Forecasting Milk Income Loss Payments

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The 2002 Farm Security and Rural Investment Act, also called the 2002 Farm Bill, authorized a national dairy program entitled the Milk Income Loss Contract (MILC) Program. This program amounts to a deficiency payment for milk production. The program rules and decisions are straightforward for producers below the production payment maximum but may require a strategic decision with regard to payment start date for large farms that are above the production payment maximum. The main principle for decision-making by producers is to maximize program payments.

The program pays farmers a deficiency payment equal to 45 percent of the amount the Boston Class I minimum price is below $16.94 per hundredweight. These payments may start with milk production in December of last year (2001) and continue through September 2005. The production cap for payment purposes is set at 2.4 million pounds per fiscal year (FY) (October 1 through September 30). The 2003 fiscal year payments are displayed in Table 1, page 2.

In each future year (FY2003-FY2005), the payments may be started in any month specified by the producer. Once the payment date specified begins, the payments occur in consecutive months until the limit production level is reached. The default start month is October. For producers with an expected production level of 2.4 million pounds or less (e.g., 120 cows at 20,000 pounds annually), the default is the desired start date. However, as the milk price, and thus the payment rate, can vary dramatically over any given year, as the farm’s expected milk production increases above 2.4 million pounds the start date becomes more important. The program rules raise many questions for dairy producers with expected annual production greater than 2.4 million pounds. This article attempts to explain the issues and potential strategies.

Issues and Decisions for Answers

Because decisions for the first year, FY 2002, already have been made, this article concentrates on determining the best strategies for future years. These issues include starting date and forecasting prices.


The start date for the following three fiscal years of the program is at the discretion of the producer. If no start date is specified, then the default starting month is October—the beginning of the fiscal year. Producers may indicate the month they want to start payments, other than October. However, once the payments begin, they continue each consecutive month until the 2.4 million pound production limit is reached. This requirement indicates that larger producers will have decisions to make to maximize program payments.

Restrictions on the choice of a start month include that a dairy operation cannot select a month for payment if:

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1. the 15th of the month before the start month is past;
2. the month is past; or,
3. no milk was produced that month by the operation.

Even after a starting month has been selected, dairy operations may change the starting month anytime before the first day of the month selected and designated in the contract. Once the designated month starts, the start date cannot be changed until the next fiscal year.

2. Tracking the Boston Class I minimum price.

All Federal milk order Class I minimum prices are set using the mover plus a fixed differential. The differential in the Boston market is $3.25/cwt. Because this value is the same every month, there is no need to find the actual Boston minimum. Instead the Class I mover, which is essentially the higher of the Class III or Class IV minimum price in the middle of the month, can be used. Using either or both of these values facilitates forecasting the price.

Class I prices vary across the Federal milk order system and are announced in advance by the 23rd of the preceding month. The Class I skim milk price is the higher of the advanced Class III or IV skim milk pricing factors plus a differential specific to each pricing point in the country. The Class I butterfat price is the advanced butterfat pricing factor plus the specific Class I differential divided by 100. The advanced pricing factors use the same product price formulas as the Class III and IV prices except that the product prices are for the most recent 2 weeks.

The Class I mover is analogous to the Basic Formula Price (BFP) under the old pricing system. It equals base skim milk price for Class I times 0.965 plus the advanced butterfat pricing factor times 3.5.

3. Forecasting milk prices.

For producers that expect to produce more than 2.4 million pounds, the decision regarding start month is facilitated greatly by the ability to accurately forecast future milk prices and thus the MILC payments. There are a number of ways that forecasting might be done. One method is to assume that milk prices the next year will look something like the past, and, therefore, one should evaluate past prices. Table 2 (page 3) illustrates the BFP (up until January 2000) and the Class I mover (back to January 2000). As you already know, examining historical data reveals that, on average, the milk price is lowest in the spring and highest in the fall. As Table 2 also illustrates, however, the variation (the standard deviation) around these average prices is often quite high. For example, the record high prices in May and June 2001 were an aberration that brought the average prices up and increased the variation, or equivalently lowered the reliability of this historical price as a forecast.

If we had no other information, and a dairy producer, for example, was to choose two consecutive months for the payments, the months chosen might be April and May. However, only in 1998 would those two months have generated the highest price over a two-month period (in 1999 November-December; in 2000 January-February; in 2001 February-March; and thus far in 2002 July-August have been the lowest prices). This example illustrates that picking the start month to maximize MILC payments might be difficult, and that historic prices are not particularly useful unless every year is “average” or “typical.”

With respect to forecasting the milk price for payment purposes, we can likely do much better than the naïve forecast generated from historic prices by considering the dairy market fundamentals. The one place where the best estimate of future prices is forecast using current information about the dairy market is, of course, the futures market. By examining historic data, we know that the futures market is usually quite accurate one month out, reasonably accurate two months out, but generally less accurate for months farther out.

The milk price depends on consumer demand, feed costs, stocks, weather, and production per cow, and a myriad of other factors that are difficult to predict. Further, small changes in demand or supply can result in large milk price changes. The futures market prices are the best estimates with the given information. The suggested way to pick a start month is to examine the current futures market prices and market outlook and choose the lowest set of consecutive months. For fiscal year 2003, we might consider the futures market prices on September 18, 2002 (Table 3).

The forecast indicates that milk prices are expected to be the lowest (meaning the highest MILC payment) in October and November. Thus, the current best guess is that milk prices,

<table>
<thead>
<tr>
<th>Month</th>
<th>Base Price</th>
<th>Boston Class I Minimum Price</th>
<th>Difference</th>
<th>Payment Rate</th>
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<tr>
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<td>$16.94</td>
<td>$15.23</td>
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<td>$3.07</td>
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<td>$13.73</td>
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<td>$13.71</td>
<td>$3.23</td>
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<td>$16.94</td>
<td>$13.40</td>
<td>$3.54</td>
<td>$1.5930</td>
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</table>
which are relatively near the support price, will recover as the fiscal year progresses. The best strategy for very large producers in FY2003 appears to be to take the payments at the beginning of the fiscal year to maximize program payments.

Note that over the long-run, we expect prices to behave like the pattern in Table 2, and a default start date for future years may be best set in the spring when lowest milk prices might be expected. The point here is that we should pay attention to the current information. For FY2003, payments are unlikely to be much higher in the next year than they are expected to be in October and November. Remember, that once the payment period begins for an operation, it continues until the production limit is reached. However, before the payment period begins, it may be changed to take advantage of the current market information.

### 4. Upper and lower limits on the deficiency payment.

The lower limit of the payment is obviously zero, which occurs when the Boston minimum Class I price is above $16.94/cwt (or, equivalently, the Class I mover is above $13.69/cwt). The upper limit is not explicitly set. However, the Price Support Program works to put an effective upper limit range on the payments. If the Class I mover is at support ($9.80/cwt for 3.5 percent fat milk), then the payment would be:

\[
\text{($13.69/cwt - $9.80/cwt Class I mover) x 0.45 = $1.7505/cwt.}
\]

We know from experience that the Class III and Class IV price can conceivably drop below support (recall the $8.57/cwt BFP from November 1998). These situations are rare, and the new pricing system, which uses the higher of Class III or IV price, makes such situations even more unlikely. Thus, any actual or projected payment rates near $1.75/cwt are likely to be near the absolute maximum.

### Summary

The Milk Income Loss Contract takes the place of the less formal dairy market loss payments that Congress approved periodically in recent years. Because the net effect of these payments is likely to increase total milk production, and depress prices, it is important that individual dairy farmers take advantage of the payment to increase revenues. While it will be too late to switch the starting date to October by the time you read this article, the outlook indicates that the early months are preferred this fiscal year.

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**Table 2. Historic Basic Formula Price* and Class I mover** prices.**

<table>
<thead>
<tr>
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<td>St. Dev.</td>
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<td>17.34</td>
<td>2.45</td>
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**Table 3. Futures prices September 18, 2002.**

<table>
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<tr>
<th></th>
<th>Class III</th>
<th>Class IV</th>
<th>Estimated Class I Mover</th>
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<td>Oct 02</td>
<td>10.17</td>
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<td>Feb 03</td>
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<td>11.30</td>
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<td>11.45</td>
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<tr>
<td>May 03</td>
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<tr>
<td>July 03</td>
<td>12.40</td>
<td>11.25</td>
<td>12.40</td>
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Nationally large production increases and relatively low consumption increases are forecasted for the foreseeable future. Through August, total milk production was up 2.85 percent over 2001 levels (Figure 1). The largest relative increases were in western states with Arizona, California, Idaho and New Mexico all showing significant milk production increases. In fact, Idaho passed Minnesota as the fifth highest milk producing state. Meanwhile, commercial disappearance was 0.2 percent lower for the first 6 months of 2002 compared with 2001. Butter consumption was up 3.0%, but cheese consumption was basically flat and fluid milk consumption was down 0.4 percent.

The result has been extremely low milk prices since spring with Class III price possibly bottoming out at $9.54/cwt in August. Summer weather did not produce heat stress sufficient to affect milk production, but the drought prevalent in many regions increased feed prices. Low milk prices mean that incentive to produce milk is lower. Note that low prices also mean that the Milk Income Loss Contract payments from the 2002 Farm Bill will be high in the next few months, which should help the cash flow of farmers.

