The Dairy Conference is held in conjunction with the meetings of the
Dairy Food Safety & Quality Conference
North Carolina Dairy Youth Foundation Board Meeting
SUDIA/American Dairy Association of North Carolina and the North Carolina Dairy Producers Association

February 15-16, 2006
Holiday In
Salisbury, North Carolina
The Dairy Conference Is An Educational Program For North Carolina’s Dairy Herd Managers And Dairy Industry Personnel

The annual conference is sponsored by the North Carolina Dairy Producers Association, and is conducted with the assistance of Dairy Extension Specialists in the Department of Animal Science at NC State University

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Edited by Dr. Donald E. Pritchard, Extension Dairy Specialist, Department of Animal Science, North Carolina State University Box 7621, Raleigh, NC 27695-7621

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February 16, 2006

Dear Dairy Producers and Dairy Industry Representatives,

The North Carolina Dairy Producers Association is pleased to be sponsoring the 55th Annual Dairy Conference. Working with the Extension Dairy Specialists from North Carolina State University, I feel that we have designed an educational program that will be beneficial to North Carolina dairy producers. I hope that you find the conference beneficial, and that you will gain some new knowledge from the speakers, published proceedings, and the various exhibitors that will be of value to you and your dairy operation.

The NCDPA thanks the agribusiness exhibitors and supporters for their financial assistance in conducting this conference. Their support of this conference and the state’s dairy industry is greatly appreciated. I encourage all producers to take the time to visit the exhibitors and talk with the company representatives.

The N.C. Dairy Producers Association continues to represent the state’s dairy industry in a variety of areas and issues, both at the state and national level. I would like to thank the members for their support, and encourage others to show their support by joining the N.C. Dairy Producers Association.

Again, I hope you gain some helpful knowledge from the Dairy Conference, and that you enjoy your time here.

Sincerely yours,

Norman Jordan, Jr.
President, NCDPA
Dear NC Dairy Producers and Industry Leaders:

On behalf of the Department of Animal Science and the College of Agriculture and Life Sciences at NC State University, I welcome you to the 55th Annual North Carolina Dairy Conference. The program committee has planned an exciting educational program for you. Time has been included in the schedule to allow you to visit sponsors and their exhibits and to have opportunities to visit other producers, educators, and industry leaders. Please take advantage of this opportunity. This conference will definitely be a highlight of the year.

Your industry, and other livestock industries in the state, continue to face challenges. In a short ten-year period, your NC Dairy Producers Association has become a powerful voice on your behalf with legislators and the general public. It is important that you attend these types of events and become actively involved with the Association. The Association can effectively represent you only when it has your input and support.

Milk prices have remained at a good level throughout 2005. Although the number of dairy herds in the state continues to decline, it is doing so at a much slower rate than in the recent past. Your industry will continue to progress and contribute to the economy and well being of the state and its citizens. The Department of Animal Science continues to provide quality research, teaching, and extension programs to support you and your industry. After having been disbanded for many years, we have reorganized a Dairy Science Club with about 20 members and re-initiated the collegiate dairy judging team. We consider it a privilege and an honor to help you provide a nutritious, safe, economical product to consumers and to educate young people about the dairy industry and its products.

Thank you for attending the conference--and for the contributions you make to our department, to the college, and to the citizens of North Carolina.

Sincerely,

Roger L. McCraw
Professor and Department Head
Minimize Environmental Mastitis through Bedding and Milking Management

Dr. Mitch Hockett, Assistant Professor
NCSU Department of Animal Science

Mastitis has been estimated to cost dairy producers over $2 billion annually, or a conservative $200 per cow per year. Not only is this disease costly, but also it causes major health problems for animals and has more recently been linked to decreased reproductive performance. Reproductive inefficiency is one of the leading causes for involuntary culling of dairy animals. Therefore, mastitis negatively impacts profitability of dairy farmers in many aspects from decreased production to increased treatment cost to increased services per conception and days open.

Pathogens which cause mastitis are commonly classified as being contagious or environmental. Contagious pathogens are those that are spread from infected gland to uninfected gland or infected mammary to uninfected mammary. Contagious pathogens such as \textit{Staphylococcus aureas} and \textit{Streptococcus agalactiae} and others are typically found in infected glands and may be spread from infected to uninfected udders during the milking process through contamination by milkers' hands, dirty paper or cloth towels, teat cup liners, dip cups and even by flies. Infections attributed to contagious pathogens have decreased dramatically and can be controlled with success by correctly using the 5 point control plan, which includes proper pre-milking and post-milking udder hygiene and correct milking procedures. Through this plan, emphasis is placed on 1) hygienic teat management, 2) prompt treatment, 3) dry cow therapy, 4) proper culling of chronically infected cows, and 5) proper milking machine maintenance.

Environmental infections result from bacteria located in the environment. Some examples of environmental pathogens include \textit{Strep. uberis}, \textit{Strep. dysgalactiae}, \textit{E. coli} and \textit{Klebsiella}. Mastitis from these environmental pathogens can result from exposure that occurs during milking, but is more commonly caused by exposure between milkings. Many of these pathogens can be found basically everywhere in the dairy environment. For instance, \textit{Strep. uberis} has been isolated from the vulva, rectum, tonsils, rumen and coat of dairy cows. Considerable numbers of these bacteria have been isolated from straw bedding, recycled manure bedding, and even on pasture-based dairies. The same can also be said of \textit{E. coli}, which may be shed in manure and cause up to 30-40\% of all clinical mastitis cases. More recently it has been reported that even \textit{Klebsiella}, which was once thought to originate from the trees and soil and be brought to the farm in shavings, can also be found in the manure of animals prior to contact with bedding. \textit{E. coli} and \textit{Klebsiella} are both gram negative pathogens which are often found in manure and dirty, wet conditions.

Increased mastitis infections caused by these environmental pathogens have been attributed largely to heavy fecal contamination of both the animals and their environment or to bedding that arrives at the farm contaminated, even prior to any exposure to manure. Bedding material may provide the appropriate environment for bacterial growth and allow for prolonged exposure, especially in confinement based dairies. Considering the current
trends in dairy management systems, exposure to some sort of bacteria seems inevitable, and in fact it is. Due to the prevalence of bacteria in the environment and our inability to remove these bacteria from the dairy environment, management strategies have been much less effective at controlling the rate of environmental mastitis compared to contagious infections.

**Controlling Environmental Infections**

Environmental mastitis can only occur if bacteria come in contact with and invade the mammary. We have already discussed the fact these bacteria are present everywhere in the dairy environment including the cows’ manure, so eliminating them is not a possibility without developing a cow that no longer defecates. What a creature that would be to solve our dairy waste and decrease environmental mastitis problems! This does not paint a pretty picture for those of us battling these infections. Anyone fighting this fight knows that there are battles that are lost and those that are won, but the way to win the war is by managing cows to minimize contact cows have with bacteria and decrease the chances of cows becoming sick when they do come in contact. This may be done through correct milking procedures, dry cow therapy, vaccinations, and bedding management.

Dry cow therapy allows for creating an intramammary environment that does not allow for growth or life of bacteria. Therefore, if bacteria are successful to invade the teat, they are not able to establish an infection. Furthermore, vaccinations with products such as an E. coli j-5 bacterin have been effective to decrease the severity and the number of clinical infections occurring due to coliforms. These management strategies can be performed at the beginning or during the dry period. Conflicting results have been reported from antibiotic treatment two weeks prior to calving, but this practice does appear to be promising.

If environmental bacteria are successful at getting on the teat, we must be more successful at eliminating them during the milking process. Good milking technique can successfully eliminate most of the bacteria present on the teat end and decrease infection rates. Predipping animals with a germicidal teat dip has been effective to decrease the number of environmental infections. Care must be taken to insure that the teat dip remains on the teat long enough to have adequate contact time to kill bacteria that are present. Furthermore, more care must be taken to make sure that teats are thoroughly dried. Teats should be dipped or washed, not the udder. Teats or udders that are wet at time of attachment of the milker unit may lead to bacteria sneaking down into the teat cup during milking. If the liner slips on the cow teat and bacteria are present in the milker unit, they may be forced into the teat. Effectively, this doses cows with bacteria. Postdipping cows with a barrier teat dip can provide protection for the cow against coliform infections. Germicidal post dips have been more effective against Streptococci infections. Post dips give the cow added protection from bacteria in the environment until the teat has time to reseal, decreasing the number of bacteria that enter the teat.

We will focus the rest of our attention on the environment we give cows. Environmental bacteria enjoy warm, wet, dirty areas. In fact, they thrive there. Barn lots and alleys covered in manure and stalls full of dirty, wet shavings are perfect areas for large
numbers of these environmental bacteria to develop. Therefore, it is most important that we maintain bedded areas that are clean and dry. Bacterial number in the bedding is very closely related to the number of bacteria found on the teat end and the more bacteria present on the teat, the more environmental mastitis occurs. Therefore, it is very important to manage bedding and bedded areas to decrease the number of bacteria present to be exposed to cows.

Two most commonly used bedding sources in the south are sand and shavings. In general, sand is a dry bedding that drains effectively. It is often cooler for cows to lay on during the summer and is considered more comfortable than many bedding alternatives. Lower correlations have been reported between the number of bacteria present in sand bedding and that found on the teat compared to shavings. However, some waste management systems do not handle sand, and without ways of separating it from the manure, systems utilizing a lagoon are apt to fill with sand. Equipment to handle and move this heavy bedding is costly. Sand may be more costly than other bedding alternatives depending on sources that are available. One predominantly Jersey herd and one Holstein herd in North Carolina have reported their bedding costs with sand average between $6.5 and $10 per free stall per month, respectively. The Jersey herd spends an additional $10,000/year to clean out the lagoon. Over the 460 freestalls in this herd, this averages $1.80 per month, bringing the cost per stall to $8.30 per stall per month.

As an alternative, shavings are much lighter in weight and easier to move and handle. They require less management and do not fill lagoons as sand does. Depending upon supplier, they may be cheaper than sand. The same Holstein herd in North Carolina averages $5 per freestall per month when bedding with shavings. However, there are drawbacks to shavings. Supply may be a limiting factor, and some suppliers have seasonal shortages. Furthermore, shavings have been implicated for being the source of *Klebsiella* on the farm. While it is not the only source, shavings may come to a farm contaminated with large numbers of *Klebsiella* which originated from trees or dirt.

A 2004 study performed by Zdanowicz and others at the University of British Columbia measured the *Klebsiella*, coliforms and *Streptococcus* populations on the teat ends of cows that were managed on either shavings or sand for 6 days. This study found that there were 2 times more coliforms and 6 times more *Klebsiella* bacteria on teat ends of cows housed on sawdust compared with those housed on sand. However, there were 10 times more Streptococcal bacteria on teats of cows housed on sand compared to those housed on shavings. Another study reported in 2005 from Kristula and others at the University of Pennsylvania confirmed that *Klebsiella* and coliform numbers in sand bedding increased dramatically over time in the summer, but were at very low levels compared to the high levels of *Streptococcal* species. What does this mean? Different bacteria may be found in differing numbers in different bedding. Some people prefer a soft mattress while others prefer a firm mattress. Similarly, different bacteria prefer or require different environments to thrive. Culturing milk from mastitis cows on the farm will lead to an understanding of what type of bacteria are causing mastitis in the herd and may help a producer decide if a switch in bedding is warranted. There are products available to mix with bedding that are promoted to decrease bacterial numbers. Many of these work by
changing the pH of the environment to either acidic or basic to try to decrease the ability of the bacteria to survive. Some have used these products with success, however in order to maintain the effects, most have to be applied every few days.

In all the studies mentioned above, one thing was consistent: bacteria numbers in bedding INCREASED over time regardless of the type of bedding used OR the bacteria in question. Manure and moisture in the bedding creates a place for bacteria to thrive. Bedding should be managed such that we maximize comfort for the cow, but create an uncomfortable bed for the bacteria. Changing bedding, especially in the back 1/3 of the stall should decrease the number of bacteria present in the stall. Remember that the number of bacteria in the bedding is highly correlated with the number of bacteria found on the teat, which is also correlated with increased incidence of environmental mastitis.

Lactating cows are not the only cows that are exposed to bacteria daily. Dry cows are often overlooked and under-managed. Managing the bedding and environment of dry and springing cows is equally important, especially at dry off and the 1-2 weeks prior to calving. While we cannot eliminate bacteria from the environment, managing the environment we present to the cows to make it as uncomfortable to bacteria as possible, coupled with proper milking techniques will help us with the war against environmental mastitis.
Dairy Research Projects in Progress

Dr. Steve Washburn, Professor and Extension Dairy Specialist
NCSU Department of Animal Science

I. Project Title: Can Dairy Cow Families be Selected for Superior Fertility?

Funding for this project was provided in part by the North Carolina Dairy Foundation. This project is being worked on by graduate student, Crystal Vierhout in cooperation with Steve Washburn, Joe Cassady, and John Clay.

Objectives include an examination of historical DHI records to identify cow families with at least 3 generations of both high production and high fertility. Within those cow families we want to compare production and reproductive performance of 4th generation daughters of cow families identified above to contemporary herdmates.

Dairy cow records from participating farms from 13 states were obtained from Dairy Records Management Systems (DRMS) and have been screened for accuracy of data. Cows were included from historical records dating back until first lactations initiated in 1983 or 1984 as foundation cows up through cows that completed lactations by August, 2005. Cows from various generations were then put in maternal family groups using dam identification within herd. Milk production and calculated pregnancy rates (based on days open) were then indexed within herd and year based on standard deviations of individual cow records from herd-year average production and pregnancy rate respectively.

The edited and indexed data are currently being analyzed by graduate student, Crystal Vierhout, to determine if there are cow families with multiple generations of above average fertility and above average production. There is evidence in the data that such cow families exist. Those cow families that do have 3 successive generations of high fertility and above average production will have their 4th generation daughters subjected to a comparison in production and reproduction to their contemporary herdmates. Our hypothesis is that such cows will be at least equal in production but superior in reproduction to contemporary herdmates. Based on the results of the pending analyses, further analyses that take into account sire differences will also be examined.

Although the heritability of most reproductive traits in both males and females is very low, there is evidence of sufficient variance to indicate that selection progress is possible. Genetic progress for reproductive traits will be slow, but the dairy breeding industry needs to try to improve reproductive performance through genetic means. Results of this research should help determine if differences in fertility of cow families currently exists and if that could lead to an improved system for improving dairy cow fertility.
II. Project Title: Characterization of Breed Differences in Puberty and Cyclicity of Dairy Heifers and Cows in a Pasture-based Dairy System

This project is supported in part by a USDA SARE grant: LS-03-154: “An evaluation of pasture-based dairy systems to optimize profitability, environmental impact, animal health, and milk quality.” This project is part of a multi year study in cooperation with several faculty at NCSU, Clemson, and Virginia Tech.

At the Center for Environmental Farming Systems (CEFS), graduate student, Christina Williams, collected blood samples though the fall of 2005 to monitor progesterone levels among a group of dairy heifers as they approached a year of age. There was evidence that the Jersey and crossbred heifers were cycling at higher percentages at younger ages and at expected lighter body weights than were contemporary Holstein heifers. Those preliminary data have helped us to decide to monitor the next crop of heifers more intensely in order to precisely determine differences in age of puberty for Holsteins, Jerseys, and reciprocal crosses.

Although different sizes of heifers is expected among these diverse breed groups, more specific knowledge of the age of puberty will allow us to more effectively manage the heifers to see that all heifers reach targeted breeding weights, are cyclic, and are in a moderate body condition at the time of breeding. We will also be analyzing blood samples from each of the breed groups to determine if there may be breed differences in the hormone, ghrelin, that may be associated with onset of puberty. Ghrelin has been associated with secretion of growth hormone in growing animals.

In the pasture-based lactating dairy cows at CEFS, we have observed breed differences in fertility. Jerseys and crosses of Jersey and Holstein cows generally having higher conception rates than Holstein cows in our seasonal fall-calving system. These differences are very important because of the need for seasonally calved cows to cycle back and rebreed so they calve in the same season each year.

There is less is known about potential breed differences in the onset of postpartum cyclicity. Through the fall of 2005 and winter of 2006, we have been collecting milk samples twice a week from all of the early lactation cows. Those milk samples are being analyzed for progesterone by Christina Williams to determine when postpartum ovulations begin and the nature of cyclic patterns within the Holstein, Jersey, and crossbred cow groups. Because of differences in fertility associated with breed, we expect that there may also be differences in postpartum cyclicity patterns among those breed groups.

Characterization of reproductive cycles for dairy cows and heifers in the various breed groups should lead to improved strategies for improving reproduction and reproductive management.
III. Project Title: Transitioning to an Organic Pasture-Based Dairy-Beef Production System

This project is being supported by a grant from the North Carolina Extension Integrated Pest Management Committee and includes several collaborators: Steve Washburn, Eileen Coite, Matt Poore, Jim Green, Jr., Dana Hanson, MaryAnne Drake, Jean-Marie Luginbuhl, Geoff Benson, and Andrew Meier

The project objectives include monitoring growth and parasite loading in de-wormed vs. control dairy steer calves reared in a pasture-based system at CEFS. Steers are to be reared with or without use of anthelmintics through the growing and finishing stages. At slaughter, carcass and meat quality characteristics will be evaluated. Also, the economic feasibility to consider rearing dairy steers (and by inference) dairy heifers organically will be investigated.

The current proposal uses dairy steers and, if feasible from future financial analyses, is applicable to part-time farmers looking to add another source of income or to dairy and beef producers with interests in niche marketing of pasture-raised beef or possibly organically raised beef.

An abstract was published in 2005 a preliminary project funded by the Extension IPM committee:


In that study, gains of dairy steers that were dewormed or not de-wormed did not vary greatly through the first year of life although some differences in gains were noted during the late summer and fall. We also noted differences in fecal egg counts with lower levels for steers that had been dewormed. Weaning calves from milk at 6 weeks vs. 12 weeks of age made no difference in the overall performance. From those results, we determined that following the animals through a pasture-finishing phase at 16 to 20 months of age would give a more realistic picture of how well they could be grown in a pasture-based system without use of anthelmintics.

One of the question marks on potential transition to organic livestock production in North Carolina and elsewhere in the Southeast is the ability to rear young stock as beef or replacement heifers without the need for use of anthelmintics. This study should provide insights into pasture management and other management strategies to enable livestock producers to learn integrated approaches to managing internal parasites for productive and profitable beef and dairy-beef enterprises.
Mastitis and Milk Quality Research

Kevin L. Anderson, DVM, PhD, Diplomate American Board of Veterinary Practitioners (Dairy Specialty)
Professor of Ruminant Health Management
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Mastitis and milk quality are concerns for all of us in the North Carolina dairy industry. These concerns may include:

1. How to manage that acute case of coliform mastitis, or that really good cow with chronic *Staphylococcus aureus* mastitis;
2. Solving that high somatic cell count (SCC) problem due to *S. aureus* mastitis or an outbreak of environmental mastitis;
3. Maintaining milk quality in order to obtain premiums or for reasons of personal pride.

Since coming to North Carolina many years ago, one of my tasks has been to set up and operate a Mastitis and Milk Microbiology Lab. I have kept the laboratory focused on solving mastitis and milk quality problems, educating veterinary students in the essentials of milk microbiology, and supporting research in mastitis and milk quality. The following text highlights some of this research.

*Participation in studies to gain approval of flunixin meglumine for mastitis:* Early research established the rationale for use of flunixin meglumine in symptomatic therapy of mastitis. Recent research work done in North Carolina in conjunction with private dairies and the NC State Dairy Educational Unit provided data that supported a major drug company in obtaining a label claim for use of a specific brand of flunixin meglumine for therapy of mastitis. Acute mastitis cases (fever >104 F, quarter flare-up, etc.) were blindly given either saline or flunixin meglumine. At 4 hours after treatment, fever and some signs of quarter inflammation were significantly reduced in flunixin-treated cows. There is no specific research indicating that flunixin therapy improves the rate of return to production or reduces death losses. However, flunixin meglumine is established as a useful adjunct to symptomatic improvement of mastitis.

*Studies on extended therapy with pirlimycin:* We evaluated the effectiveness of extended intramammary (IMM) pirlimycin therapy along with *S. aureus* bacterin administration for curing *S. aureus*. Several studies were done with either the USDA at Beltsville or Geoffrey Smith from the College of Veterinary Medicine. Pirlimycin is an antibiotic that penetrates the mammary gland tissue very well and has good activity against *S. aureus*. Several studies have shown that increasing the number of IMM treatments from 2 to 5, 8 or more days of treatment increases the success rate against *S. aureus*. (Note: Extending the number of intramammary treatments with pirlimycin constitutes extra-label
drug use). Our research was conducted in participation with private dairies, North Carolina Department of Agriculture & Consumer Services Research Dairies, and the NC State Dairy Educational Unit. The protocols varied somewhat, but included identification of *S. aureus* infected quarters and then providing a combination of vaccination along with prolonged therapy of pirlimycin intramammary (IMM) into each quarter for 5 days in a row. In the study using the USDA protocol, treatment success approached 70% in some instances. In later studies in more chronic cases, *S. aureus* infections were eliminated from 46% of cows vs. only 5% for untreated controls. Treatment success definitions in the latter studies were quite strict in that cows had to culture negative at all post-treatment cultures at monthly intervals for at least 3 months. Any extra-label use of antibiotics must be done observing appropriate slaughter and milk withdrawals and all applicable US Food & Drug Administration (FDA) guidelines.

**Studying the molecular epidemiology of *Staphylococcus aureus* mastitis:** We have been studying the epidemiology of *S. aureus* mastitis now for well over 5 years. One aspect of our study has been to determine the number of different types or “fingerprints” of *S. aureus* found within herds. Basically, we use a molecular procedure that provides “fingerprints” of the various isolates of *S. aureus* found in herds. Let’s take a 50 cow herd with 10 cases of *S. aureus*. One might ask, “Are these 10 cases all the same exact type or fingerprint of *S. aureus*, or, is it 10 different types, or some combination in between?” Looking at fingerprints, we have found that herds we investigated in NC have usually had just a couple of major types of *S. aureus* that cause the mastitis. We have identified common fingerprints that seem to be widely spread in NC. I got involved with this when we helped a herd with a serious *S. aureus* problem. To assist the producer in obtaining a farm-specific bacterin, we cultured the cows and identified the types or fingerprints of *S. aureus* that were present in the herd. Based upon our results, a private company made a bacterin from a representative set of isolates (1 each from the most common types) that worked very well for the herd.

In further work, we have studied properties of the types of *S. aureus* that cause mastitis in various herds and have discovered, for instance, that antimicrobial resistance seems to be concentrated in only certain types or fingerprints. The vast majority of isolates of *S. aureus* from NC that we have studied are susceptible to a wide variety of common antimicrobials. Thus, it appears that failure of therapy is not commonly due to resistance. In another aspect of this research, we have identified specific types of *S. aureus* that have persisted for as many as 15 years in herds in NC. Identifying the specific types of *S. aureus* causing mastitis in NC is useful in understanding the “enemy” we face. Further study of the specific properties of these isolates may provide information useful to improve therapy and control.

**Mastitis monitoring programs:** Monitoring mastitis in a dairy is accomplished in many ways. This can include periodic culturing of the bulk tank and clinical mastitis. Over the years, we have done several studies on approaches for monitoring bulk tank and clinical mastitis cultures. Fresh cow monitoring is being practiced more and more commonly. This method is used to identify cows with infections, so that they can be identified prior to spread within the herd and before milk production for the lactation is adversely affected. I have always wondered whether timing of sample collection influences cultural results from post-
partum cultures. It seems logical that the immune factors in colostrum may be inhibitory to attempts to culture microorganisms. Preliminary results from recently completed studies in several herds indicates that sample collection (1-3 vs. 3-plus to 5 vs. 5-plus to 10 days post-partum) time influence cultural results for *S. aureus*. Higher bacterial counts were found from samples on days 1-3 vs. other sampling times.

