Manure Management Plans!
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A manure management system plan is a tool a dairy producer can use to conserve nutrients, protect water resources, and save money. Most conscientious producers already are doing the things that would be part of a plan, so developing one should not be a major burden. In addition to the benefits mentioned above, there is increasing pressure from state and federal entities for every producer to have such a plan.

The Generally Accepted Agricultural and Management Practices (GAAMPS) for Manure Management and Utilization in Michigan initially were adopted in 1988. These were dictated by the Right to Farm Act as amended in 1987. The benefit to producers who follow the GAAMPS for Manure Management is that they are protected from harassment and nuisance complaints. The most recent version of the GAAMPS was adopted by the Michigan Agriculture Commission in November, 1999 (2). An important part of the GAAMPS is a Manure Management System Plan (MMSP). Here is the description given in GAAMPS for a MMSP.

A manure management system plan should focus on two subject areas: (1) management of manure nutrients, and (2) the management of manure and odor. The most critical aspect of a MMSP to ensure that a livestock operation remains environmentally sustainable is to estimate the quantity of manure nutrients (nitrogen, phosphate, and potash) generated by the operation and determine how these nutrients can be utilized on the livestock farm, or transported off the farm for utilization elsewhere. If manure nutrients are not utilized properly, accumulation of excess nutrients may result in loss of nutrients into water resources.

The GAAMPS limit the amount of manure that can be applied based upon soil test levels for phosphate (Bray P1 test). GAAMPS recommend that all fields be tested at least once every 3 years. If the test level is less than 150 lb/acre, there are no limits to the amount of manure that can be applied, but agronomic rates are recommended. Because the phosphorus (P)-to-nitrogen (N) ratio in manure is more than the P-to-N ratio for crop uptake, one should apply at agronomic rates of P (but not N) because applying at agronomic rates of N will result in P build-up. Depending upon the N loss in storage and application, P applied could be four to five times that of crop removal if application is based upon N utilization. Complying with GAAMPS requires that when P test levels exceed 150 lb/acre but are less than 300 lb/acre, manure application should be reduced to a rate where manure P added does not exceed the P removed by the harvested crop. If the Bray P1 test reaches 300 lb/acre or higher, manure applications should be discontinued until nutrient harvest by crops reduces P test levels to less than 300 lb/acre.

Unified National Strategy
On March 9, 1999, the United States Department of Agriculture (USDA) and the Environmental Protection Ag-
ency (EPA) issued a National Strategy for Animal Feeding Operations (AFO) (1). AFOs are agricultural enterprises where animals are kept and raised in confined situations and feed is brought to the animals. While AFOs may have been unfairly accused of polluting waters, and it is difficult to determine the exact contribution of any particular source on a national basis, it is widely recognized that AFOs can pose a number of risks to water quality and public health. The National Strategy is based on a performance expectation that all AFOs should develop and implement technically, economically feasible, and site-specific Comprehensive Nutrient Management Plans (CNMPs) to minimize impacts on water quality and public health.

It is my view that what EPA and USDA are describing as a CNMP is the same as what we in Michigan have defined as an MMSP. Development of the MMSP or CNMP is not dictated—it is voluntary, and the consequences for not having one in Michigan are simply that the producer foregoes the protection afforded by the Right to Farm Act. If they are voluntary, why would a producer opt to develop a plan? One could argue simply that it is the right thing to do, but the bottomline is that a MMSP will probably save a producer a significant amount of money.

The money that can be saved usually comes in the form of fertilizer purchases that one does not need to make. Doing a MMSP leads a producer to realize that there are significant amounts of nutrients: N, P, and potash (K) that are made available through the manure that the producer does not need to buy. If a dairy operation applies manure based upon P removal, it is most likely that no potash will be needed, and that up to half of the nitrogen needed will be available from the manure. Development of a MMSP requires effort on the part of the producer, but it is not an overwhelming process given the potential benefits.

### The CNMP or MMSP

The National Strategy gives the following components of a CNMP:

1. Feed Management
2. Manure Handling and Storage
3. Land Application of Manure
4. Land Management
5. Record Keeping
6. Other Utilization Options

GAAMPS defines the components of a MMSP as:

1. Production
2. Collection
3. Storage
4. Transfer
5. Treatment
6. Utilization
7. Record keeping

Details in the two plans show that the only difference between the two is that a CNMP includes feed management, whereas a MMSP does not. However, the statement in GAAMPS recommending that a producer estimate nutrients generated and utilized would necessitate one looking at feed management. The significance of feed management to a dairy producer is that most experts estimate that dairy producers routinely overdose P as much as 20%.

### A Simple P Balance

A simple way of looking at P balance on a dairy farm is proposed. For example, the average 1400 lb dairy cow in Michigan produces 60 lb of milk per day in a 305-d lactation. If the typical average P concentration in the lactation ration is 0.42% and the cow consumes an average of 50 lb of dry matter per day, she consumes 0.21 lb of P per day or 64.05 lb during the 305-d lactation. During the dry period (60 d) she consumes an average of 25 lb of dry matter ration per day which contains about 0.32% P, or 0.08 lb per day (or 4.80 lb during the 60-d dry period). Therefore, annual total P consumption equals 68.85 lb (64.05 + 4.80). The cow secretes in milk on average 0.054 lb of P per day of lactation (60 lb X 0.0009; milk contains 0.09% P) or 16.47 lb of P during the 305-d lactation. On an annual basis the cow excretes in manure the difference between total P consumption and total P secretion in milk of 52.38 lb of P per year (68.85 lb - 16.47 lb). This is about 119 lb of P,O₅ per year. The excretion value by this calculation is based on recent research at Michigan State University (3), and is substantially higher than that indicated in GAAMPS. One reason offered is that GAMMPS values are based on old data, which do not reflect the amount of ration dry matter or P a modern dairy cow consumes.

A typical corn (grain) crop removes about 0.35 lb P₂O₅ per bushel per year. For a 140 bushel corn crop, 49 lb of P₂O₅ are removed per acre, so it takes 119/49 = 2.4 acres per cow for manure application to stay in P balance IF one does not add any phosphorus fertilizer. When corn silage is removed, more dry matter is removed, so more P is removed and it takes less area per cow. For a 20 ton/acre corn silage production, about 72 lb/acre of P₂O₅ is removed, so it only takes a 1.7 acres of corn silage to use the manure P from one dairy cow. Alfalfa hay takes 2.0 acres. If replacement heifers are produced on the same farm, it will take proportionately more area per lactating cow. Generally, the number of animal units in replacements are about equal to the number of cows in the herd, so for operations that produce replacement heifers one should double the acreage noted above per cow.

There are efforts being made to reduce the amount of P typically fed in dairy rations. Researchers have suggested that the cow does not need as much P as many producers feed, and reducing P in the ration will have a substantial effect on P excreted. For example, reducing P in the ration by 22% will reduce P excreted by 31% (3).

Currently, a MMSP can be developed by the Natural Resources Conservation Service (NRCS), a competent consulting firm, or by the producer. However, the Strategy says, “USDA and EPA recommends that certified specialists be used to develop CNMPs. Although
such a certified specialist may be used. AFO owners and operators are solely responsible for implementing their CNMPs.”

The Michigan Agricultural Environmental Assurance Program (MAEAP) was formed about a year ago with the expressed purpose of developing a proactive environmental program to help Michigan producers respond to the myriad of environmental regulations and strategies being placed upon them. One of the tasks the MAEAP has addressed is to define what a CNMP is and who is certified to produce it. It is implied that NRCS also will determine what the qualifications should be for a certified planner. While the strategy designates NRCS as the agency in charge of certifying planners, in Michigan the MAEAP, in conjunction with Michigan State University, has taken the lead in educating planners. At the time of this writing, the process for becoming certified has not been specified completely, but it is expected soon.

A class was offered in Spring Semester, 2000 at MSU on developing CNMPs, and 23 students completed the class. It is assumed the first of the certified planners will come from that group. In addition, short courses will be offered in late summer and Fall, 2000 for personnel employed in the dairy industry.

It should be reiterated that at the present time, developing a MMSP or CNMP is voluntary. However, it makes good sense to have one, and it will probably save a producer money in the long run. Contact your local NRCS or Extension office for more information.

References

### Industry Future

**Michigan Dairy Farm Industry Survey Part 2: Revenues and Income**

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A survey of the Michigan dairy farm industry was conducted in 1999 to assess, among other factors, current farm conditions. Surveys were sent to 1,500 dairy farmers selected randomly by the Michigan Agricultural Statistical Service (MASS). Of the 458 respondents 323 were active dairy farmers and 135 inactive farmers. This article is Part 2 of a series and details some of the findings concentrating on the revenues and income of the dairy farm industry (Part I was presented on page 3 of the April 2000 issue of the Michigan Dairy Review; a full report of findings is available from the authors).