Through July, Michigan milk production was up 2.8 percent compared with a year ago. Milk cow numbers were down slightly to 301,000 (compared with 303,000 in July 2001). In recent years, chronically low feed prices were able to somewhat off-set the occasional low milk prices. This is not the current situation. The Michigan milk price-to-feed price ratio slipped to 2.83 for July 2002 (Figure 2), the lowest ratio since May 1998. Little relief is in sight, especially for producers purchasing feed because hay prices are expected to increase as quantity and quality deficiencies become apparent in the fall months.

The genetic quality of service sires used on your farm has a major impact on the genetic improvement in your herd. To ensure continuous genetic progress you must periodically review and update the criteria used to select AI service sires for the herd.

Net Merit (NM$) can be used as one of the primary selection tools for determining a suitable group of service sires. NM$ is an economic index that indicates the expected lifetime profit of a cow or the daughters of a bull expressed relative to the base population of the breed.

NM$ is calculated by summing three sub-indexes computed for yield, udder and other traits.

\[ NM$ = \text{Yield$} + \text{Udder$} + \text{Other$} \]

where:

a) \( \text{Yield$} \) is the expected milk income minus additional feed costs.

b) \( \text{Udder$} \) includes predicted transmitting ability (PTA) for udder (PTA Udder) and PTA for Somatic Cell Score (SCS). PTA Udder is an index that includes PTAs for the linear type traits of fore udder, rear udder height,
rear udder width, udder cleft, udder depth, and teat placement.

c) \textbf{Other$} was developed to account for lifetime net income (or loss) from productive life and remaining linear type traits. Other$ includes replacement rearing cost minus cull cow value, PTA for feet and legs (PTA F&L), and PTA for body size (PTA Size). PTA Size is used to account for additional maintenance, rearing cost, and cull cow (beef) revenue.

PTA F&L is comprised of PTAs for the linear type traits of legs-side view, legs-rear view, foot angle, and foot/leg score. PTA Size includes PTAs for stature, strength, body depth, and thurl width.

The relative weightings for the sub-indexes are: 67\% Yield$ to 16\% Udder$ to 17\% Other$.

\textbf{Recommendations}

You should select service sires from among the top 20\% of Active AI bulls based on NM$. Table 1 lists the NM$ cutoff values for several percentile ranking levels. For example, the 80th percentile cutoff for active AI Holstein sires is +440 NM$. At the 80th percentile, only 20\% of the active AI Holstein sires will have a NM$ value greater than +$440.

When you update the selection criteria for service sires, be sure to write down your criteria and share the information with other people on the farm who make semen purchasing decisions. Good communication will help ensure that you meet the sire selection goals for your herd.

\begin{table}[h]
\centering
\caption{NM$ levels of top percentiles for AI sires by breed for August 2002 USDA Sire Summary.}
\begin{tabular}{lccccc}
\hline
\textbf{Breed} & \textbf{50} & \textbf{60} & \textbf{70} & \textbf{80} & \textbf{85} & \textbf{90} & \textbf{95} \\
\hline
Ayrshire (n=23) & 216 & 257 & 282 & 316 & 346 & 398 & 412 \\
Brown Swiss (n=50) & 337 & 392 & 411 & 463 & 474 & 498 & 514 \\
Guernsey (n=21) & 313 & 324 & 333 & 344 & 370 & 371 & 379 \\
Holstein (n=648) & 333 & 367 & 403 & 440 & 461 & 483 & 516 \\
Jersey (n=91) & 320 & 336 & 358 & 385 & 392 & 420 & 471 \\
\hline
\end{tabular}
\end{table}

“n=“ indicates number of bulls in current active AI population for each breed.

\section*{Replacement Management}

\textbf{Using Intensive Calf Feeding Programs}

\textbf{Miriam Weber Nielsen, Laurie Davis, Erin Brown, and Mike VandeHaar}
\textit{Dept. of Animal Science}

\textbf{Heifer calves are an important investment because they are the future milking herd. However, replacements are a significant expense to the operation, second only to feed costs for the lactating herd. There is continuing motivation for dairy producers to improve future productivity of heifers while minimizing rearing costs.}

Management of dairy heifers is important because it influences how the heifers will produce as dairy cows. Two principles are particularly important in feeding and managing heifers for their best future lactation performance. First, Holstein heifers should be grown to achieve pre-calving body weights of 1350 to 1400 lb, to minimize calving difficulties. Second, heifers should not be consistently overfed during the post-weaning period from approximately 200 lb of body weight (about 3 months of age) until puberty (approximately 600 lb for Holsteins, about 9 to 10 months of age) to minimize the risk of fat heifers and to avoid nutrition-related impairment of normal mammary development. Following these principles helps to optimize production potential and longevity in the herd. One option for reducing costs while still raising the best possible heifers is to reduce age at first calving by increasing growth rates of calves.

“Intensive feeding” or “accelerated growth” programs have been developed to increase pre-weaning growth rates of calves, with one goal of attaining breeding weight (800 to 850 lb for Holsteins) at a younger age. An “intensive feeding” or “accelerated growth” program refers to feeding of an increased amount of a properly formulated milk replacer. Until recently, however, these programs have not been evaluated for their effects on mammary development and future milk production potential.

\section*{Normal Mammary Development}

During the period before Holstein heifers reach puberty at 9 to 10 months of age, the mammary gland grows rapidly at a rate faster than overall body growth. Mammary parenchymal tissue is forming that will eventually become the ducts that transport milk and which will give rise to the milk-synthesizing alveoli. Growth of the parenchymal tissue is regulated by hormones and growth factors that reach the mammary gland via blood or are produced locally within the gland. Our research at MSU has shown that different areas of the
parenchymal tissue receive varying levels of growth stimulation, likely in relation to the different future functions of the tissue. Growth of mammary parenchymal tissue continues at a rate faster than the rate of body growth until the time of puberty, and then slows to a rate of growth similar to the rest of the body. By the time of puberty, the ducts that form the foundation for development of alveoli during pregnancy are established. A main factor limiting the milk production potential of cows is the number of alveoli in the mammary gland (3).

**Risks in Growing Heifers Fast**

Management of heifers can negatively influence mammary development during the period of growth after weaning and before puberty (1). When rates of body weight gain exceed approximately 2.0 lb/day, heifers deposit more fat into the mammary gland, which is associated with impaired development of mammary parenchyma. This effect of overfeeding on mammary parenchymal growth occurs in part due to a direct reduction in the amount of growth-stimulating activity in the mammary parenchyma (4).

The time at which a heifer reaches puberty is more closely related to body weight than age; therefore, an increased rate of body weight gain causes a heifer to reach puberty at a younger age. This leads to a reduction in the length of time for mammary growth to occur before puberty. The significant reduction in age at puberty in overfed heifers, possibly in combination with a reduction in rate of mammary parenchymal growth, is associated with impaired mammary development and decreased future milk production. Even when heifers are fed the same diet, the heifers that are fattest around the time of puberty have the least mammary parenchyma (2).

**Intensive Feeding of Calves at MSU**

From February through August 2001, we conducted a study funded by the Corn Marketing Program of Michigan and the Michigan Corn Growers Association to evaluate the effects of increased energy and protein intake on mammary development of Holstein heifer calves. In part of the study, 42 calves were fed for either a "standard" or a "high" energy and protein intake during each of two periods: 2 to 8 weeks of age and 8 to 14 weeks of age.

From 2 to 8 weeks of age, calves on the "standard" program were fed a typical commercially available milk replacer (20% crude protein, 20% fat) and limited amounts of a calf starter (18% crude protein) to gain approximately 1.0 lb/day. Calves on the "high" program were fed a higher-protein milk replacer (28.5% crude protein, 15% fat) and free-choice calf starter (22% crude protein), to gain approximately 1.5 lb/day. All calves were weaned gradually from milk replacer by 7 weeks of age. Drinking water was available at all times.

From 8 to 14 weeks of age, calves were fed a grain mix consisting of either the "standard" calf starter or the "high" calf starter supplemented with 30% dry cracked corn. Calves on the "standard" diet were fed limited amounts of the grain mix and gained approximately 1.0 lb/day, whereas calves on the "high diet" received the grain mix free choice and gained approximately 2.5 lb/day. Calves were slaughtered after the end of the second period at 14 weeks of age for evaluation of treatment effects on body composition and mammary growth.

**Summary of Results**

Calves grown from 2 to 8 weeks of age on the "high" diet, compared with the "standard" diet:
- had increased body weight, withers height and carcass lean mass;
- had larger mammary glands, with a 50% increase in mass of parenchymal tissue; and,
- had greater body weight gains per unit of feed consumed.

Calves grown from 8 to 14 weeks of age on the "high" diet, compared with the "standard" diet:
- had increased body weight, withers height and carcass lean mass;
- had similar amounts of mammary parenchymal tissue;
- began to deposit more fat within the mammary parenchyma, which is generally associated with a reduction in future milk production; and,
- had greater body weight gains per unit of feed consumed.

**Our Recommendations**

Before weaning, feeding of higher-protein milk replacers for calves to gain about 1.5 lb/day can increase mammary development; however, we will not know if this increased mammary development translates into increased milk production during first lactation until completion of our next research study. (We shall report the results to you in a follow-up article in the Michigan Dairy Review). We currently recommend feeding calves after approximately 2 months of age to gain 1.7 to 2.0 lb/day. Feeding for gains faster than 2.0 lb/day likely will impair mammary gland development.

**Acknowledgements**

We appreciate the financial support of the Corn Marketing Program of Michigan and the Michigan Corn Growers Association in funding our research. We thank Milk Specialties Company for the donation of milk replacer used in this study. We gratefully acknowledge the assistance of Dr. Dan Grooms, MSU College of Veterinary Medicine, for health management of the calves.