**TAKE HOME MESSAGES:**

1. Research from NC helped gain FDA approval of one brand of flunixin meglumine for symptomatic treatment of mastitis—it can reduce fever and make the cow feel better.
2. Vaccination and prolonged intramammary therapy may be the best approach to attempt if you want to cure chronic *Staphylococcus aureus* mastitis cases.
3. A limited number of specific types or fingerprints of *Staphylococcus aureus* usually are the cause of mastitis on a given dairy and the bacterial types on the dairy can exhibit specific behavior in terms of antimicrobial susceptibility and persistence in the herd.
4. Time of sampling post-partum can influence cultural results for *S. aureus* and preliminary results appear to indicate that it may be preferable to collect samples after days 1-3 post-partum.

**Disclaimer:**

All drug use must follow all applicable US FDA guidelines, including observation of appropriate meat and milk withdrawal times. Mention of a particular product, or omission of mention of a particular product, does not imply endorsement or a particular product, or exclusion of the other.

**Acknowledgments:** I wish to thank the NC Dairy Foundation, Inc., for their generous support of some of our research. The efforts of the participating private dairies, North Carolina Department of Agriculture & Consumer Services Research Dairy herds and NC State Dairy Educational Unit dairies are gratefully acknowledged.
Review of Colostrum in Calves

Dr. Mark Alley, DVM, Clinical Instructor
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It is well-known that acquiring and absorbing adequate amounts of colostral immunoglobulins are essential to the health of the neonate since calves are born almost void of any circulating antibodies. Colostrum is defined as the first milk harvested from the cow immediately after calving. Colostrum is composed of high levels of immunoglobulins (IgG, IgM, and IgA), vitamins, minerals, fat, protein, and other cellular components. All of these pieces are essential for the successful development of the calf. Cows begin transporting immunoglobulins into the mammary gland from the circulatory system several weeks prior to calving. However, this process ends abruptly at calving. This colostrum declines rapidly in regard to immunoglobulin concentration and overall nutritional content shortly after calving. Therefore it is mandatory that colostrum be harvested as soon as possible after calving and be given to the calf.

Harvesting:

Colostrum donors on most farms are defined as any cow or heifer that has recently calved. However, there should probably be more selection criteria placed on these donors. Cows that have leaked milk, are sick, have evidence of mastitis or bloody milk, or have been milked prior to calving should not have their colostrum used as the primary source of immunoglobulins. However, colostrum from heifers can produce adequate levels of immunoglobulins (Tyler, 1999) and should be considered as colostrum donors. Since these calves are babies, colostrum should be harvested in as clean a manner as possible. Proper udder hygiene of these colostrum donors is mandatory to insure that large numbers of bacteria are not inoculated into these immunologically naïve calves. Also proper attention to cleanliness in milking and storage equipment is necessary. One clinical study revealed a negative association between bacteria counts in colostrum and IgG absorption (Poulsen, 2002). A recent study on a dairy in Minnesota revealed that the majority of colostrum samples taken directly from the cow contain minimal bacterial contamination (Stewart, 2005). However, there was also shown a drastic increase in total coliform count and total plate count after harvesting the colostrum into a milking bucket (Stewart, 2005). Therefore, storage after harvesting may be a more critical point in colostrum management than collection technique.

Determining Colostrum Quality:

The most commonly described method of measuring colostrum quality on the farm is with the use of a colostrometer. Fleenor and Stott (1980) determined a statistical correlation between globulin concentration and specific gravity. However some research states that there may be some potential problems with the use of a colostrometer for predicting IgG concentration. First, it has been shown that cold temperature of colostrum may adversely affect the reading causing poor quality colostrum to appear to have adequate immunoglobulin concentration. Second, as milk composition changes especially among breeds, there may be some significant variation in readings of colostrometer. Another commonly used method to determine colostrum quality is based on volume of
colostrum produced at the first milking. As milk yield increases above 17.8 pounds (8.5 kg), colostral IgG concentration decreases (Morin, 2001) and these animals should not typically be used as donors. The most recent instrument used for screening for IgG concentration in colostrum is the Colostrum Bovine IgG Midland Quick Test Kit®. This cow-side test detects IgG concentration either as < 50 or > 50 g/l. Chigerwe and others have determined this kit to be a useful tool in screening colostrum without the concerns regarding ambient temperature fluctuations seen with the use of the colostrometer (2005). The cost of the test is between $3.75 and $4 per colostrum sample.

Timing:
Rajala (1995) reported a 2 g/L decline in IgG concentration for every 30 minute delay in feeding colostrum. Therefore, calves should be fed enough volume of colostrum to receive 100 to 200g of immunoglobulins as soon as possible after birth. In most situations this equates to 3 or 4 L to insure adequate IgG concentration in the calf. Multiple studies have shown that colostrum intake through suckling alone is inadequate for sufficient IgG concentrations. Ideally all calves should be removed from dam within 2 hours of birth and force-fed the appropriate volume if they will not nurse the full volume.

Storage of colostrums:
Many times there is a significant delay between harvesting of colostrum and actually feeding the calves. If bacteria are accidentally introduced into this colostrum at harvest, bacterial numbers will quickly multiply. If colostrum is not going to be fed within 2 hours after collection, it should be stored at 47°F to minimize bacterial growth. Colostrum should be stored in refrigerators in containers that are small enough to cool quickly. If colostrum is going to be stored for longer periods of time, it should be stored in 1 gallon freezer bags (double bagged) in a frost free freezer. These bags can be easily stacked in freezer to minimize storage space. These bags should be labeled with date of collection, cow identification, and colostrometer reading. Colostrum can be stored in this method for up to 18 months without any deterioration in IgG concentration. However the cellular components present in fresh colostrum will be destroyed. Therefore fresh colostrum is preferred to frozen colostrum when available.

Colostrum Alternative:
Although fresh colostrum is definitely the preferred source of immunoglobulins for calves, occasionally there are instances when colostrum is unavailable. Until recently, the only alternative was the use of colostrum supplements. These supplements contain minimal IgG concentration (< 90 g of IgG per dose ) and have been shown to be poorly absorbed when used solely as a colostrum substitute (McGuirk, 2004 and Quigley, 2002). Fairly new to the market are products defined as colostrum replacers. In these, products the higher quality products contain at least 100 g of bovine immunoglobulin per dose. A soon to be presented study performed by Dr. Geof Smith and Dr. Derek Foster at NCSU College of Veterinary Medicine revealed that a colostrum replacer product was superior to a colostrum supplement in providing adequate passive transfer in a group of 80 Holstein bull calves on a farm in North Carolina.
Testing Strategies for Colostrum Delivery:

Typically, testing for successful colostrum delivery is based on history of problems and is not performed as a routine monitoring program. However as dairies begin to increase in size, herd owners begin to rely on employees to get colostrum to these valuable assets. One relatively inexpensive method to monitor success in colostrum delivery is the use of a small sample of blood to check total protein levels (Tyler, 1999). The test can be accurately used on healthy calves from 12 hours of age to 7 days. The goal is to have 80% of calves tested have total protein levels greater than 5.5 (McGuirk, 2004). However if colostrum replacers or supplements are being used total protein may not be an accurate measure of total IgG absorption (Quigley, 2001).

References:


What Will The Southeast Dairy Industry Will Be Like in 2015?

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Summary
Trends suggest that at some point in time the dairy industry will cease to exist in the southeast. What will it take to alter this trend? In the simplest terms profitable dairy businesses must exist for the industry to remain long term. Profitable dairies tend to have the following traits: Positive Cash Flow, Low Cost of Production, Wise Investment, Efficiency, Execution, Attitude, and People. Dairy owners will need to develop from other industries, where the tremendous tax advantages of a dairy can benefit other businesses. Existing successful dairies need to build more dairies to change the trends. There are numerous profitable and successful dairies in the southeast, and numerous models that are successful. The potential for profitable dairying currently exists and will continue to exist in the southeast for some time. In the future, just like in the past, good dairies in the southeast will make money and prosper.

What will the dairy industry in the southeast look like in 10 years? What will it look like in 5 years? I don’t pretend to know, but past history suggests that the southeast will continue to lose cow numbers and milk production. If current trends continue for another 10 years, a few people and a handful of cows may be all that is left. Some believe this has already happened in certain regions of the southeast. I don’t believe this will happen throughout the southeast, but trends are trends.

Lending has changed markedly since the period of low milk prices several years ago. Lenders require more equity up front, and are less willing to loan to dairies that lack strong financial backing. Starting up a dairy is getting to be more and more difficult – the equity drain in the first couple years is difficult for many to overcome. This difficulty will get worse and not better in years to come. For this reason, it is much easier for dairies to start where ownership has another existing dairy to ease startup. The first dairy can seed the expansion dairy with cows, people, and systems, offering a tremendous advantage over a brand new startup. In many cases ownership is involved in other businesses and desires the tax advantages of a new startup dairy. A new startup dairy is a somewhat unusual business in that the business can pay its bills yet show large losses on paper.

To alter the trends in the southeast dairy industry, several things need to happen:
1. Well managed dairies have the ability to generate profit
2. Successful dairies add cows or build more dairies
3. Owners on other businesses get involved in the dairy business.

Technology will continue to evolve as always. Technologies such as RFID, sexed semen, and robotics will impact our industry in the next 10 years. Successful dairies are not necessarily the ones that adopt all new technologies, nor are they necessarily the ones that
avoid new technologies. In the end, there are many models in the dairy industry that are successful such as low input, high input, niche, large, etc. Which is right for you?

Areas for dairy expansion throughout the US will be limited by water, people, and environmental issues. Will this provide an opportunity for the southeast down the road? Does the southeast offer critical resources such as cheap land and water? There are certainly areas in the southeast that meet these criteria that have not been tapped.

Margins continue to shrink in the dairy industry, but opportunity for profit and growth remain. There is still a wide range of profit within our industry, with reported cost per hundredweight ranging from just over $10 in some herds to nearly $20 in other herds. Do other industries have this much range in Cost of Production? It is generally accepted that southeast herds have higher costs of production. Do we really know what our costs of production are? How can a dairy business be evaluated without this information?

What makes a dairy business financially viable? Are dairies that milk 3x more profitable than dairies that milk 2x? Are herds that use bST more profitable than herds that don’t use bST? Do larger herds generate more profit than smaller herds? Do high producing herds profit more than low producing herds? Do dairyman who wear brown boots make more money than dairyman who wear black boots? What is profit?

Many in our industry proclaim that particular management strategies, such as the proceeding questions suggest, result in more or less profit. In my experience, there is no management style that is optimum, but successful dairies have common traits:

1. Cash Flow
2. Low Cost of Production
3. Wise investment
4. Efficiency
5. Execution
6. Attitude
7. People

Monitoring Cost of production, and striving to lower these costs, is key to long term financial success. To properly monitor Cost of Production, a dairy should establish a relationship with an accounting firm that can accurately handle dairy-specific issues such as herd turnover. For some dairies, more production from management strategies like bST, 3x milking, cow cooling, etc result in lower cost per cwt and fit their management style. For other dairies, lower investment and less aggressive management style lowers their cost of production and fits their management style. Each dairy should strive to find the most profitable management style to suit their resources, abilities, and personality. Dairies can profit under numerous management styles, provided they establish a philosophy, stick to it, and execute it daily.

Once a dairy knows their Cost of Production, they naturally want to compare their performance to others. This is fraught with error! Many issues can make the comparison invalid. For example, if one dairy ships 4% fat milk and receives a 50 cent quality premium, is it fair to compare to a dairy that ships 3.3% milk and gets no quality premium? The dairy receiving premiums will certainly have some costs (that will raise their cost/cwt) associated with the additional income from the quality bonuses.
Dairy producers have the opportunity to incorporate various inputs into their operation. They are constantly barraged with a host of products and services that cost money but promise to yield a return. Dairyman need to carefully scrutinize these inputs, since most are impossible to measure. Any product that promises less than 2 lbs of milk response is difficult if not impossible to measure on the farm.

In my experience, any input that favors forage quality has a high chance of return. Forage quality is the base for which cow health and productivity reside. Selected cow comfort imports can also favor healthy and productive cows. Milking 3x or incorporating bST generally work if managed properly. Expansion and facility changes need to be carefully evaluated. Growth or expansion should be a goal and not an ultimatum. Other inputs such as feed additives need to be carefully scrutinized.

During low milk price times, which are sure to come again, dairies need to focus on basics to lower Cost of Production:

1. Keep barn full, whatever full is for that particular dairy.
2. Low fresh cow culling.
3. Milk profitable cows – identify and remove unprofitable cows
4. Get quality premiums and ship high component milk
5. Generate pregnancies
6. Control feed and labor costs
7. Cheat effectively

A simple formula to guarantee profit in the dairy business does not exist. However, the dairy industry has offered the opportunity for profit and will continue to do so in the future for herds that can produce milk efficiently and at a low cost.
Dairy Situation and Outlook for 2006

Dr. Geoff Benson, Associate Professor and Extension Specialist, NCSU Dept. of Agricultural and Resource Economics

A look back at 2005

Overall, the supply-demand balance eased somewhat compared to 2004 and farm prices have been lower as a consequence. The average US All Milk price was $16.05 per 100 lb. in 2004 and current USDA projections are that it will likely fall to an average of $15.15 (mid-point of the range) in 2005, down 90 cents per 100 lb. The average blend price for 2005 was $16.23 per 100 lb for the base zone of the Appalachian Order (FO 5), down $0.77 from 2004.

Two years of good prices have certainly helped dairymen recover from the losses they suffered because of low prices in 2002 and 2003. A healthy economy and strong sales helped offset strong growth in milk production. Compared to the long run trend in cow numbers—down—there was some growth in the national dairy herd in 2004 and steady increases in cow numbers in 2005. More cows, along with increasing milk production per cow, means total milk production will be up around 3.4% in 2005. This growth has occurred despite three rounds of herd reductions under the CWT voluntary supply management program. Commercial use of dairy products is expected to be up about 2.0% over 2004, and exports of milk powder have been strong as a result of tight world markets and a weaker dollar. However, all-in-all, milk prices held up quite well relative to the record high milk prices in 2004.

Federal Dairy Policy

Dairy policy is getting a lot of attention at present as efforts are made to extend the Milk Income Loss Contract (MILC) program. Authorization for this program expired on September 30, 2005. Legislation to renew the program is being actively pursued in Congress at this time (1/30/06) but with a reduced payment rate in the formula, 34% instead of 45%. This legislation is expected to pass and, if so, payments are expected to be made retroactively. Procedures for claiming payments will need to be developed. Milk prices were above the MILC trigger in most of 2005 but that state of affairs changed in January and payments would have occurred. Payments are expected to continue in 2006.

2006 is likely to see the start of the discussions about a new farm bill to take effect in 2007 and dairy legislation will be an important part of those discussions.

Federal order hearings will be held on the “make allowances” used to compute federal order prices. A request has been submitted to raise the make allowances because of higher energy related processing costs. If granted, this would reduce the minimum federal order prices relative to any given market prices for dairy products. Ken Bailey, a dairy marketing economist at Penn State has estimated the reductions under three scenarios at $0.25 to $0.46 per 100 lb. Clearly this is not what dairy farmers would want but it must be recognized that if dairy processors do not make an acceptable margin we are likely to see plant closures and a reduction in the number of locations available to process milk. Some dairy farmer groups have suggested making these make allowances flexible, to adjust up or down based on changes in processing costs.

Hearings for Orders 5 and 7 will be held to address transportation charges and
credits in an effort to reduce the cost burden on producers.

**Outlook for 2006**

The production outlook for 2006 depends on the balance between several factors that favor higher milk production and some which would discourage it. Factors favoring higher production include a continuation of relatively low feed costs, milk production per cow that has returned to long term trends, the momentum provided by higher cow numbers, and a January 1, 2006 dairy heifer inventory that was 3.9% above year ago levels. Offsetting factors include strong cull cow prices, Round 3 of the CWT voluntary supply management program and significantly higher energy costs.

USDA projects the US average farm price for corn at $1.90 per bushel (midpoint) for the crop marketing year which began October 1, down 16 cents from the previous year. The average 48% soybean meal price is pegged at $172.50 per ton (midpoint), down $10. However, for North Carolina dairy farmers, increased transportation costs will off-set part of these reductions in farm prices. Nevertheless, the milk-feed price ratio should remain somewhat favorable for milk production.

The current CWT herd reduction program will remove approximately 66,000 cows and an estimated 1.2 billion pounds of milk, 0.7% of the milk supply. CWT will also continue to subsidize cheese exports in an effort to support milk prices. To put this in perspective, USDA’s January 1, 2006 dairy cow inventory shows the number of dairy cows was 53,000 cows greater in December, 2005 than in December 2004.

Although the worst of the short-term effects of Hurricanes Katrina and Rita on energy prices are past, significantly higher energy costs are expected to persist through 2006. Crude oil futures prices are above $60 per barrel for the next two years. Higher energy costs have both a direct effect and an indirect effect on farm production costs because most farm inputs have an energy component, particularly nitrogen fertilizer. The US Department of Energy’s data show that diesel and natural gas prices have peaked but the forecast for the whole of 2006 is for most energy prices to remain above 2004 and early 2005 levels. Diesel prices, which overtook gasoline prices in 2005 will be about one-third higher than 2004, on average, and will remain at a premium to gasoline in 2006. Natural gas prices also increased sharply in the last half of 2005 (up 40%) and then declined to levels close to pre-hurricane levels. For all of 2006, prices are expected to be substantially higher than 2005, up 11% based on USDoE forecasts. Natural gas is the feedstock for ammonia-based nitrogen fertilizers and 2006 crops are expected to be significantly more expensive to plant and harvest.

Higher energy prices will affect the health of the overall economy and consumer discretionary income and purchasing decisions. Butter sales likely will be under pressure as some consumers reduce the amount of food eaten in restaurants and buy cheaper substitutes for home consumption. The impact on sales of other dairy products is less certain but sales will likely grow more slowly than in 2005. Current stocks of cheese and butter are above year ago levels.

USDA’s latest forecast for 2006 is for milk production to increase by 2.6% to 181.5 bil. lb. The midpoint forecast for the US All Milk price is $13.80 per 100 lb., which is $1.35 below 2005. The midpoint Class III forecast is $12.45, down $1.60 per 100 lb. The current Class III futures market presents a similar picture, with Class III prices down about $1.35 for the year. If North Carolina prices track national prices as they have in the past, NC dairymen should see prices that are about $1.35 lower than in 2005, with an average
Federal Order 5 uniform (blend) price of around $14.90 per 100 lb for 3.5% butterfat milk. Monthly prices are expected to be below the MILC payment trigger and payments averaging around $0.25 to $0.30 per 100 lb can be expected if the current proposal to renew the program passes Congress.

These projections are based on "normal" weather and milk production next spring will be critical. An abnormally large spring flush would likely send milk prices lower for the rest of the year but a smaller than expected amount of spring production would have the opposite effect and could send prices higher. Similarly, if the consumer side of the equation is weaker than expected this will translate into weaker farm prices. Overall, 2006 is shaping up to generate farm prices that are fairly close to long term trends. During the 6-year period from 2000, when Federal Order 5 was created, through 2005, the average minimum blend price was $15.06 per 100 lb. However, these prices will seem quite poor relative to the strong milk prices that have existed since the fall of 2003 even if supplemented by MILC payments.

In light of this outlook, belt-tightening will be necessary and sound financial management practices and judgment will be important. This includes measuring and monitoring financial performance, including cost of production. Contact me if you would like to participate in the NC Dairy Farm Financial Performance Project and, if not, please do take advantage of the information provided on my web page at http://www.ag-econ.ncsu.edu/faculty/benson/benson.html or similar financial information provided by others.
Using Decisive™ Semen in a Herd’s A.I. Program

Dr. Thomas Bailey, D.V.M.,
Lead Technical Services Representative
Monsanto Decisive™ Semen Program

Monsanto Dairy Technical Bulletin for
decisive™ Advanced Gender Selection - A New Tool to Give Producers the Power & Freedom to Build a Better Herd

The Product

Decisive™ semen for advanced gender selection will be a new A.I. product which is cattle semen sorted to favor a specific gender. Decisive™ semen will help dairy producers generate a greater ratio of replacement heifers. Because Decisive™ provides the reliable and consistent delivery of semen selected for gender; this new product takes an element of reproductive management once left to chance and places it in the producer’s control. Ultimately, Decisive™ semen for advanced gender selection will expand the range of options available to dairy and beef producers to improve their herds.

decisive™ will combine five key components essential to the success of breeding programs

1. decisive™ will deliver the desired gender you select for herd improvement with 85% predictability.
2. decisive™ overall reproductive performance will be as effective as current A.I. programs.
3. decisive™ uses the first scalable sorting process designed to expand to meet producer needs.
4. decisive™ will fit into A.I. programs without special requirements.
5. decisive™ will provide high-quality semen from proven sires for genetic merit.

Advanced Gender Selection Technology

The process to produce Decisive™ semen separates sperm cells based on differences in DNA content between X (female) and Y (male) chromosomes. Sperm cells bearing the X chromosome have approximately 4% more DNA than Y-bearing sperm cells.

Semen is collected and processed following procedures similar to those used for freezing conventional semen.
Sperm cells are exposed to a fluorescent dye that binds specifically to DNA present in the chromosomes. This dye fluoresces when stimulated by a laser, and the fluorescence intensity is an accurate indicator of the content of DNA in the sperm cell.

Decisive™ uses flow cytometry to determine the likely chromosome (X or Y) present in the sperm cell. Individual sperm cells contained in microscopic droplets flow through the cytometer at a high speed. The flow cytometer then stimulates the droplet with a laser beam and discriminates X-bearing from Y-bearing sperm cells based on the fluorescence intensity. The cytometer uses electrical charges to separate droplets (sperm cells), so that droplets containing sperm of the desired gender are collected into one container, while other droplets (undesired gender, multi-sperm droplets, or no-sperm droplets) are pooled into a separate container.

The sorted semen is subsequently packaged into standard A.I. straws and frozen. Quality control procedures are conducted throughout the process to ensure that the product meets stringent specifications (85% gender predictability, same quality as conventional semen).

Advanced, highly efficient sorting process

One key advantage of decisive™ is the innovative approach taken to design and optimize the sorting equipment. The flow cytometer was designed specifically for sorting sperm based on DNA content which provides efficiency advantages.
Decisive™ Features

1. The overall reproductive performance of decisive™ semen will be as effective as that of conventional A.I. semen

2. Decisive™ semen will deliver 85% gender selection predictability
   Decisive™ advanced sorting technology increases the percentage of sperm of the desired gender from approximately a 50/50 ratio to a ratio of 85/15 in favor of the selected gender.

3. No Special Requirements
   Decisive™ semen requires no additional labor, skill or equipment on the part of the producer. Insemination with decisive™ semen uses the same technique and equipment as A.I. with conventional semen.

4. Scalability

5. High quality semen from proven sires for genetic merit
Value of decisive™

Decisive™ semen delivers value through
- Accelerated genetic improvement of the herd
- Improved herd quality
- Simplicity and Reliability

To understand how decisive™ semen creates value, we need to review the following concept:

Dairies breed their cows for two reasons.
1) to initiate lactation and
2) to obtain replacement heifers

The need for replacements currently forces producers to breed all cows to obtain sufficient replacement animals. This is an inefficient process with conventional semen, as only about 50% of calvings result in female offspring.

Decisive™ semen increases the percentage of female offspring and can allow producers to more stringently select which cows will be bred for replacement purposes.

With decisive™ semen, producers will need to breed fewer cows to obtain a sufficient number of replacements. Thus, instead of relying on the entire herd to obtain heifers, with decisive™ semen producers will need only 55% to 70% of the herd to produce the required replacements.

**Benefits**

**Accelerating Genetic Advancement**

Genetic progress for a trait of economic interest (i.e. milk production) is defined by factors such as the variability of the trait within the population, the accuracy of genetic merit estimates, the generation interval, and selection intensity.