The 1999 survey collected current information. However, the most recent year of financial information was 1998. Recall that 1998 was a year with an unusually high milk price. Another factor to consider when interpreting the results presented is that each respondent had the option to skip any given question. The results are presented in tables usually

<table>
<thead>
<tr>
<th>Sources of 1998 cash receipts</th>
<th>Number of farms reporting</th>
<th>Total sales by category</th>
<th>Percent of total sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk sales</td>
<td>189</td>
<td>$74,957,687</td>
<td>84</td>
</tr>
<tr>
<td>Dairy animal sales</td>
<td>76</td>
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<td>2</td>
</tr>
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<td>Cull livestock sales</td>
<td>163</td>
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<td>5</td>
</tr>
<tr>
<td>Crop sales</td>
<td>94</td>
<td>$4,192,868</td>
<td>5</td>
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<tr>
<td>Government programs</td>
<td>142</td>
<td>$2,626,355</td>
<td>3</td>
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<tr>
<td>Other livestock sales</td>
<td>43</td>
<td>$902,088</td>
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<td>Other sales</td>
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<tr>
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<th>Total cash receipts, $</th>
<th>Number of farms reporting</th>
<th>Percent of farms reporting</th>
<th>Sum of cash receipts by category</th>
<th>Percent of cash receipts</th>
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<tr>
<td>20,000 - 39,999</td>
<td>5</td>
<td>2.6</td>
<td>$145,866</td>
<td>0.2</td>
</tr>
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<td>40,000 - 99,999</td>
<td>14</td>
<td>7.2</td>
<td>$1,035,963</td>
<td>1.1</td>
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<td>100,000 - 174,999</td>
<td>24</td>
<td>12.4</td>
<td>$3,252,795</td>
<td>3.6</td>
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<td>175,000 - 249,999</td>
<td>25</td>
<td>12.9</td>
<td>$5,139,712</td>
<td>5.6</td>
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<td>250,000 - 499,999</td>
<td>64</td>
<td>33.0</td>
<td>$23,394,306</td>
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<td>500,000 - 999,999</td>
<td>47</td>
<td>24.2</td>
<td>$32,026,882</td>
<td>35.0</td>
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<tr>
<td>1,000,000 or more</td>
<td>15</td>
<td>7.7</td>
<td>$26,439,223</td>
<td>28.9</td>
</tr>
<tr>
<td>Total</td>
<td>194</td>
<td>100.0</td>
<td>$91,434,747</td>
<td>100.0</td>
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accompanied by “number of farms reporting” indicating the number of actual responses for that question in that category. This explains why every question does not have 323 total responses. The values are averages for that group or size category. The use of averages maintains anonymity but sometimes masks details.

Sales and Receipts
Milk sales were the primary source of revenue on Michigan dairy farms accounting for an average of 84 percent of the total sales (Table 1). In fact, activities directly related to milk production—including milk sales and dairy animal and culled livestock sales—accounted for an average of 90 percent of cash receipts reported. Crop sales and government programs were much smaller sources of cash receipts accounting for only 5 percent and 3 percent, respectively.

Total cash receipts provide an estimate of gross income. In 1998, almost 65 percent of dairy operations surveyed generated over $250,000 dollars per year (Table 2). A majority of total cash receipts reported were from farms with cash receipt totals exceeding half a million dollars. These farms accounted for 64 percent of the cash receipts, but represented only 32 percent of all farms responding.

Income Statement
An income statement is a summary of income and expenses for the 1998 calendar year. Distribution of operating expenses varied with herd size (Table 3). For example, operations with over 250 cows attributed about 16 percent of their operating expenses to labor in the form of salaries and benefits, while operations with herd sizes of 10 to 39 cows attributed only 2 percent of their operating expenses to salaries and benefits. Depreciation accounted for a higher percentage, 15 percent, of the operating expenses in 10 to 39 cow dairies than it...
did in dairies with over 250 cows, which averaged 10.4 percent.

Net farm income is receipts minus expenses. Average net farm income varied from $3,153 for the 10 to 39 cow herd size category to $191,047 for herds with more than 250 cows. There is a great deal of variation in net farm income across the size categories. Net farm income increased as the farm herd size became larger. However, net farm income can be misleading when discussing the profitability of the business. Net farm income is what remains to reward unpaid family labor and provide a return to owner equity. Because the amount of each of these can vary greatly from farm to farm (e.g., a low debt farm versus a high debt farm) even in a given size category, the results must be evaluated on a case by case basis.

Also, since farms with smaller herd size most likely supply relatively more unpaid family labor and owner capital, we expect that net farm income (per cow or hundredweight of milk) would be higher than for the larger herd size.

Net farm income provides an estimate of the funds available to cover the family supplied resources of labor, management, and capital. Beyond what is generated by the farm business is the income from off-farm employment. The farms with the smallest herds had the lowest net farm income but augmented these funds with the largest reliance on off-farm income. The 80 to 119 cow size group relied the least on off-farm income (in an absolute dollar sense). Note also that as farm herd size increases, there is a greater tendency for these businesses to be multi-family operations. Thus, the combination of net farm income and off-farm income may be divided among two or more families.

The increase in off-farm income with larger herd sizes may reflect the presence of more family members of working age in multi-family operations.

Average income and expenses on a per cow basis allows for comparison of each sub-component of the income statement across herd size (Table 4). One useful financial measure is net farm income per cow which standardizes the dollar values across herd sizes. Per cow net farm income was highest, on average, in herds of 80 to 119 cows. Herds with 10 to 39 cows had the lowest average net income per cow at 131. This herd size also had the highest off-farm income levels, 62 percent higher than the next highest off-farm income level. This indicates that farms with smaller herd size are more dependent on off-farm income while farms with larger herd size rely more heavily on farm related income sources. Using a per cow basis more clearly illustrates the declining per cow impact of off-farm income in larger herd sizes.

We found a correlation between size and net farm income. In the 10 to 39 cow herd size category, 40 percent of farmers were making less than $10,000 in net farm income. No farmers in this category reported a net income of over $100,000. In contrast, farms with over 250 cows had only 5 percent of farms reporting net incomes between $10,000 and $19,999 and no farms reporting net farm incomes of less than $10,000. Over 33 percent of farms with 250 or more cows had net incomes of over $175,000.
Family Living Draw

In addition to farm income and expenses, we examined the family living draw. Coupled with family ownership structure and family contribution to labor input, the family living draw reveals whether a farm adequately supported its owners.

Net farm income often supported more than one family. Multi-family operations were observed in all net farm income categories (Table 5). While many of the multi-family operations reported greater than $40,000 net farm income, 37.5 percent reporting less than $10,000 in net farm income were multi-family operations.

Over 38 percent of families reporting relied on farm income as their sole source of income. Approximately 62 percent supplemented their farm income with some amount of off-farm income. The amount of off-farm income generated varied from less than $5,000 to over $80,000 per year. Over 75 percent of farms reporting had supplemental off-farm incomes of less than $20,000 per year (Table 6).

Summary

We found a great deal of variation in net farm income across herd sizes on Michigan dairy farms based on 1998 information. As expected, net farm income increased as the farms had larger herd size. Net farm income is what remains to reward unpaid family labor and provide a return to owner equity. Net farm income provides some estimate of what is available to cover the family supplied resources of labor, management, and capital.

We also found that the farms in the smallest herd size category had lower net farm income, but to augment these funds they generated the most off-farm income. The inclusion of off-farm income offset some, but not all, of the differences in farm income. The total income still increased with herd size on average.

As farm herd size increased, there was a greater tendency for these businesses to be multi-family operations. Thus, the combination of net farm income and off-farm income may be divided among two or more families. The next article (Part 3) will incorporate the income statement into the balance sheet and analyze relevant financial ratios.

### Table 5. Net farm income for all families, Michigan dairy farms, 1998.

<table>
<thead>
<tr>
<th>1998 net farm income ($)</th>
<th>Number of farms reporting</th>
<th>Percent of farms reporting</th>
<th>Number of families operating dairy unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10,000</td>
<td>24</td>
<td>13.4</td>
<td>15 4 5</td>
</tr>
<tr>
<td>10,000-19,999</td>
<td>24</td>
<td>13.4</td>
<td>17 5 2</td>
</tr>
<tr>
<td>20,000-39,999</td>
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<td>40,000-99,999</td>
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<td>29 15 12</td>
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<td>100,000-174,999</td>
<td>29</td>
<td>16.2</td>
<td>14 12 3</td>
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<tr>
<td>175,000 and above</td>
<td>28</td>
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<td>11 5 12</td>
</tr>
<tr>
<td>Total</td>
<td>179</td>
<td>100.0</td>
<td>99 46 34</td>
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</table>

### Table 6. Non-farm income for all families, Michigan dairy farms, 1998.

<table>
<thead>
<tr>
<th>1998 non-farm income ($)</th>
<th>Number of farms reporting</th>
<th>Percent of farms reporting</th>
<th>Number of families in farm unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>97</td>
<td>38.3</td>
<td>52 31 14</td>
</tr>
<tr>
<td>Less than 5,000</td>
<td>40</td>
<td>15.8</td>
<td>21 12 7</td>
</tr>
<tr>
<td>5,000 - 9,999</td>
<td>16</td>
<td>6.3</td>
<td>11 2 3</td>
</tr>
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<td>10,000 - 14,999</td>
<td>18</td>
<td>7.1</td>
<td>12 1 5</td>
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<td>15,000 - 19,999</td>
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<td>7.9</td>
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<td>20,000 - 39,999</td>
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<td>15 9 6</td>
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<td>40,000 - 59,999</td>
<td>25</td>
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<td>60,000 - 79,999</td>
<td>3</td>
<td>1.2</td>
<td>1 1 1</td>
</tr>
<tr>
<td>80,000 and above</td>
<td>4</td>
<td>1.6</td>
<td>1 0 3</td>
</tr>
<tr>
<td>Total</td>
<td>253</td>
<td>100.0</td>
<td>137 73 43</td>
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NOTE: The Michigan Dairy Farm Industry Survey was funded partially by the Michigan Animal Agriculture Initiative through the competitive grants program of the MSU Animal Industry Coalition.
Testing for Johne’s Disease

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Michigan recently adopted a voluntary Johne’s disease control program. Under this program, there are several levels of herd status, which are based on results of regular testing. Upon enrollment in the Michigan voluntary testing program, producers will have the opportunity to be reimbursed to test serologically up to 30 animals. The 30- animal testing scheme is based on the national prevalence of Johne’s disease, which is between 17% and 22% of herds (8). The Michigan Voluntary Johne’s Testing program is an excellent way to start controlling this costly disease, particularly where clinical Johne’s disease is common. In Michigan, where herd prevalence appears to be significantly higher than the national average many producers likely will be admitted to the “management” classifications of the voluntary program (5). Producers wishing to advance their herd’s Johne’s free status or to take an aggressive stance against this disease may wish to discuss other options with their veterinarian.

This article is intended to review some of the commonly available tests for Johne’s disease as well as present information on new tests that may improve our ability to detect Johne’s disease prior to an animal showing clinical signs and shedding the Johne’s disease organism into the environment, where susceptible calves may become infected.