**References**

Employment Management

**MSUE: Spanish Language Help For Dairy Farms**

Ira Krupp  
Extension Dairy Agent  
West Michigan

With the booming economy of the late 1990’s and early 2000, unemployment was at its lowest levels in nearly 30 years. Dairy farmers in Michigan found it very difficult to hire dairy farm employees to help them operate expanding operations.

The fruit and vegetable industries of western Michigan have employed a migrant labor force for many years. As the labor shortage continued, larger dairy farms began hiring migrant farm workers and employing them on a full-time, permanent basis. A major challenge that dairy farm owners had in employing migrant farm workers on their dairies was the language barrier. Many dairy farm operators had little or no experience with speaking Spanish. Most of the Hispanic workers had little experience on dairy farms, so not only was there a large communication barrier but also a lack of understanding of how a dairy farm operates by this new group of dairy farm employees.

Michigan State University Extension Dairy Agents, Ira Krupp and Bill Robb, started hearing from their dairy farm operators of the challenges they were facing in employment of Hispanic workers who had little or no English language skills. Key dairy farm operators met with Extension staff to look at ways to better communicate with their new Hispanic workforce. Over a 2-year period, Spanish language training workshops covering key Spanish words and phrases needed in dairy operations were held for producers in western Michigan. During these two, 6-week workshops dairy farm owners and managers learned key Spanish words and phrases that were identified by class attendees as important in communicating with Hispanic farm employees. With input from class members, an extensive list of key words and phrases in Spanish was compiled for dairy farm operators.

**Audio Tapes and CD Available**

The result was development of an audio cassette tape and CD that producers could use to learn these key words and phrases. The key words and phrases were developed for the following areas: Parlor and Milking Phrases, Cow Descriptions, Calving and Calf Care, Veterinarian and Medical Phrases, Feeds and Feeding, General Terms and Commands, Tools and Machinery, and Hiring and Employment. The cassette includes common English and Spanish dairy-related phrases in a learning module and an example conversation in a practice module that can be used by farm managers to learn and practice speaking key words and phrases in Spanish. The cassette tape is made so that you can carry the cassette with you in your vehicle to practice proper pronunciation and proper inflection of many common Spanish dairy-related words and phrases. The CD includes the same audio files and script file plus additional Spanish language resources including Spanish Milking Glossary, Milker Training PowerPoint Presentation in Spanish, and Spanish at Work: 500 Useful Words.

These training materials are available through the MSU Extension Bulletin Office at 517-355-0240. For a free copy of a brochure on these training materials you may contact Ira Krupp at krupp@msue.msu.edu or Bill Robb at robb@msue.msu.edu.

Reproductive Management

**Dairy Bull Breeding Soundness Evaluations**

Paul Coe  
Dept. of Lg. Animal Clinical Sciences

Wanted: Immature, inexperienced bulls to impregnate cows that fail to conceive using synchronization of estrus and artificial insemination. Candidates must possess the athletic ability to mount and serve cows on slippery concrete. Breeding activity must continue while eating a high-energy ration that may cause digestive upsets and sore feet. Each bull will be responsible for 50 to 100 open cows at all times. Open cows must be identified from 200 cows in the pen. Intense breeding activity is expected daily until injury, illness, or temperament terminates employment.

Should dairies expend time and money evaluating bulls for breeding soundness? Every large dairy I’ve had the privilege to visit is using bulls. Some have chosen all natural service for their breeding program. Most use bulls to “clean up” cows that fail to conceive to artificial insemination. Large dairies may maintain 20 to 40 bulls, typically purchased as inexperienced yearlings with no physical evaluation of breeding soundness.
These bulls typically are placed into pens with 100 to 200 cows. Bulls are culled when they become aggressive or physically unable to breed cows. Inexperienced bulls breeding on concrete while eating the total mixed ration (TMR) for milking cows can lead to astronomical culling rates.

About 80% of bulls pass breeding soundness evaluations the first time. The other side of this statistic is that, from an untested population, one out of five bulls will not perform well in an intensive breeding system. A high failure rate among bulls examined on large dairies suggests inefficiencies in the natural service component of breeding programs. Table 1 compares the classification rates, on initial breeding soundness examination, of dairy breed bulls versus beef breed bulls examined by the author over the last 5 years.

More beef than dairy bulls were evaluated. In the cow-calf business, reproduction is everything, and the beef industry depends on natural service. Beef extension programs over the last 15 years have emphasized the importance of bull evaluation. Many bulls are examined when they change owners and progressive producers routinely have all breeding bulls examined annually before turning them out to breed cows.

The proportion of dairy bulls achieving the satisfactory breeder classification is slightly lower than for beef bulls. If all bulls on a dairy are included, the passing rate for dairy bulls is likely worse than 77%. When lame bulls identified and marked for culling without reproductive evaluation are counted, it is not uncommon to fail 40% of the bulls on a large dairy.

Adopting major management, ration, or housing changes to accommodate clean-up bulls makes little economic sense. Therefore, injuries, laminitis, and bad temperament will continue to generate high culling and replacement rates among dairy bulls. Natural service programs must accommodate young inexperienced bulls. Producers should anticipate high culling rates and short duration of service for dairy bulls in intensive breeding programs. The major goal is to maintain a bull battery capable of impregnating open cows soon after they enter the bull breeding pens. A reasonable program might include the following.

1. Start with reproductively sound bulls.
2. Allow inexperienced bulls to learn how to breed.
3. Provide regular rest periods.
4. Use regular evaluations to monitor breeding bulls and ensure that bulls in the breeding pens are fertile.

### Start with Reproductively Sound Bulls

Breeding soundness examinations can be used to screen new bulls before adding them to the herd. A breeding soundness examination as recommended by the Society for Theriogenology provides a repeatable estimate of a bull’s potential to reproduce (1). Under the current recommendations, each bull must pass a physical examination and achieve three minimum standards estimating semen production potential. If an infertile bull is identified before exposure to cows, a replacement or refund may be negotiated with seed stock producers who sell bulls with a breeder’s guarantee. Purchasers should find out about this option before purchase.

Several veterinary practices in Michigan have the equipment and trained veterinarians to provide this service. Exams can be done on the farm if adequate restraint is available. Bulls are very strong and can be difficult to handle. Having people experienced at handling cattle is paramount. Pens and gates should be set up to minimize fighting among the bulls and risk to handlers. A well-built chute with optional squeeze and an opening along the side to collect semen provides safe restraint. Older bulls with thick necks are difficult to hold in a head catch so a solid bar or stout post behind him is needed to keep the bull in the chute. Good footing for bulls and people is essential. Sand spread in the bottom of the chute improves bull performance during electro-ejaculation, reduces the risk of injury, and minimizes time to examine each bull. Physical examination and ejaculation can be performed on 8 to 10 bulls per hour. Semen evaluation requires additional time and a clean place to set up a microscope. With good facilities and experienced personnel 25 to 35 bulls can be examined in a day.

To pass the breeding soundness examination a bull must be able to see, eat, walk soundly, and possess the sexual maturity to find, mount and inseminate cows in heat. He must have no abnormalities of the reproductive organs that would interfere with breeding. Minimum standards designed to estimate sperm production potential are set so that fertile bulls of any breed should exceed them. Scrotal circumference (SC) must be above the minimum standards (Table 2). All bulls,

### Table 1. Comparison of classification rates between dairy and beef breed bulls evaluated during the past 5 years.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Dairy</th>
<th>Beef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bulls</td>
<td>149</td>
<td>2527</td>
</tr>
<tr>
<td>%Satisfactory</td>
<td>77</td>
<td>81</td>
</tr>
<tr>
<td>%Deferred</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>%Unsatisfactory</td>
<td>19</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 2. Minimum standards for scrotal circumference (SC) in centimeters.

<table>
<thead>
<tr>
<th>Age in Months</th>
<th>Minimum SC (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;12 - 15</td>
<td>30</td>
</tr>
<tr>
<td>&gt;15 - 18</td>
<td>31</td>
</tr>
<tr>
<td>&gt;18 - 21</td>
<td>32</td>
</tr>
<tr>
<td>&gt;21 - 24</td>
<td>33</td>
</tr>
<tr>
<td>&gt; 24</td>
<td>34</td>
</tr>
</tbody>
</table>
Table 3. Recommended bull-to-cow ratios for different breeding strategies (6, 7).

<table>
<thead>
<tr>
<th>Breeding Strategy</th>
<th>Bull-to-Cow Ratio¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling bulls, conventional pasture mating</td>
<td>1:25</td>
</tr>
<tr>
<td>Mature bulls, natural service after synchronization of estrus</td>
<td>1:25</td>
</tr>
<tr>
<td>Clean-up with mature bulls following A.I.²</td>
<td>1:60</td>
</tr>
<tr>
<td>Rugged terrain, mature bulls, low stocking density</td>
<td>1:35</td>
</tr>
<tr>
<td>Mature bulls, conventional pasture mating</td>
<td>1:40</td>
</tr>
</tbody>
</table>

¹Assumes bulls have passed a breeding soundness examination.
²Assumes > 60% pregnancy rate from artificial insemination.

regardless of age must ejaculate a semen sample containing 30% motile sperm and 70% normally shaped sperm.