The use of decisive™ semen has the potential to accelerate the rate of genetic advancement through increased selection intensity on the female side. This greater selection intensity results from producers obtaining replacement heifers from the better cows in the herd as depicted in the picture below:
Producers will be able to obtain the same number of replacement heifers as with conventional semen by breeding 50 to 70% of the cows with female decisive™ semen. The difference is that producers will be able to obtain these heifers from the best cows in the herd. The benefits of decisive™ semen will be additive to the current rate of genetic progress experienced by dairy herds in the U.S.

**Improved Replacement Program Management Opportunities**

- The potential exists to have an increased number of replacements, allowing the producer to apply greater selection pressure on the lactating herd. Less desirable animals in the herd could be replaced by higher quality replacements.

**Better Biosecurity**

- For herds that currently purchase heifers as replacements, decisive™ semen will offer the opportunity to increase replacements from within the herd. Sourcing replacements from within the herd reduces the risk of introducing infectious diseases through purchased replacements.

**Selection of Growing Heifers**

- With decisive™ semen, dairies will have the opportunity to replace poor performing growing heifers, avoiding potential losses associated with bringing them into the herd to perform inadequately as milking cows. This might include heifers with chronic pneumonia, heifers too slow to conceive, or disease positive heifers.

For the latest information, visit [www.getdecisive.com](http://www.getdecisive.com).
**Milk – New Perspectives on an Ancient Food**

Dr. Vivek Fellner, Associate Professor  
NCSU Department of Animal Science

**Introduction**

Milk consumption is a major factor that influences market price of milk. Milk fat is a key component that determines the price paid to the farmer. Producers do not want to lower milk fat content because it determines their ‘pay check’. Milk consumption has been closely scrutinized over the years and suffered from negative publicity due primarily to perceived 'high' milk fat content. The association of saturated fat with heart disease has influenced milk consumption. The perception of milk has changed over the past 25 years from one of being the ideal food to one of being detrimental nutritionally. Although we see a recent increase in public awareness of milk as a ‘functional’ food consumers in general are not well advised of the nutritional qualities of milk. There is a serious need to provide information to consumers on the benefits of drinking milk. Milk is not only a nutrient rich low calorie food but it also contains a number of compounds, which have beneficial nutritional attributes. Also, data suggests that the association between saturated fatty acids in milk and effects on cholesterol may have been an oversimplification. In fact, we now know that milk fat contains fatty acids that may have a potent anti-cancer effect. Monounsaturated fatty acids, that are present in milk fat, have been shown to be beneficial in altering the proportions of LDL and HDL cholesterol and it is possible to increase the concentration in milk of the principal monounsaturated fatty acid, oleic acid, by altering the diet of the cow. Finally, new evidence on the occurrence of conjugated linoleic acid isomers (CLA) that have a potent anti-carcinogenic and anti-atherogenic activity suggests that consumers need to include milk and milk products in their diet to accrue the health benefits.

A major component of my research at NC State is to document feeding strategies that alter milk yield and milk composition. However, unless we educate the consumers on the true health attributes of milk, consumption of milk will continue to decline. This paper highlights some aspects related to consumer acceptance of milk versus the true health attributes of milk consumption. The functional properties of milk will play a significant role in the future of the dairy industry.

**Role of Milk - Brief Review**

Humans have been drinking milk since ancient times. There are records of cows being milked as far back as 9000 BC. The Old Testament describes the 'promised land' as “a land flowing with milk and honey.” Some 2,300 years ago, the Greek physician Hippocrates recommended milk as a medicine. In 1611 cows arrived in Jamestown colony and one of the first laws written by the governor, Lord Delaware, was with respect to protecting cows. Milk is one of the oldest known foods and its nutritional value has long been recognized.

Several decades ago, few would have argued with the contention that milk and milk products made an extremely valuable contribution to the nutrition of the population. More recently, however, the image of milk has suffered due to the attention focused on it's content of saturated fatty acids and their link to high plasma cholesterol and coronary heart
disease. Milk-fat, while containing a high proportion of saturated fatty acids, of which some raise plasma cholesterol, also contains up to 33% unsaturated fatty acids which have a cholesterol-lowering tendency.

The dietary allowances of various nutrients as recommended by the United States National Research Council include fat intake as per the following break-up: up to 30 per cent calories from total fat (65 g/day), 10 per cent calories from saturated fat (20 g/day) and 300 mg of cholesterol/day. Dairy products provide 15-18% of the total fat in the diet and 25% of the total saturated fat. Milk contributes insignificant amounts of cholesterol.

In 2000, Americans drank an average of 38 percent less milk than in 1950s. Whole milk represented 92 percent of all beverage milk in the 1950s, but dropped to 36 percent in 2000.

<table>
<thead>
<tr>
<th>Increase in Prevalence (%) of Overweight, Obesity and Severe Obesity Among U.S. Adults.</th>
<th>Overweight (BMI &gt; 25)</th>
<th>Obesity (BMI &gt; 30)</th>
<th>Severe Obesity (BMI &gt; 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 to 2000</td>
<td>64.5</td>
<td>30.5</td>
<td>4.7</td>
</tr>
<tr>
<td>1988 to 1994</td>
<td>56.0</td>
<td>23.0</td>
<td>2.9</td>
</tr>
<tr>
<td>1976 to 1980</td>
<td>46.0</td>
<td>14.4</td>
<td>No Data</td>
</tr>
</tbody>
</table>


In the last 25 years average daily caloric intake increased by 24.2 percent. Grains accounted for 39% of the caloric increase; fats and oils, 37%; sugars, 19%; fruits and vegetables, 6% and, meats and nuts, 4%. Dairy products and eggs together accounted for a negative 6%.
Perspectives on milk fat?

Milk is perceived to be a major contributor to total fat intake when in fact it contributes only 15% of total fat in an average American diet. The implication that high intakes of dietary fat are associated with disease has, for the most part, received bad press. Media scrutiny has influenced consumers’ perceptions of the fat content in milk. A typical glass (250 mL) of 2% partially skimmed milk contains only 4.7 g of fat and provides 121 kcal. Total milk consumption has decreased 14% in the past 20 years. An increasingly health-conscious public, zealously attempting to decrease fat in their diet, has reduced the amount of milk consumed. Milk, clearly, is not a major contributor to total fat intake.

Public health messages during the past several years have advocated for low-fat milk and milk products to replace regular milk products. As a consequence, milk contributes a lower proportion to total fat in our diet. Additionally, fats are coming less from animal sources like meat, eggs, butter and milk products and more from vegetable sources like shortenings, oils, margarine, commercial baked goods and prepared food. Among certain health conscious groups this change in the source of fats may be regarded as a positive step but it may come at a cost. It is well known that fat, including milk fat, is a source of the fat-soluble vitamins (A, D, E and K). It is perhaps less well known that milk fat, in particular, has substances that have potent anticarcinogenic activity (conjugated linoleic acid (CLA), sphingomyelin and butyric acid). These substances are present in the cream layer and are all removed when milk is skimmed.

Dietary recommendations advise a general reduction in fat intake and in particular a reduction in saturates. Foods such as milk that provide some fat and for which lower fat alternatives exist, are often singled out in this advice leading to an erroneous assumption that a direct link exists between milk intake and heart disease. The saturated fatty acid content in milk is high but not all saturated fatty acids increase cholesterol in humans. In fact, some saturated fatty acids may decrease blood cholesterol. Several studies have shown no relation between, milk, butter, cheese and heart disease. The simple reduction of saturated fat from the diet imparts a complex effect on serum cholesterol levels with an undesirable decrease in HDL cholesterol. It is argued that the proportional increase in concentration of HDL produced by dietary saturated fat compensates for the adverse effect on total serum cholesterol concentration. Consuming milk and dairy fat does not lead to cardiovascular disease. In fact, milk contains several components that may exert a beneficial effect in its prevention.

Concerns about the effects of milk fat on health, whether real or perceived, decrease the economic value of dairy products (hence producer incomes) and may compromise consumption of a highly nutritious functional food. Milk products supply approximately 53% of the calcium, 60% of the vitamin D, 29% of the phosphorus, 30% of the riboflavin, 23% of the vitamin A, 31% of the vitamin B_{12}, 20 % of the protein, 17% of the potassium, 18% of the zinc, 15% of the magnesium, 18% of the fat, and a mere 15% of the calories. With the discovery of substances in milk, like CLA, and their impact on human health, the role of full fat dairy products becomes even more crucial. Given all the evidence, it is important for public health and well-being that consumption of dairy products be maintained or even increased so as to not compromise the intake of important nutrients. Indeed, the 2005 Dietary Guidelines have recommended an increase in the total number of daily servings of milk and milk products. The Guidelines recognize dairy products as nutrient dense foods.
associated with overall diet quality and nutrient adequacy and adults and children are advised to not avoid milk and milk products because of concerns about weight gain.

**Modification of Milk Fat – ‘Adding Value’**

Manipulation of the composition of milk fat can be achieved through feeding strategies, genetic approaches and manufacturing processes. Newer technologies are designing specific mixes of fatty acid products that can withstand ruminal degradation and be incorporated directly into milk. Consumers are increasingly becoming aware of the nutritional benefits of milk. The beverage manufacturers see the potential for an increase in future milk consumption. The two largest carbonated soft drink companies, both officially in the milk business (Coca-Cola Co., and PepsiCo Inc.), are not just selling milk beverages, they are selling the value of milk to a broad audience. Modifying the fatty acid profile of milk to target specific health attributes of consumers is the future of the dairy industry.

**Some Final Thoughts**

- Milk consumption during the past several decades has declined but the incidence of obesity has increased.
- Milk fat contributes only 15% of the total fat intake in an average American diet.
- Milk fat has substances that have a potent anti-cancer, anti-obesity effect.
- Altering milk fat composition to benefit health attributes will improve consumer acceptance and subsequent increase in milk consumption.
Evaluation of a Novel Pregnancy Test for Cattle

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Introduction
Detection of pregnancy in cattle offers valuable information to producers. In dairies it is desirable to know as soon as possible if a cow is open so that she can be treated and re-bred. Days open after the voluntary waiting period are a significant cost to dairy producers. Beef producers could benefit from knowing at weaning if the cow is open and should be culled or pregnant and be retained. Earlier pregnancy detection could identify calves produced by artificial insemination or by clean-up bulls. Currently there are two methods for pregnancy detection: rectal palpation and ultrasonography. Both require skilled and experienced personnel, usually a veterinarian, to perform the tests and the cost may be prohibitive for some producers. A novel blood test for detection of pregnancy in ruminants has been marketed, under the trade name Biopryn (Bio tracking, Moscow, ID, http://www.biotracking.com). The test reportedly detects the presence of a protein known as Pregnancy Specific Protein B (PSPB) in the blood using an enzyme linked immunoabsorbent assay system. Research in the scientific literature using radioimmunoassay to detect PSPB has demonstrated that this protein is produced by the embryo and is detectable beginning approximately 28 days after insemination in cattle. The publications have suggested that the protein persists for some time in the blood of postpartum cows. The company has marketed its test as being able to detect this protein. The objective of this experiment was to determine the accuracy of the test and the time frames when the test can be used.

Materials and Methods
This experiment was conducted at two research stations, the North Carolina Department of Agriculture Center for Environmental Farming Systems in Goldsboro and the Upper Piedmont Beef Research Station in Reidsville. Blood samples were taken from cows via tail vein puncture 28-40 days after insemination and at the same time trans-rectal ultrasonography was done to detect pregnancy. Ultrasonography was performed using an Aloka 550V unit (Aloka, Wallingford, CT) equipped with 5.0 megahertz linear array probe. Cows were rechecked via palpation after 60 days post insemination. If there was a discrepancy between the ultrasound and Biopryn results at Upper Piedmont the cows were rechecked by both methods. Finally, calving data were collected to verify accuracy. Blood samples were mailed to the BioTracking laboratory in Moscow, ID. Currently the test can only be performed in this facility. Results from the Biopryn test were compared with results from ultrasonography in the case of the cows that had been inseminated. Because published research indicated that the PSP-B continued to circulate in the blood of cows for some time after calving, blood samples were taken from cows that were between 30 and 80 days postpartum that were known to be open because they had not been exposed to bulls
or inseminated.

Results and Discussion

<table>
<thead>
<tr>
<th>Biopryn Pregnancy Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

False Positives were cows diagnosed pregnant by the Biopryn test but were open. False negatives were called open but were actually pregnant. We tested mostly cows that had not been seen in heat after breeding, which explains why so many more were pregnant rather than open.

Comparison of Biopryn results with ultrasonographic results confirmed by later palpation revealed that the test determined the status of cow correctly 96% of the time. The accuracy is good and the use of the Biopryn test requires less skill (collection of a blood sample) than ultrasonography or palpation. In the open early postpartum cows the test continues to detect the protein in blood for 60 to 70 days. Cows less than 60 days postpartum (n = 17) all tested as pregnant using Biopryn. For cows 74-80 days postpartum (n= 5) all tested as open. In a group of cows (n = 6) between 60 and 70 days postpartum some were classified as pregnant and some as open by the Biopryn results. This suggests that use of the Biopryn test should be restricted to cows more than 70 days postpartum to avoid false positives. In practice this is not likely to be a problem since most beef cattle would not be re-bred until 45-50 days postpartum at the earliest and most dairies observe a 50-60 day voluntary waiting period before rebreeding. Adding to these dates the 28 days after insemination before the protein levels are detectable from a new pregnancy would put cows past the 70 days postpartum when the protein from the previous pregnancy has disappeared.

The timing of detection by the Biopryn test (28 days post insemination or later) is similar to the earliest detection by ultrasonography and slightly earlier than that of rectal palpation (30-35 days). The test does not require any equipment beyond a needle and tube for blood collection. However it does require the samples be shipped to the laboratory in Idaho. Cost is approximately $2.00 per sample. Currently no cow-side test exits for this PSPB protein. This test is not the same as the early conceptus factor (ECF) cow-side test, which we and others found to be inaccurate. The results from this experiment indicate the Biopryn test is accurate and may offer producers another option for detection of pregnant cows in their herds.
Summary of Recent Dairy Nutrition Research Projects Conducted at the NCDA Piedmont Research Station

Dr. Brinton A. Hopkins and Dr. Lon W. Whitlow
Department of Animal Science

Research Project: Effects of Amounts and Degradability of Dietary Protein on Lactation, Nitrogen Utilization, and Excretion in Early Lactation Holstein Cows.

(Shannon Davidson; M.S. degree thesis project)

Five treatment diets varying in crude protein (CP) and rumen undegradable protein (RUP) were calculated to supply a postruminal lysine to methionine ratio of about 3:1. Diets were fed as a total mixed ration to 65 Holstein cows that were either primiparous (n = 28) or multiparous (n = 37) from 21 to 120 d in milk to determine effects on lactation and nitrogen utilization. Crude protein % and calculated RUP (% of CP) of diets [on a dry matter (DM) basis] were: 1) 19.4, 40 (HPMU), 2) 16.5, 34 (LPLU), 3) 16.8, 40 (LPMU), 4) 16.8, 46 (LPHU), 5) 17.2, 43 (LPHU+UREA), which is the result of adding 0.4% of the diet DM as urea to LPHU. The corn silage-based treatment diets contained an average of 24% acid detergent fiber and 1.6 Mcal/kg net energy of lactation. Milk urea nitrogen (MUN) concentrations and body weights (BW) were used to calculate predicted amounts of urinary nitrogen (N) using the relationship: urinary N (g/d) = 0.0259 × BW (kg) × MUN (mg/dl). Cows fed HPMU had greater CP and RUP intakes, which resulted in higher concentrations of plasma urea nitrogen, rumen ammonia, MUN, and predicted urinary N. Milk yield, fat yield, fat percent, protein yield, and protein percent were not significantly different among treatments. Parity primarily affected parameters that were related to body size and not measurements of N utilization. The interaction of treatment and parity was not significant for any measurements taken.

In this study, cows fed LPHU had significantly lower MUN and predicted urinary N without limiting production. These results demonstrate the potential to optimize milk production while minimizing N excretion in lactating dairy cattle.

Take home message: Milk production was maintained while the nitrogen excretion to the environment was reduced by about 19% (sum of fecal and urinary N). This was accomplished by feeding a lower crude protein diet in which the protein was less degradable in the rumen and was balanced for a postruminal 3:1 ratio of the amino acids lysine and methionine.
Research Project: Evaluation of a Calf Starter with 15% Cottonseed Hulls.

(Stephanie Hill; M.S. degree thesis project)

The development of a functional rumen is related to the intake of solid feed. A goal of conventional calf feeding programs is for the calf to increase intake of calf starter with age. The calf should be consuming enough starter at weaning to easily transition off of liquid feed. The starter should also stimulate rumen development. As part of a recent research study (S.R. Hill, Masters degree thesis), a calf starter was formulated that contained 15% cottonseed hulls. Calves received experimental treatments from birth through 63 days of age. The effects of feeding this starter on starter intake, growth, health measures and rumen development were compared to a standard calf starter with no cottonseed hulls. The ingredient composition of the two starters is shown in Table 1 and the nutrient composition is shown in Table 2.

It is important to formulate calf starter diets with enough protein. Notice that the cottonseed hull based starter fed in this study contained 18% crude protein. Starters should also contain vitamins, including B vitamins, appropriate mineral levels, and a coccidiostat.

Results from the Calf Starter Study:

Results from this study are presented in Table 3. Holstein calves fed the cottonseed hull based calf starter had significantly greater daily intakes of starter dry matter and fiber than calves fed the starter without cottonseed hulls. Calves fed the cottonseed hull based starter also had greater average daily body weight gains and lower fecal scores. Average daily gains were 1.32 and 1.19 pounds per day for calves fed the cottonseed hull based starter and those fed the starter without cottonseed hulls, respectively. Feed efficiency was lower for calves fed the cottonseed hull based starter because they had greater intakes.

In this study, calves fed the cottonseed hull based starter weighed significantly more during weeks 7, 8 and 9 of the trial and had a final average body weight about 10 pounds greater than calves fed starter without cottonseed hulls.

Take home message: Neonatal Holstein calves fed cottonseed hulls as a source of fiber in the starter diet had greater feed intake and body weight gains than those fed a starter diet without cottonseed hulls. Cottonseed hulls offer an alternative to hay as a forage source low and variable in quality. Cottonseed hulls are consistent in quality, easily handled, and support good performance and health.
**Table 1. Ingredient Composition of Calf Starter Diets (% of diet DM)**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Starter with CSH</th>
<th>Starter without CSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed hulls (CSH)</td>
<td>15.0</td>
<td>0</td>
</tr>
<tr>
<td>Corn grain, ground</td>
<td>54.6</td>
<td>64.2</td>
</tr>
<tr>
<td>Soybean meal - 48%</td>
<td>20.4</td>
<td>24.1</td>
</tr>
<tr>
<td>Soybean hulls</td>
<td>4.4</td>
<td>5.1</td>
</tr>
<tr>
<td>Dried cane molasses</td>
<td>3.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Salt</td>
<td>0.47</td>
<td>0.56</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.61</td>
<td>0.73</td>
</tr>
<tr>
<td>Calcitic limestone</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Vitamin-TM Premix</td>
<td>0.048</td>
<td>0.057</td>
</tr>
</tbody>
</table>

**Table 2. Nutrient Composition of Calf Starter Diets**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Starter with CSH</th>
<th>Starter without CSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (DM), %</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Crude protein (CP), %</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Acid-detergent fiber (ADF), %</td>
<td>15</td>
<td>6</td>
</tr>
</tbody>
</table>

**Table 3. Calf Starter Intake, ADG, Feed Efficiency and Fecal Scores**

<table>
<thead>
<tr>
<th></th>
<th>Starter with CSH</th>
<th>Starter without CSH</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily DM intake, lb.</td>
<td>1.90</td>
<td>1.65</td>
<td>0.01</td>
</tr>
<tr>
<td>Daily CP intake, lb.</td>
<td>0.375</td>
<td>0.375</td>
<td>0.70</td>
</tr>
<tr>
<td>Daily ADF intake, lb.</td>
<td>0.265</td>
<td>0.088</td>
<td>0.01</td>
</tr>
<tr>
<td>ADG, lb.</td>
<td>1.32</td>
<td>1.19</td>
<td>0.02</td>
</tr>
<tr>
<td>Feed Efficiency*</td>
<td>0.65</td>
<td>0.71</td>
<td>0.02</td>
</tr>
<tr>
<td>Fecal Score**</td>
<td>1.25</td>
<td>1.34</td>
<td>0.03</td>
</tr>
</tbody>
</table>

* ADG/DM intake  
** Based on a 1 to 5 score where 1= normal
Research Project: Effect of Feeding Supplemental Lactoferrin to Early-weaned Holstein Calves on Growth and Health During the Milk Feeding and Post-weaning Periods

(Elizabeth A. English; M.S. degree thesis project)

Objective:

To determine the effect of feeding whole milk supplemented with either one-half gram (0.5 gram) or one gram (1 gram) of lactoferrin versus whole milk with no added lactoferrin on growth and health of Holstein calves weaned at 35 days of age with post-weaning supplementation of lactoferrin continued through 56 days of age.

Background/Justification:

Lactoferrin, an iron binding glycoprotein found in milk, has been shown to have antimicrobial properties (Joslin et al., 2002). Lactoferrin is obtained by separation from the whey protein fraction. Bovine milk has a naturally low concentration of lactoferrin (Masson and Heremans, 1971). Therefore, supplementing milk fed to calves with lactoferrin may improve calf health and growth while reducing days on medication. In previous research studies, lactoferrin has been supplemented at levels of 1, 2, 3 and 10 grams per day (Joslin et al., 2002 and Robblee et al., 2003). Results indicated that lactoferrin was most effective at the 1 gram per day supplementation level. In one study, researchers found that calves fed 1 gram per day had the lowest number of days on medication compared to other calves in the trial. In addition, calves supplemented with 1 gram of lactoferrin per day had greater pre-weaning average daily gains than calves fed 10 grams of lactoferrin per day (Robblee et al., 2003). Since lactoferrin is expensive, it is of value to determine if lactoferrin can be effective at even lower levels of supplementation (0.5 g/calf/day). In previous studies, lactoferrin has been added to the milk replacer. The effect of lactoferrin added to whole milk is still unknown. Since many farms feed whole milk to calves, it is practical to determine how whole milk supplemented with lactoferrin will affect calf performance. Supplementing lactoferrin to post-weaned calves has not been evaluated and may improve calf health and post-weaning average daily gains. The lowest effective level of lactoferrin needs to be identified in order to establish lactoferrin supplementation as an economical part of a successful calf health program.

Materials and Methods:

60 newborn male and female Holstein calves from the Piedmont Research Station herd were randomly assigned to one of 3 treatments at birth. Calves were removed from the dam at birth and fed 1 gallon of colostrum as soon as possible. Calves were fed colostrum from cows that had tested negative for BLV (Bovine Leukosis Virus) and Johnes disease. Colostrum was tested using a colostrometer in order to ensure good quality. In the event that the colostrum was not good quality, the calf was fed good
quality colostrum that had been frozen. Calves were fed colostrum for one day (1 gallon/calf) and housed individually in either outdoor Calf-tel hutches with an attached fenced outside exercise area or in individual pens in an open-sided barn. The housing square footage per calf was similar. The hutches and pens were bedded with a sand/wood chip mixture. Calves were not twins and had to weigh a minimum of 75 pounds at birth to be considered for the study.

All dehorning and castration was performed after the calf was off the trial. Any calf showing clinical signs of coccidiosis was treated with amprolium (Corid). Fecal samples were taken weekly in order to determine the presence of coccidia and E. coli. Calves were monitored for body weight gains and hip height changes through 6 months of age.

Laboratory analyses are now being conducted. Growth and health data will be statistically analyzed to determine treatment differences.

**Research Project:** Comparison of an intensive calf diet milk replacer program with a traditional whole milk feeding program on growth of Holstein heifer calves through 12 weeks of age.

**Objective:** To determine the effect of feeding a specially formulated high protein milk replacer and calf starter program versus a traditional whole milk and calf starter program on growth of Holstein heifer calves through 12 weeks of age.