Identification of Johne’s Disease

As with most other infectious diseases, finding animals infected with Mycobacterium paratuberculosis (the bacterium that causes Johne’s disease) can be done in two primary ways: 1) identifying the bacterium directly, or 2) monitoring the immune responses of animals to an infection. Bacterial detection methods include direct culture in growth media, identifying the bacterium using a set of specialized antibodies, or finding the genetic material of the pathogen through a process known as polymerase chain reaction or PCR (11). Detecting an animal’s immune response to bacteria is most often done through blood testing, using a test format known as enzyme-linked immunoabsorbant assay or ELISA (4). ELISA tests detect antibodies in the blood of animals that have been exposed to bacteria or other pathogens. Another method of detecting immune responses to Johne’s disease is the gamma interferon assay (2, 6, 10). Knowing the limitations and possible benefits of each type of test for Johne’s disease can help in making decisions on management and control of this important infectious disease problem.

Test Limitations

No diagnostic test is perfect. Each test has limitations in terms of the minimum immune response that can be detected, or how few organisms can be found reliably in any sample. This parameter is often referred to as sensitivity. Most diagnostic tests show some cross-reaction with other organisms related to the pathogenic organism of interest. In the case of Johne’s disease, several closely related organisms can lead to a false positive result. The degree to which any test can distinguish between closely related microbes is referred to commonly as specificity. In building any test, a balance must be struck between sensitivity and specificity. Often, there are confounding factors that necessitate leaning toward one parameter at the expense of the other. This traditionally has been the case with detection of Johne’s disease. It is important to understand these factors when evaluating results of any testing program.

Direct culture of M. paratuberculosis from fecal material only works when an animal is shedding bacteria. Culture results take between 8 weeks for BACTEC™ culture to 12 or more weeks for normal media culture, much too long to adequately assist producers in making culling and other management decisions. Furthermore, culture of M. paratuberculosis has a sensitivity of roughly 60%, although specificity is very high (>99%) (7). To put these numbers in perspective, if a group of 100 Johne’s positive animals were tested by culture at one time point, one could expect that 40 would be seen as culture negative. On the other hand, culture testing a group of 100 Johne’s negative animals should lead to few, if any, false positive results.

The USDA-licensed ELISA test is also highly specific, but has low sensitivity, ranging between 20% for subclinically infected animals (those that are infected but showing no symptoms and shedding very low numbers of bacteria) to 57% for clinically-infected animals (1, 3, 9). Testing a group of 100 subclinically infected animals by ELISA at any one point in time could erroneously identify as many as 80 animals as being negative. Likewise, testing a group of 100 clinical animals by ELISA could identify up to 43 as negative. Leaving these animals in the herd may lead to further infections, perpetuating losses due to Johne’s disease. Such examples highlight the importance of constant vigilance in testing for M. paratuberculosis and the difficulty in actually clearing a herd of Johne’s disease.

A Change in Attitudes

Why have tests with such low sensitivities been advanced as standard methods to screen for a disease as costly as Johne’s disease? Standards that prevailed during development of culture methods and the commercial ELISA test as primary means of diagnosis for Johne’s disease held that a false positive test was more expensive to producers than a false negative test (7). That is, leaving a positive animal in the herd...
was less costly than culling an animal that was not actually infected. Heightened awareness regarding the cost of Johne’s disease to producers, development of statewide and national voluntary Johne’s control programs, and increased understanding of how Johne’s disease spreads within herds, have all combined to change these attitudes about the cost of leaving infected animals in the herd. Despite this shift in attitudes regarding Johne’s disease, new tests have been slow to be adopted and are not yet recommended by most state and federal agencies. Although this will likely change in the near future as more data become available, steps can be taken now to improve the chances that most infected animals will be found in any given herd. Adopting a whole-herd testing scheme that incorporates testing all animals over 10 months of age by ELISA with repeated testing at 60-to-90 day intervals could help. Separating any ELISA positive animals that are to be confirmed through direct culture from the rest of the herd, and particularly kept away from young animals, also will help. Discarding colostrum from suspect animals can help stop spread of infection to calves when they are most susceptible.

New Tests on the Horizon

The Molecular Pathogenesis Laboratory in the Department of Animal Science at Michigan State University has been investigating the predictive value of various tests for Johne’s disease. Along with others around the world, we have been working to establish new tests for mycobacterial infections in the hope that a more efficient and cost-effective testing procedure might be found. Two tests that currently are available for Johne’s testing, but not USDA-licensed, are the gamma interferon test and PCR testing. The gamma interferon test measures a different part of the immune response (cell-mediated immunity or CMI) to Johne’s disease than the USDA-licensed ELISA test. The CMI response to M. paratuberculosis is at its peak long before an animal produces significant antibodies to the bacteria. Thus, the gamma interferon test may be beneficial in detecting animals in the early stages of infection (1, 2, 10). As more data become available and sample handling procedures are standardized, the gamma interferon test may become an important tool in controlling Johne’s disease by helping to detect subclinical infections (10).

Tests that rely on detecting the genetic material of M. paratuberculosis by PCR generally are not available and can be expensive, costing as much as $10 to $25 per sample. Based on multiplying pieces of genetic material specific to M. paratuberculosis, PCR testing can be highly specific and is relatively sensitive, though slightly less sensitive than direct culture. In our laboratory, PCR-based tests routinely detect as few as 1000 bacteria in a 0.5 gram fecal sample or a 10-ml milk sample. Application of new technologies, instruments, and laboratory robots should reduce the cost of PCR testing considerably. Once issues of cost are addressed, PCR testing may find a place in confirmatory testing of animals found to be positive or suspect by ELISA. The primary advantage with PCR testing is speed; results generally are available within 48 to 72 hours of submission as opposed to weeks or months for culture.

Research Identifies Link

As a final note, our research at the Michigan State University Campus and at the Kellogg Biological Station dairy herds has begun to show a link between periods of stress, such as parturition and transport, and Johne’s disease status. In one example, an animal was ELISA negative just prior to purchase and transport to the MSU dairy. This animal calved within 30 days of arrival and was re-tested as part of a continuing whole-herd monitoring program. ELISA tests after transport and calving surprisingly showed a strong positive, a trend that continued for several weeks before declining back into the negative range. This animal has now returned to negative status, though culture and PCR results are still pending. In another example, a cow was tested just prior to parturition and found to be strongly positive by ELISA. Blood samples were drawn daily through calving and weekly thereafter. Surprisingly, this cow has now returned to ELISA negative status. Fecal samples taken pre- and post-calving were tested by PCR. Results of this test are in line with ELISA results, the pre-calving sample was strongly positive for M. paratuberculosis while the post-calving sample was negative. These examples underscore the importance of testing for Johne’s disease on a periodic basis and emphasize that a single test may not reveal the true status of an animal. We are now working in collaboration with Dr. Jeanne Burton and the Immunogenetics Laboratory at Michigan State University to better understand immune responses to M. paratuberculosis, and to determine if testing during the period around calving might enhance our ability to detect subclinical infections as an aide in the fight against Johne’s disease.

References

Look for MDR on the Web

Motivating Your Employees to Achieve Their Potential

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John has worked for me for more than a year. When he started this job, he was energetic and excited to come to work. He was always punctual and efficient. He understood the job well – until recently. The last few months, he has really slacked off. He doesn’t seem to care any more. Is he just getting lazy or is it something else? I just can’t figure out his problem.

Sound familiar? Workers like John can be found at most places of employment. Many employers would simply write off John as a once productive employee who has become apathetic. John may be either terminated or allowed to struggle in his current position until he quits with frustration. Although he is obviously capable of being an excellent employee, John, unfortunately, is lacking motivation.

A recent study demonstrated that work performance is highly dependent on job satisfaction (3). Although it may seem obvious, a basic principle is too often overlooked - content workers are more productive workers. By understanding what provides job satisfaction, you as an employer have an opportunity to provide the motivation that workers like John need and desire.

Evaluate Motivating Factors

To gain a greater understanding of motivation, begin by evaluating the factors you believe motivate your workers. Rank them from 1 to 9 using the listing outlined in Table 1. Rank the factor you believe most motivates your employees first, while ranking what you believe your employees least desire last.

In a recent study, employers and employees were asked to conduct this very same exercise (2). The most interesting finding from the study was not so much the actual rankings, but the discrepancy between employee and employer rankings (Table 2, page 10).

Many of the factors that the employees considered important received much lower rankings among employers. The employers tended to put the greatest emphasis on the tangible or physical factors that are relatively simple to measure, such as money. Psychologist Frederick Herzberg called these items maintenance factors. Maintenance factors are job characteristics that must be met at a minimum level or job satisfaction will be reduced. Generally, maintenance factors alone cannot motivate and satisfy workers.

Maintenance factors include:
- wages/salary;
- working conditions;
- job security;
- organization policy and administration (bureaucracy, who reports to whom);
- interpersonal relationships with others in the workplace;
- status and respect; and,
- personal life.

It is important to note that all but one of the maintenance factors are under the direct influence of the employer. Only personal life issues offer limited influence from the employer. Without meeting all of these maintenance factors it is extremely difficult to obtain and maintain a high level of employee motivation.

In contrast to employers, the job-related factors that employees ranked as the most important tended to be less tangible, more self-esteem-related factors. Herzberg considered these the motivators or satisfiers. These are the factors that when provided in addition to the maintenance factors often compel employees to do their best work.

The motivators include:
- recognition and appreciation;
- achievement, a sense of success;
- work itself, being challenged;
- advancement, promotion;
- responsibility and trust; and,
- professional growth, new skills.

The motivation factors outlined above often represent the best opportunities to generate the highest level of work performance from your employees. Once the maintenance factors have been met, an employer’s job is not done. Employees need motivators to meet their fullest performance potential and to a large extent it is the employer’s responsibility to provide these motivators.

Additional studies of employee motivators from the 1960s to the present have consistently shown four factors that rank high among employees (1). These include:
1. respect for me (the employee) as a person;
2. good pay;
3. opportunity for self-development and improvement; and,
4. large amount of freedom on the job, empowerment (chance to work without direct or close supervision).

