Air Quality and Agriculture

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“Air Quality and Agriculture: Challenges and Opportunities” was the title of a seminar held May 25 and 26, 2004. Sponsored by the Michigan State University Extension Manure Management Team, the objectives of the seminar were to increase awareness about air emissions from agricultural operations, to better understand the concerns about potential impacts of those emissions on livestock and human health, and to set the stage for future activities. Attendees included personnel from Michigan State University Extension (MSUE), Michigan Department of Environmental Quality (MDEQ), Michigan Department of Agriculture (MDA), Natural Resource Conservation Service (NRCS), and statewide agriculture organizations, and consultants.

Indoor and outdoor air quality are concerns in agriculture. Indoor air quality impacts human and animal health. Also, the increasing size and concentration of animal production units has given rise to concerns about air emissions on the earth’s atmosphere — globally as well as locally. Of concern are odor, gases, and particulate matter.

Odors, Major Issue Locally and Regionally

Odor is the major issue locally and regionally (1). For example, over 330 different odor-causing compounds have been measured in swine manure. However, the particular compounds that are perceived as offensive are not well understood. Odor is also the most difficult to measure. Olfactometry, which uses trained individuals and standardized procedures to measure odor concentrations and describe the quality of odors, is a common approach. Efforts to correlate individual odorous gas concentrations have met with some success. However, there is no known relationship between the specific gas concentrations in a mixture and its perceived odor.

Precaution: Feeding 2004 Wheat

At this printing we don’t know the extent of the problem in this year’s wheat, but cool, wet conditions favor growth of Head Scab, a fusarium mold that produces vomitoxin or DON. Vomitoxin is associated with reduced feed intake and milk yield. Refer to Michigan Dairy Review (www.msu.edu/user/mdr/) under the Reprints section, “Feeding Wheat and Potential Vomitoxin (DON) Problems” by Herb Bucholtz, August, 1996 for guidelines on feeding distressed wheat or contact your MSU Extension Dairy Agent.
Greenhouse Gases
Agriculture’s impact on greenhouse gases was discussed by Phil Robertson, Professor of Ecosystem Science, MSU. Carbon dioxide, nitrous oxide and methane are emitted to and/or removed from the atmosphere through agricultural activities. Because greenhouse gases have a potential role in promoting rapid and undesirable changes in climate, mitigating emissions through improved agricultural practices is receiving increased attention. Because mitigation of greenhouse gas emissions in agriculture will not begin of its own accord, Robertson suggested that policies for “carbon trading” likely will be established at the national and international levels to facilitate reduction of greenhouse gas emissions.

Animal Nutrition Related to Air Emissions
Dave Beede, C.E. Meadows Endowed Chair and Professor, MSU, examined the relationships between animal nutrition and air emissions. Nitrogen-containing compounds, ammonia, nitrous oxide, nitric oxide and nitrogen dioxide, have major implications regionally, nationally, and globally.

Ammonia emissions from animal agriculture account for about 50% of the total ammonia emissions into terrestrial systems (1). Ammonia, through chemical reactions in the atmosphere, causes acid rain increasing acidity of surface waters and soils. Nitrogen emissions, as ammonia, are a major nutrition issue.

Overall, Beede recommends decreasing the animals’ intake of all nutrients to dietary amounts that minimize nitrogen emissions without compromising health or productivity of animals. Of major concern is the nitrogen (as crude protein) in rations which when fed in excess of that needed to meet the animals’ requirements for growth and milk production is excreted in manure. Using properly balanced amino acid formulations (protein) to more accurately meet the animals’ needs shows promise in commercial swine, poultry, and dairy cattle feeding, when cost-effective, to reduce ammonia concentrations in manure. Unfortunately, we currently have poor understanding of protein (amino acid) metabolism in the rumens of and tissue utilization by cattle, greatly limiting effective implementation of “specific amino acid or protein feeding” to reduce ammonia excretion.

Beede also commented that nitrogen applied to pastures in grazing systems, if not managed effectively, can result in as much or more nitrogen emission compared with feeding well-balanced rations to dairy cattle in confinement. The type of “system” is much less the issue than some people think, he commented.

The key is effective and responsible nutrient management (e.g., control of nitrogen inputs, flows, and outputs) in any animal feeding system. For example, ineffective use of feeds (grazed or harvested forages) with high amounts of readily ruminally degradable crude protein can result in increased nitrogen emissions. Interestingly, some byproduct feeds (e.g., dried whey or distillers dried grains) that would otherwise be industrial wastes from the food and ethanol industries, currently are largely fed in animal agriculture. However, these byproduct feeds contain excess or improperly balanced nutrient profiles (e.g., protein and phosphorus) compared with animal requirements. Therefore, the excess chemicals (e.g., nitrogen and phosphorus) transferred from other industries into animal feeding operations end up in manure and are current and future challenges for animal agriculture.

Lack of Information Confounds Regulation
Efforts to regulate air emissions from agricultural sources is confounded by a lack of information. Indeed, air emission requirements in the Clean Air Act apply to animal production facilities even though agriculture is not referred to in the Act itself. But there are no uniform studies to determine the size of operations or which manure management methods produce air emissions that exceed legal thresholds of regulated pollutants—ammonia, hydrogen sulfide, particulate matter, nitrous oxide and volatile organic compounds. William Schrock, Environmental Protection Agency (EPA), and Carrie Monosmith and Maggie Sadoff (MDEQ), presented the regulatory perspectives. Wayne Whitman, MDA, described experiences in Michigan with Right-to-Farm and air emissions.

The Air Emissions Consent Agreement, recently negotiated between the livestock and poultry industry and the EPA, is an effort to find the required answers before regulations are formulated and imposed. As described by Carrie Tengman of the National Pork Board, the agreement provides for a nationwide emissions monitoring program, funded by the livestock and poultry industry. Emissions data and accumulated best management practices and technologies will be used in formulating regulations for the future. Interestingly, the dairy industry is not part of Consent Agreement activities.

Larry Jacobson and David Schmidt of the Biosystems and Agricultural Engineering Department, University of Minnesota, brought to the seminar several years of experience related to air quality and agriculture. They described measuring air emissions and odors, and the use of biofilters for odor control. Along with Dann Bolinger and Jerry May, MSUE, use of the computer program OFFSET (Odor From Feedlots Setback Estimation Tool) to site animal production facilities was discussed. This information is especially useful when planning for expansion or siting new animal feeding facilities.

Community interactions are an extremely important aspect of the air quality issue. According to Pat Norris and Beth Moore, MSU, participation by many segments of the community that view the issue very differently is required. Those with involvements and interests in agriculture have an opportunity to step forward, taking leadership roles in providing forums for discussion.

In the future, sound science must be the basis for policies and regulations related to air emissions from agricultural sources. A combined effort of the agricultural industry,
regulatory agencies, and the scientific community will enhance these developments. Encouraging the mitigation of air emissions from agricultural sources is the responsibility of all stakeholders.

Note: In addition to his professorial position in the Dept. of Biosystems and Agricultural Engineering, Dr. Bickert currently serves as Director of College of Agriculture and Environmental Management.

Environmental Management

Stop Fertilizing, But Let the Cows Graze!

Don Comis
Agricultural Research Service Information

Farmers who find excessive levels of nitrates in groundwater can keep on grazing their cattle without fear of further contamination from the nitrogen in cattle waste as long as they reduce or eliminate nitrogen fertilizer application for at least a few years.

That particular wisdom comes from a study at the Agriculture Research Service’s North Appalachian Experimental Watershed Laboratory in Coshocton, Ohio. For several years, Dr. Lloyd Owens, a soil scientist at Coshocton, used a herd of 30 beef cows to rotationally graze four 8-acre fields on a hillside. Owens sampled nitrate concentrations in the groundwater below each field. U.S. Environmental Protection Agency guidelines for human drinking water stipulate 10 parts per million (ppm) as the maximum allowable safe level for nitrate-nitrogen. There is no danger to cattle from grazing on pastures with high nitrate levels.

Scientist’s Findings on Nitrate Levels Helps Farmers

Scientists have gathered data on the watersheds in this rolling countryside for more than 60 years. The fields had been used as pasture for about 30 of those years. During the 11 years before the latest study began, Owens tested heavy nitrogen fertilization of 150 pounds per acre each year to see whether it would produce more and better grass for the cattle to graze without doing environmental harm. Unfortunately, it caused too much nitrogen to leach into the groundwater under these experimental conditions. Levels reached 13 to 26 ppm.

Some fields are more likely to have high nitrate levels in the groundwater beneath them, and annual fertilization can eventually turn them into problem fields. So Owens began a study to see whether he could lower nitrate levels by eliminating fertilizer for 7 years and either grazing cattle or harvesting hay from the fields.

He compared two pastures where cattle were allowed to graze with two pastures that were fenced to keep the animals out. In the “no cattle” pastures, the grass was cut and baled for hay twice a year.

“When you harvest the hay, you remove some nitrogen from the soil,” Owens says. “And when cattle graze, they remove some of the nitrogen.”