**Materials and Methods:**

Forty-eight newborn Holstein heifer calves from the Piedmont Research Station herd were assigned randomly to one of two treatments at birth. Newborn calves were fed 1 gallon of colostrum, using an esophageal tube, immediately following birth. In the event that a calf was born overnight, that calf was given 2 quarts of colostrum by tube or nurse bottle in the a.m. and 2 more quarts in the p.m. Calves were fed colostrum for two days and housed individually in either outdoor Calf-tel hutches with an attached fenced outside exercise area or in individual pens in an open-sided barn. The housing square footage per calf was similar. The hutches and pens were bedded with a sand/wood chip mixture. Calves were not twins and had to weigh a minimum of 75 pounds at birth to be considered for the study.

**Treatment 1:** (24 Holstein Heifer Calves)

Calves on Treatment 1 were fed a specially formulated milk replacer (Cow’s Match® from Land O’ Lakes Animal Milk Products Company, Arden Hills, MN) that contained 28% CP and 20% fat using buckets and the following feeding protocol:
Week 1 (first 7 days on trial): Calves were fed 1.8 pounds of Cow’s Match® milk replacer divided into 2 equal feedings per day. (0.9 pounds of powder brought up to 2.5 quarts of solution at each feeding). Milk replacer was mixed in 110 to 120 F water. Calves were fed the calf starter (Intense Calf Diet 22 B-60) that contained 22% crude protein (CP) and Bovatec®. No hay was fed. Water was available at all times.

Weeks 2 through 6 (day 8 through day 42 on trial): Calves were fed 3.5 quarts twice daily of the same milk replacer solution fed in week 1. Calves were fed the calf starter (Intense Calf Diet 22 B-60) that contains 22% crude protein (CP) and Bovatec®. No hay was fed. Water was available at all times.

Week 7 (day 43 through day 49 on trial): Calves were fed 3.5 quarts once daily of the same milk replacer solution fed in week 1. Calves were fed the calf starter (Intense Calf Diet 22 B-60) that contains 22% crude protein (CP) and Bovatec®. Daily starter intake was monitored closely. No hay was fed. Water was available at all times.

Weeks 8 through 12 (day 50 through day 84 on trial): Calves were weaned from milk replacer at the end of week 7. Calves remained in their individual calf hutch or pen and were fed the same calf starter (Intense Calf Diet 22 B-60) free choice. No hay was fed. Water was available at all times.

Treatment 2: (24 Holstein Heifer Calves)

Weeks 1 through 6 (day 1 through day 42 on trial): Calves were fed 2 quarts of marketable whole milk twice daily using buckets. Calves were fed an 18% CP calf starter (Future Cow Starter B90 with Bovatec®) from Land O’ Lakes. No hay was fed. Water was available at all times.

Week 7 (day 43 through day 49 on trial): Calves were fed 2 quarts of marketable whole milk once daily using buckets. Calves were fed an 18% CP calf starter (Future Cow Starter B90 with Bovatec®) from Land O’ Lakes. No hay was fed. Water was available at all times.

Week 8 (day 50 through day 56 on trial): Calves were weaned from whole milk at the end of week 7. Calves remained in their individual calf hutch or pen and fed a blend of the 18% CP calf starter (Future Cow Starter B90 with Bovatec®) from Land O’ Lakes and a cottonseed hull based TMR (that contains 16% CP and 60 grams/ton of actual Bovatec®). No hay was fed. Water was available at all times.

Weeks 9 through 12 (day 57 through day 84 on trial): Calves remained in their individual hutch or pen through 12 weeks. Calves were fed a cottonseed hull based TMR (that contained 16% CP and Bovatec®). No hay was fed. Water was available at all times.

Results of this trial were analyzed statistically using the Proc Mixed procedure in SAS®.
Table 1. Effect of Feeding an Intensive Milk Replacer Program or a Traditional Whole Milk Feeding Program on Growth of Holstein Heifer Calves through 12 Weeks of Age

<table>
<thead>
<tr>
<th>Item</th>
<th>28:20 Milk Replacer ¹</th>
<th>Whole Milk ²</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Average Weight (lb)</td>
<td>87.0</td>
<td>87.0</td>
<td></td>
</tr>
<tr>
<td>Week 7 weight (lb)</td>
<td>178.2</td>
<td>153.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>Week 12 weight (lb)</td>
<td>263.3</td>
<td>232.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>ADG Weeks 1-7 (lb)</td>
<td>1.86</td>
<td>1.36</td>
<td>0.0001</td>
</tr>
<tr>
<td>ADG Weeks 7-12 (lb)</td>
<td>2.43</td>
<td>2.25</td>
<td>0.0304</td>
</tr>
<tr>
<td>ADG Through 12 weeks (lb)</td>
<td>2.10</td>
<td>1.73</td>
<td>0.0001</td>
</tr>
<tr>
<td>Average Dry Feed Intake (DM Basis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First 7 Weeks (lb of DM)</td>
<td>42.2</td>
<td>76.5</td>
<td>0.0001</td>
</tr>
<tr>
<td>Next 5 Weeks (lb of DM)</td>
<td>213.7</td>
<td>223.1</td>
<td>0.2031</td>
</tr>
<tr>
<td>Through 12 weeks (lb of DM)</td>
<td>256.0</td>
<td>299.6</td>
<td>0.0001</td>
</tr>
<tr>
<td>Average Fecal Consistency Score³</td>
<td>1.30</td>
<td>1.24</td>
<td>0.5528</td>
</tr>
<tr>
<td>Average Respiratory Score⁴</td>
<td>1.08</td>
<td>1.06</td>
<td>0.6182</td>
</tr>
<tr>
<td>Wither Height Gain Through 12 weeks (cm)</td>
<td>19.9</td>
<td>16.8</td>
<td>0.0035</td>
</tr>
<tr>
<td>Hip Height Gain Through 12 weeks (cm)</td>
<td>20.5</td>
<td>17.2</td>
<td>0.0001</td>
</tr>
<tr>
<td>Body Length Gain Through 12 weeks (cm)</td>
<td>31.6</td>
<td>27.5</td>
<td>0.0063</td>
</tr>
<tr>
<td>Heart Girth Gain Through 12 weeks (cm)</td>
<td>34.1</td>
<td>29.2</td>
<td>0.0005</td>
</tr>
<tr>
<td>Hip Width Gain Through 12 weeks (cm)</td>
<td>9.2</td>
<td>8.2</td>
<td>0.0034</td>
</tr>
<tr>
<td>Body Volume⁵ Gain Through 12 weeks (cm³)</td>
<td>235.0</td>
<td>193.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Body Condition Score⁶ at Week 12</td>
<td>2.83</td>
<td>2.39</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

¹ A 22% CP calf starter was also fed through 12 weeks.
² An 18% CP calf starter was also fed through 7 weeks. During week 8, these calves were fed a 50:50 blend of the 18% calf starter and a 16% CP cottonseed hull based TMR. The 16% cottonseed hull based TMR was fed from weeks 9 through 12.
³ Fecal consistency scores through first 2 weeks of age: 1=Normal (soft, solid, no fluid); 2= Soft (semi-solid); 3= Runny (semi-solid, mostly fluid); 4= Watery (fluid); 5= Bloody
⁴ Respiratory Score 1-5 scale: 1=Normal; 2=Runny nose; 3= Heavy breathing; 4= Moist cough; 5= Dry cough
⁵ Body Volume, cm³= (heart girth, cm/3.14)x(body length, cm)x(hip height, cm)
Research Project: Effect of BGY on Health and Growth of Holstein Calves

OBJECTIVES: To determine the potential benefits of inclusion of a brewers yeast product (BGY) in the calf starter concentrate mix and heifer grower feed on health and growth of Holstein calves.

JUSTIFICATION AND DESCRIPTION:

BGY is a commercial blend of plant protein products, processed grain by-products and brewers yeast. Previous research suggests that certain natural feed additives such as brewers yeast may reduce the number of days with elevated body temperatures and the need for antibiotic therapy in neonatal calves. In a study at North Carolina State University, researchers found that calves fed BGY had significantly greater body weight gains and lower death losses.

This study is designed to determine the effect of BGY on incidence of coccidiosis, cryptosporidiosis, inflammation, disease incidence, calf losses, growth and feed efficiency in neonatal and postweaned calves.

MATERIALS AND METHODS:

One hundred newborn Holstein calves (50 per treatment) will be assigned to treatments in a completely randomized block design and housed in individual pens at the Piedmont Research Station. An equivalent proportion of heifers and bulls will be utilized within each treatment. Each type of housing (outdoor hutches or indoor pens) will have equal numbers of each treatment and sex. Treatment 1 calf starter and heifer grower TMR contains BGY while Treatment 2 (control) calf starter and heifer grower TMR contains substitute feed ingredients to provide similar amounts of fiber, protein and minerals as the BGY replaced. All calves will receive one gallon (3.8 L) of colostrum initially and then one gallon (3.8 L) of milk replacer fed once daily for 28 days at which time all calves will be weaned. Calves will be offered their respective calf starter treatment ad libitum from day one through 56 days of age. Calves will remain in their individual pens for 56 days and then placed in one of two groups according to their treatment and fed the same heifer grower TMR (with or without BGY) through 180 days of age. Individual weekly starter intakes will be measured during the calf starter phase and group cumulative feed intakes will be measured during the TMR feeding phase. Hay will be offered after 90 days in addition to the TMR. Respiratory
problems will be treated according to veterinarian’s recommendations.

**Treatments:**

1). Calf starter concentrate that contains 25% BGY; and heifer grower TMR that provides 4 ounces of BGY per heifer per day 2). Calf starter concentrate and heifer grower TMR without BGY, but with similar concentrations of nutrients.
Effect of Eight Feed Additives on Aflatoxin in Milk of Dairy Cows Fed Aflatoxin-contaminated Diets.

J. Summer Stroud, Elizabeth English, Shannon Davidson, B. A. Hopkins, G. Latimer, W. M. Hagler, Jr., Cavell Brownie, L. W. Whitlow
North Carolina State University, Raleigh and Texas A&M University, College Station.

Research Project Summary (Summer Stroud; M.S. degree thesis project)

Sixty lactating Holstein cows were used in a replicated block experiment to determine the efficacy of eight feed additives to reduce the transfer of aflatoxin from feed to milk. Six cows were allocated to each treatment group and 12 to a control group. All cows were fed the same aflatoxin-contaminated TMR (=170 ppb, provided by naturally contaminated corn grain) and then either no additive (control) or one of eight additives at 0.5% of the TMR dry matter. Milk samples were collected twice daily on day five after initiating aflatoxin feeding and on days five and six after including additives. Milk aflatoxin concentration [µg/L] was measured by HPLC. Changes in milk aflatoxin concentration, milk aflatoxin excretion (milk aflatoxin concentration times milk yield); and aflatoxin transfer from feed to milk (aflatoxin excretion as a percentage of aflatoxin intake) were evaluated. All changes were expressed as percentages and calculated relative to the control group which defined zero change. Changes were considered significantly different from zero when \( P < 0.05 \). Additives are described by their analyzed composition to include ammonium acetate extractable amounts of calcium, magnesium, sodium and potassium and organic carbon (personal communication, Dr. Joe Dixon, Texas A&M University).

<table>
<thead>
<tr>
<th>Additive</th>
<th>Additive Specification</th>
<th>Change in Milk Aflatoxin Concentration (%)</th>
<th>Change in Milk Aflatoxin Excretion (%)</th>
<th>Change in Aflatoxin Transfer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NH(_4)OAc extractable</td>
<td>Ca  Mg  Na  K  Organic Carbon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>cmol(_{eq})/Kg</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7.1 17.5 18.6 29.5</td>
<td>47.99</td>
<td>+7.81</td>
<td>+6.71</td>
</tr>
<tr>
<td>2</td>
<td>28.0 11.6 18.4 10.9</td>
<td>14.05</td>
<td>-7.36</td>
<td>-7.85</td>
</tr>
<tr>
<td>3</td>
<td>59.3 12.1 1.5 9.3</td>
<td>0.27</td>
<td>-6.62</td>
<td>-8.00</td>
</tr>
<tr>
<td>4</td>
<td>92.1 12.9 0.6 1.5</td>
<td>0.50</td>
<td>-40.39*</td>
<td>-42.59*</td>
</tr>
<tr>
<td>5</td>
<td>73.7 15.2 26.8 9.4</td>
<td>18.98</td>
<td>-34.98*</td>
<td>-36.36*</td>
</tr>
<tr>
<td>6</td>
<td>9.5 11.1 0.4 1.6</td>
<td>0.74</td>
<td>-7.85</td>
<td>-13.79</td>
</tr>
<tr>
<td>7</td>
<td>51.7 15.3 43.5 0.5</td>
<td>0.27</td>
<td>-48.90*</td>
<td>-52.28*</td>
</tr>
<tr>
<td>8</td>
<td>43.1 14.5 12.1 0.9</td>
<td>0.16</td>
<td>-46.49*</td>
<td>-48.46*</td>
</tr>
</tbody>
</table>

Pooled standard error: 12.69 13.75 13.12

*Values are significantly different from zero (\( P < 0.05 \)).

Products vary in effectiveness. Four of the eight additives added at 0.5% of DMI significantly reduced milk aflatoxin concentration, excretion and transfer from feed to milk of dairy cows consuming about 170 ppb aflatoxin. Other research shows that amount of product used is also an important factor.
Mycotoxin Concerns in Dairy Cattle

L. W. Whitlow and B. A. Hopkins, Department of Animal Science, and W. M. Hagler, Jr., Department of Poultry Science
North Carolina State University, Raleigh, NC 27695

Introduction

Molds are filamentous (fuzzy or dusty looking) fungi that occur in many feedstuffs including roughages and concentrates. Molds can infect dairy cattle, especially during stressful periods when they are immune suppressed, causing a disease referred to as a mycosis. Molds also produce poisons called mycotoxins that affect animals when they consume mycotoxin contaminated feeds. This disorder is called a mycotoxicosis. Mycotoxins are produced by a wide range of different molds and are classified as secondary metabolites meaning that their function is not essential to the mold’s existence. The FAO has estimated that worldwide, about 25% of crops are affected annually with mycotoxins (Jelinek, 1987). Such surveys reveal sufficiently high occurrences and concentrations of mycotoxins to suggest that mycotoxins are a constant concern. Tables 1 and 2 provide mycotoxin occurrence and concentration of farmer submitted feedstuffs in North Carolina over several years.

Mycotoxins can be formed on crops in the field, during harvest, or during storage, processing, or feeding. Molds are present throughout the environment. The spores are high in the soil and in plant debris and lie ready to infect the growing plant in the field. Field diseases are characterized by yield loss, quality loss and mycotoxin contamination. Mold growth and the production of mycotoxins are usually associated with extremes in weather conditions leading to plant stress or hydration of feedstuffs, insect damage, poor storage practices, low feedstuff quality, and inadequate feeding conditions.

It is generally accepted that the Aspergillus, Fusarium and Penicillium molds are among the most important in producing mycotoxins detrimental to cattle. The mycotoxins of greatest concern include: aflatoxin, which is generally produced by Aspergillus mold; deoxynivalenol, zearalenone, T-2 Toxin, and fumonisin, which are produced by Fusarium molds; and ochratoxin and PR toxin produced by Penicillium molds. Several other mycotoxins such as the ergots are known to affect cattle and may be prevalent at times in certain feedstuffs. There are hundreds of different mycotoxins which are diverse in their chemistry and effects on animals. It is likely that contaminated feeds will contain more than one mycotoxin. This paper is directed toward those mycotoxins thought to occur most frequently at concentrations toxic to dairy cattle. A more extensive review is available in the popular press (Whitlow and Hagler, 2004).

Major toxigenic fungi and mycotoxins thought to be the most prevalent and potentially toxic to dairy cattle.

<table>
<thead>
<tr>
<th>Fungal genera</th>
<th>Mycotoxins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspergillus</td>
<td>Aflatoxin, Ochratoxin, Sterigmatocystin, Fumitremorgens, Fumigaclavines, Fumitoxins, Cyclopiazonic Acid, Gliotoxin</td>
</tr>
<tr>
<td>Fusarium</td>
<td>Deoxynivalenol, Zearalenone, T-2 Toxin, Fumonisins, Moniliformin, Nivalenol, Diacetoxyscirpenol, Butenolide, Neosolaniol, Fusaric Acid, Fusarochromanone, Wortmannin, Fusarin C, Fusaproliferin</td>
</tr>
<tr>
<td>Penicillium</td>
<td>Ochratoxin, PR Toxin, Patulin, Penicillic Acid, Citrinin, Penetrem, Cyclopiazonic acid, Roquefortine, Isofumigaclavines A and B, Mycophenolic acid</td>
</tr>
<tr>
<td>Claviceps</td>
<td>Ergot alkaloids in seed/grain of small grains, sorghum, grasses</td>
</tr>
<tr>
<td>Epichloe, and Neotyphodium</td>
<td>Ergot alkaloids in fescue grass.</td>
</tr>
<tr>
<td>Stachybotrys</td>
<td>Stachybotryotoxins, trichotheccenes</td>
</tr>
</tbody>
</table>
Table 1. Percentage of feeds positive for mycotoxins, in all feeds submitted by North Carolina dairy producers over a 13-year period (Whitlow et al., 1998).

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Low, range</th>
<th>High, range</th>
<th>Total positive, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td>5-19 ppb</td>
<td>≥ 20 ppb</td>
<td>10.4</td>
</tr>
<tr>
<td>Deoxynivalenol</td>
<td>&lt;500 ppb</td>
<td>≥ 500 ppb</td>
<td>46.2</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>100-299 ppb</td>
<td>≥ 300 ppb</td>
<td>15.4</td>
</tr>
<tr>
<td>T-2 Toxin</td>
<td>50-99 ppb</td>
<td>≥ 100 ppb</td>
<td>8.1</td>
</tr>
<tr>
<td>Fumonisin</td>
<td>&lt;5 ppm</td>
<td>≥ 5 ppm</td>
<td>42.0</td>
</tr>
</tbody>
</table>

Aflatoxin n=3266, Deoxynivalenol n=5053, Zearalenone n=4563, T-2 Toxin n=5136, Fumonisin N=822

Table 2. Occurrence of five mycotoxins in corn silage, corn grain and in all feed samples submitted for analysis by producers in North Carolina over a nine-year period (Whitlow et al., 1998).

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Corn Silage</th>
<th>Corn Grain</th>
<th>All Feeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n   % Pos   mean ± s.d.</td>
<td>n   % Pos   mean ± s.d.</td>
<td>n   % Pos   mean ± s.d.</td>
</tr>
<tr>
<td>Aflatoxin</td>
<td>461 8 28 ± 19</td>
<td>231 9 170 ± 606</td>
<td>1617 7 91 ± 320</td>
</tr>
<tr>
<td>Deoxynivalenol</td>
<td>778 66 1991 ± 2878</td>
<td>362 70 1504 ± 2550</td>
<td>2472 58 1739 ± 1880</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>487 30 525 &quot; 799</td>
<td>219 11 206 &quot; 175</td>
<td>1769 18 445 ± 669</td>
</tr>
<tr>
<td>T-2 toxin</td>
<td>717 7 569 &quot; 830</td>
<td>353 6 569 &quot; 690</td>
<td>2243 7 482 &quot; 898</td>
</tr>
<tr>
<td>Fumonisin</td>
<td>63 3</td>
<td>37 60</td>
<td>283 28</td>
</tr>
</tbody>
</table>

n = number of samples
% = percentage of samples positive above given concentrations
mean ±s.d. = mean of the positive samples plus and minus the standard deviation

Aflatoxin production by Aspergillus flavus in corn is favored by heat and drought stress associated with warmer climates. Fusarium molds commonly affect corn causing ear and stalk rots, and small grains, causing head blight (scab). In wheat, excess moisture at flowering and afterward is associated with increased incidence of mycotoxin formation. In corn, Fusarium diseases are more commonly associated with warm conditions at silking and with insect damage and wet conditions late in the growing season or late harvest. Penicillium molds grow in wet and cool conditions and require little oxygen.

Mycotoxins can increase the incidence of disease and reduce production efficiency in cattle (Coulombe, 1993; Joffe, 1986; Pier, 1992). Mycotoxins can be the primary agent causing acute health or production problems in a dairy herd, but more likely, mycotoxins are a factor contributing to chronic problems including a higher incidence of disease, poor reproductive performance or suboptimal milk production. They exert their effects through four primary mechanisms: (1) intake reduction or feed refusal, (2) reduced nutrient absorption and impaired metabolism; (3) alterations in the endocrine and exocrine systems; and (4) suppression of the
immune system. Recognition of the impact of mycotoxins on animal production has been limited by the difficulty of diagnosis. Symptoms are often nonspecific and the result of a progression of effects, making a diagnosis difficult or impossible because of the complex clinical results with a wide diversity of symptoms. The difficulty of diagnosis is increased due to limited research, occurrence of multiple mycotoxins, non-uniform distribution, interactions with other factors, and problems of sampling and analysis.

Because of the difficulty of diagnosis, the determination of a mycotoxin problem becomes a process of elimination and association. Certain basics can be helpful: 1) Mycotoxins should be considered as a possible primary factor resulting in production losses and increased incidence of disease. 2) Documented symptoms in ruminants or other species can be used as a general guide to symptoms observed in the field. 3) Systemic effects as well as specific damage to target tissues can be used as a guide to possible causes. 4) Post mortem examinations may indicate no more than gut irritation, edema or generalized tissue inflammation. 5) Because of the immune suppressing effects of mycotoxins, atypical diseases or increased incidence of disease may be observed. 6) Responses to added dietary sorbents or dilution of the contaminated feed may help in diagnosis. 7) Feed analyses should be performed, but accurate sampling is a problem (Schiefer, 1990).

Symptoms of a mycotoxicosis in a dairy herd vary depending on the mycotoxins involved and their interactions with other stress factors. The more stressed cows, such as fresh cows, are most affected, perhaps because their immune systems are already suppressed. Symptoms of mycotoxins may be nonspecific and wide ranging. Symptoms may be few or many. Symptoms may include: reduced production, reduced feed consumption, intermittent diarrhea (sometimes with bloody or dark manure), reduced feed intake, unthriftiness, rough hair coat, reduced reproductive performance including irregular estrus cycles, embryonic mortalities, pregnant cows showing estrus, and decreased conception rates. There generally is an increase in incidence of disease, such as displaced abomasum, ketosis, retained placenta, metritis, mastitis, and fatty livers. Cows do not respond well to veterinary therapy.

Molds can cause disease

A mold (fungal) infection resulting in disease is referred to as a mycosis. Fungal pathogens include Aspergillus fumigatus, Candida albicans, Candida

Aspergillus fumigatus has been proposed as the pathogenic agent associated with mycotic hemorrhagic bowel syndrome (HBS) in dairy cattle (Puntenney et al., 2003). A. fumigatus is thought to be a fairly common mold in both hay (Shadmi et al., 1974) and silage (Cole et al., 1977). While healthy cows with an active immune system are more resistant to mycotic infections, dairy cows in early lactation are immune suppressed (Kehrli et al., 1989a&b) and HBS is more likely in fresh cows (Puntenney et al., 2003). It is theorized that in a mycosis, mycotoxins produced by the invading fungi can suppress immunity, therefore increasing the infectivity of the fungus. A. fumigatus produces several mycotoxins, including gliotoxin, which is an immune suppressant. Gliotoxin has been present in animals infected with A. fumigatus (Bauer et al., 1989). Reeves et al. (2004) using an insect model demonstrated the significance of gliotoxin in increasing the virulence of A. fumigatus. Niyo et al. (1988a, b) have demonstrated that in rabbits, T-2 toxin decreased phagocytosis of A. fumigatus conidia by alveolar macrophages and increased severity of experimental aspergillosis. It is possible that gliotoxin, T-2 toxin or other mycotoxins that suppress immunity may be a trigger to increased infectivity by the fungus, ultimately resulting in HBS or other fungal infections. If this is true, then reducing animal exposure to mycotoxins may be a key to control of mycoses such as HBS. A commercial feed additive with anti-fungal and adsorbent properties appears to reduce HBS (Puntenney et al., 2003), although these additives can have other functions including the reduction of mold growth.