Sargent and Terry (3) reinforced the importance of these factors in an intensive study reported in 1998. The study found that variables related to employee empowerment were most closely associated with increased job satisfaction, thereby work performance. This emphasizes the importance of entrusting your employees with decision making. Being more concerned with the results
How well do you as a farm owner, manager, or nutritionist communicate with the feeder or feeders who actually do the feeding? Have you ever evaluated how well you communicate? Or do you assume you’re an effective communicator?

It is often said, There actually are three rations for each group of cows: 1) the ration formulated by the nutritionist; 2) the ration mixed by the feeder; and 3) the ration consumed by the cows.

The nutritionist formulates nutritionally sound rations that the cows will consume to produce as anticipated. The feeder is expected to mix each batch using the correct ingredients and pounds of ingredients. The hope is that the cows will eat the ration delivered to them. But, cows have some ability to sort a TMR (Totally Mixed Ration), and may consume a ration that is somewhat different from what is presented to them.

So the best a nutritionist can do is to formulate sound rations that will support the cow’s needs. Nutritionists expect that the rations will be mixed and delivered correctly at every feeding. Unfortunately, there is no opportunity to communicate directly with the cows to tell them they must consume so many pounds of each ration ingredient every time they take a bite and eat. However, the farm owner/manager and nutritionist should take the opportunity to communicate feeding instructions to the feeder. They also should educate the feeders on why the feeding operation needs to be done a certain way.

Having a third party provide the range of rankings for each motivational factor also may be useful in determining variation or uniformity of opinions among employees.

As you evaluate the results, consider how many of the top five items are maintenance factors versus motivators. More maintenance factors may be indicative of serious job dissatisfaction among your employees. These maintenance factors need to be addressed immediately. If your employees indicated more motivators in the top five, you are in a more desirable situation, but you are not off the hook. These motivators represent your opportunity to improve worker performance, which leads to increased profitability and peace of mind.

If you have an employee like John or want to avoid having one, reflect on what opportunities may exist to satisfy and motivate your employees. Worker motivation, like so many other parts of business management, is more of a journey than a destination. Either way, you will not get anywhere if you do not start moving. Move toward motivation!

References
During the past 2 years, the Extension Dairy Team at Michigan State University has conducted a number of “Feeder Schools”. These 2-day educational programs were designed to teach feeders various technical skills. Interestingly and unfortunately, when discussing their communications with their employer and nutritionist most feeders reported that they normally are not involved in meetings or discussions concerning the feeding program. This certainly is a missed opportunity for the farm business to obtain valuable information. This also brings up the question: how and from whom does the feeder obtain feeding instructions and recommendations that are essential for rations to be successful?

The feeder position is one of the most important positions on the dairy farm. The success of the feeding program will depend greatly on the feeders’ knowledge, skills, enthusiasm and their ability to communicate with others involved in the feeding program. If the feeder is not considered a vital member of the farm’s nutrition team, then how successful will the feeding program be?

All aspects of the feeding operation are complicated. Every day the feeder will need to make a number of decisions that can impact a herd’s nutritional, health, and performance status.

Let’s look at some decisions a typical feeder will need to make at each feeding to identify opportunities where the owner/manager and nutritionist can provide guidance and assistance to help the feeder make the best possible decisions.

**Daily Decisions a Feeder Makes:**

1. **What size (pounds) batch to mix for each group. This depends on the following.**
   a. Number of cows in each group. How and when is the feeder informed of group size changes?
   b. Orts (the pounds of feed left in the bunk) need to be weighed or estimated to decide the size of the new batch.
   c. What to do with the orts, assuming there are orts:
      - leave the orts in the bunk and place new feed over top (this is not recommended).
      - push the orts to the end of the bunk so the cows will clean it up; or,
      - remove the orts and either discard or refeed to the same group, or feed the orts to another group of cattle.

2. **After the pounds of orts have been determined/estimated, the feeder can determine what batch size to mix.**

   This requires the feeder to do arithmetic to determine the pounds to increase or decrease the next batch. At the MSU Feeder Schools, most feeders were uncomfortable doing the arithmetic. They were often unsure if their answers were correct. Most feeders will need some educating to do the calculations.

3. **Mix the new batch of feed using the correct ingredients and adding the correct pounds of each ingredient.**

The feeder will need to evaluate the quality of the ingredients to be used. They will need to decide based on quality, if the ingredient should be added to the batch. This is a daily decision especially with silages, other high moisture feeds, and perhaps baled hays that can go out of condition from one day to the next. The employer and nutritionist need to educate the feeder so they have the skills and understand the criteria to make the appropriate decisions.

4. **The feeder needs to know how to adjust the amount (pounds) of a high moisture feed ingredient to add to a mix when the ingredient becomes wetter or drier.**

   Dry matter content of silages stored in bunkers or upright silos will change often. And the pounds added to a TMR batch will need to be adjusted in order to keep their inclusion rate on a dry matter basis the same every day. How do the feeders on your farm handle this? Are they instructed to determine dry matter contents on a scheduled basis or just now and then?

At the MSU Feeder Schools, this is what the feeders indicated.

- a. Most had never actually determined the dry matter content of a high moisture feed.
- b. Most of the farms they represented did not have a moisture tester. Moreover, if they did, the testers were not located in a convenient place to facilitate frequent testing.
- c. The feeders indicated their farms did not have a set protocol for when dry matter contents would be determined. Those farms that had testing equipment said they tested silages only when they thought it looked wetter.
- d. In addition, most feeders thought they were accurate at determining dry matters by looking and feeling silages or TMR. When they were asked to determine dry matters of feeds during the class, their accuracy was poor. From this they learned and realized the importance of actually doing a dry matter analysis.

5. **When the dry matter content of a feed ingredient changes, how does the feeder adjust the pounds of that ingredient they put into the mixer?**

   a. The feeder will need to do some arithmetic. Again, in the MSU Feeder Schools when we used examples to teach them how to do this, many of the feeders were uncomfortable doing the calculations and unsure if their answers were correct.
   b. In addition, they were unaware of the impacts that just a 5% change in dry matter content of a particular ingredient actually can have on the nutrient composition of a TMR.
   c. Many said they did not know how to adjust for dry matter changes even when the batch mixing sheets their farm uses included a table for adjusting the pounds of a feed when its dry matter changed. They had not been instructed how to use such a table.
   d. Feeders need instruction from their employer or the
farm’s nutritionist on how to adjust the ration when ingredient dry matter contents change.

6. Decisions feeders need to make when something goes wrong.
   a. When the feeder inadvertently puts too much of an ingredient into the mixer, how do they handle that? Do they remove the excess? Have they been instructed how to adjust the entire batch by adding more of all the other ingredients?
   b. What if the feeder is a few pounds short when adding a particular ingredient? Are they instructed to spend the time to get a few more pounds of the ingredient? On the other hand, is it a standard practice to assume if the mix is a little off it will still be close enough?
   c. These real-life and tough questions need to be discussed with the feeder along with standard operating procedures and guidelines. The feeder needs to be educated on the possible effects even small mixing errors can have on the herd’s production and health.

7. The feeder needs to use the most current batch mixing instructions. Do they have them?
   Feeders at the MSU Feeder Schools related that they often do not receive promptly “new” batch mix sheets. Usually, they indicated the nutritionist leaves “new” batch sheets at the farm office for the “boss” to give to the feeder and that often may take a few days. Is the farm’s nutritionist allowed or instructed to communicate directly with the feeder?

8. A farm’s feeding philosophy can affect decisions a feeder makes.
   The most common feeding strategy used on the farms of the feeders who attended the MSU Feeder Schools was “feed just enough TMR so the cows just about clean it up before they are fed again”. Subscribing to this feeding philosophy says the cows will be limit fed.
   Although, this feeding management strategy eliminates the logistical problem of what to do with the orts, milk production will be limited particularly for the high-producing cows. Is the decision to have the “cows just about clean up all the TMR before feeding again” because there is no plan or system in place to deal with the orts?
   The farm’s owner/manager, nutritionist and the feeder need to work together to develop a plan for dealing with orts to assure palatable feed is always available. The feeder should not be expected to develop this plan alone; he/she need guidance in developing the most profitable plan for the whole farm.

Recording Feed Intakes
   Another responsibility of the feeder should be to record daily feed intakes. The feeder will need assistance to accomplish this task. Communicating to the feeder, by the owner/manager and nutritionist, the value of recording daily feed intake by groups is needed first. Many feeders will think recording intakes is just a worthless task until they understand its value. For the owner/manager and the nutritionist, knowing feed intake for each group on a per cow and dry matter basis is essential information for evaluating a ration or solving a nutritional problem.

A majority of feeders attending the MSU Feeder Schools had never been asked to record feed intake data. Why wouldn’t a feeder record group feed intake data? The underlying reason was the procedure is complicated and that the owner/manager and nutritionist had not attempted to develop a plan.

During the MSU Feeder Schools, when various methods were taught on how to record dry matter intakes, many of the feeders were confused. The feeders were given a “homework assignment” to record intakes for at least one group of cows using a notebook they were given. At the second class held 2 weeks later only two of the feeders had recorded any data. The reasons others expressed for not having the data were: not fully understanding how to do it, not having the needed equipment (functioning scale on the mixer, or moisture tester), not enough time, or the employer showed no interest. The feeders were still confused on how and why to record feed intakes on their particular farm. They needed more guidance and on-the-job training at their farm.

Developing a plan for recording dry matter intakes requires the owner/manager and nutritionist to understand the every day feeding routines on the farm. A commitment to have feed intake data by the farm’s management team is needed as well as the cooperation of the feeder. Everyone involved in this will need to have a win-win feeling. The feeder will win if they feel they are doing a better job and may be rewarded in some way for recording intakes. The farm will win if recording of feed intakes results in higher milk production. The farm also can win by accurately knowing feed costs and by controlling feed wastage. The nutritionist can win by being able to accurately evaluate the rations they have formulated and to predict possible metabolic and health problems associated with the feeding program.