By the end of the 7-year study, Owens found that the nitrate-nitrogen in groundwater was brought down to about the same level (2 to 4 ppm) under both management practices, and the lack of fertilizer caused only a slight decrease in grass growth. But, most importantly, it did not make any difference whether cattle were on the land or not.

“It’s a nice finding, because it doesn’t force farmers to remove cattle from problem fields, as long as they stop fertilizing. And it saves the time and labor of baling hay for feed,” Owens says.

This research is part of Water Quality and Management, an ARS National Program (#201) described on the World Wide Web at www.nps.ars.usda.gov.

Lloyd B. Owens is with the USDA-ARS North Appalachian Experimental Watershed Laboratory, State Rte. 621, Coshocton, OH 43812; phone (740) 545-6349, fax (740) 545-5125.

“High Nitrate in Groundwater? Stop Fertilizing But Let the Cows Graze!” was published in the June 2004 issue of Agricultural Research magazine.

Reference

Have Enough Land to Apply Your Manure?

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Do you have enough land to apply manure? In order to answer this question, you must collect a few pieces of information. You will need: current soil test levels for your fields, amount of phosphorus (P) excreted by your livestock, crop rotation, P removal, distance to surface waters, and capacity of manure storage.

Let’s start by looking at the manure application guidance provided by the Generally Accepted Agricultural and Management Practices (GAAMPs) for Manure Management and Utilization that is applicable specifically to this topic.

1. The agronomic (fertilizer) rate of N recommended for crops should not be exceeded by the amount of available N added, either from manure application or from manure plus fertilizer N application and (or) other sources.

2. If the Bray P1 soil test level for P reaches 150 lb/acre (75 ppm), manure applications can be made where the rate of manure P added does not exceed the P removed by the harvested crop. Manure can be applied at a rate equivalent to the amount of P removed in 4 years by crops. Guidance surrounding N application in number 1 above still applies. If the Bray P1 soil test level for P is greater than 300 lb/acre (150 ppm), then manure applications should be discontinued until soil test P levels drop below 300 lb/acre. To protect surface water quality, adequate soil and water conservation practices should be employed.

3. Manures should not be applied to soils within 150 ft of surface waters or to areas subject to flooding unless: a) manures are injected or surface-applied with immediate incorporation (i.e., within 48 hours after application) and (or), b) conservation practices are used to protect against runoff and erosion losses to surface waters.

The amount of P\(_2\)O\(_5\) removed by crops can be determined using tables in the Manure Management and Utilization GAAMPs. Table 1 provides an example of removal rates of P\(_2\)O\(_5\) for various crops.

### Table 1. Crop removal rates of P\(_2\)O\(_5\).

<table>
<thead>
<tr>
<th>Crop</th>
<th>Form</th>
<th>Unit</th>
<th>P(_2)O(_5) Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>(Hay)</td>
<td>ton</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>(Haylage)</td>
<td>ton</td>
<td>3.2</td>
</tr>
<tr>
<td>Corn</td>
<td>(Grain)</td>
<td>bu(^a)</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>(Silage)</td>
<td>ton</td>
<td>3.3</td>
</tr>
<tr>
<td>Potatoes</td>
<td>(Tubers)</td>
<td>cwt(^a)</td>
<td>0.13</td>
</tr>
<tr>
<td>Soybean</td>
<td>(Grain)</td>
<td>bu</td>
<td>0.88</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>(Roots)</td>
<td>ton</td>
<td>1.3</td>
</tr>
<tr>
<td>Wheat</td>
<td>(Grain)</td>
<td>bu</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>(Straw)</td>
<td>ton</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source: Manure Management and Utilization GAAMPs.

\(^a\)bu=bushel; cwt=100 lb.

### Determining Whether You Have Enough Land

The following steps are used to determine whether or not you have enough land to apply all of your manure.

### Table 2. Amount of P\(_2\)O\(_5\) removed on a hypothetical farm - current situation.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Land</th>
<th>Yield</th>
<th>Unit</th>
<th>P(_2)O(_5) Removed</th>
<th>P(_2)O(_5) Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn silage</td>
<td>125</td>
<td>x 15</td>
<td>T/acre(^a)</td>
<td>3.3</td>
<td>6,188</td>
</tr>
<tr>
<td>Corn grain</td>
<td>175</td>
<td>x 125</td>
<td>bu/acre(^a)</td>
<td>0.37</td>
<td>8,094</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>50</td>
<td>x 5</td>
<td>T/acre</td>
<td>13</td>
<td>3,250</td>
</tr>
<tr>
<td>Alfalfa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haylage</td>
<td>275</td>
<td>x 14</td>
<td>T/acre</td>
<td>3.2</td>
<td>12,320</td>
</tr>
<tr>
<td>Soybean</td>
<td>75</td>
<td>x 35</td>
<td>bu/acre</td>
<td>0.88</td>
<td>2,310</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>700</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>31,952</strong></td>
</tr>
</tbody>
</table>

\(^a\)Tons/acre; bushels/acre.

For a very basic example, determine how many acres are in a given crop each year. Then for each crop multiply the expected yield by the removal rate to get pounds of P\(_2\)O\(_5\) removed per acre. Then multiply this by the number of acres of that crop; the result is pounds of P\(_2\)O\(_5\) removed. Do this for each crop and sum the crops to arrive at the total P\(_2\)O\(_5\) removed from your farm’s cropland.
1. Eliminate fields with soil test P levels greater than 300 lb P/acre (150 ppm).
2. Eliminate fields or portions of fields that are within 150 ft of surface water, if you are broadcasting manure and not incorporating it within 2 days.
3. Categorize remaining fields into N based (soil test P levels less than 150 lb P/acre) or P based (soil test P level between 150 and 300 lb P/acre) application. It would be prudent to apply manure at P based rates on all fields, to keep soil test P levels from building. This should insure future availability of land for manure application.
4. Determine the crop rotation in your fields.
5. Calculate crop removal for each field over the rotation.
6. Try to solve the puzzle: Is there enough land or is more needed?

Let's walk through an example. Suppose you have 40,000 lb P$_2$O$_5$ in manure produced annually on your farm. This is the amount of phosphorus (on P$_{0.4}$) excreted and can be calculated based on feed rations. Phosphorus in feed rations is typically listed as elemental P. Therefore, to convert to P$_2$O$_5$, divide the value for elemental P by 0.44.

Next, determine how many acres are really available for manure application. Say you have 1,300 acres but 150 acres have soil test P levels greater than 300 lb P/acre, 50 acres are within 150 ft of surface water and you broadcast manure and incorporate it when you have time, and 400 acres you’d prefer not to use because they are too far away. This leaves you with 700 acres to spread on (1300 - 150 - 50 - 400 = 700).

Next determine the amount of P$_2$O$_5$ removed each year by crop production on your farm. For this hypothetical farm, 32,162 lb P$_2$O$_5$ are removed each year. If we take the lb P$_2$O$_5$ produced and subtract crop removal from it, there is an excess of 7,838 lb P$_2$O$_5$. Therefore, something needs to be done to resolve this situation.

### Use These Tips for Solving Land-Base Problem

The following are a few tips for solving this land-base problem.

1. Obtain more land suitable for manure application. Do this by buying, renting, or trading with a neighbor.
2. Be willing to haul manure to fields that are further away and which may not have received manure applications previously.
3. Change manure application and incorporation methods so that ground within 150 ft of surface waters can be used.
4. Adjust crop rotations. Crops that remove a lot of biomass remove a lot of P; corn silage is a good example. This could be done by rebalancing purchased vs. grown feeds.
5. It might be possible to improve crop yield through improved management.
6. Are there new technologies that you could implement that would reduce the amount of P in the manure?
7. Reduce manure P production. This can be accomplished by not overfeeding P or using phytase in hog and poultry rations.

Once you have worked through these calculations, you will have a good idea as to whether you have enough land to apply all of the manure produced on your farm. Also, if you are considering expanding your operation, you can use this procedure to determine if you have enough land-base for more manure.

After you have determined that sufficient land-base exists, there are additional questions to consider to fine tune manure applications. In situations where a farm has less than 6 months of storage, the crop rotation needs to allow windows of opportunity to spread manure. The same philosophy exists for winter spreading. Ask yourself, are there suitable fields for winter spreading that essentially eliminate the risk of runoff to surface waters?

Natalie Rector, MSUE Manure Agent, is acknowledged for her contributions to this article.

## Genetics

### Al Bulls Ranked by Conception Rates

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Improving fertility is a common goal for many dairy herds. Getting cows pregnant in a timely manner is important in maintaining a profitable dairy business. Let’s look at the factors influencing conception rates in dairy cattle and tools available to rank bulls on fertility.

Improvement in many traits of interest in dairy cattle can be achieved in two ways. You can select animals that are genetically superior for the traits. Or you can make management changes that positively impact the traits. Quite often dairy producers use a combination of the two approaches.