Toxicity of Individual Mycotoxins

Aflatoxin

Aflatoxins are a family of extremely toxic, mutagenic, and carcinogenic compounds produced by Aspergillus flavus and A. parasiticus (Deiner et al., 1987; Kurtzman et al., 1987). Toxigenic A. flavus isolates produce aflatoxins B1, and B2 and toxigenic A. parasiticus isolates produce aflatoxins B1, B2, G1, and G2 (Cotty et al., 1994). Aflatoxin B1 is a carcinogen and is excreted in milk in the form of aflatoxin M1. Table 3 provides the Food and Drug Administration (FDA) action levels for aflatoxin in feeds and milk. The FDA limits aflatoxin to no more than 20 ppb in lactating dairy feeds and to 0.5 ppb in milk. A thumb rule is that milk aflatoxin concentrations equal about 1.7% of the aflatoxin concentration in the total ration dry matter. Cows
consuming diets containing 30 ppb aflatoxin can produce milk containing aflatoxin residues above the FDA action level of 0.5 ppb. In Europe the regulatory levels of aflatoxin are 20 ppb for dairy feeds and 0.05 ppb in milk, therefore, an illegal milk residue can occur when feed contains more than 3 ppb of aflatoxin. Figure 1 shows the clearance and appearance of aflatoxin in milk over a 16 day period in association with the feeding of clean or aflatoxin-contaminated corn, in diets with and without clay products added at 1%.

Table 3. U.S. Food and Drug Administration action levels for total aflatoxins in food and feed

<table>
<thead>
<tr>
<th>Food or Feedstuff</th>
<th>Concentration (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All products, except milk, designated for humans</td>
<td>20</td>
</tr>
<tr>
<td>Corn for immature animals and dairy cattle</td>
<td>20</td>
</tr>
<tr>
<td>Corn and peanut products for breeding beef cattle, swine, and mature poultry</td>
<td>100</td>
</tr>
<tr>
<td>Corn and peanut products for finishing swine (&gt;100 lb)</td>
<td>200</td>
</tr>
<tr>
<td>Corn and peanut products for finishing beef cattle</td>
<td>300</td>
</tr>
<tr>
<td>Cottonseed meal (as a feed ingredient)</td>
<td>300</td>
</tr>
<tr>
<td>All other feedstuffs</td>
<td>20</td>
</tr>
<tr>
<td>Milk&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<sup>a</sup> Wood and Trucksess, 1998.  <sup>b</sup> Aflatoxin M1.

Symptoms of acute aflatoxicosis in mammals include: inappetance, lethargy, ataxia, rough hair coat, and pale, enlarged fatty livers. Symptoms of chronic aflatoxin exposure include reduced feed efficiency and milk production, jaundice, and decreased appetite (Nibbelink, 1986). Aflatoxin lowers resistance to diseases and interferes with vaccine-induced immunity in livestock (Diekman and Green, 1992). In beef cattle, Garrett et al. (1968) showed an effect on weight gain and intake with diets containing 700 ppb aflatoxin, but if increases in liver weights are used as the criteria for toxicity, 100 ppb would be considered toxic to beef cattle. Production and health of dairy herds may be affected at dietary aflatoxin levels above 100 ppb which is considerably higher than the amount that produces illegal milk residues (Patterson and Anderson 1982 and Masri et al. 1969). Guthrie (1979) showed when lactating dairy cattle in a field situation were consuming 120 ppb aflatoxin reproductive efficiency declined and when cows were changed to an aflatoxin free diet, milk production increased over 25%. Applebaum et al. (1982) showed that impure aflatoxin produced by culture reduced production while equal amounts of pure aflatoxin did not.

Aflatoxin is more often found in corn, peanuts and cottonseed grown in warm and humid climates. Aflatoxin can be found in more temperate areas as was seen in the drought year of 1988 when aflatoxin was found in 5% of corn grain in the Midwestern U.S. (Russell, et al., 1991). The General Accounting Office (GAO, 1991) concluded that industry, federal and state programs are effective in detecting and controlling aflatoxin and that it is doubtful that additional programs or limits would reduce the risk of aflatoxin in the food supply.
Deoxynivalenol (DON) or Vomitoxin

Deoxynivalenol is a Fusarium produced mycotoxin, commonly detected in feed. It is sometimes called vomitoxin because it was associated with vomiting in swine. Surveys have shown DON to be associated with swine disorders including feed refusals, diarrhea, emesis, reproductive failure, and deaths. The impact of DON on dairy cattle is not established, but clinical data show an association between DON and poor performance in dairy herds (Whitlow et al., 1994). Dairy cattle consuming diets contaminated primarily with DON (2.5 ppm) have responded favorably (1.5 kg milk, P<.05) to the dietary inclusion of a mycotoxin binder, providing circumstantial evidence that DON may reduce milk production (Diaz, et al., 2001). Field reports help substantiate this association (Gotlieb, 1997 and Seglar, 1997). Results from a Canadian study using 6 first-lactation cows per treatment during mid-lactation (average 19.5 kg milk) showed that cows consuming DON contaminated diets (2.6 to 6.5 ppm) tended (P<0.16) to produce less milk (13% or 1.4 kg) than did cows consuming clean feed (Charmley et al., 1993). DON had no effect on milk production in 8 cows fed over a 21 day period (Ingalls, 1994). Beef cattle and sheep have tolerated up to 21 ppm of dietary DON without obvious effects (DiCostanzo et al., 1995).

Table 4. U.S. Food and Drug Administration advisory levels for deoxynivalenol in wheat and wheat derived products

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Concentration, ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>All finished wheat products, e.g. flour, bran and germ, for human consumption</td>
<td>1</td>
</tr>
<tr>
<td>Grains and grain by-products destined for ruminating beef cattle and cattle and cattle in feedlots older than 4 months and for chickens (these ingredients should not exceed 50% of the diet)</td>
<td>10</td>
</tr>
<tr>
<td>Grains and grain by-products destined for swine (these ingredients should not exceed 20% of the diet)</td>
<td>5</td>
</tr>
<tr>
<td>Grains and grain by-products for all other Animals (these ingredients should not exceed 40% of the diet)</td>
<td>5</td>
</tr>
</tbody>
</table>

Like other mycotoxins, pure DON added to diets, does not have as much toxicity as does DON supplied from naturally contaminated feeds (Foster et al., 1986). This is thought to result from the interaction of multiple mycotoxins in naturally contaminated feeds. These mycotoxins can interact to cause symptoms that are different or more severe than expected. For example, it is now known that fusaric acid interacts with DON to cause the vomiting effects earlier attributed to DON alone and resulted in use of the trivial name of vomitoxin for DON (Smith and MacDonald, 1991). It is believed that DON serves as a marker, indicating that feed was exposed to a situation conducive for mold growth and possible formation of several mycotoxins.

T-2 Toxin (T-2)

T-2 toxin is a very potent Fusarium produced mycotoxin that occurs in a low proportion of feed samples (<10%). Russell, et al. (1991) found 13% of Midwestern corn grain contaminated with T-2 toxin in a survey of the 1988 drought damaged crop.

T-2 is associated with reduced feed consumption, loss in yield, gastroenteritis, intestinal hemorrhage, reduced reproductive performance and death. Effects are less well established in cattle than in laboratory animals (Wannemacher et al., 1991). T-2 toxin is associated with gastroenteritis, intestinal hemorrhages (Petrie et al., 1977; Mirocha et al., 1976) and death (Hsu et al., 1972 and Kosuri et al., 1970). Dietary T-2 toxin at 640 ppb for 20 days resulted in bloody feces, enteritis, abomasal and ruminal ulcers and death (Pier et al., 1980). Weaver et al. (1980) showed that T-2 was associated with feed refusal and gastrointestinal lesions in a cow, but did not show a hemorrhagic syndrome. Kegl and Vanyi (1991) observed bloody diarrhea, low feed consumption, decreased milk production and absence of estrus cycles in cows exposed to T-2. Serum immunoglobulins and complement proteins were lowered in calves receiving T-2 toxin (Mann et al., 1983). Gentry et al. (1984) demonstrated a reduction in white blood cell and neutrophil counts in calves. McLaughlin et al. (1977) demonstrated that primary basis of T-2 reduced immunity is reduced protein synthesis.

Zearalenone (ZEA)

Zearalenone is a Fusarium produced mycotoxin that has a chemical structure similar to estrogen and can produce an estrogenic response in animals. Zearalenone is associated with ear and stalk rots in corn and with scab in wheat (Christensen et al., 1988).
Controlled studies with ZEA at high levels have failed to reproduce the degree of toxicity that has been associated with zearalenone contaminated feeds in field observations. A controlled study with non-lactating cows fed up to 500 mg of ZEA (calculated dietary concentrations of about 25 ppm ZEA) showed no obvious effects except that corpora lutea were smaller in treated cows (Weaver et al., 1986b). In a similar study with heifers receiving 250 mg of ZEA by gelatin capsule (calculated dietary concentrations of about 25 ppm ZEA), conception rate was depressed about 25%; otherwise, no obvious effects were noted (Weaver et al., 1986a).

Several case reports have related ZEA to estrogenic responses in ruminants including abortions (Kellela and Ettala, 1984, Khamis et al., 1986, Mirocha et al., 1968, Mirocha et al., 1974, and Roine et al., 1971). Symptoms have included vaginitis, vaginal secretions, poor reproductive performance and mammary gland enlargement of virgin heifers. In a field study, (Coppock et al., 1990) diets with about 660 ppb ZEA and 440 ppb DON resulted in poor consumption, depressed milk production, diarrhea, increase in reproductive tract infections, and total reproductive failure.

New Zealand workers (Towers, et al., 1995) have measured blood ZEA and metabolites ("zearalenone") to estimate ZEA intake. Dairy herds with low fertility had higher levels of blood "zearalenone". Individual cows within herds examined by palpation and determined to be cycling had lower blood "zearalenone" levels than did cows that were not cycling. The reproductive problems in dairy cattle were associated with dietary ZEA concentrations of about 400 ppb.

Fumonisin (FB)

Fumonisin B₁, produced by F. verticillioides, was first isolated in 1988. It causes leuconecphaltalomalacia in horses, pulmonary edema in swine and hepatoxicity in rats. It is carcinogenic in rats and mice (NTP, 1999) and is thought to be a promoter of esophageal cancer in humans (Chu and Li, 1994 and Rheeder et al., 1992). Fumonisins are structurally similar to sphingosine, a component of sphingolipids, which are in high concentrations in certain nerve tissues such as myelin. Fumonisin toxicity results from blockage of sphingolipid biosynthesis and thus degeneration of tissues rich in sphingolipids.

While FB₁ is much less potent in ruminants than in hogs, it has now been shown toxic to sheep, goats, beef cattle, and dairy cattle. Osweiler et al., (1993) fed 18 young steers either 15, 31 or 148 ppm of fumonisin in a short term study (31 days). With the highest feeding level, there were mild liver lesions found in two of six calves, and the group had elevated liver enzymes indicative of liver damage. Lymphocyte blastogenesis was significantly impaired at the end of the feeding period in the group having the highest dose.

Dairy cattle (Holsteins and Jerseys) fed diets containing 100 ppm fumonisin for approximately 7 days prior to freshening and for 70 days thereafter demonstrated lower milk production (6 kg/cow/day), explained primarily by reduced feed consumption (Figure 2, Diaz et al., 2000). Increases in serum enzymes concentrations suggested mild liver disease. Because of greater production stress, dairy cattle may be more sensitive to fumonisin than are beef cattle. Fumonisin carryover from feed to milk is thought to be negligible (Scott et al., 1994).

A USDA, APHIS survey of 1995 corn from Missouri, Iowa and Illinois found that 6.9% contained more than 5 ppm fumonisin B₁ (Anon., 1995). Fumonisin was prevalent in Midwestern corn from the wet 1993 season. Corn screenings contain about 10 times the fumonisin content of the original corn.
Table 5. U.S. Food and Drug Administration Guidance for Industry on Fumonisin Levels in Human Foods and Animal Feeds

<table>
<thead>
<tr>
<th>Total Fumonisins (FB₁+FB₂+FB₃)</th>
<th>Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Foods</strong></td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td></td>
</tr>
<tr>
<td>Degermed dry milled corn products (e.g., flaking grits, corn grits, corn meal, corn flour with fat content of &lt; 2.25%, dry weight basis)</td>
<td>2</td>
</tr>
<tr>
<td>Whole or partially degermed dry milled corn products (e.g., flaking grits, corn grits, corn meal, corn flour with fat content of ≥ 2.25 %, dry weight basis)</td>
<td>4</td>
</tr>
<tr>
<td>Dry milled corn bran</td>
<td>4</td>
</tr>
<tr>
<td>Cleaned corn intended for masa production</td>
<td>4</td>
</tr>
<tr>
<td>Cleaned corn intended for popcorn</td>
<td>3</td>
</tr>
<tr>
<td><strong>Animal Feeds</strong></td>
<td></td>
</tr>
<tr>
<td>Corn and corn by-products intended for:</td>
<td></td>
</tr>
<tr>
<td>Equids and rabbits (no more than 20% of diet)</td>
<td>5</td>
</tr>
<tr>
<td>Swine and catfish (no more than 50% of diet)</td>
<td>20</td>
</tr>
<tr>
<td>Breeding ruminants, breeding poultry and breeding mink and including lactating dairy cattle and hens laying eggs for human consumption (no more than 50% of diet)</td>
<td>30</td>
</tr>
<tr>
<td>Ruminants ≥ 3 months old being raised for slaughter and mink being raised for pelt production (no more than 50% of diet)</td>
<td>60</td>
</tr>
<tr>
<td>Poultry being raised for slaughter (no more than 50% of diet)</td>
<td>100</td>
</tr>
<tr>
<td>All other species or classes of livestock and pet animals (no more than 50% of diet)</td>
<td>10</td>
</tr>
</tbody>
</table>

Other Mycotoxins

Many other mycotoxins may affect ruminants but they are thought to occur less frequently or be less potent. Diacetoxyscirpenol, HT-2 and neosolaniol may occur along with T-2 toxin and cause similar symptoms. Ochratoxin has been reported to affect cattle, but it is rapidly degraded in the rumen and thus thought to be of little consequence except for pre-ruminants. Tremorgens such as fumigaclavine A and B produced by *Aspergillus fumigatus* are thought to be common in silages of the southeastern US and were toxic to beef cattle in a field case.

In Georgia (Cole, et al., 1977). Tremorgens can cause anorexia, diarrhea, unthriftiness and irritability. Mycotoxins such as rubratoxin, citrinin, patulin, cyclopiazonic acid, sterigmatocystin and ergot alkaloids may also be of importance. Mycotoxins in forages have been reviewed by Lacey (1991).

Mycotoxin Testing

Analytical techniques for mycotoxins are improving. Several commercial laboratories are available and provide screens for a large array of mycotoxins. Cost of analyses has been a constraint but can be insignificant compared with the economic consequences of production and health losses related to mycotoxin contamination. Newer immunoassays have reduced the cost of analyses.

Collection of representative feed samples is a problem primarily because molds can produce very large amounts of mycotoxins in small areas making the mycotoxin level highly variable within the lot of feed (Whittaker et al., 1991). Core sampling of horizontal silos shows mycotoxins can be highly variable throughout the silo. Because mycotoxins can form in the collected sample, samples should be preserved and delivered to the lab quickly. Samples can be dried, frozen or treated with a mold inhibitor before shipping.

Concentrations of mycotoxins, that are considered as acceptable and of no consequence, should be conservatively low due to non-uniform distribution, uncertainties in sampling and analysis, the potential for multiple sources in the diet, and interacting factors affecting toxicity (Hamilton, 1984).
**Prevention and Treatment**

Prevention of mycotoxin formation is essential since there are few ways to completely overcome problems once mycotoxins are present. Drought and insect damage are most important in instigating molding and mycotoxin formation in the field. Choosing varieties that have some resistance to fungal disease, and resistance to insect damage (Bt hybrids) have fewer field produced mycotoxins. Varieties should be adapted to the growing area. Irrigation can reduce mycotoxin formation in the field. When harvesting, avoid lodged or fallen material, because contact with soil can increase mycotoxins. Mycotoxins increase with delayed harvest, and with late season rain and cool periods. Damaged grains have increased mycotoxin levels, thus for dry grain storage, harvesting equipment should be maintained to avoid kernel damage. Mycotoxin concentrations are greatest in the fines, and in broken and damaged kernels, thus cleaning can greatly reduce mycotoxin concentrations in the feedstuffs. After harvest, grains should not be allowed to remain at levels of moisture greater than 15 to 18%. While there is little mold growth in grain at moisture levels below 15%, drying to levels below 14% and preferably to <13% help to compensate for non-uniform moisture concentrations throughout the grain mass. The high ambient temperatures of Florida also dictate that grain must be dried to the lower levels because higher temperatures increase the amount of free moisture (water activity) in the grain which is the primary cause of mold growth in storage. Storage should be sufficient to eliminate moisture migration, moisture condensation or leaks. Grain stored for more than two weeks should be kept aerated and cool. Aeration is important because as molds start to grow in isolated spots, the moisture produced by metabolism is sufficient to stimulate spread of the mold growth. Aeration reduces moisture migration and non-uniform moisture concentrations. Commodity sheds should protect feedstuffs from rain or other water sources. They should be constructed with a vapor barrier in the floor to reduce moisture. If wet feeds are stored in commodity sheds near dry feeds, a method must be devised to prevent moisture contamination of the dry feed. Bins, silos and other storage facilities should be cleaned to eliminate source of inoculation. Check stored feed at intervals to determine if heating and molding are occurring. Organic acids can be used as preservatives for feeds too high in moisture for proper storage.

It can be difficult to make hay at moisture levels low enough to prevent mold growth. Mold will grow in hay at moisture levels above 12 to 15%. As molds and other microorganisms grow they produce heat and cause deterioration. Heating can become so intense as to cause spontaneous combustion and hay fires. Feeding moldy hay can reduce intake and performance and the deterioration results in reduced nutritional value. Hay harvested at high moistures will tend to equilibrate to moisture contents of 12 to 14%, but rate of moisture loss is dependent on moisture at harvest, air movement, humidity, air temperature, bale density and the storage facility. Rate of dry down is enhanced by ventilation, creation of air spaces between bales, reduced size of stacks, and alteration in the direction of stacking and avoidance of other wet products in the same area.

Prevention of mycotoxins in silage includes following accepted silage making practices aimed at preventing deterioration primarily by quickly reducing pH and elimination of oxygen. Generally accepted silage making practices are to harvest at the proper moisture content; chop uniformly at the proper length, fill the silo rapidly; pack the silage sufficiently; use an effective fermentation aide; and cover completely and well. Infiltration of air after ensiling can allow growth of acid tolerant microorganisms, an increase in the pH and then mold growth. *Penicillium* molds are somewhat acid tolerant and may grow if any air is present. Some additives are beneficial in reducing pH very rapidly and therefore they can reduce mold growth and mycotoxin formation. Ammonia, propionic acid, sorbic acid and microbial or enzymatic silage additives are shown to be at least partially effective at inhibiting mold growth. Ammonia may prevent silage from reaching a low pH, but it can reduce mold growth through direct inhibition of the mold. Organic acids provide the acidity for preservation without relying solely on acids produced in the ensiling process. Organic acids may be used to treat the entire silage mass, or to selectively treat the outer layers of the silo. Organic acids are also used during feedout to treat the silo feeding face and/or the TMR in an effort to reduce continuous deterioration of the feeding face and to reduce heating in the feed bunk. Silo size should be matched to herd size to insure daily removal of silage at a rate faster than deterioration. In warm climates it is best to remove a foot of silage daily from the feeding face. The feeding face of silos should be cleanly cut and disturbed as little as possible to prevent aeration into the silage mass. Silage or other wet feeds should be fed immediately after storage removal. Spoilage should not be fed and feed bunks should be cleaned regularly.

As with silage, high moisture grains or byproduct feeds must be stored at proper moisture contents in a well maintained structure and managed well to prevent mold. Wet feeds must be handled in quantities which allow them
to be fed out within 7 to 10 days. Organic acids are very helpful in preventing mold in wet commodity feeds and can extend storage life. Discard any spoilage.

Obviously moldy feed should be avoided. Spoilage or deteriorated silage can reduce feed consumption, fiber digestibility and production. If unacceptably high levels of mycotoxins occur, dilution or removal of the contaminated feed is preferable; however, it is often impossible to completely replace some feeds in the ration, particularly the forage ingredients. Ammoniation of grains can destroy some mycotoxins, but there is no practical method to detoxify affected forages. Cleaning grains can be helpful. Dietary strategies to counteract the effects of mycotoxins have been reviewed (Galvano et al., 2001). Increasing dietary levels of nutrients such as protein, energy and antioxidants may be advisable. Animals exposed to aflatoxin show marginal responses to increased protein. In some situations, poultry respond to water soluble vitamins or to specific minerals. Acidic diets seem to exacerbate effects of mycotoxins, and therefore adequate dietary fiber and buffers are recommended. Because mycotoxins reduce feed consumption, feeding management to encourage intake can be helpful. Dry cows, springing heifers and calves should receive the cleanest feed possible. Transition rations can reduce stress in fresh cows. Strategic use of mold inhibitors can be beneficial.

When animals are exposed to mycotoxins, favorable results have been seen when absorbent materials such as complex indigestible carbohydrates (glucomannans or mannoligiosaccharides) or clays (bentonites and others), are added to mycotoxin contaminated diets of rats, poultry, swine and cattle. Some of these products have been reviewed by Huwig, et al., (2001), and yet many studies have been published since this review. Responses in dairy cattle to some of these products have been very encouraging. Overall results are variable by type and amount of binder, specific mycotoxins and their amounts, animal species, and interactions of other dietary ingredients. No adsorbent product is approved by the FDA for the prevention or treatment of mycotoxicoses. Several of these adsorbent materials are recognized as safe feed additives (GRAS) and are used in diets for other purposes such as flow agents, pellet binders, etc. Figure 3 shows the effects of some feed additives on reducing aflatoxin in milk, theoretically as a result of binding the aflatoxin and therefore reducing intestinal absorption.

![Figure 2](image.png)

**Figure 2.** Effect of feed additives on reduction of milk aflatoxin residues in two studies. MS, mycrosorb, a sodium bentonite fed at 1% of DM (American Colliod Co.) FG, flowguard, a sodium bentonite fed at 1% of DM intake (La Port Biochem.), AB-20, a sodium bentonite fed at 1% of DM intake (Prince AgriProducts, Inc.). RC, Red Crown, a calcium bentonite fed at 1% of DM intake (Prince AgriProducts, Inc.) and MTB-100, a modified glucomannan product fed at 0.05% of DM intake (Alltech, Inc.) significantly reduced ($P<.0001$) AFM1 residues in milk. AC-A, an activated charcoal fed at 0.25% of DM intake had no effect. Diaz, et al. 2004.

**Summary**

Mycotoxins are prevalent in feedstuffs. Many different mycotoxins exist. Mycotoxins affect dairy cattle in many ways, and the most important is perhaps immunosuppression. Mycotoxins can cause acute toxicity, but they are more likely to cause chronic problems of increased disease and decreased milk production. Diagnosis of a mycotoxicosis is difficult and indirect, but mycotoxins should be considered as a potential cause of increased disease and loss of production. Contamination of milk by aflatoxin can cause huge economic losses. Management of crops and feeds is important to reduce mycotoxin contamination. Certain feed additives are proved to be helpful in treatment.
Literature Cited


DiCostanzo, A., L. Johnston, H. Windels and M. Murphy. 1995. A review of the effects of molds and mycotoxins in


Intakes, Milk Yield and Milk Composition of Lactating Dairy Cows Fed Varying Proportions of Total Mixed Rations and Pasture

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NCSU, Departments of \textsuperscript{1}Animal Science, \textsuperscript{2}Crop Science, and \textsuperscript{3}Statistics

Background and Objectives

Vastly used throughout the US, confinement feeding systems are based on some combination of conserved forages and grain-based concentrates and protein sources. This feeding system, typically referred to as a total mixed ration (TMR) has long been proposed to increase feed efficiency in dairy herds, while maximizing milk production. Utilizing this feeding approach, it is not uncommon to observe well-managed dairy herds producing as an average over 10,000 kg of milk per lactation with feed costs typically representing over 50% of total production costs.