On some farms, the feeder may be interested in improving his/her abilities and performance but is limited by the employer and possibly the nutritionist. Feeders need to know that they are an important part of the feeding program and their input is valued.

Summary
   Communication is an important aspect in operating a business. Communicating with the feeder is becoming more essential as dairy farms become larger. Feeders have an important position with great responsibilities. As the science of nutrition becomes more complicated, effective communication with the feeders will become even more important.
Forage Analysis: Getting a Good Sample, Selecting the Right Tests

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The importance of testing soils, feeds, manure, milk and various other farm inputs and outputs cannot be over-stated. Many management decisions are based on results from samples sent to a laboratory for analysis of composition. These management decisions then dictate, in large part, the financial outcomes of the farm business.

Over the next 6 months, many dairy producers and nutrition consultants will pore over laboratory analyses of forages to determine their nutritional value and how to use these forages in rations. Just as important as testing, is getting a representative sample and analyzing the sample for the correct chemical components using the appropriate method. Otherwise, ration formulation efforts all may be in vain.

How to Select the Sample

Meaningful sample analysis starts with the proper sample. Be sure the sample you, your employee, or consultant takes is representative of what the cows are eating. Getting that proper sample is challenging. Sampling should be done as a normal part of the process of feeding cows, not a “special” activity requiring extra people at a special time. The most representative samples will be collected while the feeding operation is occurring. Teach and train feeders to take proper samples, whether testing for dry matter content or nutrient analysis.

Whether dealing with silage or dry hay, the process of obtaining the final sample to submit for testing is the same. Collect a gallon or more of the feed by taking several (many) sub-samples. In an enclosed room out of the wind, dump the sample on a tarp or piece of heavy plastic about 4 ft square. Take one corner of the tarp and fold the tarp diagonally to the other corner (Figure 1). Unfold the tarp and continue the same procedure with the other three corners in succession. After all corners have been folded and unfolded, use your hand to carefully split the sample into four equal parts. Discard two opposing quadrants of the original sample (Figure 1) and remix the remaining two quadrants using the corner-fold technique. Continue this procedure until the remaining sample is the size needed to send to the laboratory for testing. After the last split and discard is completed, place the remaining sample into the sample container. Be sure to capture the fine particles and include them in the sample.

When to Sample

The best time to sample forages depends on the type of forage, the structure in which it is stored, and its intended use. Fermented feeds are best sampled for analysis after they have fermented completely because fermentation alters the nutrient content. Dry forage can be sampled immediately after harvest. One advantage to testing dry feed going into storage is that a grower knows the quality of the forage in inventory. To get an early idea about feed quality, forage that is to be stored in upright silos, bags, or as round bales (balage) can be sampled prior to going into storage. This may be before fermentation is complete, but it will provide a preliminary idea of varying quality of stored forage within different sections of the silo or groups of bales. These forages should be resampled and analyzed for final ration formulation.

The frequency of testing depends on the type of storage. For bunker silos, the layering effect requires less frequent analysis. A rule of thumb would be to sample the bunk length by quarters. A 200 ft bunker silo would be sampled every 50 ft. In uprights and bags, sample when the feed changes, or when the known source has changed (i.e., from one cutting or field to another). Sampling to determine dry matter content should be done at least weekly, and more often if variation occurs. Significant change in dry matter content can be a clue that a new laboratory analysis should be done, even if the feed is from the same field and harvest date. Significant changes in forage composition, milk production, or onset of metabolic or health disorders also can trigger a need for updating forage tests.

How to Sample

Bunker Silos When sampling from a bunker silo, keep the first rule in mind – sample what the cows receive. Therefore, be sure you are gathering sample material from the whole face or section of the silo, whichever applies. There are a couple of ways to do this.

1. Clean out the TMR mixer and add the feeding allotment of silage for that feeding to the mixer. Blend the silage by running the mixer, then dump out the sample and take your total sample of a gallon or more from throughout the mixed silage. Follow the tarp mixing procedure mentioned earlier to get the sub-sample to submit for analysis.

2. Using the bucket loader as a mixing tool, dump some silage on a clean area and use the bucket to lift and dump the silage several times to mix the silage. It will take several buckets mixed together to get a representative sample. Take the...

Figure 1. The diagonal fold (left); the circle in the center represents the feed sample. Two remaining quarters (right) of the original sample for remixing or submission to the laboratory. (See text for more information.)
total sample and use the tarp mixing procedure to acquire the sub-sample ready for submission.

When you feed, if you remove spoiled feed from the top or sides of the bunker, then remove them from your sample. If you don’t, then keep it in the sample you prepare. Do not make special attempts to include or exclude sections of the silo.

**Tower Silos.** Sample the silage from tower silos while the silo unloader is running. Sample several times throughout the unloading process because this will include feed from the top layer as well as silage underneath. The top layer can dry out between feedings and would not represent what the cows are actually eating. Taking a partial sample every 1/2 to 1 minute will provide samples from around the silo as it unloads. Determine how much time it takes for the silo unloader to make one revolution and divide by 8 to get your sampling interval. This also is important when running weekly dry matter content tests. Refrain from grabbing samples out of conveyors or off belt feeders. There is great risk of injury when working around such equipment. Your total sample should be at least 1 gallon in size. Then use the folding tarp method to mix and obtain your sub-sample. When filling a tower silo with some silage already in it, use a marker – such as white plastic squares in 1 x 1 or 2 x 2 inch dimensions – to identify the old silage during feed out. Before adding the first load of new silage to the silo, run the plastic markers through the blower. Also, take a sample of the silage that is to be buried. When you reach the old silage again at feed out, you will have a forage analysis ready to use. Be prepared to take a new sample and make ration adjustments because nutrient content of the old silage could change.

**Silage Bags.** Silage in bags can be sampled the same as from bunkers, or because of their short height, a composite sample can be taken from several locations across the face and then a sub-sample taken from the composite. Marking different fields in the bag is easy. Add white plastic squares to the bagger between loads from different fields or mark the outside of the bags. At feed out, the plastic squares or the markings on the outside will indicate the change.

**Round Bale Silage.** Use a core sampler with an extension if possible to gather sub-samples from at least 12 locations. This can be 12 different bales, or 6 bales sampled twice on opposite sides. Take core samples from the rounded sides of the bales not the flat ends. Collect the sub-samples and use the tarp mixing procedure to acquire a representative sample to submit to the laboratory. Place on the tarp and use the fold and divide technique to acquire the sample for analysis.

**Dry Hay.** Although dry hay does not make up a large amount of forage in many dairy rations today, it is still important to know the nutrient content of the hay. Using a core sampler – with an extension for round bales and large squares – form a composite sample from a minimum of 12 bales. Use the folding tarp technique to acquire your sub-sample.

**What to Test For**

Now that you have done your part to get a good representative sample, determining the nutrient constituents to test for is the next step. The capabilities of the ration formulation program will determine to a large extent the nutrient constituents to request for laboratory analysis. Most forage testing procedures will provide the following as standard test items that will be useful for the vast majority of ration formulations: dry matter; crude protein; soluble protein; bound protein or ADF insoluble protein (heat damaged protein) for silages; ADF – acid detergent fiber; NDF – neutral detergent fiber; NFC – non-fiber carbohydrates or NSC – non-structural carbohydrates (both are calculated values from other test results); major minerals (calcium, phosphorus, magnesium, potassium, sulfur sodium and chloride), and microminerals (manganese, copper, zinc, molybdenum, iron.)

Optional tests available from many forage testing laboratories include: pH; fat (ether extract); urea; ammonia; lignin; nitrate; mycotoxins; and starch.

Further testing can be performed at a few select laboratories across the country. These analyses include: fermentation acids, the volatile fatty acids content of forages after fermentation. Different concentrations of the acids can indicate the success or failure of the fermentation of the forage.

**In Vivo or in Vitro NDF Digestibility.** In vitro (in a test tube) testing is done in a laboratory with ruminal fluid; the other is actually done in a cow’s rumen (in vivo). These tests give an indication of the extent of digestion and the speed at which the forage may be digested. A limitation of these tests is that ruminal fluids or the ruminal environment of the cow used to digest the submitted sample will differ from the rumen environment of your cows.

**Calculated Values.** Some nutritional entities used in ration formulation are calculated values based on other tests. These include a net energy value [for maintenance (NEm); for lactation (NEm_g); for growth (NEG); Relative Feed Value (RFV)]; and, NFC or NSC.

**How to Test**

A good deal of debate can be had determining the best method for analyzing forages. Whether you choose wet chemistry, NIRS (Near Infrared Reflectance Spectroscopy), or a combination of both, there are advantages and disadvantages with each method.

Wet chemistry is more accurate across all situations and samples. However, it takes longer and costs more. NIRS is reasonably accurate for protein and fiber components in relatively pure samples of forage, and NIRS is less expensive. It also takes less time. NIRS is less accurate than wet chemistry for
Reproductive Management

Successful AI: Manage the Details – Part 3

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If conception rate in your herd is as high as you desire and if all of your calves are conceived from artificial insemination (AI), stop reading and move to the next article of interest.

This article is the third in a series that focuses on the technical details of AI. A goal of this series is to guide you through a review of procedures for success with AI. It is suggested that you use this series of articles as a check list. To insure that the review of your procedures is objective and critical, invite a neutral observer who is a specialist with AI to evaluate your procedures. If your technique differs from proven guidelines, you should make appropriate changes.

From the first two articles in this series (see Michigan Dairy Review, January 2000, p. 9 and April 2000, p. 15), remember these points.

1. Your biggest opportunity to increase reproductive success in your herd is to increase the rate of detection of estrus, to inseminate more cows, and thus to increase pregnancy rate. Technique for AI should not be a major opportunity to increase reproductive success. But, be sure that AI technique does not limit success in your herd.
2. Maintain an accurate inventory of semen in the tank at your farm.
3. Be gentle when you use or transport the semen tank.
4. To remove semen from the tank and to thaw semen, follow instructions carefully.
5. Do not make arbitrary changes in procedures.
6. The tiny environment that contacts a straw of semen directly can be harsh. It is your job to make sure that the environment of a straw is comfortable for sperm.
7. All equipment for AI must be clean and function reliably.