**Factors Influencing Conception Rates**

Conception rates are influenced by a variety of factors. Management and environmental factors account for 96% of the variation in conception rates. Herd differences in nutrition, metabolic disorders, reproductive health, heat detection, and climate can result in significant differences in conception rates.
The remaining 4% of variation in conception rates is due to genetic factors with 3% for the cow and 1% for the service bull. These small values indicate that improvement in conception rates due to genetic selection will occur at a relatively slow rate. Nonetheless, given the significant economic importance of getting cows pregnant, some selection for improved fertility may be justified in a herd’s genetic program.

Genetic evaluations for cow fertility have been calculated since February 2003 and are expressed as predicted transmitting abilities for Daughter Pregnancy Rates (PTA DPR). In addition, the trait, PTA DPR, was added to the Net Merit (NM$) index in August 2003 to allow for efficient selection for DPR. (See articles in April 2003 and October 2003 issues of Michigan Dairy Review for more details.)

Service bull conception rates can be evaluated by using Estimated Relative Conception Rate (ERCR) data. This article focuses on the ERCR calculations and how to use ERCR in sire selection decisions.

What is ERCR?

ERCR measures 70-day non-return rate of an AI service bull relative to service bulls of herdmates. A cow is assumed pregnant if no repeat breeding or heat is reported within 70 days. Adjustments are made for environmental factors that can affect conception rates, including herd, lactation number of the cow, stage of lactation, month of breeding, and milk production of each cow. Only the first breeding in each cow’s lactation is used in the ERCR calculations.

ERCRs are computed by Dairy Records Management Systems (DRMS) in Raleigh, NC and Ames, IA twice yearly (May and November). Data from DRMS, AgSource in Wisconsin and AgriTech Analytics in California are used to calculate the ERCRs for Holsteins and Jerseys. AI breedings from the most recent 3 years are used.

ERCRs can be accessed at the DRMS website: www.drms.org/sire.htm.

Interpreting ERCRs

ERCR for a given bull is expressed as the difference in conception rate from the average AI service bull of herdmates. The ranges of ERCRs published in May 2004 are -5% to +4% for Holstein bulls and -7% to +4% for Jersey bulls. When comparing a bull at +4% with an average bull at 0% within the same breed, you would expect conception rates to average 4 percentage units greater for the higher ranking ERCR bull.

Researchers at Virginia Tech reported that a premium of $2 could be paid per each 1 percent ERCR. For example, let’s look at two bulls that have similar genetic merit for your primary selection traits. One bull has an ERCR of +3% and the other bull’s ERCR is 0%. You could justify paying $6 more for the bull with the higher ERCR. (3 units ERCR x $2).

In another example, you are considering Bull A at +1% ERCR and +$500 NM$, and Bull B at -3% ERCR and +$600 NM$. If you choose Bull A, you will give up $100 potential lifetime profit (NM$) for an $8 advantage in ERCR. Be sure to consider the overall impact of your sire selection decisions.

Summary

Keep these key points in mind when using ERCRs to make sire selection decisions.

- Management and environmental factors have the greatest influence on variation in conception rates. Identify those management changes that can significantly improve conception rates for your herd.
- Primary selection of service sires should be based on high lifetime profitability.
- ERCRs can be used as a secondary sire selection tool to identify higher ranking bulls for conception.

References

Water, like energy, protein, vitamins and minerals, is essential for any dairy herd. A lactating cow can drink from 30 to 50 gallons per day (1) depending on age, milk yield and environmental conditions. Most farmers assume that if they provide some water sources in the barn, their cattle will self regulate the intake of water to support milk production. But that assumption might just be incorrect.

**Water Intake**

The social structure of a group of cattle, the moisture content of the ration, the physical environment inside the barn, location of water in the pen, day-to-day human activities and routine all influence the amount any particular cow drinks on a given day. If water intake is limited then feed intake may be limited. If maximizing milk production is the goal, then maximizing water consumption is a high priority. In research done with cows kept in tie-stalls at Michigan State University cows drank a high of 1.6 gallons per drinking bout at a rate of 1.3 gallons per minute. These cows drank 16.1 times per day for a total of 16.7 minutes per day. About 38% of the cow’s daily water requirement was from moisture in the feed and 62% from water consumed at a drinking fountain (2). For a “theoretical” 100-cow average group this indicates that 1.2 cows would be drinking at any one moment during the day.

But we need to apply some reality to the picture. Cows in your herd perhaps are not as organized as the “100-cow average group”. Within that same 24-hour period there will be times when cows will be resting, eating, ruminating or in the holding pen or milking parlor which all keep them away from opportunities for drinking. The dairy manager’s job is to counteract those barriers to water consumption and provide incentives for the cows to drink more.

**Location, Location, Location**

Just as in Real Estate the location (of water sources) can mean increased satisfaction for the client (the cows). A commonly quoted recommendation calls for one watering spot (or 2 ft of space) for each 15 to 20 cows (3). This suggests 15% of the herd should be able to access water at the same time (4). But space alone is not enough. Location of water in the pen can influence use. Research from Kansas State University (4) reported that about 73% of water was consumed at troughs located in the exit half of the pen. In pens with three crossovers alleys 39% of the water was consumed at the center crossover. The addition of temporary water tanks on outer walls between crossovers affected the water tank use throughout the barn, even at the end tank. This reduced cow crowding and stress by spreading cattle over a larger area of the barn. Of the water consumed at the crossovers, 60% was consumed from the water tank nearest the feed bunk (4), which indicates that water should be placed near the feed bunk. The other important place for water availability is at the parlor exit lanes or return alleys back to the barn. In the research example above, cattle exiting the parlor consumed 3 to 5 gallons per day at water tanks in the return alleys during the summer months.

**Water Quality is Job One**

Consideration needs to be given to the chemical and bacterial qualities of the water supply for the dairy herd. Several quality properties of drinking water are considered for both humans and cattle. These include: smell and taste, salinity (total dissolved solids and total soluble salts), chemical properties (pH, hardness, dissolved oxygen and solids), excess minerals, toxic compounds and bacteria. A short synopsis of water quality measures is in order.

The determination commonly used when measuring salinity is total dissolved solids (TDS). With the exception of the potential for some diarrhea, a TDS of up to 500 ppm is acceptable in most cases, though the lower the TDS level the better. Water hardness generally does not adversely affect cows (5). Nitrates can, in certain circumstances, constitute a health risk to cows and humans. The general safe concentration of nitrates in water is less than 44 ppm and less than 10 ppm of nitrate-nitrogen. Be aware that the effects of nitrates in feed and nitrates in water are additive. This can become important when considering potential nitrate poisoning (6). Sulfur or sulfates in well water is a significant issue in parts of Michigan. When sulfur exceeds 500 ppm, determination of the specific salt form should be made to determine potential toxicity (6). Hydrogen sulfide, the most toxic form of sulfur, can decrease water intake at levels as low as 0.1 ppm (6). Toxic compounds and bacteria in water need to be monitored as well. A maximum level for a number of contaminants and toxins is provided on page 8 in Table 1 (6). Bacterial contamination is perhaps the most common contaminant of farm water sources.

Though the Michigan Department of Agriculture tests water on dairy farms annually, it is still important to consider bacterial contamination in water destined for cattle consumption. For animal consumption, especially young calves, total and fecal coliform counts should be less than 1 per 100 milliliters. For adult animals total and fecal coliform counts should be under 15 and 10 per 100 milliliters, respectively. It also is recommended that fecal streptococci counts not exceed 3 or 30 per 100 milliliters for calves and

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**Nutrition**

**Water Intake and Supply for Dairy Cattle**

_Dean Ross_

Extension Dairy Agent
Southeast Michigan
adult cattle, respectively (6).

General cleanliness of drinking facilities (tanks and cups) is very important. What is often considered somewhat acceptable is the presence of algae growth in the water or decaying plant material dropped into the water by the cows. These organic materials can produce off-flavors and even add nitrates to the water. Regular cleaning of water sources in the barn can help maintain water intake particularly in hot weather when temperatures encourage water quality problems. Clean water tanks can lead to more production by making the water more desirable to drink.

Facility Usage and Demand

A hidden management hurdle in maximizing water intake is supplying enough at the right time. Planning for adequate flow rates (gallons per minute) for the entire facility is important. The water supply system must be able to supply enough gallons per minute to meet the maximum draw during peak water use periods. As an example, cattle often go to the water tank immediately following milking. For a 100-cow group there may be 10 or more animals attempting to drink at various water tanks simultaneously. Using the 1.5 gallons per minute drinking rate (2) and multiplying that by 10 cows equals a 15 gallon per minute requirement. Keep in mind this is only for one pen.

There could be other simultaneous water requirements, such as in the parlor or flush tanks. A plate cooling system uses about 3 gallons of water for each gallon of milk cooled and some water might be used for watering heifers or cattle in other pens or even animal cooling. All this water adds up quickly. In practical terms, if the flow rate or water demand for the entire water supply system cannot be met, some animals cannot drink as much water as they would desire when they want it, robbing them of potential production. Maximum milk production requires maximum water availability.