Dairy farm numbers in the U.S. continue to decline. In North Carolina, a more than ten-fold decrease in commercial dairy farm numbers has occurred since 1960, and more recently, current commercial farm numbers are less than half the commercial farm numbers operating in 1990. In order to remain economically viable, alternative feeding systems have been examined. Several simulation, accounting, survey, and case studies conducted primarily in the Northeastern and Mid-Western regions of the U.S. have suggested reduced input costs and increased net returns for pasture-based dairy systems.

Alternatively, high producing dairy cows on pasture need supplemental energy to reach the genetic potential for milk production when pasture plus concentrate is fed to high genetic merit cows. Research studies comparing dairy confinement systems with pasture-based systems (with or without supplementation) have reported lower feed intakes, milk production and body condition scores for cows on pasture leading many dairy farmers to avoid using pastures in their systems. Also, in pasture-based dairying, estimating pasture consumption is inherently difficult, and comparisons between the two systems, particularly with respect to their overall economic merits, are a complex matter.

Given current research data base on the two systems we can predict with some accuracy the production response of animals on either system. However, there is no study, so far, that has evaluated animal performance under a 'partial system' i.e. restricted TMR feeding and high quality pasture grazing. The approach of focusing on a narrower range of feeding systems has not been explored, and allows for an adequate search of where the break point is in terms of performance and economics under conditions of increasing pasture dry matter intake. The main objectives of the current study were to 1) determine the optimal combination between a total mixed ration and pasture-based dairying; and 2) address the extent to which TMR feeding could be restricted without seriously affecting milk production and milk composition.
Experimental Procedures

Two 8-week studies (each with n = 30 lactating Holstein cows) beginning late October 2004 (F2004) and late March 2005 (S2005) were conducted at the NCSU Lake Wheeler Dairy Educational Unit, Raleigh, NC. Animal performance was examined under different combinations of partially-restricted total mixed ration feeding and high-quality pasture grazing. Cows averaged 32.4 ± 2.5 kg milk, 87.1 ± 9.2 days in milk (DIM), 1.6 ± 0.2 lactations, 560.6 ± 11.8 kg body weight (BW), and 3.03 ± 0.06 body condition score (BCS) at the initiation of F2004; and 36.6 ± 1.5 kg milk, 125.7 ± 6.7 DIM, 1.9 ± 0.2 lactations, 607.3 ± 11.9 kg BW, and 2.88 ± 0.06 BCS at the initiation of S2005. Cows were assigned to either an all-TMR diet (100T, no access to pasture, positive control) or one of the following three partial mixed ration systems: 1) 85% TMR-restricted (85T), 2) 70% TMR-restricted (70T), and 3) 55% TMR-restricted (55T) dietary treatments.

The same corn-silage based TMR was fed throughout both studies and contained (% on a dry matter basis): corn silage (26.9%), alfalfa silage (13.0%), whole cottonseed (18.0%), soybean hulls (9.1%), corn gluten feed (8.9%), a rumen-undegradable protein source (Nutrimax; 4.4%), and a concentrate mix (19.7%). The concentrate mix contained (% in mix, DM basis) ground corn (81.0%), SBM (6.3%), limestone (2.8%), salt (2.2%), sodium bicarbonate (3.8%), bentonite (3.3%), a vitamin TM premix (0.6%), and potassium carbonate (0.1%). The TMR contained approximately 52.5% DM, 92.9% OM, 43.0% NDF, 21.6% ADF, and 15.8% CP, corresponding to a net energy of lactation (NEL) value of 1.70 Mcal/kg DM (NRC, 2001).

Cows on the TMR-restricted diets grazed a cool-season pasture (annual ryegrass, average paddock size 0.18 and 0.15 ha/d for F2004 and S2005, respectively) as a single group for 7 h/d between the a.m. and p.m. milking. Individual pasture intake was measured weekly on one cow selected randomly from each grazing group for 6 (F2004) and 8 weeks (S2005). The nutritive value of the pasture varied throughout the 8 weeks (Tables 1 and 2). Animal performance, however, is based on the composition of weeks 5 through 8 for both studies. Data from individual pasture and TMR intakes, milk weights, and milk components were analyzed according to a randomized complete block design using PROC MIXED with initial milk, parity, DIM, and BW as covariates when significant (\(P < 0.05\)) in the model. For the current study, if two treatment means are reported to be significantly different (\(P < 0.05\)), the probability is greater than 95% that the difference was caused by the treatments.

Summary of Results and Conclusions

Individual pasture organic matter intakes (OMI) averaged 6.1 kg/d in F2004 and did not differ between grazing groups due primarily to a large variation among cows (Table 3). Crude protein intakes were highest for the 85T and 100T groups (4.22 and 4.99 kg CP per cow daily, respectively) and were lowest for the 55T group. In S2005, pasture OMI was greater (\(P = 0.002\)) for the 55T group vs. 70T and 85T (Table 4). Despite lower pasture crude protein content in spring, compared to fall, crude protein intakes were lower for 55T compared to 100T. As expected, intakes of total mixed ration were different (\(P < 0.001\)) among all treatments.
Milk yields were similar across treatments (F2004, Table 5) but were greater for the 85T and 100T groups vs. the 55T and 70T groups (S2005, Table 6). Fat corrected milk (4%-FCM), also did not differ across treatments (F2004) and was greater for the 85T and 100T groups vs. the 70T group, with 55T yielding an intermediate value (S2005). Milk protein (g/d) was greater for the 85T and 100T groups. Increasing the proportion of pasture in the diet lowered the content of linoleic acid and c9,t11 CLA and increased the concentration of cis-trans methylene isomers and linolenic acid.

Restricting TMR intake lowered total dry matter intake (DMI). Partial mixed rations exhibited enhanced feed efficiency (4% fat-corrected milk per OMI unit) with values ranging from 1.67 to 1.45 kg for 55T vs. 100T (F2004) and 1.79 to 1.40 for 85T vs. 100T (S2005), respectively. Based on actual pasture intakes of cows the proportion of pasture in diets was 39, 34, and 24% during the fall of 2004; and 34, 21, and 10% during the spring of 2005 instead of the formulated proportions of 45, 30 and 15%, respectively. Our data suggest that high quality pasture can be included in TMR rations in large proportions without having a major impact on milk yield. Rough estimates of feeding costs that are specific to the experiment station, suggest an advantage to higher pasture proportions in the diet.

Table 1. Nutritive value of annual ryegrass (Fall 2004).

<table>
<thead>
<tr>
<th>week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>13.9</td>
<td>13.3</td>
<td>14.7</td>
<td>15.9</td>
<td>13.2</td>
<td>16.2</td>
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</tr>
<tr>
<td>OM*</td>
<td>88.3</td>
<td>86.5</td>
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<tr>
<td>CP*</td>
<td>31.9</td>
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<td>25.7</td>
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<td>25.8</td>
<td>24.6</td>
<td>24.0</td>
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<tr>
<td>NDF*</td>
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<td>NEI**</td>
<td>1.63</td>
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<td>1.68</td>
<td>1.65</td>
<td>1.66</td>
<td>1.81</td>
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</table>

*%DM; **Mcal/kg DM
Week 1 = late October; Week 8 = mid December

Table 2. Nutritive value of annual ryegrass (Spring 2005).

<table>
<thead>
<tr>
<th>week</th>
<th>1</th>
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*%DM; **Mcal/kg DM
Week 1 = late March; Week 8 = mid May
Table 3. Organic matter and crude protein intakes, body weights (BW), and income over feed costs (IOFC) of lactating dairy cows fed partial mixed rations (Fall 2004).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Intakes, kg/d</th>
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<th>70</th>
<th>85</th>
<th>100</th>
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<tr>
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<td>-</td>
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<td></td>
<td>11.1a</td>
<td>13.2a</td>
<td>16.3b</td>
<td>23.9c</td>
<td>0.73</td>
<td>0.001</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>17.8</td>
<td>19.8</td>
<td>21.3</td>
<td>23.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CP</td>
<td></td>
<td>2.10a</td>
<td>3.55b</td>
<td>4.22bc</td>
<td>4.99c</td>
<td>0.43</td>
<td>0.03</td>
</tr>
<tr>
<td>BW, kg/c</td>
<td></td>
<td>554.0a</td>
<td>577.9b</td>
<td>582.0b</td>
<td>576.9b</td>
<td>3.56</td>
<td>0.001</td>
</tr>
<tr>
<td>IOFC, $/c/d*</td>
<td></td>
<td>8.46</td>
<td>7.52</td>
<td>8.12</td>
<td>7.50</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

55, 70, 85, and 100 represent TMR-restricted treatments 55T, 70T, 85T, and 100T.
*Milk: Federal Order 5 2000-2004 class I price: 0.3467/L (AOMA).
TMR: $0.181/kg DM (LWDEU); pasture: $0.076/kg DM (LWDEU).
Means with different superscripts differ (P < 0.05).

Table 4. Organic matter and crude protein intakes, body weights (BW), and income over feed costs (IOFC) of lactating dairy cows fed partial mixed rations (Spring 2005).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Intakes, kg/d</th>
<th>55</th>
<th>70</th>
<th>85</th>
<th>100</th>
<th>SE</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td></td>
<td>6.0a</td>
<td>3.7b</td>
<td>1.9b</td>
<td>-</td>
<td>0.92</td>
<td>0.002</td>
</tr>
<tr>
<td>TMR</td>
<td></td>
<td>11.8a</td>
<td>14.3b</td>
<td>16.8c</td>
<td>22.9d</td>
<td>0.28</td>
<td>0.001</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>17.8</td>
<td>18.0</td>
<td>18.7</td>
<td>22.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CP</td>
<td></td>
<td>2.89a</td>
<td>2.99a</td>
<td>3.16b</td>
<td>3.89c</td>
<td>0.05</td>
<td>0.001</td>
</tr>
<tr>
<td>BW, kg/c</td>
<td></td>
<td>596.5</td>
<td>631.2</td>
<td>601.7</td>
<td>611.1</td>
<td>12.0</td>
<td>0.09</td>
</tr>
<tr>
<td>IOFC, $/c/d*</td>
<td></td>
<td>10.40</td>
<td>8.73</td>
<td>8.45</td>
<td>5.93</td>
<td>0.23</td>
<td>-</td>
</tr>
</tbody>
</table>

55, 70, 85, and 100 represent TMR-restricted treatments 55T, 70T, 85T, and 100T.
*Milk: Federal Order 5 2000-2004 class I price: 0.3142/L (AOMA).
TMR: $0.181/kg DM (LWDEU); pasture: $0.076/kg DM (LWDEU).
Means with different superscripts differ (P < 0.05).
Table 5. Milk yield and milk composition of lactating dairy cows fed partial mixed rations (Fall 2004).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SE</th>
<th>( P \leq )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>55</strong></td>
<td>1.37</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>70</strong></td>
<td>0.26</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>85</strong></td>
<td>99.5</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>100</strong></td>
<td>1.91</td>
<td>0.29</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>32.3</td>
<td>30.7</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.50</td>
<td>3.99</td>
</tr>
<tr>
<td>Fat, g/d</td>
<td>1133</td>
<td>1158</td>
</tr>
<tr>
<td>FCM, kg</td>
<td>29.8</td>
<td>30.6</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.86</td>
<td>3.12</td>
</tr>
<tr>
<td>Protein, g/d</td>
<td>940</td>
<td>923</td>
</tr>
<tr>
<td>SNF, %</td>
<td>8.62</td>
<td>8.97</td>
</tr>
<tr>
<td>MUN, mg/dL</td>
<td>14.2</td>
<td>13.9</td>
</tr>
</tbody>
</table>

55, 70, 85, and 100 represent TMR-restricted treatments 55T, 70T, 85T, and 100T. Values on a per cow basis.

Table 6. Milk yield and milk composition of lactating dairy cows fed partial mixed rations (Spring 2005).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SE</th>
<th>( P \leq )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>55</strong></td>
<td>1.06</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>70</strong></td>
<td>0.16</td>
<td>0.37</td>
</tr>
<tr>
<td><strong>85</strong></td>
<td>65.1</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>100</strong></td>
<td>1.51</td>
<td>0.003</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>32.8a</td>
<td>31.4a</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.62</td>
<td>3.58</td>
</tr>
<tr>
<td>Fat, g/d</td>
<td>1163</td>
<td>1127</td>
</tr>
<tr>
<td>FCM, kg</td>
<td>30.4ab</td>
<td>29.6a</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.86</td>
<td>2.92</td>
</tr>
<tr>
<td>Protein, g/d</td>
<td>924a</td>
<td>924a</td>
</tr>
<tr>
<td>SNF, %</td>
<td>8.69</td>
<td>8.61</td>
</tr>
<tr>
<td>MUN*</td>
<td>9.2a</td>
<td>9.4a</td>
</tr>
</tbody>
</table>

55, 70, 85, and 100 represent TMR-restricted treatments 55T, 70T, 85T, and 100T. Values on a per cow basis. Means with different superscripts differ (\( P < 0.05 \)).
Table 7. Fatty acid composition in milk from cows fed partial mixed rations (Spring 2005).

<table>
<thead>
<tr>
<th></th>
<th>Treatments</th>
<th></th>
<th></th>
<th></th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55</td>
<td>70</td>
<td>85</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>% of total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>1.36</td>
<td>1.22</td>
<td>1.44</td>
<td>1.31</td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td>2.98</td>
<td>2.99</td>
<td>3.13</td>
<td>2.46</td>
<td></td>
</tr>
<tr>
<td>C12</td>
<td>3.38</td>
<td>2.79</td>
<td>2.96</td>
<td>2.60</td>
<td></td>
</tr>
<tr>
<td>C14</td>
<td>11.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.92&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.81&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>C16</td>
<td>29.89</td>
<td>27.75</td>
<td>30.12</td>
<td>30.12</td>
<td></td>
</tr>
<tr>
<td>C18:0</td>
<td>15.94</td>
<td>16.50</td>
<td>16.16</td>
<td>17.32</td>
<td></td>
</tr>
<tr>
<td>C18:1&lt;sub&gt;t&lt;/sub&gt;</td>
<td>2.70&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.66&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.06&lt;sup&gt;b,d&lt;/sup&gt;</td>
<td>2.92&lt;sup&gt;a,e&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>C18:1&lt;sub&gt;c&lt;/sub&gt;</td>
<td>24.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.77&lt;sup&gt;b&lt;/sup&gt;</td>
<td>24.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.65&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>c-t isomers*</td>
<td>0.63&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.64&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.54&lt;sup&gt;d,e&lt;/sup&gt;</td>
<td>0.49&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>C18:2</td>
<td>2.62&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.15&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.05&lt;sup&gt;d,e&lt;/sup&gt;</td>
<td>3.21&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>C20</td>
<td>0.32</td>
<td>0.24</td>
<td>0.24</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>C18:3</td>
<td>0.50&lt;sup&gt;c,e&lt;/sup&gt;</td>
<td>0.42&lt;sup&gt;d,e&lt;/sup&gt;</td>
<td>0.45&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.28&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>CLA c9, t11</td>
<td>0.38&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>0.29&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.31&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>CLA t11, c12</td>
<td>0.08</td>
<td>0.03</td>
<td>0.07</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

* Methane interrupted isomers

**Treatment means differ P<0.05**

**d,e,f Treatment means differ P<0.10**

Acknowledgement
The authors wish to thank Weston McCorkle, Wayne McLamb, and the entire LWDEU crew, along with Pete Thompson, Justin Garrett, and Sarah Jo McLeod for their hard work and enthusiasm.
Supplementation of Diets with Limited Methionine Content with Rumen-protected Forms of Betaine, Choline and Methionine in Early Lactation Holstein Cows.


(S. Davidson; Ph.D. dissertation project)

Objective: To investigate the impact of supplementing rumen-protected forms of betaine, choline and methionine to diets with limited methionine content on performance and metabolism of early lactation Holstein cows.

Design and Dietary Treatments:

Eighty Holstein cows from the Piedmont Research Station in Salisbury, NC were assigned randomly to one of four treatment groups within either primiparous or multiparous blocks. Each treatment group consisted of eight primiparous and twelve multiparous cows. Four three-quartered multiparous cows were included in the study with one assigned to each of the four treatments. Cows were added to the study individually over approximately a 12 month period at the time each calved. Following calving, cows were trained to Calan feeding stations and adjusted to their treatment diets (American Calan Inc., Northwood, NH). By 21 days in milk (DIM), cows were adjusted to the feeding stations and consuming experimental diets fed as a total mixed ration (TMR). In order to provide adequate adaptation to feeding stations and diets, data collection began at 28 DIM and continued through 91 DIM. Cows were housed in a free stall barn, fed for ad libitum consumption, and daily feed allocations and orts were recorded for each cow. Overall, the average percentage of orts was 15% for all cows on all treatments throughout the duration of the experiment.

The four dietary treatments were applied continuously throughout the study. Twenty cows received each treatment. All cows received the same Met-limited basal TMR with the addition of one of four supplements: 1.) control supplement (fat only), 2.) rumen-protected methionine, RP-met, (20 g/d Met and fat), 3.) rumen-protected betaine, RP-bet, (45 g/d betaine and fat), or 4.) rumen-protected choline, RP-chol, (40 g/d choline and fat). The basal TMR was formulated to meet the NRC (2001) requirements for NE\textsubscript{L}, MP, RDP, RUP, macrominerals, microminerals and the vitamins A, D, and E. The TMR was formulated to contain approximately 22% ADF, 39% NFC, 5.7% EE, 16.5% CP, and 39% RUP (of CP). In addition, the basal TMR was formulated to contain a limited amount of methionine, but adequate lysine, so that the diet supplied approximately 47g Met and 171g Lys (Lys to Met ratio of 3.7:1) according to the Mepron Ration Evaluator (Version 2.6).

All four supplements supplied equivalent amounts of fat to the diet. The supplements containing betaine and choline were fed at levels that supplied equivalent amounts of the
compounds on a molecular weight basis. Rumen-protected methionine was supplemented to the second treatment so that enough Met was supplied to ensure that Met intake was above each cow’s requirement. All four supplements were mixed thoroughly into the TMR before feeding.

Results:

Intake of DM was not different among treatments. Cows fed RP-chol had greater milk yield (kg/d) than cows fed control or RP-bet (P < 0.05), (control: 32.9, RP-met: 33.9, RP-bet: 32.4, RP-chol: 35.8). The treatment by parity interaction for milk yield (kg/d) tended to be different (P = 0.07) with 44.8 kg/d produced in multiparous cows fed RP-choline compared to multiparous cows fed all other treatments (control: 38.5, RP-met: 40.1, RP-bet: 39.2, RP-chol: 44.8) while there were no differences among treatments for milk yield (kg/d) in primiparous cows (control: 28.1, RP-met: 27.8, RP-bet: 25.9, and RP-chol: 27.5). Cows fed RP-met or RP-choline had higher milk CP yield (kg/d) than cows fed control or RP-betaine (P = 0.03), (control: 1.82, RP-met: 1.99, RP-bet: 1.82, RP-chol: 2.03) Milk crude protein percentage was higher in cows fed the RP-Met (P < 0.05), (control: 2.54, RP-met: 2.70, RP-bet: 2.56, RP-chol: 2.59). There were no differences in milk fat yield or milk urea nitrogen (MUN) (P > 0.2). Milk fat percentage was lower in cows fed the RP-Met (P < 0.05), (control: 2.98, RP-met: 2.68, RP-bet: 3.05, RP-chol: 2.85). Body weight and body condition scores (BCS) were not different among treatments (P > 0.25).

Table 1. Effect of Feeding Rumen-Protected Methionine (RP-met), Betaine (RP-bet) and Choline (RP-Chol) on Milk Yield, Milk Components, Body Weight and Body Condition Scores

<table>
<thead>
<tr>
<th>Item</th>
<th>control</th>
<th>RP-met</th>
<th>RP-bet</th>
<th>RP-chol</th>
<th>SEM</th>
<th>Treatment</th>
<th>Parity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield, kg/d</td>
<td>32.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>33.9&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>32.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.9</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Primiparous</td>
<td>28.1</td>
<td>27.8</td>
<td>25.9</td>
<td>27.5</td>
<td>1.4</td>
<td>0.07</td>
<td>NA</td>
</tr>
<tr>
<td>Multiparous</td>
<td>38.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.1</td>
<td>39.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>44.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.4</td>
<td>0.07</td>
<td>NA</td>
</tr>
<tr>
<td>Milk CP, %</td>
<td>2.54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.59&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>0.04</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Milk CP, kg/d</td>
<td>1.82&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.99&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.82&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.06</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Milk Fat, %</td>
<td>2.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.68&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.85&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Milk Fat, kg/d</td>
<td>2.13</td>
<td>2.01</td>
<td>2.17</td>
<td>2.23</td>
<td>0.08</td>
<td>0.26</td>
<td>0.01</td>
</tr>
<tr>
<td>MUN, mg/dl</td>
<td>17.0</td>
<td>15.7</td>
<td>16.6</td>
<td>16.2</td>
<td>0.6</td>
<td>0.45</td>
<td>0.07</td>
</tr>
<tr>
<td>Body weight, kg</td>
<td>550</td>
<td>576</td>
<td>551</td>
<td>575</td>
<td>13</td>
<td>0.25</td>
<td>0.01</td>
</tr>
<tr>
<td>BCS</td>
<td>2.35</td>
<td>2.43</td>
<td>2.29</td>
<td>2.28</td>
<td>0.09</td>
<td>0.48</td>
<td>0.47</td>
</tr>
</tbody>
</table>

<sup>a,b</sup>Means within a row with different superscripts differ (P < 0.05).
Milking and Mastitis Management Articles for 2005

Dr. Donald E. Pritchard, Adjunct Professor and Extension Dairy Specialist
NCSU Department of Animal Science

During 2005 I wrote several articles about various milking management and mastitis management topics. I have compiled them in the following article for people to read who perhaps did not see them previously, or to read again. I hope they will assist people do a better job of managing the aspects of their dairy operations that have been addressed in the articles.

The SCC Debate Continues

What should be the legal limit for somatic cell counts (SCC) in milk produced on U.S. dairy farms? For the last several years the value has been 750,000 cells/ml of milk. Many people within the dairy industry think the value should be lower. This opinion, however, is not shared by most of the regulatory people who are charged with making sure that milk and milk products do not contain any human health risks. The regulators have not been persuaded by the available scientific research evidence that a lower SCC legal limit value would make dairy products safer. Still, the discussions continue about lowering the SCC value.

Arguments have been put forth that the SCC value should be lowered for reasons other than human health risk. International trade competitiveness is one such reason. Other countries of the world that are major exporters of dairy products have SCC limits of 400,000 or less. So, some contend that for the U.S. dairy industry to be able to compete in the world trade market our SCC limit should be lowered to that of other countries. This argument, however, has not been a very strong one since the U.S. exports only a small amount of dairy products (usually less than 5% of total annual production). Additionally, companies that are exporting dairy products are already using milk that complies with the SCC requirements of the country they are exporting to.

Public perception of the quality of dairy products is another argument sometimes raised. Some people contend that a lower SCC value would imply higher quality dairy products. While there have been incidences of dairy products causing some human health problems, those cases have not been caused by high SCC milk. Bacterial contamination after pasteurization, or the consumption of milk or dairy products that were not pasteurized have been the causes of those health problems. So, a lower SCC limit would not prevent such health problems. Consumers already believe from their experiences that dairy products are of high quality, so lowering the SCC limit would probably have little or no impact on public opinion or sales of dairy products.