This article will focus on loading semen into a semen syringe and depositing semen into females.

A. Loading the Semen Syringe (AI gun)
1. Rub the AI gun briskly with a paper towel to warm the stainless steel.
2. Dry the straw. Water kills sperm!
3. Be sure that the print on the straw is legible. If not, do not use the straw and seek a refund from your semen supplier.
4. With the crimped end of the straw up, gently flick the straw to move semen away from the crimped end of the straw and to shift air bubbles out of the semen.
5. Insert the straw into the AI gun with the plunger of the gun pulled back, but not out of the gun. The crimped end of the straw should visibly protrude from the gun.
6. Cut the crimped end of the straw perpendicular to the sides.
7. Install a sheath over the straw and the AI gun.
8. Be sure that the sheath is pushed down on the gun so that the end of the straw that you cut contacts the end of the sheath. There should be no space for movement of the straw or for leakage.
9. Position the locking ring so that the straw and sheath cannot move.
10. Position the plunger of the AI gun against the plug in the straw. Gently push the plunger until there is no air space at the tip of the straw or until you feel a slight increase in resistance.

B. Transporting a Loaded AI Gun to an Animal for Insemination
1. Protect semen from sunlight and cooling by wrapping the loaded AI gun with a paper towel to shield ultraviolet light and to keep the sheath warm.
2. Insert the wrapped AI gun into your coveralls or insulated container to avoid rapid changes in temperature. Worry about this all year not just during winter. Remember, after semen is thawed the major challenge is to keep the semen as near 95 degrees Fahrenheit as possible.
3. Within 15 minutes after semen is thawed, semen should be
deposited into a female. To achieve this time requirement there must be:

- a. a short distance from the location where the semen is thawed to the location where the semen is deposited into cows or heifers;
- b. facilities to sort and restrain females for insemination; and,
- c. only one straw thawed at any time.

C. Deposition of Semen into Females
1. The female to be inseminated must be restrained before the semen is thawed. Facilities to restrain animals securely are critical for timely insemination of thawed semen, for accurate deposition of semen, and for safety of animals and people (see Michigan Dairy Review, August 1999, p.10).
2. Confirm identification of the female to be inseminated.
3. Clean the vulva and area where you will be working on the animal.
4. Insert the loaded and sheathed AI gun into the vagina. Avoid or minimize contact of the sheath with walls of the vagina.
5. With a hand in the rectum grasp the cervix. Place a thumb over the vaginal or posterior end of the cervix to locate the opening.
6. Advance the gun gently until it stops against the cervix or your thumb.
7. Move the cervix and thus your thumb toward the tip of the AI gun.
8. When the gun contacts your thumb, move your thumb from the opening into the cervix and pull the cervical opening over the AI gun. If you are using double sheaths, this is the time when you will need to pull the outer sheath over the tip of the AI gun.
9. Work the AI gun through the rings of the cervix by moving the cervix backwards over the AI gun. Do not push the AI gun forward with any significant force. The AI gun should be held with your finger tips and moved gently much like a violinist holds their bow while playing a soft soothing waltz.
10. Use your index finger to determine when the AI gun is through the uterus or anterior end of the cervix.
11. As soon as you feel the AI gun in front of the cervix you are in the body of the uterus. The uterine body is the target for AI.
12. Distance to insert the AI gun. You are feeling through thick tissues. If you feel the gun in front of the cervix you are at least one half inch into the uterus. Remember that in most cows the length of the uterine body is less than one inch. There is large opportunity for error and little flexibility to be on target. If the gun is inserted too far, all of the semen will go into one uterine horn. If the ovulation occurs from the opposite ovary, the chance for conception will be low. If insertion is too shallow so the tip of the AI gun is within the cervix, this can be successful. But, if the AI gun is still within the cervix, it is possible that semen may be deposited against a cervical ring with consequent back flow, loss of semen, and reduced number of sperm in the uterus.
13. Before you begin to deposit semen:
   - a. lift your index finger from the cervix to not block a uterine horn; and,
   - b. be sure that your wrist is straight with your forearm. With your left hand on the cervix it is easy to twist your wrist and to angle the cervix. For example, if the cervix is angled right most of the semen will go into the right uterine horn. Conception is not likely if ovulation was from the ovary opposite to the uterine horn that received the semen.
14. To deposit the semen, advance the plunger of the AI gun gently. The semen should move out of the straw slowly and into the uterus by gravity and assisted by contractions of the uterus. Forceful or rapid injection of semen is not optimal.
15. After deposition of semen, be sure that the plug in the straw moved and that the semen is gone.
16. Record the number or name of the female that was inseminated.
17. Record name or sire code for the bull that produced the semen.
18. Adjust the semen inventory for the straws that were used.
19. Discard the empty straw and the used sheath.
20. Clean the AI gun and all other non-disposable equipment.

D. General Comments About Deposition of Semen
1. Do not attempt to use semen from one straw to inseminate more than one female. Based on extensive research and current knowledge, the number of sperm per straw is adequate for success of AI in one female. Note that there is no evidence that the number of sperm in a straw is excessive, such as twice that needed for one female. It is rare that timing of insemination is perfect, so any extra sperm might compensate for poor timing of AI. Thus, there is high risk to use one straw of semen for two females and to knowingly use fewer sperm than are required for each female. Yes, there are stories that dividing a straw to inseminate two females was successful. But, remember that few people talk about their failures.
2. Insemination directly into a uterine horn, “horn breeding”, can enhance success of AI. But, to realize increased success of AI after “horn breeding”, intensive training is required to deposit semen into a specific uterine horn. In addition, examination of ovaries to determine where ovulation will occur can rupture the ovulatory follicle with loss of the egg (oocyte) into the body cavity. If this occurs, there is zero chance for conception. Thus, for most inseminators, “horn breeding” is not a reasonable alternative to insemination of the uterine body and is not a major opportunity to increase reproductive success for most dairy herds.

Summary
The challenge is to recognize and to apply three main principles.
1. No details are too trivial to ignore. Do not allow the routine of AI or distractions of other responsibilities make you care-
Monitoring reproductive performance of your dairy herd can increase profits by reducing culls, calving intervals, and semen and veterinary expenses. Monthly monitoring of several reproductive measures will allow you to identify and solve problems before economic losses are significant. One measure is Days to 1st Service, which is available from Michigan DHIA via the Dairy Records Management Systems’ (DRMS) DHI-202 Herd Summary report and in Test-Day Update (TDU) reports 147 and 148 in PCDART 6.0 management software.

You should complete a refresher course for AI at least once every 5 years. This repetitive training will provide a critique of how you actually perform the procedures for AI and will keep you informed about new developments.

If a cow or heifer does not conceive to AI, be sure that this is not caused by limited knowledge or erroneous technique. If there are multiple inseminators for your herd, monitor success for each individual. But, before you judge individual inseminators be sure there are enough total inseminations so you are not misled by numeric differences in percent success.

References

Reproductive Success: Part I - Days to 1st Service

Monitoring reproductive performance of your dairy herd can increase profits by reducing culls, calving intervals, and semen and veterinary expenses. Monthly monitoring of several reproductive measures will allow you to identify and solve problems before economic losses are significant. One measure is Days to 1st Service, which is available from Michigan DHIA via the Dairy Records Management Systems’ (DRMS) DHI-202 Herd Summary report and in Test-Day Update (TDU) reports 147 and 148 in PCDART 6.0 management software. You can use these reports to monitor reproductive success and evaluate effects of management on known problems or management of new reproductive technology. DHIA members, non-DHIA members, and dairy consultants should have interest in the summary data for reproductive performance.

A Reproductive Goal

A general reproductive goal is to detect cows in heat early in the breeding period and get them pregnant with few inseminations resulting in few reproductive culls and a profitable calving interval. For example, a goal is to get cows pregnant by 120 days after calving with less than two units of semen. To be successful, you must optimize heat detection and conception rates. The desired end point is a pregnant cow that will calve again in 12.5 to 13.5 months. Cows that are bred late in lactation obviously will decrease in milk production below a profitable level prior to scheduled “dry off”. So shorter calving intervals (12 vs 14 months) are more profitable because more days are spent at a higher production and profit level. However, this relationship can be altered by changing the shape of the lactation curve. Use of bST is a technology that changes the shape of lactation by providing a second peak and, therefore, may increase the optimum length of calving intervals.

Figure 1. Reproductive time line for a cow that becomes pregnant and calves again.
Figure 1 shows the relationship between days to 1st service, last service and calving interval. You can monitor the status of a herd at these three points along the reproductive time line. Days to 1st service affects all three measurements in Table 1. I shall concentrate on days to 1st service in this article.

**The Voluntary Waiting Period**

The voluntary waiting period (VWP) is the desired waiting period after calving for cows to receive their 1st AI service as determined by the herd manager. Because VWP relates directly to days to 1st service, it needs to be established with considerable thought. The established herd value is found on the left side of the Reproductive Summary of Current Breeding Herd section of the DHI-202 Report; 50 days in the example herd (Figure 2). If heat detection is perfect and VWP is followed for all cows, the average days to 1st service would be 10 to 11 days past VWP assuming no synchronization of estrus. Ten to 11 days is one-half of a 21-day estrous cycle. If the VWP is varied for high producing cows, still use the minimum value for VWP but keep in mind that average days to 1st service will be greater, in part, because the VWP is varied. Make sure the DHIA Technician has set the VWP correctly in PCDART. In addition, an accurate VWP value is needed to determine the Projected Minimum Calving Interval and Projected Minimum Days Open in the Reproductive Summary of Total Herd and to calculate percent of Heats Observed in the Yearly Reproductive Summary on the DHI-202.