Distributing Water

To meet demand, both current and future estimates of daily usage and demand will be needed to determine well capacity and (or) number of wells needed. The main line from the well or storage tank area needs to be sized properly. On farms planning for future expansion the main line should meet the demand for all current and future water uses. Water distribution problems will occur in the future when this line is sized only for current use.

The distribution lines branching off the main water line are routed to a specific building or use. An example would be the line to the freestall barn. This line should be sized to supply the drinking needs of the cows and for current and future animal cooling purposes. These lines are often too small. Branch water lines carry water from the distribution lines to waterers or water tanks. The water movement capacity of these lines can become a problem if the branch lines are utilized as distribution lines for other water uses. Usually they cannot carry enough water to work well (1).

A final consideration for water system planning is the loss of pressure in a piping system. This pressure loss is due to friction in the pipes, elevation differences between the pump and the end use, and velocity losses. Friction losses are due to water flowing through pipes, fittings, and valves. Old dirty pipes, typically metal, are often responsible. If these losses are too great, then the system will not be able to move enough water to the end use points to meet water requirements (1). The mechanical and hydraulic engineering requirements of a complicated watering system such as that commonly used on dairy operations call for careful consideration the needs of the farm and cows, particularly before construction or renovation.

On a practical basis, what does this mean for most dairy farms? First, look around the cattle facilities during times of both peak and non-peak water use. If the cows must wait for their turn at the water tank, then perhaps there are not enough water sources in the pen. If the cows need to wait for the water tank to fill before drinking or the tanks are all but dry, then a water supply problem exists. Another test of the system can entail running all the water sources simultaneously for a short period to see how long it takes to fill the water tank farthest from the well. No doubt, other simple tests can be devised to challenge or determine the capacity of the water system.
supply system in almost any farm. The question remaining is, does your water supply meet the needs of your cows?

References

2004 Labor Update (Part 2)

This article is the second part of a two-article series that addresses frequently asked questions about labor laws and regulations in dairy farming. The first article addressed the hiring procedure, the proposed AgJOBS legislation, and the application of the HIPAA Privacy Rule in agriculture (see MDR, April 2004, p 12-14.)

The current article addresses minimum wage and overtime in agriculture, social security letters regarding mismatch of numbers, and a procedure for terminating an employee. A good way for managers to stay current on labor laws is through newsletters or websites. The author maintains an agricultural labor website with links to useful information sources and a news section on current developments at www.msu.edu/user/bitsch.

The underage son of one of my employees would like to work on our farm. He says he will work for $4.00 per hour. Can I accept this arrangement?

Minimum wage is currently $5.15, and exemptions very rarely apply. For the first 90 consecutive days of hire for employees under 20 years of age, a youth opportunity wage of $4.25 may be paid if no other workers are replaced by the newly hired youth.

There are a few other cases when the Department of Labor will issue a certificate that allows employment at 85% of minimum wage. These include workers with disabilities, apprentices, student learners, and certain full-time students. It is strongly advised to request the certificate before agreeing to an arrangement below minimum wage. Managers need to remember that youths under 16 years old may not do any dangerous work, such as driving a tractor, except if certified under a training program; or going into a yard, pen, or stall occupied by a cow with a newborn calf or a bull.

I hire a couple of migrant workers over the summer and pay them by the piece. Whether they receive minimum wage or not, is none of my concern, or is it?

Federal labor law has a so-called “local hand harvest exemption.” Hand harvest workers, who are paid a piece rate in an operation generally recognized as piece work in the region, may be exempt from minimum wage. The workers must commute from their permanent residence each day to the farm and have been employed in agriculture less than 13 weeks in the previous calendar year. This also applies to youth who are not local residents, who are employed on the same farm as their parent or guardian and paid the same piece rate as older employees.

Before deciding to pay below minimum wage, managers are strongly advised to seek legal counsel of an experienced agricultural labor law attorney. Piece rate does not constitute a reason to not pay minimum wage. On the contrary, by keeping the required documentation on hours worked, quantities, piece rates, etc., employers must be able to show that their piece rates are meeting the minimum wage for each employee.

A neighbor of mine who is also a dairy farmer pays his employees time and a half for every hour they work over 40 hours. My employees have heard about this and requested that I pay them overtime, too. They say it’s the law.

The Fair Labor Standards Act of 1938 and its amendments address minimum wage, overtime, and child labor provisions. Overtime is any time period worked over 40 hours in a workweek and must be compensated by time and a half of the agreed upon wage rate—the workweek does not need to be identical with the calendar week. Agricultural production operations are exempted from paying overtime wages. That means as long as employees are limited strictly to agricultural production, from a legal standpoint there is no requirement to pay more than the standard rate. However, many agricultural employers have found that their employees are more motivated and more willing to put in the extra hours, if they receive extra compensation. Therefore, dairy farmers often choose to pay a higher hourly wage for hours worked beyond the typical weekly load.
Recently, I received a letter from the Social Security Administration stating a mismatch of names and social security numbers for two of our employees. Must I fire these employees?

A letter from the Social Security Administration, advising an employer that names and numbers of one or more employees do not match their records, is not a statement about employees’ immigration statuses. Therefore, it is not appropriate and may be considered discriminating to fire an employee based on such a letter. The best policy to deal with social security “mismatch letters” is to follow the letter literally, i.e., inform the employee first verbally and then in writing to his or her home address that there has been a mismatch and ask them to correct the problem. A sample letter can be obtained from the author. Misspelled names, a mixed up order of numbers, or an error in the order of composite names can result in “mismatch letters.” To avoid discrimination, it is recommended to follow the same procedure for each case. It is also helpful to document any steps taken to correct the mismatch. Documentation is important because it establishes a good faith effort. If at any time during the process an employer discovers that the employee is not eligible to work in the U.S., e.g., because the employee says so, employment must be terminated.

I have heard that I can check social security numbers of prospective employees before I hire them to protect myself against hiring illegal immigrants. How do I do this?

Social security numbers mismatching employee names are not a statement about an employee’s immigration status or eligibility to work in the U.S.; therefore, an employer should not use the checking service that the Social Security Administration provides for job applicants. An employer can choose to check current or former employees. If an employer starts checking newly hired employees, all newly hired employees should be checked. If an employer decides to check her or his database, then all employees should be checked to avoid a discrimination charge.

Currently, the Social Security administration offers two options to check employees’ social security numbers. To verify up to five numbers call 1-800-772-6270. The employer will need to provide the following information: name of company and employer identification number (EIN), social security number of employee, last name, first name, middle initial, date of birth, and gender. Up to 50 names can be verified through the local Social Security Office. The Social Security Administration is testing an online service that is planned to be available in 2005.

There are laws and legislations about everything. What is the regulation for firing someone? Is there a set number of warnings that I must issue before firing an employee?

Michigan is an “at-will” employment state, which means that theoretically either employer or employee can terminate the employment at any time with or without reason. However, this doctrine holds only if the employer has not promised otherwise in a contract, a contract-like agreement, through rules established in an employee handbook, or verbal statements (beyond passing remarks). In addition, firing should never be discriminatory or retaliatory.

When no records exist, any allegations against an employer may be assumed correct. Therefore, many employers prefer to create a paper trail before firing an employee. Yearly evaluations documented in each employee’s file, even if informal and short, provide a record of the employee’s performance. Firing for performance deficits must not come as a surprise to an employee.

In case of disciplinary action, a policy establishing a progressive discipline process with a verbal warning, a written warning, and a suspension without pay or a decision making leave with pay, is a common approach. Of course, there are situations that warrant immediate suspension, such as theft or violence. Those should be addressed explicitly in the discipline policy. When something severe has happened, a signed witness statement helps to establish a paper trail. Employers should not act on impulse. Before firing someone, stipulating immediate suspension and taking a day or two to get all the facts and make the final decision is in order.

I have an employee whom I want to fire. How do I handle this in a professional manner?

Once the decision to fire an employee has been made, it is recommended to follow through with it as soon as possible. Firing should be planned carefully. It is a good idea to do it in person, not on the phone or in a letter. While firing must be done in private, not in a public place, a neutral site works better than the manager’s office. An employer should not compliment the employee he or she is about to fire on the excellent work they have done. It works better to skip any small talk, get right to the point, and keep it short. “You are fired,” is not necessarily the best way to phrase the decision. How about something along the lines of “Your skills do not match the needs of our farm” or “It is not working out”? Explain why the employee is let go. Afterwards, the employee needs some time to cool down and be reasonable. Therefore, the employer should listen and be available for questions. It also is important to identify the next step, e.g., getting the employee’s belongings and escorting him or her off the premises.

I do not recommend firing on a Friday. Firing earlier in the work week, enables the employee to take an active approach to the situation, such a contacting government agencies and other prospective employers. Having a weekend ahead with nothing to do, often causes fired employees to get very upset about their situation.
What can I do to make sure I am in compliance?

There are three ways a manager can prepare for an audit: record-keeping, record-keeping, and record-keeping. Most auditors look favorably upon a good faith effort. If an employer is able to show an effort to comply and do the right thing, penalties might not be assessed or assessed on a minor level. Some examples of records to be kept in a systematic way include: I-9 forms and any copies of documentation presented (in a separate file), the required records on wages, hours worked, and others prescribed by the Department of Labor, certificate of age and parental consent for minors (in a separate file), and individual personnel files, including evaluations, disciplinary information, emergency contacts, and other employee-related documents.

