One big reason is that it makes it difficult to plan for business expenses such as reinvestment in facilities. Dairy farming is a capital intensive business and uncertain margins can lead to poor decisions that financially stress the operation. But more important than how much volatility exists is whether the milk price or margin is adequate to cover other expenses and generate a return to unpaid capital, labor and management. Farm managers likely can deal with volatility that occurs when prices are adequate—although they may not enjoy it.

As of this writing (June 10, 2011), the July corn price on the Chicago Board of Trade was trading at just shy of $8/bushel, while soybean meal was trading at about $375/ton. Meanwhile, Class III price for July is $19.70/cwt. Using a representative basis for each, and the income-over-feed-margin, calculated as the National Milk Producers Federation (NMPF) does in their margin policy proposal, the income over feed margin is about $6.25/cwt. This value is below the 10-year average of $7.60/cwt. It is not profit—instead it is the amount that is available to pay for everything else. The futures market at the present time does not forecast Class III milk prices remaining at $20/cwt with prices dropping off to $17.50/cwt by the end of the year.

The exceptionally high feed grain prices are in part driven by planting problems which occurred on top of a small stocks from last year’s crop. In order to maintain a respectable margin at these feed prices, Class III milk prices must remain at historically high levels. Wholesale cash cheese prices near $2.00/lb will generate Class III prices around $20/cwt. Whether cheese can hold this price depends heavily on demand—both domestic and international. Domestically, the economy continues to underachieve with high unemployment while retail dairy prices are high which curbs demand growth. Internationally, product prices remain strong but austerity measures and concerns about inflation abound that could hurt longer-term prospects.

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What’s Happening
July -- October

2011 Breakfast on the Farm Events

Dates and Places

July 9, 2011
Ogemaw County
Circle K Farms
4443 S. M-30
West Branch, MI 48661

July 16, 2011
Isabella County
Pasch Dairy, Inc.
3837 N. Nottawa Rd.
Mt. Pleasant, MI 48858

August 13, 2011
Ottawa County
Daybreak Dairy, LCC
4861 Adams St.
Zeeland, MI 49464

August 20, 2011
Huron County
S & M Dairy
9175 Toppin Rd.
Harbor Beach, MI 48841

September 17, 2011
Chippewa County
Taylor Creek Farm, LCC
7065 E. Taylor Rd.
Pickford, MI 49774

September 24, 2011
Missaukee County
Benthem Brothers Dairy
7927 W. Stoney Corners Rd.
McBain, MI 49657

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Breakfast on the Farm Website