The importance of selecting bulls with large testicles for intensive breeding cannot be over-emphasized. Scrotal circumference is the most reliable measure of testicular size. Bulls of all breeds attain puberty, the ability to produce sperm cells, when they reach an average SC of 27.9 + 0.2 centimeters (2). Because SC is correlated highly to paired testicle weight, measuring the circumference of a bull’s testicles is a good estimate of testes weight (3, 4). Because each gram of functional testicle tissue has the same amount of tubular epithelium and sperm production per gram of testis is constant, bulls with larger testicles produce more sperm per day (5). In intensive breeding programs, bulls with small testicles are likely to use up sperm reserves more quickly and impregnate fewer cows than bulls with large testicles. Over the last 5 years among Holstein bulls under 2 years of age who passed a breeding soundness examination the average scrotal circumference measured by this author was 36.6 centimeters.

When the examination is finished, each bull is assigned to one of three classifications (Table 1). Satisfactory means that a bull possesses acceptable physical characteristics, has no abnormalities of the reproductive tract that would interfere with breeding, and achieves all three of the minimum standards that estimate sperm production potential. Bulls that are deferred have failed the physical or one or more of the minimum standards but have the potential to improve and should be re-examined at a later date, usually in 30 to 60 days. Bulls that are unsatisfactory failed the physical or one or more minimum standards with little chance of improving and should not be used.

Lessen Inexperience in Young Bulls

Once new bulls have passed a breeding soundness examination and appropriate tests to screen for disease, breeding performance can be improved if they learn to breed cows in a non-stressful situation. Virgin bulls are inexperienced breeders that need to learn how to identify females in estrus, properly mount and breed a cow, and inseminate multiple cows per day. Breeding a few heifers or small cows on dirt lots allows inexperienced bulls to figure out how to do the job without worrying about slipping or getting beaten up by larger, older cows. The learning curve is short for most bulls and injuries can be reduced if the first attempts to serve cows occur in uncrowded conditions with good traction. This also allows evaluation of a new bull’s libido (sexual desire) and athletic ability to mount and serve cows. These are important factors that cannot be easily assessed during a routine breeding soundness examination.

Provide Regular Rest Periods

Most dairies I’ve visited use a much higher bull-to-cow ratio than is recommended in Table 3. These recommendations were developed for beef bulls in a limited breeding season and assumes the use of bulls that have passed breeding soundness examinations. Yearling bulls quickly will deplete their sperm reserves in intensive continuous breeding. To maintain high levels of libido and semen quality, overuse of young bulls should be minimized and regular rest periods should be provided to allow bulls to replenish sperm reserves. A dairy should have enough extra bulls to establish a rotation that allows isolation from non-pregnant cows, access to a low energy, high fiber diet, and surfaces with good traction. Conversations with dairy veterinarians indicate 50 to 60% of eligible cows will be diagnosed pregnant 45 days after a pair of young bulls is placed in a pen containing 50 to 100 open cows. If the same bulls are allowed to continue breeding another 45 days, pregnancy rate among eligible cows often drops to 15 to 20%. In the absence of data from controlled trials, this anecdotal evidence suggests sperm reserves decline in young bulls after 30 to 45 days of intense breeding activity. Assuming continuous sperm production, 3 to 4 weeks of rest should allow bulls to rebuild sperm reserves.

Monitor Breeding Bulls

After bulls enter the breeding pens, daily visual appraisal should identify lame or sick bulls. Lame bulls will not breed cows or heifers. Instead, they spend a lot of time lying down, which insulates their scrotum and decreases sperm quality. Sick bulls also decrease sexual activity and may have reduced semen quality following periods of fever or toxemia. Lame bulls and sick bulls should be removed from the breeding pen immediately upon identification and replaced by sound bulls to maintain an active breeding battery.

Periodically, bulls should be sorted from the breeding pens for closer evaluation and breeding soundness examination. Lameness that might not have been noticed in the pens can be identified. Injuries to reproductive organs and poor semen quality can be found during a breeding soundness examination. Frequency of breeding soundness examination depends on how much emphasis dairy management wishes to place on the natural service component.
of the breeding program. For clean up bulls, twice a year seems like a reasonable recommendation for periodic evaluation and breeding soundness examination. For bulls on dairies where all breeding is by natural service, more frequent examinations are likely appropriate. Examination towards the end of programmed rest periods should help ensure fertile bulls re-enter the breeding pens. Certainly, any time decreased reproductive performance can be traced to one or more bulls, those animals can be screened quickly with a breeding soundness examination.

Summary

Using bulls for natural service creates both need and opportunity for management. Use breeding soundness examinations to screen for reproductively sound bulls at acquisition. Allow inexperienced bulls to learn how to breed. Rotate bulls out of the breeding pens so they can heal minor injuries and rebuild sperm reserves. Monitor the active breeding bulls and maintain enough bulls to substitute a sound bull for one that quits breeding. Now we have the makings of a program for dairy producers that want to actively manage the male side of their natural reproduction program.

References


George Smith
Dept. of Animal Science

Dairy Wars Episode II: Attack of the Clones

The ideal cow: Dairy farmers have a clear picture of her in their head. She has 40,000 lb of milk production per year with high protein, high fat, ideal body type and mammary conformation. She is truly a super cow, a high longevity cow, a cow that is always healthy and produces a calf every year. Perhaps this is a high performance cow currently in your herd, one in a neighbor’s herd, or a record setting cow you read about in Hoard’s Dairyman. Nevertheless, this is the type of cow that you are likely to point out to your spouse, business partner, or your banker and say “I wish I had a whole barn full of cows exactly like her.”

As little as 5 years ago, your wish would have been as grounded in real life as the recent box office science fiction thriller from which the title of this article was coined. However, since the landmark report in 1997 of the birth of Dolly (1), the world’s first farm animal cloned from an adult somatic cell (non reproductive cell), there has been an explosion of research that has helped pave the way for cloning of dairy cattle. Now there is the potential for cloning to reach the commercial sector and provide the foundation for the above wish (for a whole barn full of identical copies of your ideal cow); to move from purely science fiction to possible reality in the future.

Fundamental research has improved cloning technology, clearly established the health status of cloned animals, and addressed the question of whether such animals age normally. In this article, some of the important discoveries in cloning research critical to future commercial application will be highlighted, as well as some of the current and future obstacles yet to be overcome before cloning of a whole barn full of exact copies of your ideal cow will ever become practical.

Is This Real Life or Still Science Fiction?

As stated above, the potential for commercial application of cloning technology has become a reality in the past 5 years since the announcement of the birth of Dolly (1). Commercial cloning technology offers potential opportunities for exact genetic duplication of high merit animals currently in production and for banking of cells and subsequent recreation of animals that are identical genetically to animals that are dead, dying or out of production. A couple of examples are provided below to illustrate this point. The example likely most familiar to readers of the Michigan Dairy Review comes from the 2000 World Dairy Expo where an exact genetic duplicate of Lauduc Broker Mandy (EX-95 2E), one of the premiere cows in the Holstein breed, sold at auction for $82,000 (2). All that is required to re-create (using cloning technology) prized animals that have since moved on to that infamous milking parlor in the sky are ordinary cells (such as skin cells) collected from the animals prior to or right at death, and prepared and frozen using special procedures. Thus, exact genetic duplicates of special animals that have died can be re-created allowing the exact genetic potential of such animals to live on. Clones of one of the most recognized cows of the Holstein breed (Stookey Elm Park Blackrose-ET RC), who died in 2001, also

An update on breakthroughs in animal cloning research since the birth of Dolly that have helped cloning technology reach the commercial sector and the key obstacles yet to be overcome.
have been generated recently to allow the exact genetic potential of this legendary cow to continue to directly influence the Holstein breed (2).

**What is the Catch?**

Thus, you likely now are convinced that a few people in the seed stock industry are utilizing this powerful technology to re-create or duplicate the exact genetic potential of valuable animals. Above examples are in no way meant to serve as an endorsement of widespread investment in cloning technology on the farm, but rather as examples to illustrate that such technology has potential in the commercial sector. After the birth of Dolly (1), and subsequent birth of the world’s first cloned dairy cattle (3), several key questions had to be resolved, which were critical to greater future commercial application of cloning technology. The key questions were: What is the health status of cloned animals? Are cloned animals really normal? What is the longevity of cloned animals? Will they age prematurely? Such questions have indeed been resolved in favor of potential commercial application.

**Are Cloned Animals Really Normal?**

The answer is yes and no. There are still some major problems to be overcome before commercial application of cloning technology becomes widely practical beyond the seed stock industry. A recent issue of Science magazine (4) reported the health status of 24 sexually mature Holstein females derived by standard cloning procedures. In the experiments to generate these 24 cloned animals, 496 cloned embryos were transferred into 247 recipient females. Approximately 45% of recipients were diagnosed as pregnant at 35 to 40 days, results not dramatically different from commercial embryo transfer. So far, so good. However, 80 of the 110 pregnant recipient females aborted and only 30 recipients carried their pregnancies to term. Then, six of the 30 calves born were lost shortly after birth. The cause of this dramatic loss during pregnancy was a defective placenta, and the perinatal death loss in animals that went to term was attributed to heart and lung problems that resulted from the placental insufficiency (4). This is a common problem with cloned pregnancies, but the reasons for the placental defect are not known.