A technique to ensure that records are up-to-date is a self-audit. Managers can use a time when there is less other work to go systematically through their files and make sure all are complete and current. Farmers working with accountants should discuss employee records with them and enlist their help. If missing files, I-9 forms, or wage and hour information are discovered, it is advised strongly to update the missing information but not falsify any files. Auditors respect efforts to comply even if they reveal past gaps.

U.S. labor law is case law, which means that it changes over time even without new regulations being passed. To stay current, it helps to receive a newsletter, follow newspapers and televised discussions, or visit related websites regularly. A farmer who has been informed that any kind of labor-related audit is pending should contact an experienced agricultural labor attorney or similar professional service, immediately. There is no substitute for professional advice.

Suggested additional resources
- Social Security Administration, Employer Services at 1-800-772-6270, http://ssa.gov/employer and local offices.

Disclaimer
This information has been compiled from reliable sources as of February, 2004. It is a reference for general educational use. It does not constitute legal advice and the author and publisher assume no liability for actions taken based on the information provided. It is the employer’s responsibility to keep abreast of current laws and changes.

Heifer Management

Dairy Replacements: Where Are They?

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Southwest Michigan

“Where can I buy some heifers?” is now a familiar phone inquiry from dairy farmers needing heifers to maintain herd size and those planning to expand. Management practices and the government importation ban of Canadian dairy cattle have restricted dairy replacement numbers in the U.S. What is the status of dairy replacements in the United States and what are the management practices that impact supply and price of dairy heifers?

Cow and Replacement Numbers

Firstly, how many replacement heifers are there and has this number changed over time? Table 1, on page 12, lists the cow and replacement numbers as reported by USDA, National Agricultural Statistical Service, for the past 10 years. Cow numbers have declined from 9.6 million head in 1994 to 8.99 million cows in 2004, a consistent downward trend for decades. Replacements also have declined from 4.2 million head to around 4 million head in the last 10 years. The dairy replacements reported by USDA include only heifers over 500 pounds of body weight. As a percentage, replacements per 100 cows, has improved from 43.5 in 1994 to 44 to 45% for the years 2001 to 2004. Any percentage larger than 45% is considered an expansion rate. During 2004, USDA expects 2,761,000 milk cow replacements to calve, down 4% from 2003.

The Dairy 2002 National Animal Health Monitoring System (NAHMS) study provides information about dairy operations in the United States. It identifies health related segments of dairy operations that impact cow numbers and potential replacement heifers for the herd. NAHMS reports that of the dairy heifers born alive, 8.7% died before weaning. Nearly 2% of weaned heifers died between weaning and calving. Overall, 10.5% mortality of heifers in 2001 essentially was unchanged from 10.8% in 1995.

Cow Herd Culling Impact

Secondly, considering the need for replacements in the cow herd, 4.8% of the January 1 cow inventory died in 2001. That’s over 440,000 head. The NAHMS Dairy 2002 survey reports 24% of cows were culled. Larger operations culled a larger percentage (27.6%) than medium (23.5%) or small (23.3...
% operations. While 60.3 percent of the cows were culled after 200 days in milk, about a fourth (24.1%) were culled between 50 to 199 days in milk. Another 15.6 % were culled at less than 50 days in milk, indicating forced culls early in lactation. Large and medium operations culled more cows at less than 50 days in milk (17.2% and 16.7 % respectively) than small herds (12.2 %). Lameness cases were similar across all herd sizes with 20.4 % of cows and 8.1 % of heifers reported lame during the previous 12 months.

**Economic Loss From Herd**

Due to culling or death, 30% or more of the herd needs to be replaced each year. This does not take into account individual farm expansion requirements for replacements. The 2002 Dairy Farm Business Analysis Summary from Michigan Telfarm records shows a drastic difference of breeding livestock inventory for low versus high farms based on return on assets (ROA). The low 25% ROA farms had a negative $27,663 Depreciation and Capital Adjustment for Breeding Livestock while the high 25% ROA farms had a positive $23,438 value. This is a $51,101 difference between these two groups of herds and represents 28% of the difference of Net Farm Income between the highest 25% and the lowest 25% of farms.

In May 2004 the average annual percentage of cows that left the herd for 775 Michigan DHIA farms was 37%, which included 6% average death loss for the herds (4). These herds have a current actual calving interval of 14.1 months and a projected calving interval of 14.9 months. In a 12-month period only about 83 % of the cows will calve. Remember also that the long term average of heifer calves born is about 46%.

Table 2 compares reasons producers reported why dairy cows left the herd. Cows selected to leave the herd for poor production were about 14 to 19% of total culls. Mastitis, reproduction, lameness and injury were other top reasons for cows leaving dairy herds. It is clear that many health related events result in cows leaving the herd, thus requiring a replacement.

**Demand Drives Prices**

Demand for replacement heifers may out pace the supply, thereby driving up the prices to grow heifers. If you cannot find a supply of replacement heifers at a price you are willing to pay, you can improve management practices to reduce your need for replacements. Recently, the shortage of heifers has contributed to the milk price increase that will provide added capital for dairy farmers to reinvest in facilities and practices that can increase heifer and cow numbers. Improved cow comfort, higher quality facilities, improved reproduction, and other management practices should reduce cow and heifer mortality. Many of these practices to improve cow and heifer health may only require management changes rather than large capital investments. They are “doable” on your farm with a focused goal and implemented standard operating procedures. Involve your on-farm management and off-farm consultant teams in tackling the major reasons for cows leaving the herd on your farm.

<table>
<thead>
<tr>
<th>Year</th>
<th>Milk Cows head</th>
<th>Replacements million head</th>
<th>Replacements per 100 cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>8.99</td>
<td>4.02</td>
<td>44.7</td>
</tr>
<tr>
<td>2003</td>
<td>9.15</td>
<td>4.10</td>
<td>45.0</td>
</tr>
<tr>
<td>2002</td>
<td>9.11</td>
<td>4.06</td>
<td>44.6</td>
</tr>
<tr>
<td>2001</td>
<td>9.20</td>
<td>4.05</td>
<td>44.2</td>
</tr>
<tr>
<td>2000</td>
<td>9.19</td>
<td>3.95</td>
<td>43.5</td>
</tr>
<tr>
<td>1999</td>
<td>9.14</td>
<td>4.06</td>
<td>44.6</td>
</tr>
<tr>
<td>1998</td>
<td>9.19</td>
<td>3.98</td>
<td>43.3</td>
</tr>
<tr>
<td>1997</td>
<td>9.28</td>
<td>4.04</td>
<td>43.6</td>
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<td>1996</td>
<td>9.41</td>
<td>4.11</td>
<td>43.6</td>
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<tr>
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<td>9.53</td>
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<td>43.6</td>
</tr>
<tr>
<td>1994</td>
<td>9.64</td>
<td>4.20</td>
<td>43.5</td>
</tr>
</tbody>
</table>

Source: Cattle, USDA, National Agricultural Statistics Service.

<table>
<thead>
<tr>
<th>Reason for culling or left herd</th>
<th>NAHMS Dairy 2002</th>
<th>DHIA 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastitis</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Udder problem</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Reproductive problems</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>Poor Production</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>Lameness or injury</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Feet or Legs</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Injury and other</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Disease</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Other or (not reported)</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Aggressive behavior</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Dairy Purposes</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Died</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

1Some categories do not match or are combined between the reports.
Where do you find replacements? Maybe on your own farm! Quality heifer rearing will insure an adequate supply of dairy heifers for the industry. Reduced culling and mortality in the cow herd will help reduce the need for new replacements.

References

Dairy Foods

I Said Grana Cheese, Not Granny’s Cheese!!

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As promised in the last installment of the cheese travelogue, a trip up the Italian peninsula to the Po River Valley and Lombardy region of the Italian Alps will bring us to a discussion of a very interesting class of cheeses known as “grana”-type. The two major contributors to this category of cheese are Parmigiano-Reggiano and Grana Padano. The “grana” name comes from the Latin for grain and results from observation of the distinctive grainy texture of these traditional cheeses. Grana cheeses are often referred to as grating cheeses due to their very hard body and flavor profiles that make them desirable and familiar garnishes to many foods from pasta to salads.

Both cheeses are on the list of 30 Italian varieties protected by the European Union’s (EU) program of “Protected Designation of Origin” (PDO). Therefore, in the EU only cheeses made in the designated geographical locations may be labeled and marketed with the Parmigiano-Reggiano and Padano names. In the U.S. market, domestically produced grana cheeses are called Parmesan. Much of the domestic production ends up in the grated cheese containers found on tables in both institutional and home environments.