A third argument sometimes offered for lowering the SCC limit is that higher SCC milk has
a higher incidence of antibiotic contamination. Since there is a small percentage of the human population that is very sensitive to antibiotics, this argument is definitely one that regulators might be sensitive to. The dairy industry does an excellent job of testing milk for antibiotic residues to prevent contamination of processed products. The very small amount of milk that is found to contain residues is disposed of, so antibiotic contaminated milk almost never reaches the market place. Also, various dairy professionals are continually working with producers to educate them and their employees about the importance of using antibiotics correctly so no residues occur in milk. So, would a lower SCC limit reduce the already very low incidence of antibiotic residue contamination? Probably not.

The average SCC level of milk produced in the U.S. is already well below the legal limit. This is because most producers realize the economic benefit of producing low SCC milk, and some processors require the milk they buy to be below a certain SCC value. Processors want milk with a low SCC value in order to produce higher quality dairy products that have a longer shelf-life. So, if the dairy industry is already striving to produce milk and dairy products with a low SCC count, why do the discussions continue? Why the debate over what the legal limit should be?

I think the main reason is that education and payment incentives for low SCC milk have not convinced all producers that they should be producing lower SCC milk. Thus, changing the legal limit is the last resort. If producers can “get by” producing high SCC milk that is within the legal limit, then some will do so. They may think they are saving money, or they may just not care about the quality of product they produce as long as they can sell it, or there may be some other reason. But whatever the reason, they are not going to produce lower SCC milk because they don’t have to. In order to get those producers to produce lower SCC milk, or sell out, many believe the legal limit for SCC must be lowered.

At the recent annual meeting of the NMC (National Mastitis Council) a symposium was held at which the speakers addressed different aspects of the topic “Does High SCC in Milk Constitute a Human Health Risk?”. After all the presentations and discussions, the conclusion reached was that high SCC milk (up to the 750,000 legal limit) does not pose any direct, specific health risks to humans. Thus, I would suspect that when the regulatory officials meet later this year, they will again not be receptive to the proposal of lowering the legal SCC limit.

I believe that the processors and the milk handlers hold the key to getting all producers to lower the SCC of milk they produce. If the position was taken that producer milk would not be marketed by a handler or accepted by a processor that was over a realistic, attainable SCC value (value determined jointly by the handlers and processors in the region or market), all producers would comply very quickly with the requirement in order to sell their milk. If they didn’t, they would go out of business or find another use for their milk. Don’t spend time trying to change the legal limit, let the market place dictate what producers must do, is my suggestion. Some may not agree with my approach, but then aren’t solutions usually more acceptable when they are determined by consensus rather than through a legal process?
Dry-Off Milk Yield and Mastitis

An interesting article published recently in the Journal of Dairy Science looked at the relationship of milk yield at dry-off and the probability of mastitis at the subsequent calving. While the study evaluated only 116 lactations in one herd, the results suggest that a review of the practices used in many herds at dry-off time would certainly be warranted.

What the researchers found was that as the level of daily production increased at dry-off, there was a significant increase in the risk factor for both a cow and a quarter to be infected with environmental pathogens at the subsequent calving. The environmental pathogens cultured for in duplicate quarter milk samples within 3 days of calving were *Escherichia coli*, *Klebsiella* species, *Citrobacter* species, *Enterobacter* species, *Serratia* species, and species of streptococci other than *Streptococcus agalactiae*. These are the types of pathogens that cause the majority of intramammary infections (mastitis) in most herds today. Interestingly, infections caused by coagulase negative staphylococci (CNS) at calving were not associated with milk yield at dry-off. The CNS species most commonly isolated from udders are *chromogenes*, *hyicus*, and *epidermidis*.

The researchers found that for every 11 pound (5 kilogram) increase in daily milk yield above 27.5 pounds (12.5 kg) at dry-off, the odds of a cow having an environmental IMI at calving increased at least 77%. This is a shocking finding, and should get the attention of all producers. These results occurred even though all cows were routinely treated in all quarters with dry cow preparations at dry-off. There were no associations with somatic cell count at the end of lactation, days in milk at dry-off, or dry period length and IMIs at calving.

Why the tremendous increase in susceptibility to new IMIs for the higher producers? Previous research reports have shown that higher producers have a greater tendency to leak milk after dry-off, which prevented or reduced the complete formation of a keratin plug in the teat canal. Without the keratin plug to serve as a barrier, environmental pathogens had a fairly open channel into the mammary gland. Another research group found that cows leaking milk following dry-off were 4 times more likely to develop clinical mastitis during the dry period than cows that did not leak.

So, what can producers do to reduce new IMIs at time of dry-off, especially in their cows that leak milk after dry-off? I suggest the following practices be reviewed and considered:

1) reduce the dry period length to around 35-45 days – by milking higher producing cows longer, their production level should be lower when it is time to dry them off – be sure the cows are in good body condition to incorporate this practice, and don’t do it with first lactation cows – they need the extra rest time to prepare for the next lactation

2) try to keep the facilities in which the dry cows are kept as clean and dry as possible – reduce the environmental bacteria load the teat-ends are subjected to – the type of bedding material used and bedding additives that can reduce bacteria growth should be discussed with your consultants
3) reduce water intake and offer lower quality feed to cows for the first several days after they are turned dry to reduce the intake of nutrients needed to make milk
4) removing some of the milk from the udder once a day for a few days after dry-off may be justified for certain very high producing cows to help reduce the milk leaking problem – however, remember the objective at dry-off is to keep the back-pressure in the udder high so the milk secretion process is stopped
5) apply a barrier teat dip every few days for the first 7-10 days dry and the last 7-10 days before expected freshening – these dips can provide some protection against pathogens entering the teats
6) infuse a teat sealant into all quarters at time of dry-off – ask your veterinarian or other consultant about what product(s) are available to use – continue to also infuse a dry cow antibiotic product at dry-off before infusing the teat sealant

Dairy producers should always be looking for ways to increase the productivity and profitability of their cows. Reducing the incidence of mastitis in their herds is one way to help realize these objectives. Giving extra attention to higher producing cows at time of dry-off, especially to those that leak milk, is a practice that should be incorporated into all dairy managers routines. I encourage producers to discuss the practices mentioned above with their extension agent, veterinarian, milk handler fieldman, or other competent advisor.

**The Effects of Early Lactation SCCs in Heifers**

In a series of papers published in several recent issues of the Journal of Dairy Science, collaborative researchers from Belgium and Canada reported on various associations and impacts of high somatic cell counts (SCCs) at first calving in heifers. The findings might give dairy producers insight as to how to better manage their heifers.

From the records of nearly 2,000 heifers in 159 Belgium herds, it was found that SCCs between days 5 and 14 of lactation were associated with certain herd characteristics. Higher-producing herds, herds with an average first calving age of less than 27 months, and herds with lower bulk tank milk SCC scores were associated with heifers that had lower SCCs at between days 5 and 14 of lactation. Cleanliness of the calving area was also associated with SCC scores. Heifers calving in cleaner areas (heifers that were on slatted floors) had lower SCC scores than heifers calving in more unclean types of areas (on non-slatted floors). These associations suggest that better managed herds have heifers calving with lower SCC scores.

The researchers further reported that the early lactation SCCs of heifers had an impact on both the milk yield and also the SCCs over the entire first lactation. As the early lactation SCCs increased, the daily milk yield decreased throughout the lactation. Additionally, as the SCCs in early lactation increased, the test-day SCCs throughout the rest of the lactation were correspondingly higher. Thus, it was concluded that the udder health of heifers in early lactation had a lasting impact throughout the lactation.
The association between level of culling of first lactation heifers and their early lactation SCC score was also studied. It was found that udder health problems were the culling reason for 10% of the culled heifers in the study. As the SCC score between days 5 and 14 of lactation increased, the culling level during the first lactation for udder health reasons also increased.

These findings may not be new information for many producers, based upon their experiences. However, I believe the results of the study give all producers further reason to pay closer attention to how they manage heifers and the factors that can affect the udder health of their heifers.

I encourage all dairy producers to review of the heifer management practices used in their herds. Contact your Extension agent, veterinarian, dairy plant/handler fieldman, or other competent consultant and ask for a review of your heifer management practices. Reducing the level of udder infections in heifers at time of calving can have a significant positive impact on the profitability of a dairy operation. The results are worth the time and effort.

**Review Your Milking Management Practices**

As a dairy herd manager, how well are you monitoring the job being done by the people who milk your cows? Do you check to see that they are following the milking routine you established for them to use? Do you have that routine and the other things the workers are supposed to do while milking cows written down? Do you train new milkers, and do you ever retrain workers who have been with you for sometime? I would guess that very few producers are doing all these things. However, research conducted at the University of Wisconsin by Dr. Pamela Ruegg, DVM, and her colleagues strongly suggests you should be.

Results from their study on 101 Wisconsin dairies using freestalls reveled that the combination of using a complete milking procedure, providing frequent milker training, and having and using a written milking routine protocol resulted in improved parlor throughput and a reduced number of new cases of mastitis when compared to herds that did not follow these procedures. A complete milking procedure was defined as a routine that included forestripping, predipping, drying before unit attachment, and post-dipping.

The use of the three practices independently had a significant impact on cow throughput rate and clinical mastitis cases. The number of cows milked per hour per operator increased by over 5 when a complete milking routine was used, and the monthly rate of clinical mastitis was cut in half (from about 10% to about 5%). The impact of milker training was also dramatic. Cow throughput rate increased to almost 50 per hour with frequent training versus only about 33 per hour with no training and about 41 per hour with training only at time of hiring. Clinical mastitis cases were reduced by about 50% with training versus no training. Following a written milking routine protocol also impacted performance
greatly. Throughput rate was increased by about 12 cows per hour, and clinical mastitis cases were reduced by about 50%. Combining the practices resulted in the greatest improvement in parlor throughput rate, increasing from between 35-38 to 52 cows per hour.

So, the message from this study is that the people who are milking cows need to have a written milking routine protocol they can refer to and use, the workers need to be trained when hired and then receive periodic refresher training, and the milking routine they use needs to be a complete one (strip, predip, dry attach, post-dip). Cow udder health will improve and parlor throughput rate will increase when these procedures are followed. For more information on the Wisconsin study, contact their internet web site at [http://www.uwex.edu/milkquality](http://www.uwex.edu/milkquality).

For additional recommendations on proper milking procedures to follow contact your Extension agent or specialist, veterinarian, milk handler/co-op field representative, or other competent consultant. The potential is there for greater profit from your dairy by improving your milking management practices.

### The Components of Producing High Quality Milk

As a dairy producer, what are the components of your milk quality program? Do you have a written protocol for producing high quality milk? What practices do you and the people who milk and handle the cows on your farm follow to insure that you are producing the highest quality milk possible?

Dr. Pamela Ruegg, an Extension Milk Quality Specialist at the University of Wisconsin, a few years ago wrote a very good paper on the 10 smart things she thought dairy farms do to achieve the production of high quality milk (achieve milking excellence is what she called it). I have taken the liberty of adding my comments and suggestions to her list of 10 things to do to produce high quality milk. The list is presented below.

1. **Set Performance Goals:** Quality goals must be set so the performance and progress of the workers and quality measurements of the milk produced can be evaluated. Set goals for bulk tank milk SCC and SPC values. Striving to keep SCC scores always under 400,000 cells/ml should be an attainable goal. Once attained, keep lowering the value and strive for a herd SCC value of less than 250,000. Other goals to work towards are having Standard Plate Count values that average less than 10,000 cfu, a new subclinical infection rate of less than 5% per month, and over 85% of the cows in your herd with a DHIA linear SCC score of less than 5.

2. **Identify Milk Quality Problems Quickly:** Use practices that detect mastitis infection early. The use of cow-side SCC measurement devices can be helpful. Using the CMT on all fresh cows within the first few days after calving is recommended. Stripping a few streams of milk from each quarter before attaching the milking unit is very important.
And monitoring the monthly bulk tank SCC values, as well as reviewing monthly individual cow SCC values can help detect problems early.

3. **Milk Clean Cows:** To reduce the time needed in the milking parlor to clean cows before milking, the cows should be as clean as possible when they get to the parlor. You should have properly sized and maintained free stalls. Use sand bedding if possible, and be sure an adequate amount of clean bedding is kept in the stalls at all times. Alleys should to be scraped as often as needed to be kept reasonably clean. Use a predip to reduce the number of environmental bacteria on the teats at time of milking.

4. **Standardize Your Milking Routines:** Establish a written protocol of the milking preparation routine to use in your dairy, and then be sure everyone follows it at every milking. Your protocol should include forestrip, predip, dry, attach, and post dip. Consistent use of these components will help you produce better quality milk.

5. **Train Your Staff:** People who work in your dairy should have written protocols for the jobs they perform, they should receive training for the jobs they are expected to do, and they should receive periodic update or refresher training for those jobs.

6. **Maintain and Update Your Milking System:** Milking systems in small herds need to be serviced 1-2 times a year, and systems in large herds should be serviced more frequently (at least quarterly). Replace inflations and other components as recommended by the manufacturer. Adjustments to automatic take-off units should be made to conform to current standards for milk flow rate at time of removal and detacher delay time before removing the milking unit.

7. **Have Written Treatment Protocols:** Treatment protocols are used to define standard treatments for common diseases. Protocols are especially important when multiple people have responsibility for treating sick animals or when extralabel drug use is prescribed by your veterinarian. The protocols can be simple, but should be developed by you, your veterinarian, and your key employees who take care of the animals.

8. **Have A Mastitis Biosecurity Plan:** Have in place a plan for how to protect your cattle from contagious mastitis pathogens. Steps to include in your plan are to only buy healthy cattle, buy from a healthy herd, keep purchased cattle healthy (separate for a time after bringing onto your farm), and culture bulk tanks twice monthly after newly purchased cattle are brought into your herd to monitor for new pathogens.

9. **Take Proper Care of Your Dry Cows:** Most new cases of mastitis occur during the dry period. Maintain clean, dry housing for dry cows, infuse a dry cow antibiotic into all quarters, use a teat sealant at time of dry off (either an internal or external product can help prevent new infections), use appropriate vaccines, and feed properly balanced rations.

10. **Use Appropriate Consultants:** While producers obtain information from a variety of sources, consultants can help determine what practices are appropriate for your herd and your management level. Form a consultant team for your farm that meets periodically to review your programs and the progress you are making at reaching your goals for producing high quality milk. I suggest you include on your team your Extension agent, veterinarian, milk handler field representative, and other qualified individuals who you currently consult with.
A host of resources on producing quality milk are available from the University of Wisconsin Milking Research and Instruction Laboratory. Dr. Ruegg is a faculty member in that lab. The web address for the Milk Quality Resources site is http://www.uwex.edu/milkquality/index.htm. I encourage you to access it and review the many materials available.

### Combating the Summer Rise In SCC

The heat and humidity of summer are upon us, and it sure gets uncomfortable at times for both people and cattle. Dairy cows usually respond to the heat and humidity by both eating less feed and producing less milk. These decreases are obviously undesirable. Also undesirable is the increase in the bulk tank somatic cell count (SCC) that usually occurs in many herds during the uncomfortable months of summer. Unfortunately, this increase usually means that there is a corresponding increase in the udder infection level in the herd. So, what can producers do during the heat-stress months of the year that can help minimize the increase in their herd's SCC level? I offer the following management practices for consideration.

1. **Keep the cows' udders as clean as possible so the number of bacteria the teat ends are exposed to is minimized.** The cleanliness of the free stalls and alleys is very important for keeping clean udders, so the stall bedding material and the alleys may need to be cleaned at each milking (or perhaps more frequently) to minimize the soil that gets on the cows.

2. **Consider using a different stall bedding material that is less supportive of bacteria growth.** Since the teat ends are exposed to bacteria as the cows are resting in the stalls, try to use a bedding material that does not support the growth of bacteria. Sand is the preferred bedding material of many producers. If your waste handling system cannot handle sand, then use kiln dried sawdust/shavings. Avoid green sawdust. Pine products are preferred to hardwood products. You may want to try adding a pH-altering product to the bedding material to slow the growth rate of bacteria in the bedding. Such products must be added every 2-3 days.

3. **Keep your cows as cool as possible so they don't congregate in wet, mucky areas where they will surely end up with dirty udders.** Cooler cows usually have better functioning immune systems to combat udder-invading bacteria. Provide shade if the cows are on pasture or in an exercise lot. Install fans and water misters in your free stall barn alleys, parlor holding pen and return alleys to cool the cows. In certain areas of the country cooling ponds are used to cool cows, but proper maintenance of the ponds is required to keep them from becoming contributors to a problem rather than a solution.

4. **Proper udder preparation at milking time is critical to reducing/preventing the introduction of bacteria into the udder during milking.** The use of predips and post dips, proper wiping and drying of the teats when cleaning them, and minimizing the machine on time are all very important in reducing the new cases of intramammary infections and
in keeping the SCC value low. Barrier post milking dips may be helpful in reducing environmental pathogen caused infections.

5. Ask your nutritionist to check your rations to be sure your cows are receiving adequate levels of vitamins A and E, and selenium. These nutrients help promote a strong functioning immune system which is needed to combat udder invading bacteria and elevating SCC values.

While producers may not be able to prevent completely the increase in bulk tank SCC values that occur during the summer, there are practices that can be used that will reduce the economic impact of heat stress on cows. I encourage producers to talk with their consultants about what practices should be considered for their dairy.

**Mastitis During Early Lactation Affects Reproductive Performance**

The incidence of mastitis increases in many dairy herds during early lactation. Most of these new infections originate during the dry period and then become clinical in the first one or two months after freshening. Lost milk production is an obvious result of clinical cases, but reproductive performance is also affected.

Over the last several years there have been articles published in the Journal of Dairy Science and other publications about the relationship between mastitis in early lactation and reduced reproductive performance. Researchers at the University of Tennessee (UT) reported in 1998 that intramammary infections in early lactation resulted in the following effects on reproduction:

- the number of days to first insemination was significantly greater for cows having clinical mastitis BEFORE first insemination (93.6 days), versus AFTER first insemination (71.0 days)
- the number of inseminations required to result in a conception were significantly greater for cows having clinical mastitis AFTER first insemination (2.9) than for cows having clinical mastitis BEFORE first insemination (1.6)
- the number of days to conception for cows that developed clinical mastitis after first insemination was significantly greater than for cows that developed clinical mastitis after confirmed pregnancy (136.6 days versus 92.1 days)

Additional research conducted at UT and published in the July 2005 issue of the Journal of Dairy Science provides further information about the connection between mastitis and reproductive performance. The researchers found that clinical mastitis incidences occurring immediately before ovulation had a negative impact on normal endocrine and follicular function. When the immune system was stimulated by an udder infection, there was a release of chemicals to combat the inflammation. Cortisol blood levels also increased when cows were stressed by mastitis and the immune response activated. These responses resulted in less release of luteinizing hormone (LH), a reduction in estradiol-17B production which resulted in a decrease in the expression of estrous by some cows, and a
reduction in ovulation rate.

This latest research report seems to explain how mastitis (or some other inflammation or stressful situation) can reduce the reproductive performance of animals. The report also should serve as a reminder to dairy producers of how important it is to incorporate management practices and programs that will minimize new udder infections during the dry period. The use of dry cow udder therapy, teat sealants, vaccinations, and providing clean, adequate housing for dry and recently fresh cows are some of the practices to consider.

Preventing new intramammary infections can increase milk production and profitability, as well as improve the reproductive performance of dairy cows. And having cows reproduce in the desired time interval also will result in more profit for the dairy. I encourage producers to ask their consultants for suggestions on how to reduce new mastitis infections in their herds.

**Somatic Cell Counts Continue To Decline In DHIA Herds**

Consumers expect the dairy products they buy to be nutritious and of high quality, and dairy producers strive to produce the highest quality milk they can. One measure of the quality of milk as it leaves the dairy farm is its somatic cell count (SCC). The legal limit for somatic cells in milk is 750,000/ml. Other tests of quality are also conducted on both the unprocessed milk and processed dairy products.

More than half of the dairy herds in the U.S. participate in the DHIA production record keeping program. The quality of milk produced in these DHIA herds, as measured by the SCC scores, continues to improve each year. While SCC average data for all of the non-DHIA herds is not available, the information that is available indicates that the SCC scores for those herds are also improving yearly.

The SCC values for all herds on the DHIA SCC program for 2004 were recently released by the Animal Improvement Programs Laboratory in the ARS branch of USDA. The data show very interesting and encouraging information. The 2004 national average SCC value for DHIA herds was 295,000 cells/ml. This is the first time that the yearly average value has gone below 300,000. Eighteen states averaged fewer than 300,000 for the year, while only 7 states averaged over 400,000. No states averaged above 500,000 which is a very encouraging indicator of the continual improvement in milk quality in the U.S.

Other data reported for 2004 showed that the SCC averages decreased as the size of the dairy herds increased. Larger herds usually have people specialized in and responsible for only certain tasks, which allow them the time to do their jobs more thoroughly and accurately. Consequently, the factors that affect cow udder health (as indicated by SCC values) are usually given closer attention in larger herds, with the result being lower average SCC values.
Another bit of information in the 2004 report was that SCCs rose somewhat in the more humid-high temperature months of the year. This fact is expected by most dairy producers, as the warmer temperatures and more humid conditions promote bacteria growth in the cows’ environment, thus increasing the bacteria challenge to the cows’ udders. Various management practices can minimize the increase in bacteria load, thereby helping to reduce the increase in SCC values.

Regional differences in average SCC values occurred in 2004 just as they have in previous years. Values generally were lower in the western states and higher in the southeastern/southern states. However, even within a region, neighboring states with similar climatic conditions had differences in their SCC average values. This indicates that mastitis prevention and control programs can be effective, regardless of the weather conditions. It also suggests that there may be differences in the mastitis programs used by producers in different states.

**Dry Periods Are Important**

Over the last three years there have been several dairy magazine articles and research reports about shortening the dry periods of cows. The traditional practice of letting cows have a 60-day dry period between lactations was questioned after Florida researchers found little difference in milk production in the subsequent lactations of cows when their dry periods were shortened from 60 to about 30 days. After the results of the study were published, many people then wondered how long the dry period needed to be. Some people even wondered if profitability could be maximized by eliminating dry periods. With the ability we now have of feeding and managing cows for maximum productivity perhaps dry periods were not required by all cows.

A recently published article in the Journal of Dairy Science supports continuing the practice of giving cows dry periods. However, the Danish researchers did not answer the question of how long or short the dry period must be. The study they conducted compared the metabolic status and milk production performance of high producing cows given either a 7-week or no dry period between lactations. High producing cows were defined as those with peak climatic yields of more than 100 pounds per day. The cows were producing more than 55 pounds daily at the 7-week dry-off time. (Note that the 7-week period is about 10 days shorter than the traditional 60-day dry period still used by many producers.)

The researchers found that only about 1/3 of the cows assigned to the no dry period group actually continued to lactate throughout the gestation period. The rest of the cows either dried themselves off before parturition, or reduced their daily milk production to below about 11 pounds per day and were thus dried off.

In the first 5 weeks of the subsequent lactation the cows with the 7-week dry period
produced about 22% more milk than those with no dry period. This production difference occurred in spite of the finding that cows in both groups consumed the same amount of dry matter intake daily, and their changes in body weight and body condition score during the 5 weeks pre-partum through 5 weeks post-partum were not different. Cows in the 7-week dry period group, however, experienced more metabolic imbalances, as their need for nutrients to support milk production was greater than was the amount of nutrients being consumed. More body fat was apparently being mobilized in the cows with the 7-week dry period, even though the body weight and body condition scores did not reflect this.

While this study shows the need for a dry period, how long the dry period needs to be will vary between cows. Many producers have learned from experience that some cows can handle a shorter dry period, while others can not. The age of the cows, the body condition of the cows when they are turned dry, the quality of the ration the cows receive while they are dry and also after they freshen, the transition ration the cows receive during the late pregnancy period, the health status of the cows, and other factors all have an effect on how long the dry period should be.