Now, if you are still reading this article you are probably sitting there thinking out loud that the author is crazy. First, he told me that the cloned animals are healthy. Then, he proceeded to tell me about all the problems with prenatal death loss and perinatal complications observed in cloned offspring. Now for the good news. Evidence indicates that those animals that make it to term and survive the first 1 to 2 days following birth are indeed normal. The remaining 24 animals in aforementioned studies all exhibited a normal body weight, body condition score, blood chemistry and immune function (4). Behavior and social interaction of the cloned animals also was normal and all 24 females reached puberty at 10 to 12 months and exhibited normal first service conception rates. To date, at least two of the animals have given birth to perfectly normal offspring. In addition, biological and molecular evidence indicates that the biological clock or ageing process is truly reversed in the cells of a cloned animal (5). Thus, cells of a 1-year-old animal that was cloned from cells of a 10-year-old cow show biological and molecular indices of ageing similar to those of a normal 1-year-old rather than those of a 10-year-old. Thus, the lifespan of cloned animals is not predicted to be any different than that in normally conceived animals. The take home message from these studies is that cloned animals...
that make it to term and survive the first 1 to 2 days of life are indeed normal.

So, What is the Bottom Line?
It is the author’s opinion that cloning technology is here to stay in the commercial sector, and that it will ultimately be possible in the future for a dairy farmer to realize his or her dream (if desired) and have a whole barn full of exact genetic duplicates of their ideal cow. However, the following breakthroughs must take place before this prediction makes it from the realm of science fiction to reality. First of all, more research is needed to develop ways to increase the efficiency of the cloning process, such that calving rates are no different following transfer of cloned embryos than observed with traditional embryo transfer. Fundamental research into how the cloning process works and the mechanisms whereby a skin cell from an adult animal can be tricked into thinking it is back at the earliest stage of embryonic development and thus can direct development of an entire offspring is needed. Understanding how the cloning process works is the key to understanding the reasons why the placentas develop abnormally in cloned animals and pregnancy loss is so high. Identification of noninvasive markers that allow one to predict the developmental capacity of cloned embryos prior to transfer also would increase dramatically the efficiency of the cloning process. Finally, FDA approval and consumer acceptance of dairy products derived from cloned animals also are necessary obstacles to overcome. These obstacles do not seem insurmountable because all evidence indicates that production traits of cloned animals are in no way different from traditional herd animals derived via artificial insemination. In fact, identical twins in essence are Mother Nature’s own version of clones, and dairy products from such animals are already in the food chain. So beware. “Attack of the Clones” may indeed open at a dairy farm near you in the foreseeable future.

References

Sand-laden Dairy Manure: Collection, Transport, Processing, and Storage
Bill Bickert
Dept. of Agricultural Engineering

Dairy manure collected in freestall barn alleys may be transported 1) to hauling equipment, 2) to a device that transfers it to storage or to treatment equipment, or 3) to storage directly. Most options available for manure containing organic bedding materials can be used for collection of sand-laden manure. Manure and organic bedding mixtures can be transferred up to several hundred feet by gravity or piston pumps with minimal problems. In some cases, additional water facilitates the transfer process. But, besides not being compatible with frozen manure, these methods of transferring manure do not work well with sand-laden manure. Four combination methods used for sand-laden manure are described subsequently: 1) scrape-scrape; 2) scrape-auger; 3) scrape-flush; and, 4) flush-flush.

Scrape-Scrape
The simplest method, scrape-scrape, depends on a scraping device to collect the sand-laden manure in the freestall alleys. By continuing the scraping process, manure may be moved directly to storage or to a pit or other temporary storage before being loaded into a truck, a spreader, or a sand-manure separator. Tractor- or skidsteer-mounted buckets, blades or rubber-tire scrapers are used. Alleys longer than 200 to 250 feet generally require multiple passes throughout the alley length.

Often, the layout of barns requires that the manure be turned at the end of an alley, by 90 degrees or more, to reach its final destination. Box scrapers or scrapers fabricated from large, used rubber tires make this less troublesome. Nonetheless, turning manure is time-consuming and is considered undesirable by some.

Another alternative is a mechanical alley scraper, a device pulled along the alley by cable or chain, moving manure to the end of the alley. But these devices are less satisfactory with sand-laden manure because of wear and abrasion. Also, additional equipment is required usually to move the manure out of the barn.

A recent development uses a vacuum manure tanker equipped with scraper arms. The scraper arms adjust to the width of the alley, collecting manure from the alley as the trailer- or truck-mounted equipment traverses the alley length. Manure is drawn into the tank by vacuum during the process.

Scrape-Augur
An auger or screw conveyor, designed for manure
containing sand, can be used to convey sand-laden manure (4). In particular, a horizontal screw conveyor, positioned across a freestall barn at the end of the alleys, eliminates the need to turn manure during the scraping process. Manure scraped directly into a trough containing a screw conveyor is conveyed from the barn. Conveyor lengths up to 144 feet have been reported. Manure can be conveyed over greater distances using screw conveyors in tandem.

In horizontal screw conveyors designed for sand-laden manure, a sizeable clearance between the conveyor flights and the trough minimizes abrasive wear. Also, the trough should be designed to be no more than 45% full during normal operation. This allows hanger bearings to be normally above the manure level in the trough during operation.

Inclined augers, possibly in tandem with a horizontal auger, can be used to convey manure to a storage area or to a manure spreader. Specially-designed inclined augers are used also to meter sand-laden manure at a consistent rate into a sand-manure separator (1,3).

**Scrape-Flush**

Scraping manure into a collection channel charged with flowing water has been described by Wedel (5). This collection channel may be installed cross-wise in the barn, allowing for scraping manure straight into the channel for subsequent conveying from the barn by moving water. Special consideration must be given to the design of the collection channel and the flowing water.

Sand-laden manure scraped directly into a collection channel without flowing water will move sporadically and unpredictably in the channel. Some movement will occur by gravity, similar to what occurs in a conventional gravity-gutter manure transfer system with organic bedding. Gravity channels are being used to move sand-laden manure, also, but usually only over short distances of less than 30 feet. Furthermore, channels are constructed for access by mechanical equipment for eventual removal of settled sand. Where successful movement of sand-laden manure by gravity has been reported, the success most likely has been achieved as a result of using less-than-recommended amounts of sand in the freestalls. Reduced sand use enhances manure movement. However, the primary benefits of sand—cow comfort and udder health—will have been compromised.

Attempts to move sand-laden manure in a channel by adding water to the sand-laden manure are counterproductive. The added water will cause separation and subsequent settling of sand to occur and, eventually, the channel will have to be cleared of settled sand. However, in other cases (e.g., flushing or dilution) water can be beneficial (see subsequently).

For a flush channel to be a success, sand-laden manure must be introduced into water already moving at above scour velocity, which is the mean horizontal velocity required for a fluid to impart motion to an at-rest particle. Care must be taken not to introduce sand-laden manure in quantities large enough to clog the channel.

Typical installations have collection channels 18 to 24 inches wide with flows ranging from 1500 to 5000 gallons per minute.

**Flush-Flush**

Water is sometimes used to flush sand-laden manure from the freestall alleys themselves. When the water mixes with the sand-laden manure, a sequence of dilution, agitation, and separation will occur. Whether or not settling of sand occurs will depend upon water velocity. Intentional settling for the purpose of removing sand from the manure stream is often accomplished in a settling basin or apron (6). But uncontrolled settling results in some organic material settling as well, making the reclaimed sand a risky candidate for reuse as freestall bedding.

To assure the greatest success when flushing sand-laden manure from freestall alleys, maintain a floor slope of 2.5% and alley lengths less than 250 feet. The alley must have a uniform slope from beginning to end, especially avoid any dips or pockets that will cause the water to lose velocity. Also, the alley surface must be level from one side to the other—this is very important! As with flush channels, water velocity must be maintained above scour velocity at every point throughout the width and length of the alley to avoid settling of sand.

Flushing is a convenient method for removing manure from a freestall barn. However, system design should be thought out carefully, including water sources, method of releasing water onto alleys, related barn construction features, provisions for separating solids following flushing, and final disposition of flushed water and manure. Even with the most successful systems, periodic scraping to remove accumulated solids will be necessary.

**Dilution of Sand-laden Manure**

Sand-laden dairy manure, as it is collected in freestall barn alleys, does not exhibit significant settling behavior. When left to stand, a shallow liquid layer gradually will form at the top and a thin layer of settled sand will appear at the bottom. The remainder in between will be a mixture of liquids, organic solids and sand.

Dilution of sand-laden manure is necessary to accomplish significant separation by settling, the basis of operation for a sand-manure separator (3). The complete separation process involves 1) dilution of the sand-laden manure, 2) agitation of the mixture, and 3) differential settling. A minimum dilution rate of approximately 1:1, water:sand-laden manure (by weight) is necessary for effective separation of sand to occur. Agitation of the diluted mixture results in the manure particles and grains of sand being washed free of manure mucus. During differential settling, the higher-density sand grains are allowed to settle while the lower-density organic particles in the manure remain in suspension and are carried out of the sand-manure...
Nutrient Management

Fall Manure Management Strategems in Dairy-Forage Systems

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Although manure nutrient management should be a year-round plan, fall is one of the most critical seasons on dairy farms. In the fall, growth of most forage crops starts to slow and even becomes dormant in preparation for overwintering, and this limits utilization of manure nutrients as a fertilizer source for forage crops.

In addition, soil temperature declines, which slows activity of soil microorganisms. The best time to apply dairy manure on forage crops is in spring and early summer when forage crops maximize nutrient utilization for growth.

Dairy manure, however, is produced every day and should be collected, processed, stored, or applied to fields. So, what are the best manure management strategies for the fall, that utilize manure nutrients most efficiently and minimize environmental impacts such as surface- or ground water contamination as well as greenhouse gases?