Unpasteurized Cows’ Milk Still Used in Cheese

Although advances in the science and engineering of the cheese manufacturing industry have allowed for larger plants to be built, these special cheeses are still made from unpasteurized cows’ milk. In ages past, poor quality milk resulted in the use of small amounts of formaldehyde to prevent souring of the milk during gravity separation in shallow pans. In modern plants, high quality milk is refrigerated, the pans have been replaced by centrifugal separation, and a non-heat process called bactofugation, which is capable of removing most bacteria, especially Clostridium tyrobutyricum. The removal of C. tyrobutyricum is important because spores of this organism can germinate in the aging cheese to produce gas, thus causing a defect known as late blowing.

The properly prepared milk is added to copper kettles where starter cultures and rennet are added for coagulation of the milk. The curd is cut into small pieces about the size of grains of rice. The curd is cooked, followed by removal of all the curd at once for molding in large 60 to 80 pound cylindrical hoops and pressed for about 10 hours. The cheeses are then held for 3 days before being placed in salt brine for 14 to 16 days. After salting, the cheeses are placed on shelves in the aging room where they must be turned frequently to maintain the symmetrical squat-barrel shape. Grana Padano tends to be slightly lower in fat that Parmigiano-Reggiano and therefore ages a little faster; however, 18 months is a minimum and both cheeses are often aged for 24-36 months to develop the best possible flavor profile.

Traditional Italian Cheeses Made Since 1100s

Grana Padano and Parmigiano-Reggiano have been manufactured in this region since the 1100s and they are the most important cheeses in Italy. Traditionally, both cheeses were produced seasonally between mid-spring and mid-fall when cows were on pasture and producing excess milk. Although both cheeses are now manufactured year round by similar methods, differences in cheese characteristics result from seasonal feed differences and type of feed. Cheeses made in the late spring, summer and early fall while cows are on pasture or getting fresh feed tend to have a more golden color and a richer, grassy flavor profile. Producers in the Po River Valley also use corn silage which results in a whiter color and a richer, grassy flavor profile. The corn silage also tends to be a source for C. tyrobutyricum, so proper milk preparation is very important for the Parmigiano-Reggiano manufacturer.

Although most know Grana Padano and Parmigiano-Reggiano as a garnish, the uses for these outstanding cheeses are much broader. Whether using imported or domestic grana cheeses, when used as an ingredient in a variety of foods, they provide not only excellent flavor enhancement but are good sources of protein and calcium. Also, do not overlook using these fine cheeses as part of an appetizer or dessert, as they are excellent compliments to fine baked goods, fruits, vegetables and wines.

As long as the foothills of the Alps have been reached, next time a little mountain climbing will provide a chance to explore the world of Swiss-style cheeses.

References
Enterobacter Sakazakii:
A Pathogen Linked to Powdered Infant Formula

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Enterobacter sakazakii is an occasional cause of sporadic outbreaks of sepsis, meningitis, and necrotizing enterocolitis in human infants. Intrinsic contamination of powdered infant formula (PIF) with *E. sakazakii* has been linked to infection and illness in infants less than 1 year of age. On April 9, 2002, the Food and Drug Administration (FDA) alerted health professionals regarding the risk associated with *E. sakazakii* infections among neonates in conjunction with the recall of PIF containing *E. sakazakii*. (3,4). In this review, we present general information on occurrence of *E. sakazakii* in PIF, possible contamination sources, and some key strategies for managing *E. sakazakii* during manufacture and use of PIF.

The Organism Enterobacter Sakazakii

*Enterobacter sakazakii* is a motile, non-spore-forming, Gram-negative facultative anaerobic bacterium belonging to the family *Enterobacteriaceae*. This organism was classified as a ‘yellow pigmented *Enterobacter cloacae*’ until 1980, when it was designated as a new species in honor of the Japanese bacteriologist Riichiazaki (5).

Although associated with infant death in 1958 (12), *E. sakazakii* was brought to public attention only recently as a result of several outbreaks and product recalls (3, 4, 7). The World Health Organization classified both *E. sakazakii* and *Salmonella enterica* as category A pathogens based on the severity of illness in infants. Both of these pathogens can occur in PIF, which has been linked both epidemiologically and microbiologically to infections in infants (7). The International Commission for Microbiological Specifications for Food identified *E. sakazakii* as ‘a severe hazard for restricted population, …life threatening or subsequently chronic sequelae of long duration’. *Enterobacter sakazakii* has the same severity ranking as other foodborne pathogens such as *Listeria monocytogenes*, *Clostridium botulinum* types A and B, and *Cystosporidium parvum* (6).

Populations Susceptible To Infection

*Enterobacter sakazakii* causes meningitis, bacteremia, sepsis, diarrhea, and necrotizing enterocolitis (6, 7, 9, 12). Although *E. sakazakii* can cause disease in all segments of the population, infants less than 1 year of age are most prone to infection. (6, 7, 9). Of those infants infected, approximately half had birth weights less than 5.5 lb and two-thirds of these were premature, being born at less than 37 wk gestation. The United States FoodNet survey (2002) estimated that the rate of *E. sakazakii* infection was 1 per 100,000, whereas the rate among low birth weight neonates was 8.7 per 100,000. In a review of 48 *E. sakazakii* cases from 1962 to 2003, 25 (52%) cases involved infants of low birth weight with immunocompromise or medically debilitated infants likely being more susceptible to *E. sakazakii* infections (6, 7, 9).

Outbreaks Associated With Infant Formula

Worldwide, more than 75 cases and outbreaks of *E. sakazakii* infection have been documented in neonates and infants from 1958 to 2002 (6). Although the reservoir for *E. sakazakii* is usually unknown, an increasing number of reports have established PIF as the source and vehicle of infection (6, 7, 8, 13). In 1983 Muytjens et al. (10) were first to report the association between *E. sakazakii* infection and PIF while investigating eight cases of meningitis and sepsis in the Netherlands (12). *Enterobacter sakazakii* was isolated subsequently from prepared infant formula, a dish brush and a spoon (6). Van Acker et al. (13) described 12 cases of neonatal necrotizing enterocolitis that occurred in 1998 in Belgium. Eleven strains of *E. sakazakii* were isolated from stomach aspirate, anal swabs and blood samples and 14 strains were isolated from commercial infant milk preparations. Using molecular typing, the milk and patient isolates were identical. In 2001, the Centers for Disease Control and Prevention (CDC) investigated several *E. sakazakii* outbreaks in Tennessee involving neonatal intensive care units (1). One male infant born at 33.5 weeks developed meningitis 11 days after birth and died 9 days later with *E. sakazakii* isolated from the cerebrospinal fluid. Ten additional cases of *E. sakazakii* infection were identified subsequently at the same facility. Feeding of PIF, from which *E. sakazakii* was eventually isolated, was the only factor associated with illnesses (1). PIF is now widely recognized as the major vehicle and source (direct or indirect) of *E. sakazakii*-induced illness in infants with FAO/WHO estimating that 50 to 80% of cases in infants traceable to PIF (7).

Enterobacter Sakazakii Found in Infant Formula

Several outbreaks have been traced to contaminated PIF (6,7). Unlike liquid infant formula, dry milk powders are not sterile. In 1988, Muytjens et al. (10) reported that 52% of 141 PIF samples from 35 countries were contaminated with *Enterobacteriaceae*, 25, 21 and 14% of which contained *E. agglomerans*, *E. cloacae*, and *E. sakazakii*, respectively. Infant formula from 13 of the 35 countries contained *E. sakazakii* at levels of 0.36 to 66.0 colony forming units (CFU)/100 g (6). Nazarowec-White and Farber (1997) reported *E. sakazakii* in 6.7% of 120 cans of PIF from five different companies in Canada. The levels of *E. sakazakii* in positive samples were typically 0.36 CFU/100 g (11). Although the
numbers of *E. sakazakii* in PIF are low, a lapse in hygiene during preparation followed by extended holding of the rehydrated product at refrigerator abuse temperatures can lead to levels sufficiently high to cause outbreaks of illness (6). While the infectious dose for *E. sakazakii* is currently unknown, FAO/WHO maintains that levels as low as 3 CFU/100 g of formula can cause infections in infants (7).

**Sources of Enterobacter Sakazakii Contamination**

Powdered infant formula is produced from milk, milk derivatives, soy protein isolate, carbohydrates, fats, minerals, vitamins, and some food additives. These ingredients typically are mixed with water and then pasteurized at 71.6°C for 15 sec, 74.4°C for 25 sec or 105-125°C for at least 5 sec. The mix is then homogenized, and stored in large holding tanks at 4°C. Vitamins are incorporated into the mix just before spray drying. In the drying process, the mix is heated to 82°C and then pumped under high pressure to spray nozzles or an atomizer mounted in the drying chamber through which flows filtered air ranging from 135 to 204°C at the inlet to 45 to 80°C at the outlet. The mix is dried instantly after exiting the spray nozzle or atomizer and the powder falls to the bottom of the drier for collection. The final product is then filled into cans or other containers that are flushed with inert gas, sealed, coded, labeled, and packed into cartons for shipping (7). A number of critical control points where *E. sakazakii* can be introduced into PIF during production and use are shown in Figure 1.