**Days to 1st Service**

Average days to 1st service is 104 days for the example herd shown in the Reproductive Summary of Current Breeding Herd (Figure 2). The 72 cows in the Current Breeding Herd include cows past the VWP that are not bred, and cows bred but not confirmed pregnant.

Average days to 1st service (Days open at 1st service) for the entire example herd also is 104 as found in the Reproductive Summary of the Total Herd (Figure 3, column 4). In the example, this section includes a distribution for days open at 1st service in columns 1 to 3. A desirable distribution would have average days to 1st service around 75 days with less than 15 percent of the cows over 100 days at 1st service. In the example, this distribution shows 36 cows (42%) did not receive a 1st service before 100 days. Distributions provide important information. For example, this one points out how many cows have not met the goal, and for this example herd suggests there has been a significant problem getting cows detected in heat and (or) inseminated.

**Are You Achieving Your Goals?**

Several factors may prevent you from meeting your goal for days to 1st service.

These include:
- cows with postpartum health problems;
- the VWP is not set or followed

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**Reproductive Summary of Total Herd section of DHI-202.**

- **DAYS OPEN AT 1st SERVICE**
  - Number fewer than VWP
  - Number from VWP to 100 days
  - Number over 100 days

- **SERVICES PER PREGNANCY**
  - Cows bred
  - All cows
  - Calving interval

- **SERVICE OR HEAT INTERVALS**
  - Service number
  - Number intervals
  - % Successful
  - Service Sire PTA $

- **% OF ALL 1st SERVICES**
  - Current actual calving interval

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**Reproductive Summary of Current Breeding Herd section of DHI-202.**

- **VOLUNTARY WAITING PERIOD (VWP)**
  - Number cows
  - % of breeding herd
  - Days to 1st service
consistently; i.e., using a longer VWP for high producers or bST-treated cows; and,
• the Heat Detection Rate (HDR) is low.

For the example herd (Figure 3), there were 54 days between the VWP (50 days) and average days to 1<sup>st</sup> service (104 days) suggesting that only 1/3 of estrus (heats) are observed. Average periods of days to the first expected estrus is 50 + 10½ (61 days) or half of one estrous cycle past VWP. The average days to the second expected estrus should be 61 + 21 (82 days) and the third should be 82 + 21 (103 days). So in this example herd the average cow of milk in the US became almost universally accepted and the safety of milk and milk products is based on pasteurization began in the first half of the 1900’s. Continued lack of understanding breeds distrust, let us take a look at the origins and purposes of pasteurization.

First, one must understand that milk has the potential to be a good carrier (vector) of many disease-causing (pathogenic) microorganisms. The most troubling of these microorganisms has been the group called bacteria. Even before the knowledge of and ability to monitor bacteria, milk was recognized as a source of health problems. In 1599, the city of Vienna, Austria, passed an ordinance forbidding the sale of milk, butter and cheese suspected of being the cause of an epidemic. In 1743, officials in Paris, France, forbid feeding of brewery waste to milk cows in an effort to clean up the milk supply (3). In 1882, beer heated to 122 to 131°F to prevent souring was first called pasteurized. In 1886, Dr. Soxhlet was the first to advocate pasteurization in Germany for milk given to infants. In 1889, Dr. Abraham Jacobi, a pediatrician in New York City, recommended heating milk to boiling (212°F) momentarily before feeding to infants and young children. The results of these recommendations were so successful that Dr. Henry Koplik established the first dispensary for heated milk in 1889. Four years later, Nathan Straus started the first of 17 depots for the distribution of pasteurized milk to children in New York City. He also established depots in several other urban centers in the U.S. and advocated the use of pasteurized milk to health officials throughout the U.S. and Canada. In 1898, one New York children’s hospital switched to pasteurized milk and the mortality rate was cut in half for the following 3 years. During this same time frame, the modern battle against tuberculosis was initiated (3,4).

The History of Pasteurization

First, one must understand that milk has the potential to be an excellent carrier (vector) of many disease-causing (pathogenic) microorganisms. The most troubling of these microorganisms has been the group called bacteria. Even before the knowledge of and ability to monitor bacteria, milk was recognized as a source of health problems. In 1599, the city of Vienna, Austria, passed an ordinance forbidding the sale of milk, butter and cheese suspected of being the cause of an epidemic. In 1743, officials in Paris, France, forbid feeding of brewery waste to milk cows in an effort to clean up the milk supply (3).

However, the most important development for the assurance of safe dairy products came as a result of Dr. Louis Pasteur’s work on eliminating the souring defect in wine and beer. During the 1860s and 1870s, he found that a low level of heat applied to wine or beer reduced the souring by contaminating microorganisms but did not significantly affect the desirable characteristics of the products. In 1872, beer heated to 122 to 131°F to prevent souring was first called pasteurized. In 1886, Dr. Soxhlet was the first to advocate pasteurization in Germany for milk given to infants. In 1889, Dr. Abraham Jacobi, a pediatrician in New York City, recommended heating milk to boiling (212°F) momentarily before feeding to infants and young children. The results of these recommendations were so successful that Dr. Henry Koplik established the first dispensary for heated milk in 1889. Four years later, Nathan Straus started the first of 17 depots for the distribution of pasteurized milk to children in New York City. He also established depots in several other urban centers in the U.S. and advocated the use of pasteurized milk to health officials throughout the U.S. and Canada. In 1898, one New York children’s hospital switched to pasteurized milk and the mortality rate was cut in half for the following 3 years. During this same time frame, the modern battle against tuberculosis was initiated (3,4).

Scientist Discovers TB Organism

Dr. Robert Koch in 1882 discovered a staining technique that enabled him to see the tubercle bacillus (Mycobacterium tuberculosis), the organism that causes tuberculosis in humans. In 1890, he developed the tuberculin test while working on a vaccine. By 1892, the thought had occurred to Koch to apply his tuberculin test to cattle. This resulted in development of voluntary testing programs, the first of which was introduced in Pennsylvania in 1895. At the turn of the century, one out of seven people were dying from tuberculosis. One should note, however, that the bovine type (Mycobacterium bovis), was only responsible for 9% of tuberculosis world-wide (2).
Compulsory pasteurization regulations were first introduced in Chicago in 1909. Milk was required to be pasteurized if supplied by a herd of cows that were not regularly tested for tuberculosis. By 1910, 46 of 52 leading cities in the U.S. required or officially encouraged pasteurization of milk. The combined effects of improved inspection procedures, tuberculin testing programs, and the spread of pasteurization in New York City were credited with decreasing the death rate among children under 5 years of age from 96.5/1000 in 1891 to 34.0/1000 in 1916 (1). Despite this evidence, the general population at the turn of the century did not readily accept pasteurization.

### Pasteurization Done in Secret

The general populace was inclined to prefer raw milk based on the belief that pasteurization reduced the nutritional quality. Therefore, pasteurization of milk for the general population was performed initially in secret by processors trying to extend the keeping quality of their milk rather than to provide a safer product. Ironically, the first regulatory measures regarding pasteurization were directed toward eliminating the practice of secret pasteurization. New York City forbid secret pasteurization in 1906 and then established time/temperature standards for pasteurization of milk in 1910 (3,4).

The first pasteurizers designed for milk were of European origin. Albert Fesca of Berlin, Germany, developed a pasteurizer in 1881 capable of heating milk to 165.2 to 170.6ºF for an unspecified time. In 1890, N. J. Fjord of Denmark added the important feature of continuous agitation. The work of Theobold Smith, 1899, Russel and Hastings, 1900, and M. J. Rosenau, 1909 established the destruction of *Mycobacterium tuberculosis* (*M. bovis*) at 140ºF for 20 minutes. Research indicated that the tubercle bacillus was the most heat resistant pathogen to be found in milk. Therefore, in 1911 the National Committee on Milk Standards recommended a time/temperature treatment of 145ºF for 30 minutes for pasteurization of milk (4). The Endicott Experiments of the early 1920s demonstrated the shortcomings of much of the pasteurization equipment and procedures being used at the time and resulted in major improvements in the design and construction of pasteurization equipment (3).

In 1924, the state of Alabama requested help from the U.S. Public Health Service to develop a standardized, state-wide milk sanitation program. Out of this effort the first proposed standards for pasteurization of milk in 1910 (3, 4).

### Improvements in Technology

During the 1930s and 1940s, improvements in technology for monitoring processes and providing efficient heat exchange resulted in the development of High Temperature, Short Time (HTST) pasteurizers that are found in modern dairy plants. These systems require a minimum time/temperature treatment of 161ºF for 15 seconds, which allows for continuous rather than batch processing. The effectiveness of this heat treatment in killing pathogenic bacteria is equivalent to the batch process. Improved monitoring resulted in the development of ‘flow diversion valves’ that direct any improperly pasteurized product back to the beginning of the process for re-treatment.

Since the wide acceptance and standardization of pasteurizing processes, the only known cases of tuberculosis caused by consumption of milk have all been related to ingestion of raw milk. The last known case of tuberculosis caused by *M. bovis* in the U.S. occurred on a Michigan farm in 1974 and involved a young boy who had consumed raw milk from his family’s herd of 34 cows. A few additional cases of bovine type tuberculosis have been reported, however, these individuals were exposed to raw milk either during their youth or while living in foreign countries (2).

### Pasteurization Protects Public

Although the relationship of pasteurization and *M. bovis* was the focus of this article, one should remember that pasteurization also eliminates other more common milk-borne pathogens including *Listeria monocytogenes*, *Escherichia coli* O157:H7, *Salmonella spp.*, *Campylobacter jejuni* and *Yersinia enterocolitica*. Outbreaks caused by these organisms have been traced to consumption of raw milk and raw milk products as well as by contamination or improper handling of pasteurized products. Pasteurization has an excellent record of protecting the consuming public from pathogens found in raw milk. Because these pathogens are typically found in, on or around cows without causing any visible effects to the environment or the dairy herd, one should always consume pasteurized milk regardless of the source.