1. Forage Crops Where Manure Can Be Applied

On most dairy farms, two major sources of dairy feed are alfalfa haylage and corn silage. Manure should not be applied to bare ground after silage corn is harvested in the fall. Instead winter rye can be planted as a cover crop, which provides an important ground cover to lower surface runoff, erosion, and nitrate nitrogen leaching problems as well as increasing utilization of manure nutrients. As soon as the corn silage harvest is completed, a winter rye cover crop can be established shortly before or after manure application.

Alfalfa has a deep tap root with secondary roots, which are very beneficial in scavenging soil nitrates that otherwise could be leached into the soil and contaminate ground water. Approximately 480, 120, and 360 lb of nitrogen, phosphate, and potash per acre per year can be utilized by alfalfa (for yield of about 10 tons dry hay per year), which is a much higher nutrient removal than corn and small grains. The good news about manure application to alfalfa is that the crop can utilize nitrogen from the two sources, symbiotic nitrogen fixation and soil nitrogen from organic (manure) or fertilizer sources. Applying dairy manure to alfalfa reduces the amount of nitrogen fixed by the alfalfa root nodules. This is good in terms of manure nutrient utilization because alfalfa will absorb nitrogen from the dairy manure as a substitute for nitrogen fixation. It’s important to apply manure within 3 to 5 days after harvesting to reduce smothering or scorching effects from surface manure application. Because alfalfa is an expensive crop to establish, good manure nutrient management is necessary to maintain good stands for both high yield and quality. Manure application to alfalfa, however, should be optional. If enough fields of cool-season grasses, pastures, and small grains are available that need nutrients, then one can use dairy manure for those fields for more efficient manure nutrient utilization and sensible whole-farm nutrient cycling.

2. Controlling Application Rates

Because nutrient uptake by forage plants is low in the fall, it’s not safe to apply higher rates of dairy manure in the fall.
fall than in either spring or summer. It is a good idea to test your soils once a year to determine soil nutrient levels and budget nutrient inputs and outputs. In particular, soil phosphorus should be monitored because manure is not allowed to be applied where soil phosphorus levels are above 300 lb P (Bray P1) per acre in Michigan. In addition, it is important to lower manure application rates where soil types are coarse-textured to minimize nitrate-nitrogen (NO3-N) leaching (the process that occurs when inorganic forms of nitrogen, particularly nitrate-nitrogen are soluble and carried with water through the soil profile or with surface waters). Additionally, if higher rates of dairy manure are applied to fine textured soils, denitrification can occur under anaerobic conditions, which produces gaseous forms of nitrogen such as N2 and nitrous oxide (N2O). In particular, nitrous oxide is 310 times as high as carbon dioxide among greenhouse gases in terms of global warming potential. Thus, before application, manure should be tested to know its nutrient levels and thereby determine application rates for specific crops.

3. Other Things To Consider
   Because manure contains approximately 50% ammonium-nitrogen in an organic form, which can be converted to nitrate-nitrogen by soil microorganisms that break down the organic nitrogen when soil temperatures are above 50°F, it is important to delay manure applications until soil temperature falls below 50°F.

   To minimize manure nutrient runoff, erosion, and leaching risks in the fall, efforts and strategies should be made to spread the dairy manure as evenly as possible at rates that do not exceed the nitrogen and phosphorus needs of the forage crops grown on dairy farms.

Summary

Fall manure nutrient management planning is critical in terms of maintaining valuable manure nutrients for forage crops as well as reducing potential environmental impacts of surface runoff and leaching on dairy farms. Reducing manure application rates in the fall as compared with spring or summer periods is a better and safer management practice. It is important to identify fields where manure can be applied, and develop a manure nutrient management plan in advance based on both soil tests and a manure analyses.

Nutrition

Mycotoxins: Possible Risk, But Know the Facts

Phil Taylor
Extension Dairy Agent
Barry, Calhoun, Eaton and Ionia Counties

Variable growing conditions during a season may cause high levels of mycotoxins in crops. Weather patterns, however, are not necessarily an indication that feeds for dairy cattle will contain elevated levels of toxin-producing molds. These molds are naturally present in fields where crops are grown for feed. Therefore, any environmental conditions favorable for mold growth possibly can result in feedstuffs being contaminated with molds that cause problems for cattle related to mycotoxicosis. The effects of mycotoxins on dairy cattle can range from virtually unnoticeable consequences to death. The number of types of different molds and the mycotoxins they produce, combined with other nutritional and environmental impacts on dairy cattle, make it very difficult to troubleshoot perceived mycotoxin-related problems. This article reviews information about mycotoxins and their sources, discusses dairy nutrition research on mycotoxins, and offers management tips to reduce or eliminate the negative effects of mycotoxins.

A Review

Mycotoxins are organic compounds produced by molds. When molds experience a stress in their growing conditions, production of mycotoxins increases. It is often concluded that weather stresses during a growing season will increase the presence of mycotoxins in feeds. This is complicated by the fact that favorable environments for various species of molds are not the same. Some molds prefer moist, cool conditions whereas others thrive in moist, warm environments. All molds, however, require oxygen, moisture, a proper temperature range, a place to grow, and a nutrient source. Therefore, mold growth and mycotoxin production is possible under many weather or environmental conditions. Crops are infected by molds in the field, and the molds may proliferate in storage. Molds do not grow well in very dry (less than 14% moisture) environments, which explains why dry grains and hay crops are stored in this moisture range. For example, molds that are found in dry hay bales grew there when the bale was damp before it cured and dried to less than 14% moisture.

What Is Known

Mycotoxins of potential detriment to dairy cattle are produced by three primary species of fungi (molds) that occur naturally in the environment.

1. Fusarium molds produce mycotoxins called deoxynivalenol (DON) also known as vomitoxin, zearalenone (ZEN) or F-2 toxin, T-2 toxin, and fumonisins.
2. Aspergillus mold produce aflatoxins.
3. Penicillium mold produces ochratoxin.

Aflatoxin is especially dangerous to humans as a
carcinogen. It can be found in milk produced by cows that eat aflatoxin contaminated feeds. However, aflatoxin is seldom found in feeds grown in the cooler climates of the upper Midwest. Aflatoxin is only likely to enter dairy rations in Michigan through grain or cotton by-products hauled from southern U.S. regions. Ochratoxin is transformed to a non-toxic substance by ruminal microbes and is not a major concern for dairy cattle.

_Fusarium_ is a common mold found in Michigan crops, dry and high moisture grains, and corn silage. Silage fermentation does not eliminate mycotoxins. In fact, poor management of ensiled feeds may result in feeds with higher levels of mycotoxins because air is allowed to infiltrate the silo face of bunkers, bags, or upright silos at feed out time.

With many reported incidences of mycotoxin contamination one would conclude that definitive cause and effect relationships must exist between concentrations of mycotoxins and their influence on livestock. However, published research results indicate these relationships do not exist. Table 1 presents a summary adapted from a review by DiCostanzo (1) of three studies that examined the effects of vomitoxin on dry matter intake and milk production of lactating dairy cows.

All investigators found no significant differences in feed dry matter intake on milk yield when lactating cows were fed varying concentrations of vomitoxin ranging from 0 to 14.6 ppm per head per day.

Four research studies evaluating the effects of zearalenone on reproductive performance in dairy heifers and cows reported variable results. At a dietary concentration of 15 ppm fed to heifers and a ration with 1.25 ppm fed to lactating cows reduced conception rates resulted. However, higher dietary concentrations of 26 ppm in one study and 25 to 100 ppm in another study resulted in normal estrous cycles and ovulation, but enlarged genitalia (1).

Anecdotally, non-research reports from dairy producers and dairy industry representatives in the field seem to suggest a relationship between mycotoxin contaminated feeds and reduced or poor animal performance. A positive test for mycotoxins, however, does not necessarily mean mycotoxins are causing a performance problem. Also, the testing methods used may not be appropriate for the feedstuff and may give incorrect results. Producers who are experiencing animal performance problems and have a feed that tested positive for mycotoxins should make every effort to eliminate other possibilities first before concluding that the problem is mycotoxin. It is far more beneficial to attempt to eliminate the potential for mold growth and mycotoxin contamination by adhering to proper feed harvesting, storage, and handling practices.

**Reducing the Effects of Mycotoxins**

Based on the prevalence of mycotoxins found in testing laboratories, it is doubtful that total elimination of mycotoxins is an attainable goal. When a problem with moldy feeds occurs or is suspected, follow these guidelines.

1. Be certain that poor animal performance is not due to some other management issue.
2. Screen individual feeds, beginning with the feeds suspected of containing mycotoxins.
   - Contact a testing laboratory and inquire as to testing methods used for mycotoxins. Follow the laboratory’s suggested procedures for sampling feeds for analysis.
   - Procedures available for testing samples for mycotoxins include the ELISA assay, thin layer chromatography (TLC), gas chromatography (GC), and high-performance liquid chromatography (HPLC) (3). The ELISA test is useful for screening dry grain samples only to determine mycotoxin presence; however, positive ELISA results should be verified by other methods (3). The complexity of silage creates special challenges for mycotoxin analysis using the ELISA test; false positives often occur (3). Silage samples should be tested using TLC, GC, or HPLC methods.
   - Select feeds and testing procedures carefully. Be sure the feed tested is representative of the feed being fed to the animals expressing the problem.
3. If test results are positive for mycotoxins, the feed source should be eliminated from or diluted in the ration. Detoxifying agents or binders have been used in an attempt to bind the mycotoxin to the agent. However, there is no published scientific experimental evidence to substantiate their use in dairy cattle rations (2).
4. Make every effort to enhance proper fermentation of feeds at ensiling.