*Enterobacter sakazakii* does not survive the heat treatment during production of PIF (6, 7), and most likely enters the finished product as a post-pasteurization contaminant from the factory environment or from heat sensitive micronutrients added after heating. However, the final product also can become contaminated during bottle preparation in the hospital or at home. *Enterobacter sakazakii* has been isolated from dairy processing environments and hospital kitchen equipment including cleaning brushes, blenders, and mixing spoons (6). *Enterobacter sakazakii* has been isolated from a range of foods including cheese, fermented bread, tofu, sour tea, cured meats, minced beef and sausage meats, sorghum seeds, rice seeds, and vegetables (6, 7). The organism has been recovered from flies and rodents, and also comprises a portion of the normal microflora of soil, water, and various plants. Thus, *E. sakazakii* is widespread in the natural environment.

**Growth Characteristics of Enterobacter sakazakii**

The minimum growth temperature for *E. sakazakii* in common laboratory media is strain-dependent, varying from 5.5 to 8°C, with the organism dying off slowly at 4°C. The maximum growth temperature for clinical and food isolates ranges from 41 to 45°C. At room temperature (22°C), this organism has a doubling time of about 75 min in reconstituted infant formula. The doubling time at low temperature is approximately 10 h in infant formula at 10°C, suggesting that growth occurs in some home refrigerators (6, 7). *Enterobacter sakazakii* is thermotolerant. According to Nazarowec-White and Farber (11), *E. sakazakii* exhibited D values (i.e., the time required to decrease the population 10-fold) of 54.8 min and 2.5 min at 52 and 60°C, respectively, in reconstituted infant formula.

When dry infant formula was inoculated to contain 10⁶ *E. sakazakii* CFU/ml and held at room temperature for 1.5 years, populations declined about 2.5 logs during the first 6 months of storage with a lesser decrease thereafter (2). Thus, holding dried infant formula at room temperature will not ensure complete elimination of *E. sakazakii*.

**Reducing Risk of Enterobacter Sakazakii Infection**

At a 2004 FAO/WHO meeting in Geneva, Switzerland, the following strategies were suggested to reduce the risk of *E. sakazakii* in PIF during production and subsequent use (7).

1. **Concentration/prevalence of *E. sakazakii* in PIF**
   - Develop a supplier assurance scheme and monitor raw materials.
   - Reduce levels of *Enterobacteriaceae* in the production environment. Key aspects could include effective separation between wet and dry processing operations and an effective plant hygiene program within a HACCP plan.
   - Monitor and test for the prevalence of *Enterobacteriaceae* in finished products.
   - Tighten the Codex microbiological specifications for PIF that were first developed in 1979.

2. **Effect of heating and pasteurization**
   - Where feasible, use commercially available sterilized liquid products as a replacement for powdered formula.
   - Employ an effective point-of-use pasteurization step following formula reconstitution.
   - Reconstitute PIF in hot water at 70 to 90°C.

3. **Minimize contamination of reconstituted formula during preparation.**

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**Figure 1. Critical control points (CCP) for introduction of *E. sakazakii* into PIF during manufacture.**

- **Raw ingredients**
- **Heat**
- **Dry**
- **PIF**

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**Table 1. Critical control points (CCP) for introduction of *E. sakazakii* into PIF during manufacture.**

<table>
<thead>
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<th>Critical Control Point</th>
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<td>Raw ingredients</td>
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<td>Dry</td>
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<td>PIF</td>
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**Figure 2. Flowchart of PIF production process.**

- **Raw ingredients**
- **Heat**
- **Dry**
- **PIF**

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**Figure 3. Flowchart of PIF production process.**

- **Raw ingredients**
- **Heat**
- **Dry**
- **PIF**

---

**Figure 4. Flowchart of PIF production process.**

- **Raw ingredients**
- **Heat**
- **Dry**
- **PIF**
• Use good hygienic practices to prevent cross contamination from the environment and equipment during preparation.

4. Minimize the growth of E. sakazakii in reconstituted PIF before consumption.
• Ensure rapid cooling of reconstituted product and store at 4°C if not for immediate use.
• Reduce the length of time between reconstitution and consumption.

Summary
When present in PIF, E. sakazakii can cause fatal infections in infants, including sepsis, meningitis, and necrotizing enterocolitis. Children less than 1 year of age, especially those that are pre-term, immunocompromised, or of low birth weight are at greatest risk of illness. Although the concentration and prevalence of E. sakazakii in PIF are both very low, the risk increases dramatically if the organism is allowed to multiply during preparation and holding of reconstituted PIF prior to consumption. Contamination of PIF by E. sakazakii will most likely occur after pasteurization and in preparation of reconstituted formula. The risk of an E. sakazakii infection can be reduced through good hygienic practices in both the manufacturing and hospital/home environments. More work is needed urgently to better understand the epidemiology, ecology and means by which this emerging pathogen produces life-threatening illnesses in infants.

References

Industry and University
North American Intercollegiate Dairy Challenge
Miriam Weber Nielsen and Joe Domecq
Dept. of Animal Science

The MSU team captured runner-up honors in the 3rd annual North American Intercollegiate Dairy Challenge held at Pennsylvania State University on April 2-3, 2004. The dairy management contest tests students’ skills and knowledge of all aspects of a dairy business in an interactive, educational and challenging contest. Students on the MSU team were Lindsay Kirk (St. Johns), Kristin Kramer (Harbor Beach), Ashley Liddy (Gladwin) and Beth Munsell (Fowlerville). The team was coached by Joe Domecq.

Twenty-five four-person teams from 23 four-year college programs across the nation visited one of three dairy farms at the start of the contest. The three contest farms in the Altoona, PA area were PA Fair Valley Farms, a 530-cow operation owned by Randy and Karen Huntsman of Martinsburg; Kulp Family Dairy LLC, owned by Larry and Phil Kulp, a 1,350-cow operation also located near Martinsburg; and Weeping-Hollow Farms, a 515-cow herd owned by Bill and Bertha England of Williamsburg. Students were given selected farm records and then walked through the farm operation. After the farm visit, each team had the opportunity to interview the farm manager. In addition, students were provided with a laptop computer containing an electronic version of the herd’s production records. The teams of four students then used this information to develop management recommendations, which were presented to a panel of five judges for evaluation and feedback.

Top honors were taken by Virginia Tech, University of Idaho, and University of Wisconsin-Madison, with each team receiving an $800 cash scholarship. Michigan State University, Cornell University and the Coast-to-Coast Aggregate Team with students from North Dakota State University, Penn State, University of Vermont, and Washington State University earned the runner-up awards and $400 cash scholarships.

Dairy Challenge Prepares Students for Dairy Industry
The Dairy Challenge was created to enhance the education and preparation of students for careers in the dairy industry. Michigan State University has partnered with the dairy industry since 2000 to stage an annual Dairy Challenge that combines the idea of a competition with concepts of farm evaluation used in dairy farm management classes at universities.

With leadership from a steering committee of dairy industry enthusiasts, the event was expanded to a national competition. This year, members of the steering committee recruited over $90,000 from the dairy industry to fund contest activities and
to provide travel support to universities. Staff from Pennsylvania State University and AgChoice Farm Credit coordinated the contest.

The students representing MSU in the national contest were selected from four-year students participating in the MSU Dairy Challenge held February 27-28. The contest farm was K&K Dairy near Portland, owned by Bob and Diane Keilen. The winning team received a $1,000 cash scholarship and consisted of Josh Gamble (New Carlisle, IN), Tom Oesch (Alto, MI), Brent Simon (Pewamo, MI), and Bryant Trierweiler (Portland, MI), all 2004 graduates of the Ag Tech Dairy Management program. The runner-up team, which received a $500 cash scholarship, consisted of Lindsay Kirk, Kristin Kramer, Ashley Liddy, and Beth Munsell. Additional participants in the contest were Emily Blair, a junior in Animal Science from Jackson; Beth Douglass, a sophomore in Animal Science from Pioneer, OH; Matt Jakubik, a sophomore in Agriscience from Whittemore; Aron Jaskolski, a junior in ANR Communications from Alpena; Josh Lehman, a freshman in Animal Science from West Branch; Katy McCracken, a freshman in Animal Science from Carson City; Matt Munsell, a freshman in the Ag Tech dairy program from Fowlerville; and Carlyle Westendorp, a freshman in the Ag Tech dairy program from Nashville.

Cargill Animal Nutrition sponsored cash scholarships and meals for the event, a gift of appreciation to K&K Dairy Farm, and tickets for all contest participants to the MSU Dairy Club banquet where awards were announced. Judges for the contest were Dr. Jerry Kehr, Portland Veterinary Clinic; Dr. Kathy Lee, MSU Extension Dairy Team; Ed Nichols, NorthStar Cooperative; and Jody Whitmore, Cargill Animal Nutrition.