### References

DHIA Began Testing for True Protein

Kathy Lee
Extension Dairy Agent
Northwest Lower Michigan

All DHIA testing laboratories in the U.S. began testing for true protein on May 1, 2000. This change corresponds to the testing changes made by milk cooperatives and processors on January 1, 2000, as required by the Federal Milk Marketing Order reform. The Federal Milk Marketing Administrator in the Cleveland, OH office estimated the average protein test for the Mideast federal order would decline by 0.18%. The previous method was based on crude protein testing and measured the total of true protein plus non-protein nitrogen in milk.

Rebecca Mitchell, New Dairy Agent
Pam Jahnke
Dept. of Animal Science

Business and people management are two key areas that Rebecca Mitchell would like to emphasize in her new role as recently named Michigan State University Extension Dairy Agent for Ionia, Kent and Montcalm Counties.

Mitchell, who replaces Dr. Barbara Dartt, began her duties June 12. Dartt currently is a farm business management specialist in the Department of Agricultural Economics at MSU.

An MSU graduate, Mitchell has a Bachelor of Science degree with a dual major in agribusiness management and animal science.

“I wanted to get back to the dairy industry because that’s where my interests lie and I wanted to work directly with producers,” said Mitchell.

Following her graduation in 1998, she was hired by Cargill Inc., in the Animal Nutrition Division, where she most recently served as administrative manager for the Memphis District in Tennessee. She managed the cost of inputs for the nutrition division as well as the business’s accounting records and analysis of the unit’s financial performance. She has worked closely with cattle, hog, horse, and catfish farmers.

Being an Extension Dairy Agent allows her to reconnect with the Michigan dairy industry that has supported her immediate and extended family for more than 100 years. Mitchell grew up on her parent’s 180-cow dairy farm in Hersey, located in Osceola County. Her oldest sister, Jennifer, graduated with a B.S. in crop and soil science and her younger sister, Christina, is an undergraduate in MSU’s Animal Science Department.

“I grew up on the farm and loved that life and wanted to contribute back to the agricultural field,” she said.

How does Mitchell see her role as an Extension Dairy Agent? “To provide education available to dairy farmers and to be that liaison between the university and the folks out there in production.”

Part of that education would involve training farmers in human resource or “people” management so they have the necessary tools for hiring, paying and retaining good employees. Because of current low unemployment rates, dairy farmers are finding it increasingly difficult to keep employees. Another area important to Mitchell, is strategic planning or “holistic business management.” The first step in this process is to understand the farmer’s environment, including the weaknesses and strengths of the operation, followed with a plan designed to keep the farm business financially secure.

Mitchell plans on meeting the people in her 3-county area through veterinarians, feed representatives and others who have established farm contacts. “It’s important to have an open door policy so people feel they can approach you at any time,” she said.

Her office is located at 100 Library Ct. in Ionia. She can be contacted by phone at 616-527-5357 or e-mail at mitchelr@msue.msu.edu.

Here is what you can expect to happen relative to your DHIA records.

• Protein data for test dates on or after May 1 are based on true protein analysis. Just as you observed a decline in the milk plant protein tests, you also will see an average decline in test day protein percentages of approximately 0.2%.

• No adjustments to DHIA records will be made for protein percentages on test dates prior to May 1, 2000. This means: - lactation records with one or more test dates before May 1 will include protein tests based on a combination of true and crude protein analyses; and, - rolling herd averages for protein will be based on a combination of true and crude protein until May, 2001.

• Your DHIA reports will contain a reminder message that true protein testing began on May 1.

• To keep this testing change in perspective, let’s consider a typical lactation record based on crude protein and true protein. A cow producing 21,000 lb milk at 3.20% crude protein would have a lactation total of 672 lb protein. Based on 3.02% true protein, her lactation yield for protein would be 634 lb (38 lb less).

Information about how the protein testing changes will be accounted for in predicted transmitting ability (PTA) calculations for protein will be included in the article about genetic evaluation changes in the October, 2000 issue of the Michigan Dairy Review.
Michigan Milk Market Update - July 2000

Christopher Wolf
Dept. of Agricultural Economics

US Dairy Situation

As expected, US milk production increased significantly in 1999 (Table 1). While 1999 US dairy cow numbers were basically unchanged (+0.02%) from 1998, total milk production jumped 3.4% from the previous year on the strength of a 3.4% increase in milk yield per cow. Given how sensitive milk prices are to small changes in the quantity supplied (or demanded), this 3.4% increase in quantity produced resulted in lower milk prices. All forecasts indicate that high production levels, and the consequent dairy product surpluses, should continue this year. However, a heat wave in a major dairy producing region (or two) could change the situation.

With the massive growth in production, it is not surprising that milk prices have been lower this calendar year. Further, with the high average milk prices the past 2 years, milk prices were bound to be lower. Recall that 2000 ushered in a new pricing system. This may turn out to be a very good situation for dairy producers because this new pricing system has paid dividends. Since the Federal Milk Marketing Order Reform, the base price is the higher of either Class III (cheese) or Class IV (butter and nonfat dry milk) prices. The old Basic Formula Price (BFP) was a survey price augmented by a weighted average of recent changes in the cheese and butter markets. While the old BFP would have been substantially lower than the recent prices, the new base price benefits from recent strength in the butter market.

Figure 1 displays the BFP for 1997 through 1999 and the 2000 class III price for January through May (dashed line). To see what might have been without the new base price system under order reform, consider the dashed line which represents Class III prices for 2000 which is up to $2.54/cwt lower than the Class IV price. Table 2 contains the minimum prices for Classes III and IV. The base price has been the Class IV (butter and nonfat dry milk price) each month. While the old BFP would have been a weighted average of the two prices, the new system clearly resulted in a higher price. Because Class I and II minimum prices are built off of the base price, the new system is helping those prices as well.

Michigan Production

In Michigan, total milk production increased slightly in 1999 relative to 1998 (Table 3). Total Michigan milk production has been around 5.4 billion pounds for several years. The long-term

Table 1. US Dairy Summary, 1997-1999.

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<tbody>
<tr>
<td>Production (billion lb)</td>
<td>156,091</td>
<td>157,348</td>
<td>162,711</td>
<td>+0.8</td>
<td>+3.4</td>
</tr>
<tr>
<td>Cows (thousands)</td>
<td>9,252</td>
<td>9,154</td>
<td>9,156</td>
<td>-1.0</td>
<td>+0.02</td>
</tr>
<tr>
<td>Milk/cow (lb)</td>
<td>16,871</td>
<td>17,189</td>
<td>17,771</td>
<td>+1.9</td>
<td>+3.4</td>
</tr>
</tbody>
</table>

Source: USDA/National Agricultural Statistics Service

Table 2. US Milk Price: Classes III and IV, 2000 to date.

<table>
<thead>
<tr>
<th></th>
<th>Class III</th>
<th>Class IV</th>
<th>Base Price</th>
</tr>
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<tbody>
<tr>
<td>Jan</td>
<td>10.05</td>
<td>10.73</td>
<td>10.73</td>
</tr>
<tr>
<td>Feb</td>
<td>9.54</td>
<td>10.80</td>
<td>10.80</td>
</tr>
<tr>
<td>Mar</td>
<td>9.54</td>
<td>11.00</td>
<td>11.00</td>
</tr>
<tr>
<td>Apr</td>
<td>9.41</td>
<td>11.38</td>
<td>11.38</td>
</tr>
<tr>
<td>May</td>
<td>9.37</td>
<td>11.91</td>
<td>11.91</td>
</tr>
</tbody>
</table>
trends of declining milk cow numbers with increased productivity per cow also continued.

Michigan Class I (fluid) milk price declined sharply during Fall 1999 (Figure 2). From its peak at $18.11/cwt in November 1999, the Class I price has hovered around $13.00/cwt into early 2000. Meanwhile, the superpool premium continued to move opposite the Class I price helping to off-set large price changes.

**Michigan Milk and Feed Prices**

Figure 3 displays the Michigan ‘all’ milk-to-feed price ratio. A higher ratio indicates a better margin above feed costs. As with the milk price, the milk-to-feed price ratio declined in late 1999. While not as low as the early months of 1998, when feed prices were quite high, the ratio currently is the lowest since spring 1999. However, unlike last spring and summer, we might not see a rebound in the ratio this summer. The forecast is for continued low feed prices (of course, also dependent on national weather patterns), so future changes in the ratio will likely depend largely on the milk price.

**Calendar of Events**

**August 14 & 15**

*Top Dairies 2000 - Management and Marketing Workshop.* Organized by the Dairy Farm Analysis Committee of the National Program on Dairy Education, the workshop will be held at the Wyndham Palace Resort and Spa in Orlando. Attendees will participate in small group discussion sessions. Producers who have submitted financial data will have the opportunity to gather into small, regionally diverse groups of 8-10 participants to discuss dairy enterprise benchmarks and their own management and marketing strategies.

For additional information, visit the web site: http://cpdmp.cornell.edu/topdairies or contact, Dr. Barb Dartt: (517) 353-4618 or Dr. Sherrill Nott: (517) 353-4522 at Michigan State University.

**Table 3. Michigan Dairy Summary, 1997-1999.**

<table>
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<tbody>
<tr>
<td>Production (billion lb)</td>
<td>5.407</td>
<td>5.369</td>
<td>5.434</td>
<td>-0.7</td>
<td>+1.2</td>
</tr>
<tr>
<td>Cows (thousands)</td>
<td>306</td>
<td>300</td>
<td>295</td>
<td>-2.0</td>
<td>-1.7</td>
</tr>
<tr>
<td>Milk/cow (lb)</td>
<td>17,655</td>
<td>17,895</td>
<td>18,036</td>
<td>+1.4</td>
<td>+0.8</td>
</tr>
<tr>
<td>All Milk Price ($/cwt)</td>
<td>12.96</td>
<td>14.84</td>
<td>15.60</td>
<td>+14.5</td>
<td>+5.1</td>
</tr>
</tbody>
</table>

**Figure 2. 1999-2000 Michigan Class I Milk Price and Premium.**

**Figure 3. Michigan All Milk Price/Feed Ratio, January 1998-April 2000.**