### Table 1. Effects of vomitoxin on dry matter intake (DMI) and 4% fat-corrected milk yield (4% FCMY) of dairy cows (1).

<table>
<thead>
<tr>
<th>Investigators</th>
<th>Trial Duration, d</th>
<th>Dose, ppm/d</th>
<th>DMI, lb/d</th>
<th>4% FCMY, lb/d</th>
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<tr>
<td>Charnley et al. (1993)</td>
<td>70</td>
<td>0</td>
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<td>47.5</td>
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<td>39.8</td>
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<td>35.9</td>
<td>42.7</td>
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<tr>
<td>Ingalls, 1994</td>
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<td>0</td>
<td>52.1</td>
<td>64.9</td>
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<tr>
<td>Ingalls, 1994</td>
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<td>3.6</td>
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<tr>
<td>Ingalls, 1994</td>
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<td>10.9</td>
<td>49.5</td>
<td>67.3</td>
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<td>2.9 (%BW)</td>
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<tr>
<td>Noller et al. (1979)</td>
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<tr>
<td>Noller et al. (1979)</td>
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<td>8.3</td>
<td>2.8 (%BW)</td>
<td>48.8</td>
</tr>
</tbody>
</table>

1DMI as a percent of body weight.

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| 16 MICHIGAN DAIRY REVIEW | OCTOBER 2002 |
• Harvest forages as quickly as possible.
• Pack tightly to exclude air (oxygen), which will prevent mold growth.
• Use plastic to cover bunkers and properly seal upright silos. Wrap bales adequately and seal silage bags properly.
5. Manage feeds properly during storage and feeding.
• Patch holes in wrapped bales, bags, and bunker silo covers as quickly as possible to exclude air.
• Keep areas around wrapped bales, bags, and silos clear of debris and tall grass that act as hiding places for rodents and other animals that could cause holes in plastic.
• Minimize exposure of stored feeds to air (oxygen) and water during feed-out. Eliminate disturbance of the bunk or bag face that allows air to enter into the remaining feed, and clean up loose feed daily.
• When designing silage storage, match size with feed out rates to minimize spoilage. Remove 4 to 6 inches (minimum) from bunker surfaces and 3 to 4 inches from upright surfaces per day. Use the higher number during the warm seasons (2).
• Remove moldy feed from all silos and discard. Don’t feed poor quality feed to young stock. Use gloves and a particle mask when handling this potentially dangerous material.

References

University and Industry

Attracting Students to Dairy Science

Miriam Weber Nielsen
Dept. of Animal Science

Many undergraduate students come to the Department of Animal Science with little or no background in the dairy industry, seeking career opportunities in the livestock industry or simply wishing to learn more about animals. Involving those undergraduates in dairy science research through the G.C. and Gwendolyn Graf Memorial Student Enhancement Program is an effective way to inform them about the dairy industry and also to attract them to future careers in the dairy industry. This year, two of these students participated enthusiastically in research programs of our faculty. Yvonne DeBuck and Faith Fickett conducted experiments related to enhancing the effectiveness of immunization of dairy cows against mastitis and the kinetics of starch digestion in the rumen of dairy cows, respectively.

Determining if anti-coliform antibodies cross the blood-mammary gland barrier to increase protective antibody titers in milk is the focus of Yvonne DeBuck’s research with Dr. Jeanne Burton in the Department of Animal Science. Yvonne is an Animal Science major from Monroe. Last year, Yvonne collected milk and blood samples weekly from cows that were immunized either 3 times or 12 times using the J5 bacterin. Two previous students in the Graf Program, Rebecca Darch and Karen Smith, determined that immunization of steers and cows 12 times produced higher blood antibody titers than immunizations given 3 times. Yvonne built on the previous work to develop an assay to detect antibodies in milk whey. Using the assay she developed, it was possible to determine that an increased number of immunizations provided greater antibody titers in milk as it did in blood.

The overall goal of her research is to improve the effectiveness of active immunization of dairy cows in preventing coliform mastitis throughout lactation. Yvonne completed her research in December 2001 and began a Master’s program in immunology at the University of California at Davis this fall.

Evaluating the kinetics of starch digestion in the rumen is the goal of the research project of Faith Fickett, a senior from South Haven, with a double major in Animal Science and Zoology. Starch digestion in the rumen is extremely variable, ranging from less than 40% to over 80%. Excess acid production in the rumen from starch digestion can affect negatively fiber digestibility, feed intake, milk yield, and animal health. With guidance from Dr. Mike Allen in dairy nutrition, Faith conducted in vitro studies to evaluate the kinetics of starch digestion by ruminal microbes, using corn grain varying in endosperm type. Most models that have been used to predict starch digestion in the rumen assume that enzyme activity is not limiting. However, Faith’s results show that enzyme activity is variable in the rumen depending on diet fed and over time relative to feeding. This resulted in large differences in rate of starch digestion. These results will help refine nutrition models for dairy cows to better formulate diets to maximize milk yield and animal health. Faith presented her results at the annual meeting of the American Dairy Science Association held in July, 2002 in Quebec. She is submitting her work for publication in the Journal of Dairy Science. Faith graduated in May and began a Master’s program in dairy nutrition at the University of Florida this fall.
Tom Herdt New Chair of Large Animal Clinical Sciences

Dr. Thomas H. Herdt, a professor in the Department of Large Animal Clinical Sciences, is the new Chair of the Department.

“My hope is to take advantage of the expanding opportunities to advance the practice of veterinary medicine through new knowledge in research, and to work closely with veterinary practitioners and serve their needs, their profession, and their animals,” he said when asked about his vision for the department.

In addition to promoting the Department’s mission statement, Herdt said he wants to ensure that the Department “is a place where faculty members can achieve their potential – their best.” He hopes that a challenging atmosphere for faculty will, in turn, translate to the skilled training of students.

Herdt grew up in a small town called Gahanna, located on the outskirts of Columbus, Ohio. In 1969, he received his bachelor’s degree in Dairy Science from The Ohio State University, where he went on to receive his doctorate in veterinary medicine 4 years later. Herdt spent 1 year working in a dairy cattle practice in western Ohio and then began his residency in large-animal medicine at the University of Minnesota. After completing his residency in 1978, he joined MSU’s College of Veterinary Medicine. Prior to his current appointment, he was chief of the nutrition section of the Animal Health Diagnostic Laboratory.

The nutritional assessment of animals and animal populations, particularly dairy cattle, is his area of expertise. Herdt has published in numerous journals, including the Journal of Animal Science, Journal of Dairy Science, and the Journal of Nutrition. He wrote A Lecture Outline of Veterinary Physiology: Gastrointestinal System, published by MSU’s University Printing in 1996 and was also a guest editor for several editions of Dairy Nutrition Management and Metabolic Diseases of Ruminant Livestock.

He is a diplomate of the American College of Veterinary Nutrition and of the American College of Veterinary Internal Medicine.

Calendar of Events

Nov. 5-6, Forage, Pasture Management Workshop will be held at the Michigan State University Extension - Isabella Co. Conference Room 320, 200 N. Main St., Mt. Pleasant. The MSU Forage Area of Expertise Team is sponsoring the workshop for farmers who desire a more effective and efficient grazing system. Planning paddock layout, forage species, watering and fencing systems, animal nutrition, and other topics will be covered. The program begins at 10 a.m. Nov. 5 and includes a fencing demonstration, presentations from MSUE agents and specialists, and an Amish catered dinner. In addition to producers, crop consultants, Natural Resources Conservation Service staff, seed company representatives, farm management consultants, and Ground Water Stewardship technicians should also consider attending this event. The $150 registration fee is due Oct. 25. Full cost scholarships are available for those who live in the Saginaw Bay watershed (Arenac, Gladwin, Isabella, Midland, Bay, Saginaw, Tuscola, Genesee, and the contiguous parts of surrounding counties). To register or receive more information, contact the Clare County MSUE office at 989-539-7805 or send an e-mail to clare@msue.msu.edu.

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Changes in State 4-H Dairy Youth Responsibilities

Laurie Davis
Dept. of Animal Science

Staff changes recently were made in the way the statewide 4-H dairy youth program is carried out. After 6 years of service as the State 4-H Dairy Youth Specialist, Dr. Richard Pursley has stepped down and will focus solely on his extension and research programs in reproductive management of dairy cattle. Melissa MacFarlane, who has assisted Pursley in the 4-H Dairy Program for the last year will be working on her graduate research with Pursley. They would like to thank everyone for their valuable time and support.

Dr. Joe Domecq will assume the responsibilities as the State 4-H Dairy Youth Specialist. Domecq already is actively involved with the youth of Michigan. For many years he has helped with several 4-H events and with the 4-H Dairy Judging Team, where he has served as coach for the last 5 years.

Domecq’s other responsibilities include coach for the 2-year and 4-year Dairy Judging Teams, coordinator for the Ag Tech Dairy Management Program, teaching classes in both the 2- and 4-year programs, and advisor for the MSU Dairy Club.

Domecq’s assistant for the 2002-2003 year will be Laurie Davis, a graduate assistant in the Department of Animal Science at MSU. Davis also is pursuing the Ph.D. degree under the direction of Dr. Miriam Weber Nielsen.

Lon McGilliard MSU Dairy Science Professor Dies

Dr. Lon D. McGilliard, a professor of dairy science at Michigan State University for 38 years, a former editor of the Journal of Dairy Science, and a devoted paddleball player died during the summer at the age of 80.