The Department of Animal Science is grateful to the Dairy Challenge contest farm and judges for generous donation of their time and effort and sincerely appreciates the continuing sponsorship by Cargill Animal Nutrition of the MSU Dairy Challenge. Appreciation is extended to the Halbert family for establishment of the Frederick Pierce Halbert Memorial Endowed Scholarship Fund, which funded the MSU team’s travel to the national contest in Pennsylvania. Special thanks goes to Dean Ross, MSU Extension Dairy Team and Doug Brook of NorthStar Cooperative for their continued assistance in coordinating the MSU Dairy Challenge.

New Composting Manure Turner on Campus

Pam Jahnke
Dept. of Animal Science

A new manure compost turner is a key component of a goal shared by Michigan State University manure experts, who are responsible for handling an annual output of 3 million gallons of liquid manure and 12,000 tons of solid manure and bedding produced by the university’s farms and Pavilion. A minimum goal is to recycle manure from MSU’s farms as compost for campus grounds.

Compost Turner Unveiled to the Public

The compost turner was unveiled to the public in July 2003 during the Michigan Ag Expo week. Since then, MSU manure specialists have worked at the facility to fine-tune the system that includes a “proto-type” machine purchased from Global Earth Products in Canada. The turner was installed in a 66-by-150-foot roof-covered, open-ended building located at the Dairy Cattle Teaching and Research Center.

Such a system is currently in use by only one other university in Canada, said Ben Darling, assistant director of the Land Management Office at MSU.

University Farms is responsible for “handling the manure that is generated by the livestock farms on south campus,” Darling said. That includes manure from the horse, dairy, beef, sheep, and swine barns and the Pavilion. (The MSU Swine Farm does its own composting on a concrete, sheltered composting pad.)

“We are looking at ways to make the composting system better,” Darling said.
bays through a pumping system.

- Bacterial pathogens are killed after the compost heats to at least 131°F for a minimum of 72 hours.
- The compost turner, which is mounted on 6-foot high concrete walls “throws” the composting material about 8 to 10 feet down the 120-foot-long bay. It takes about 3 to 4 weeks for the composting material to reach the other end of the bay at which time it is ready for an outside curing process. The compost is placed in a large window outside, next to the facility, on a curing pad where it is covered with a fleece blanket to maintain proper temperatures and to keep it from becoming too wet. It stays on the pad for 3 to 6 months to complete the final curing process. The steps of the entire process are continuous.

The curing time is necessary to stabilize the mixture and turn the nitrogen into an organic form so it cannot leach into the ground after leaving the facility, noted Tony Boughton, manager of the compost facility.

“It has been a learning experience,” Boughton said, of the new composting process. A daily challenge has been adapting the varying moisture content to the different kinds of manure produced in different barns. For example, raw manure that arrives from the Pavilion has been produced by visiting animals, many of them horses which is much different than the liquid manure from the dairy farm.

To date the composting process has produced 500 cubic yards of cured compost, which has been used during April and May. Another 1,000 cubic yards are currently in the curing process. The goal is for the composting process to annually produce 6,000 to 7,000 cubic yards of finished compost.

**Finished Product Resembles Peat**

The finished product is an odorless material with the consistency of peat. “Right now we need to make a viable product and lighten the nutrient load off south campus,” Shelle said.

In the finished form, the compost can be transported easily away from the farms, recycling the nutrients to a more useful location. The plan “generates” a win-win for everybody. “They (University Grounds Department) end up with a product they can use and we don’t have to use,” Darling said. Ultimately, the University could save money it spends on fertilizer, peat and bedding needs.

Darling and his colleagues will be awaiting feedback from the University Grounds once the material has been used.

“So far, University Grounds seems to like what we have produced, and as we get better at what we do, the product will only get better,” Darling said.

Once the need of the University Grounds has been met “the sky is the limit” as to what the surplus – if any – could be used for, Shelle noted. He envisions the compost being used by other Departments on campus—such as Crop and Soil Science for their research plots, or by the Athletic Department for its fields. Off campus he could see it being sold in bulk to landscapers or suppliers for use as top dressing for golf courses or for grounds around municipal facilities.

Units at MSU involved in the composting facility include: University Farms, University Grounds, Land Management, Dept. of Animal Science, Michigan Agricultural Experiment Station, MSUE, Dept. of Agriculture Engineering, and the College of Veterinary Medicine.

### Alumni Profile

**Varied Career Keeps Barbara Dartt Working with Farmers**

**Pam Jahnke**

**Dept. of Animal Science**

Former veterinarian, Extension Dairy Agent, and now farm business management specialist, Barbara Dartt, has pursued a varied career while maintaining a close relationship with agricultural producers — a goal she has had since she was a Michigan State University freshman.

“I’m doing what I thought I’d be doing but I thought I’d be doing it in a veterinary clinic,” she said.

Dartt is a business consultant for Salisbury Management Services Inc. (SMS), an Eaton Rapids company with an office in Twin Falls, Idaho. The company, co-owned by Mike Salisbury and Mike Fussler, was formed in 1979.

Three out of 5 days, she finds herself on farms assisting farmers in financial management, strategic planning, and business succession planning. She works primarily with Michigan clients – from Newaygo to Lapeer and Dowagiac to Clio - although she works with SMS clients in other states as well.

**Family Business Succession A Common Concern**

Family business succession tends to be a common concern among SMS clients. “With the average age of agricultural producers at about 55 years, many are thinking about transferring the farm from one generation to the next or developing an exit plan,” Dartt said.

Only 30% percent of family owned and managed businesses are transferred successfully to the third generation, according to national figures. Business succession is a risky time in the life of any business.

Her clients are varied and include single and multiple owners of small and large farms. Some are planning for retirement and have no children, while others have extended families to consider. Business plans are customized to each operation.

“We’ve found that business succession has a higher probability of success when management responsibility is transitioned before ownership,” Dartt said.

Other clients face the unique challenges associated with
Attending MSU Was A “Family Thing”

Her decision to attend MSU as a freshman was just a “family thing.” “It didn’t cross my mind to go anywhere else,” she said. At the time, her goal was to work with agricultural producers. After 3 years as an undergraduate, she studied veterinary medicine so she would have the necessary skills to relieve the suffering of animals. She also wanted a career within the dairy industry, and she wanted to work full-time with food animals. Later she decided an economics degree might ensure successful growth. One farm client has doubled in size, from a revenue stand point, in the last 6 years. As a result of rapid growth, a common problem is that the owners are so busy with operations that they have not developed the systems and processes necessary to efficiently manage a much larger business.

Dartt’s immediate family (parents and siblings) hold eight degrees from MSU. Including Barb’s extended family – her maternal grandparents, Warren and Hazel Cook, their five children, grandchildren and spouses (20 people in all) – brings the total to 19 MSU degrees.

As a result, she earned her M.S. in agricultural economics in 1998, her Doctorate of Veterinary Medicine in 1996, and her B.S. in animal science in 1993 - all from MSU.

Advice For Today’s Animal Science Students

Her advice for today’s animal science students? “A B.S. in animal science is a flexible degree with strong science behind it—make sure you understand the breadth of career opportunities that are available to you.” She urges students to have an open mind and to seek opportunities and resources outside of the classroom.

Dartt joined SMS in September 2001, bringing experience in both financial and production management. Prior to joining Salisbury Management Services, she worked in the MSU’s Department of Agricultural Economics as a Farm Business Management Specialist. She became a Certified Agricultural Consultant in the fall of 2003. She currently coordinates the annual Michigan Bovine Practitioners Meeting and is a member of the Michigan Veterinary Medical Association Food Animal Practitioners and Ethics and Grievances Committees.

Prior to working in the MSU Department of Agricultural Economics, Dartt served as a MSUE Dairy Agent for Ionia, Kent and Montcalm counties from September 1998 through November 1999. Previously, she was a graduate research assistant for the MSU Department of Agricultural Economics, where she conducted her master’s research on the profitability, labor efficiency and quality of life on rotationally grazed Michigan dairy farms, and practiced veterinary medicine on dairy farms in the Fowlerville area.

Despite her winding career path, her career goal has remained the same: “To move my skills forward and be a valued resource for agricultural business owners.”

Editor’s Note: If you know of a MSU animal/dairy-related alumni who you would like to see featured in our column, please e-mail Pam Jahnke at jahnkep@msu.edu and include contact information.

Calendar of Events

Michigan Summer Grazing Series meetings are sponsored by the Michigan Hay and Grazing Council and the MSU Extension Forage AoE Team.

Wednesday, Aug. 18 - Tom Cook Dairy Farm near Pewamo at 6:30 p.m.. The Cook Dairy features 170 cows of mixed dairy breeds calving seasonally.

Tuesday, Aug. 24 - at 1:30 p.m. at the David McCartney dairy farm near Coleman, featuring grazing field corn as a summer slump alternative crop, and a new swing parlor.

Tuesday, Sept. 14 - at 10:00 a.m. at the Mike Iho Dairy Farm at Trenary in the Upper Peninsula. The Iho Dairy features grass and legume species mixes for U.P grazing.

For more information, visit www.msue.msu.edu/fis/workshops.htm on the web or contact Jerry Lindquist, Extension Agriculture Agent at the Osceola County MSU Extension Office at 231-832-6139.

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