An Okemos resident, he was born August 9, 1921, in Manhattan, KS, the son of P.C. and Laura McGilliard. Lon grew up in Stillwater, OK, and received a B.S. degree from Oklahoma State University (Oklahoma A & M), a M.S. from MSU, and a Ph.D. from Iowa State University. He served as a Staff Sergeant in the 183rd Field Artillery Battalion with the U.S. Army in Europe during WWII.

During his tenure as a professor at MSU, he specialized in dairy cattle genetics, supported the MSU Dairy Club, and served as coach for the MSU dairy judging team. This was after he won the National Dairy Cattle Judging Contest while attending Oklahoma State.

While at MSU he always played paddleball during his noon hour (volleyball and badminton in earlier years), recalled his son, Dr. Michael McGilliard. “He was relentless with this noon exercise, playing through injuries and more than one era of faculty meetings I am sure. I think he may have won the Michigan Senior Doubles championship in paddleball one year,” his son added.

He also proved to be a relentless editor during the 11 years that he served in that position for the Journal of Dairy Science. “Looking at his annual summaries, I tally 3,496 manuscripts published (and numerous more not published that he read also),” noted his son, a professor in the Department of Dairy Science at Virginia Tech. In 1986, the senior McGilliard received the Award of Honor from the American Dairy Science Association.

Memorial Services were held at Eastminster Presbyterian Church in East Lansing, where McGilliard was a charter member, “parking himself and his car in the same spot for almost 50 years,” recalled his son. He also helped organize the Okemos Presbyterian Church in the early 60’s.

McGilliard was preceded in death by his parents and his brother, A. Dare McGilliard. Survivors include his wife, Nancy (Dobson) McGilliard; sisters, Jean Schuetz and Faye Morris of Tulsa, OK; his children, Mike (Jan) McGilliard of Blacksburg, VA, Scott (Jean Galbraith) McGilliard of Ypsilanti, MI, Kip (Carol) McGilliard of Charleston, IL, Tricia (Terry) Hedin of Eugene, OR, Anne (Pete) Morgan of Tucson, AZ, Abbie (Barry) VanDenBerg of Orlando, FL, Sarah (Jeff) Bates of Midland, MI; and 16 grandchildren.

Memorials may be made to: Dr. Miriam Weber Nielsen, Michigan Dairy Memorial and Scholarship Foundation, Michigan State University, Dept. of Animal Science, 1250 Anthony Hall, East Lansing, MI 48824.
Michigan State University’s 2003 - Extension Dairy Education Program January 21 to February 19

Dairy Herd Turnover — How to Control It

Concerned about increasing herd turnover and culling rates?

Is herd turnover becoming a challenge on your dairy?

What are acceptable or profitable herd turnover rates?

Do you know your herd’s turnover rate?

Voluntary Culling Rate
Involuntary Culling Rate
Other Herd Loss Rates

Do you know why cows are exiting the herd?

Looking for Management Tips to Help in Controlling Herd Turnover / Involuntary Culling in the following areas?

1. Udder Health
2. Metabolic / Nutritional Disorders
3. Infectious Diseases
4. Reproduction
5. Lameness & Injuries

We invite you to participate in the 2003 MSU Extension Dairy Educational Program.

PROGRAM AGENDA

9:00 – 10:00 a.m. Registration
Milk, Coffee & Refreshments

10:00 – 10:30 a.m.
Michigan and National Trends in Culling Rates and Cow Longevity
Ted Ferris, Dean Ross

10:30 – 11:00 a.m.
Why is Culling Rate Important?
Chris Wolf, Craig Thomas, Ben Bartlett, Bill Robb

11:00 a.m. – 12:00 noon
How to Monitor Your Herd’s Culling
Ron Erskine, Phil Sears, Kathy Lee, Dann Bolinger, Roxanne Pillars

Noon – 1:00 p.m. - Lunch

1:00 – 1:30 p.m.
Case Studies: Making Business Decisions - Based on Using Herd Turnover Monitoring Data
Chris Wolf, Craig Thomas, Dann Bolinger, Kathy Lee

1:30 – 3:00 p.m.
Technical Tips – To Help Control Herd Turnover
1. Udder Health
   Ron Erskine, Phil Sears, Mike McFadden
2. Metabolic / Nutritional Disorders
   Herb Bucholtz, Mike Allen, Dave Beede, Phil Taylor, Ira Krupp
3. Infectious Diseases
   Ron Erskine, Phil Durst, Roxanne Pillars, Dan Grooms,
4. Reproduction
   Richard Pursley, Kathy Lee, Dann Bolinger, Bill Robb
5. Lameness & Injuries
   Dann Bolinger, Kent Ames, Ben Bartlett, Ira Krupp

3:00 – 3:15 p.m.
Program Wrap-up and Discussion
DATES AND LOCATIONS

Jan. 21 (Tu) - Bark River  
Note: Registration begins at 9 a.m. Central Time/10 a.m. Eastern Time. Bark River Senior Center, 0.25 mile south of the blinking yellow light off US-2 and US-41, in Bark River, 906-486-2331.

Jan. 22 (W) - Alpena  
Alpena Community College, Center Building-106, 1/2 mile east of M-23 North out of Alpena on Johnson (Long Rapids) Rd. 989-356-9021.

Jan. 23 (Th) - West Branch  
Quality Inn/Forward’s Conference Center, 0.25 mile north of Exit 212 off I-75 on BL-75, 989-345-3503.

Jan. 28 (Tu) - Cadillac  
Carl T. Johnson Hunting and Fishing Center, M-115 approx. ½ mile northwest of intersection with M-55, on west end of Cadillac, 231-779-1321.

Jan. 29 (W) - Grandville  
Jerry’s Country Inn, 3360 Fairlanes, S.W. Take exit 69A off I-196, east on Chicago Drive, south on Fairlanes, 616-249-3660.

Jan. 30 (Th) – Mt. Pleasant  
Comfort Inn, Business 27 to Bluegrass Rd., turn west to Comfort Inn, which is on the south side of town, 989-772-4000.

Feb. 4 (Tu) - Tekonsha  
Union Church United Church of Christ, Corner of Church and Randall, 1 block West of Main St. (Old 27) in Tekonsha. From NB I-69, take Old 27 north into Tekonsha; continue on Main St. to Randall. From SB I-69, take M60 East to Old 27 (Main St.) south to Randall, 517-767-4199.

Feb. 5 (W) - St. Johns  
Clinton County RESA, located in South-Point Mall, Business US-127, 989-224-6831.

Feb. 6 (Th) - Chelsea  
Chelsea Fairgrounds Service Center, from I-94 take M52 Exit (Chelsea). Travel north about 1 mile to Jackson Rd. (Old Rt.12). Turn left (west) for one block and the fairgrounds will be on the left.

Feb. 11(Tu) - Ubly  

Feb. 12 - Michigan State University  
MSU-Pavilion - I-496/US-127, Jolly Rd. Exit (exit 11), east to Collins Rd. light, turn left (north) travel on Collins Road which changes to Forest St. to the east, then left on Farm Lane to Pavilion. 517-432-5566

Feb. 19 (Th) – Goshen, IN  
Elkhart County Fairgrounds, 17746 E County Rd. 34, Goshen, IN.

EXTENSION CONTACTS

Locations  Phone numbers
Bark River             906-786-3032
- Warren Schauer
- Ben Bartlett
Alpena                906-439-5880
- Phil Durst
West Branch            989-345-0692
- Phil Durst
Cadillac              989-345-0692
- Kathy Lee
Grandville            616-846-8250
- Ira Krupp
- Phil Taylor
- Bill Robb
Mt. Pleasant          231-839-4667
- Mike McFadden
Tekonsha              517-439-9301
- Roxanne Pillars
- Dean Ross
- Phil Taylor
St. Johns             517-543-2310
- Dann Bolinger
Chelsea               517-439-9301
- Roxanne Pillars
- Dean Ross
Ubly                  810-648-2515
- Craig Thomas
MSU                   517-546-3950
- Dean Ross
- Phil Taylor
Goshen, IN            574-533-0554
- Jeff Burbrink
- Bill Robb

PRE-REGISTRATION FORM
(Complete form, clip, include payment, and mail)  
Please return this form with a check at least 14 days before the meeting you plan to attend:

Pam Jahnke  
Department of Animal Science  
Michigan State University  
2265L Anthony Hall  
East Lansing, MI 48824-1225

1. Name ____________________________  
2. Name ____________________________  
Address ____________________________  
City/State __________________________ Zip ______  
County ______________________________ Phone __________

WHICH MEETING WILL YOU ATTEND?

___ Bark River  ___ Tekonsha  
___ Alpena  ___ St. Johns  
___ West Branch  ___ Chelsea  
___ Cadillac  ___ Ubly  
___ Grandville  ___ MSU  
___ Mt. Pleasant  ___ Goshen

PRE-REGISTRATION IS REQUIRED!  
Pre-registration is $40.00 per person which includes lunch and one program notebook. On-site registration is $50.00. Lunch for each additional farm or family member is $20. Lunch is not guaranteed for on-site registrants.

Number of people Pre-registration fee Amount

X $40.00 ______

Additional farm/family/business members: X $20.00 ______

Ck. Number _________ Total Enclosed ______

Make checks to: MICHIGAN STATE UNIVERSITY  
(Your canceled check is your receipt)

If you have need for special materials or services, please contact Pam Jahnke at 517-353-4570.
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