The general recommendation I give when asked about what the dry period length should be is that heifers completing their first lactation should, in most cases, receive the traditional 60-day dry period to allow for body growth. Older cows, if in good body condition and fed correctly, can usually handle a 40-50 day dry period. Some people have even successfully reduced the dry period of their cows to about 30-35 days. The level of management given to the herd is the key to how short the dry period can be.

While it is always a safe practice to check the milk of fresh cows for antibiotic residue resulting from treatment of an illness, dry cow or pre-freshening udder therapy, this practice is especially important when cows are given shorter dry periods. Discuss shorter dry periods with your nutritionist, veterinarian, or other qualified consultant before implementing this practice in your herd.

The Changing Mastitis Research Scene

In June 2005 the International Dairy Federation held its fourth International Mastitis Seminar. These seminars are held every ten years to allow mastitis researchers from around the world to meet and discuss their current research efforts and findings. The meetings also provide an opportunity for researchers and others to review how the mastitis situation in dairy herds from all regions of the world has changed in the past decade.

The opening keynote address at the 4th IDF mastitis seminar was given by Dr. K. Larry Smith, renowned mastitis researcher for the last 3½ decades from The Ohio State University. Dr. Smith presented an overview of the previous three international mastitis seminars, and offered his thoughts on where mastitis research is heading. A paragraph from his concluding comments is presented below. The paragraph is used with the
permission of the Wageningen Academic Publishers which printed the proceedings of the 4th seminar in a book titled “Mastitis in Dairy Production”.

“The first three International Mastitis Seminars have shown that there has been overall progress in the control of mastitis in dairy herds as demonstrated by the reduction in herd somatic cell counts. There has been less progress on reducing the amount of clinical mastitis and little improvement in our ability to treat clinical cases of mastitis and to reverse the damage done by the infection. There have been major advances in our understanding of the natural defense mechanism associated with the bovine mammary gland but little of this knowledge has been incorporated into mastitis control schemes. There has been a clear progress in the understanding of the important aspects of milking machines that can cause or contribute to mastitis in dairy herds but there is still a lack of knowledge on the exact mechanisms of teat canal penetration by mastitis pathogens. Over the 30 year period, studies have demonstrated that genetic selection can be a component of mastitis control in dairy herds. Since 1975 there has been a shift in the importance of mastitis as being strictly a production limiting disease to the fact that mastitis adversely affects the processing properties of milk, its suitability as a human food and does impact human health issues.”

I believe Dr. Smith’s comments about the several areas of mastitis control that still need to be researched and solved are “right on”. While we have gained much knowledge about mastitis control, there is still much to be learned. Unfortunately though, much of what is already known about how to prevent and manage mastitis is not being used and applied on dairy farms around the world. I encourage all dairy producers to seek the suggestions of a competent advisor on ways to improve the mastitis management program in their herds. The result could be considerably less mastitis for our dairy cows and more profit for the producers.

**Mastitis Extended Antibiotic Therapy Using Ceftiofur**

Trying to cure intramammary infections in lactating dairy cows is a challenge. Cure rates for infections caused by certain types of pathogens (like *Strep. ag.*) have been very good, but the tough guys like *Staph. aureus* and some of the environmental organisms have posed a much greater problem. Most of the antibiotic products available for use have not been maximally effective for several reasons, with the degree and length of time of the infection being a major one. Other reasons associated with the action and use of the antibiotic that affect cure rates include the fact that the antibiotic may not have been infused into the udder for enough days, or the concentration of the active ingredient was not high enough, or the product did not stay in the udder long enough because the cow was milked two or more times a day.

Administering an antibiotic for several consecutive days is a practice that is used to treat many types of infections. Researchers and veterinarians have used this practice in their
attempts to increase the cure rates when treating mastitis infections. Extended therapy treatment (beyond the usual two days) using pirlimycin has been shown to improve the cure rate of *Staph. aureus* mastitis infections. Since pirlimycin is not labeled for daily infusion for more than two consecutive days, to follow an off label daily infusion regime beyond two days requires that pirlimycin be given under the supervision of a veterinarian. Producers wanting to use pirlimycin could also follow the treatment regime of treat for two days, wait thirty-six hours, and then repeat the regime one or more additional times. Until recently no antibiotic had been approved and labeled for use beyond three consecutive days. Ceftiofur hydrochloride was recently given FDA approval for infusing up to eight consecutive days for treating clinical mastitis caused by coagulase negative staphylococci (CNS), *Streptococcus. dysgalactiae*, and *E. coli*.

Ceftiofur hydrochloride is a new broad-spectrum, third generation cephalosporin antibiotic that has the potential for improving mastitis cure rates. The product works by inhibiting bacterial cell wall synthesis, thereby preventing the bacteria from multiplying in the udder and maintaining an infection. It can be used in an extended therapy regime for up to eight continuous days in lactating cows to provide some level of cure against a wide range of both contagious and environmental mastitis pathogens.

Dr. Steve Oliver and his colleagues at the University of Tennessee studied the effectiveness of the new antibiotic in three research herds and reported their results in the Journal of Dairy Science. In their study, cows with one or more subclinical intramammary infections (based upon quarter milk samples with an SCC >400,000/ml) were blocked by parity and days in milk, and were randomly divided into four treatment groups – no antibiotic treatment, or ceftiofur infusion into the infected quarter once a day for either 2, 5 or 8 days. A bacteriological cure was considered to have occurred when the pretreatment infected quarter was free of the pathogen causing the infection on days 14 and 28 after the last antibiotic treatment.

Ceftiofur proved to be the most effective when it was administered for 8-days, with an overall infection cure rate from all types of pathogens of about 66%. Cure rates for the 5 and 2-day administration times were reduced to about 54% and 39%, respectively. The non-treatment group had a 11% spontaneous cure rate. While ceftiofur is not labeled for treating *Staph. aureus* infections, the researchers found that the cure rates of infections caused by *Staph. aureus* were 36% for the 8-day treatment group, but only 17% for 5-day, 7% for 2-day, and 0% for the no treatment groups. The cure rates for CNS caused infections, however, were not significantly different for the three antibiotic treatment groups (70%, 62%, and 86%, respectively for the 2, 5, and 8-day groups). The researchers further found that when all the environmental *Strep.* species caused infections were grouped together, the cures rates for the 2, 5, and 8-day treatment groups were also similar (50%, 67%, and 78%, respectively), but they were greater than for the non-treatment group (17%).

While this study showed that overall an 8-day extended therapy infusion regime of ceftiofur was the most effective for curing existing intramammary infections, it did not show
overwhelming evidence that treating for 8 days would be justified in all herds. In herds with mostly non-contagious environmental pathogen infections and a low level of *Staph. aureus* mastitis, treating for 2 or 5 days appeared to be nearly as effective as an 8 day treatment regime. Herds with a considerable amount of *Staph. aureus* infections may have a better cure rate from a different product and/or treatment regime, e.g. multiple day treatment at time of dry-off.

Producers should consider the feasibility of obtaining a cure and the costs of treating for an extended time period before implementing this practice, regardless of the antibiotic used. Remember that milk must be discarded during the entire treatment period, plus for a designated number of hours after the last infusion. Extended mastitis treatment therapy is not a practice to follow for all cows or in all herds. Consideration must be given to how long the cow has been infected and the type of pathogen causing the infection. Some infections will not be worth the effort and expense to try and cure. I urge producers to discuss the pros and cons of using extended mastitis therapy treatment with their veterinarian, regardless of the antibiotic being considered. Extended therapy may be a useful treatment approach in many herds or in selective cows, but it is not a cure-all approach for all mastitis infections.

**Practices That Might Impact Udder Health**

Progressive dairy producers should always be looking for herd management practices that might affect the udder health status of their cows. In the December 2005 issue of the Journal of Dairy Science there were two research reports that producers might want to factor into the management decisions they make.

The first study conducted by researchers from Pennsylvania and Ohio compared the bacteria populations in clean and recycled sand used for bedding in dairy facilities. This study should be of interest to producers who are already using sand as bedding and are considering using recycled sand. The study may also be of interest to producers who are having difficulty obtaining wood shavings or sawdust or straw, or are experiencing udder health problems caused by their bedding material, and are considering changing to sand.

Bedding samples were collected in both the winter and summer from commercial dairies that were using either clean sand or recycled sand. The composite samples were sub sampled and analyzed for dry matter percent and cultured for the types and numbers of bacteria present. The researchers reported that “The results from this study suggest that bacterial populations and numbers were similar for both clean sand and recycled sand in either summer or winter.” They further stated that either type of sand could safely be used to bed free stalls, as the number of coliform and *Klebsiella* spp. in both sand types were below the generally accepted thresholds thought to cause mastitis. The researchers did find, however, that there was a high level of *Streptococcus* spp. in both sand types on day 1 after sand was placed in the stalls, and persisted through day 7 in both the winter and
summer. Why this occurred is unknown, and further study is needed into the effects of sand source, particle size and other management factors on *Streptococcus* spp. populations in the sand. Producers who are either already using or are considering using sand as bedding should keep this finding in mind.

The second study published, also from Ohio researchers, looked at various physiologic and immune system responses to feeding selenium from two different sources (inorganic or organic). In this study dry and early lactation cows were fed diets containing either selenite or selenized yeast at the 0.3mg/kg of dry matter level. In all the parameters measured (blood, serum, colostrum, milk), the feeding of selenized yeast resulted in higher levels of selenium. This finding would suggest that the immune systems of cows consuming the selenized yeast diet should have been more effective at killing bacteria. This was not the case, however. When blood neutrophils were isolated and used in an in vitro kill assay of *Escherichia coli* 487 there was no difference in kill rate response due to the selenium source fed the cows. Other researchers have also reported no response difference in kill rate of *Staphylococcus aureus* by neutrophils of cows fed the two types of selenium. So, while the elevated serum levels of selenium may provide other health benefits to both cows and their new born calves, this study suggests that feeding organic selenium appears to provide minimal, if any, increase in resistance (immune system response) to bacteria invading the mammary gland and causing new udder infections. Producers should discuss the pros and cons or necessity of feeding organic selenium with their feed consultant and veterinarian before incorporating the use of it into their cattle diets.
Highlights from the 2005 North Carolina 4-H Dairy Youth Program

Dr. Brinton A. Hopkins
Professor and Extension Dairy Specialist

North Carolina Dairy Youth Foundation Provides Funding Support:
The funding provided by the North Carolina Dairy Youth Foundation for statewide 4-H Dairy Youth Program activities and many statewide FFA dairy activities fills a critical need and is greatly appreciated. This funding support is what makes these opportunities possible for North Carolina youth.

North Carolina Youth Participate in the 2005 National 4-H Dairy Youth Conference

Congratulations to the following youth for being selected, through an application and interview process, to attend the National 4-H Dairy Conference: Erin Morgan (Forsyth County), Kerri Beth Frazier (Randolph County) and John Hoffner (Rowan County). Youth from across the United States and certain provinces of Canada participated in this educational conference that was held at the University of Wisconsin-Madison during World Dairy Expo. Funding for our youth to attend this conference was generously provided by the North Carolina Dairy Youth Foundation. Dr. Brinton Hopkins, Extension Dairy Specialist and Melissa Staebner, Yadkin County 4-H Agent, accompanied the youth to this conference.

From left to right: John Hoffner (Rowan County); Melissa Staebner (4-H Agent in Yadkin County); Erin Morgan (Forsyth County); Kerri Beth Frazier (Randolph County); and Dr. Brinton Hopkins (NCSU Ext Dairy Specialist).

At the conference, youth participated in many outstanding educational sessions and seminars on the University of Wisconsin - Madison campus and visited several dairy farms, a commercial dairy heifer grower farm, ABS headquarters and the World Dairy Expo. They also toured the Hoard’s Dairyman Farm, Hoard’s Dairyman publishing company, the National Dairy Shrine and NASCO.
North Carolina State 4-H Dairy Judging Team:
Congratulations to the 2005 North Carolina State 4-H Dairy Judging Team for an outstanding judging season. Team members were: Megan Mann (Alamance County); Brittany Thompson (Alamance County); Brenda Crouse (Alleghany County) and Aaron McCain (Randolph County). Dr. Brinton Hopkins (Extension Dairy Specialist), Ken Vaughn (County Extension Director in Iredell County), and J. D. Brooks (volunteer from Alleghany County) served as coaches. Primary funding for the team to travel and compete was generously provided by the North Carolina Dairy Youth Foundation.

North Carolina 4-H Places 8th at Pennsylvania Contest:
Our team placed 8th overall in the Pennsylvania Youth Dairy Cattle Judging Contest held in Harrisburg, PA. North Carolina won 1st place in the Jersey breed, placed 5th in the Holstein breed, and 5th in the Linear Evaluation part of the contest. On an individual basis, Megan Mann placed 3rd in the Jersey breed and was the 10th high overall individual in the contest.

On the trip to Harrisburg, the team visited the Gettysburg battlefield and the North Carolina memorial. The team also had a great time touring Hershey, PA and the Amish area in Lancaster County, PA.

North Carolina Places 15th at the National 4-H Dairy Judging Contest held at the World Dairy Expo in Madison, Wisconsin:
Next, the team traveled to Madison, Wisconsin and competed at the National 4-H Dairy Judging Contest held at the World Dairy Expo. Our team did a great job placing 15th in total overall score and 14th in total reasons score out of 28 U.S. teams.

In the Guernsey breed, the team placed 3rd in the contest with Brittany Thompson placing 5th high individual. In the Brown Swiss breed, the team placed 5th overall in the contest, with Aaron McCain placing 17th and Megan Mann placing 23rd on an individual basis. Our team placed 12th in the Holstein breed, 16th in the Ayrshire breed and 23rd in the Jersey breed. Brittany Thompson also placed 16th in total reasons score for the contest.

On Saturday before the contest, our North Carolina State 4-H Team and North Carolina State Collegiate Team traveled together to practice judging sessions at Daltondale Ayrshires in Hartland, WI; Vilter Guernseys in Hartland, WI; Agnew Farm in Oconomowoc, WI and Crescentmead Holsteins in Ixonia, WI. On the day before the contest, the teams had a great time participating with the other teams in touring dairy sites in Fort Atkinson, Wisconsin including NASCO, the Dairy Shrine, and the Hoard’s Dairyman Farm. They also participated in judging practice sessions at Sunshine Genetics, Inc. in Whitewater, Wisconsin and Barlass Jersey Farm in Janesville, Wisconsin. On the day following the contest, the teams visited World Dairy Expo where they saw hundreds of dairy exhibits as
well as some of the finest dairy cattle and dairy shows in the world.

From left to right: J.D. Brooks (volunteer coach from Alleghany County); Megan Mann (Alamance County); Brittany Thompson (Alamance County); Brenda Crouse (Alleghany County); Aaron McCain (Randolph County); and Robin Mann (volunteer coach from Alamance County).

**North Carolina Alternate State 4-H Dairy Judging Team:**

Congratulations to the Alternate State 4-H Dairy Judging Team who competed at the North American Dairy Judging Contest in Louisville, Kentucky. Team members were Carrie Hoffner (Rowan County), Tyler Bussard (Rowan County), Hillary Robinson (Rowan County) and Kerri Beth Frazier (Randolph County). The team was coached by David Correll (volunteer and coach of the Rowan County Team), Ken Vaughn (County Extension Director in Iredell County), and J. D. Brooks (volunteer from Alleghany County). Primary funding for this team to travel and compete was generously provided by the North Carolina Dairy Youth Foundation. We also appreciate the support of the Rowan County Holstein Association and Rowan County Extension for use of the van to transport the team.

The team did a great job placing 12th overall and 10th in reasons. The team also placed 6th in Jerseys, 7th in Holsteins and 11th in Guernseys. Individually, Tyler Bussard was 13th and Kerri Beth Frazier was 17th high individual in reasons. Tyler also placed 3rd in Jerseys and 13th in Holsteins as well as 14th high individual overall in the contest.
Left to right: David Correll (volunteer coach from Rowan County); Tyler Bussard (Rowan County); Hillary Robinson (Rowan County); Carrie Hoffner (Rowan County); Kerri Bet Frazier (Randolph County); and J.D. Brooks (volunteer coach from Alleghany County).

North Carolina State 4-H Dairy Quiz Bowl Team Competes at National Contest

Congratulations to the Alamance County 4-H Dairy Quiz Bowl Team who did an outstanding job representing North Carolina and competing at the North American 4-H Dairy Quiz Bowl Contest in Louisville, Kentucky. Team members included Megan Mann, Brittany Thompson, Brandy Horner and Kayla Isley. The coach was Robin Mann, volunteer from Alamance County.

Left to right: Front row: Robin Mann (coach); Megan Mann; Back row: Brittany Thompson. Brandy Horner and Kayla Isley.
**2005 Competition Highlights from the North Carolina State University Dairy Club**

Dr. Mitch Hockett  
NCSU Assistant Professor

**Dairy Judging Team Competes Well**

North Carolina State University was proud to have a tremendous group of students represent the University at the three national dairy judging competitions this fall. The students on the team were Justin Hardin, Jesse Ledbetter, Jason Wright, and Van Proctor. The team, coached by Dr. Mitch Hockett, competed at Harrisburg, PA, Madison, WI, and Louisville, KY. Their best showing of the year was at Louisville, where the team was second high team in Holsteins, fourth high team in Jerseys and tenth high team in reasons out of eighteen teams. Thanks go out to these young men for their time and hard work and for representing their university so well.

![Image of team members](image)

Left to right: Justin Hardin, Jason Wright, Van Proctor, Jesse Ledbetter, and Dr. Mitch Hockett, coach.

**North American Intercollegiate Dairy Challenge Competition**

The 2005 North American Intercollegiate Dairy Challenge (NAIDC) Competition was held in State College, PA on April 8-9, 2005. The NC State University team competed this year for the first time and did very well, earning a GOLD rating (out of silver, gold and platinum). Only three teams in NCSU's division earned a platinum rating. There were a record-setting 27 teams competing in three divisions. The NC State team consisted of Animal Science majors Jessica Hockney of Durham, NC, Lindsay Lyle of Rougemont, NC, Abigail Nelkie of West Branch, MI, and Ag Education major Jesse Ledbetter of Olin, NC. All four are active members of the Dairy Science Club in the Department of Animal Science at NC State.
University. Dairy Science Club advisors Kas Ingawa, Steve Washburn, and Mitch Hockett helped prepare the team for their first entry into this contest.

The NAIDC is an innovative two-day competition for students representing dairy science programs from Universities across North America. It enables students to apply theory and learning to a real-world dairy, while working as part of a team. Day one begins with each four-person team receiving information about a working dairy, including production and farm management data. After an in-person inspection of one of three designated dairies, participants conduct interviews with the herd managers. Then each team develops a farm analysis and presentation materials, including recommendations for nutrition, reproduction, milking procedures, animal health, housing and financial management. Day two is presentation day. Team members make recommendations to a panel of judges and then field questions from the judges. Presentations are evaluated based on the analysis and recommendations. Generous support from corporate sponsors makes NAIDC possible.

The North American Intercollegiate Dairy Challenge was established as a management contest to incorporate all phases of a specific dairy business. It strives to incorporate a higher-learning atmosphere with practical application to help prepare students for careers in the dairy industry. For more information, please visit the website at http://www.dairychallenge.org.

Team members pictured from left to right are: Jessica Hockney of Durham, NC, Jesse Ledbetter of Olin, NC, Abigail Nelkie of West Branch, MI, and Lindsay Lyle of Rougemont, NC.
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<table>
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<td>Mr. J.D. Brooks</td>
<td>2006</td>
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<td>Mr. Johnny Brooks</td>
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<td>Mr. Ronnie Charles</td>
<td>2006 V. Pres.</td>
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<td>Mr. Daniel Chapman</td>
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<td>Mr. Vance Dalton</td>
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<td>Ms. Marti Day</td>
<td>2006</td>
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<td>Mr. Robert G. Hardin, III</td>
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<td>Mr. Mike Helms</td>
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<td>Mr. Lonnie Hoffner</td>
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<td>Dr. Brinton Hopkins (Ex-officio)</td>
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<td>Mr. Jim Howie</td>
<td>2008</td>
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<td>Mrs. Jill Karriker</td>
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<td>Mrs. Nancy Keith</td>
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<td>Mrs. Amy Kidd</td>
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<td>Mr. Corey Lutz</td>
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<td>Mrs. Shelley G. Lutz</td>
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<td>Mrs. Robin Mann</td>
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<td>Mr. Chuck Michael</td>
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<td>Mrs. Melissa Staebner</td>
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<td>Mr. Mike Strickland</td>
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<td>Mr. Aaron Ray Tompkins</td>
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<td>Mr. Ken Vaughn</td>
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<td>Mr. Ken Weavil</td>
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<td>Dr. Lon Whitlow</td>
<td>2007 Ex-officio</td>
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<td>Ms Sheela Wright</td>
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<td>Mrs. Clair Wylie</td>
<td>2007</td>
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<td>Mr. Keith Oakley</td>
<td>Dairy Foundation</td>
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<td>Mr. Keith Oakley</td>
<td>2008</td>
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Director: Dr. John Clay
Address: 313 Chapanoke Road, Suite 100, Raleigh, NC 27603
Administrative support/main telephone number: (919) 661-3100
Computer support telephone number: (919) 661-3120
Marvin E. Senger Distinguished Dairy Farmer Award Program

The Marvin E. Senger Distinguished Dairy Farmer Award is a program that was established by the Department of Animal Science at North Carolina State University in 1974 to honor Dr. Marvin E. Senger, long-time and highly respected dairy Extension specialist in the department. The award is presented yearly at the NC Dairy Conference to an outstanding dairy leader, family, or farm business. Nominations are submitted to the Department by anyone who cares to. An anonymous committee from the Department reviews the applications and selects the recipient. Criteria used in evaluating the applications and selecting the winner include 1) leadership in dairy, farm and community organizations at the local, area, state, regional and national levels, 2) leadership in business and production management practices used, and 3) leadership in the use of modern technology. Printed below is a listing of the recipients.

1974 - Franklin Teague
1975 - S. F. Nesbit
1976 - Thomas L. Reeves
1977 - S. E. Johnston, Jr.
1978 - Douglas Darch
1979 - G.C. Palmer
1980 - J. Woodley Wallace
1981 - Albert M. Clark
1982 - W. Glen Caruthers
1983 - Robert J. Davis
1984 - Charles Spurgeon Brooks
1985 - David C. Knox
1986 - William F. Covington
1987 - J. B. Stroup
1988 - Eston S. Stokes
1989 - H. L. "Doc" Hill
1990 - C. M. "Mac" Ivey
1991 - Charles and Ethel Lutz and Family
1992 - Beecher H. Gross, Sr.
1993 - Bobby R. And Sara Atkins
1994 - Jim and Charles Eaton
1995 - James M. Cook
1996 - Sam and Eubert Correll
1997 - Robert and Lucy Crowell
1998 - Daniels and Daniels Dairy, Inc.
1999 - Maple View Farm, Inc.,
       Robert and Chris Nutter
2000 - Norman Jordan, Jr.
2001 - Dwayne Myers
2002 - Keck's Dairy, Inc.
2003 - G.K. and Ken Davis Dairy
2004 - Branson, Kay, David, Amy & Will Coltrane
2005 - George L. Pless and Sons Dairy, Inc.
2006 – Wayne Lutz
Don Wesen Quality Milk Producer Award Program

The Don Wesen Quality Milk Producer Award is a program sponsored by the North Carolina Dairy Producers Association to recognize producers in three herd size categories who have consistently produced the highest quality milk the previous calendar year. Yearly average bulk tank somatic cell count and bacteria count values, as well as the ranges in the monthly values, are reviewed to select the recipients. The award is named after Dr. Don Wesen who was a widely known and well respected milk quality dairy extension specialist in the Department of Animal Science at NC State University. Printed below is a listing of the recipients.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cows</th>
<th>Location</th>
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<tbody>
<tr>
<td>1996</td>
<td>&lt;100 cows: H. Durayne Hood, Vale, NC</td>
<td>100-250 cows: Carroll and William Roper, Morganton, NC</td>
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<td>&gt;250 cows: Tony Nesbitt, Fletcher, NC</td>
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<td>1997</td>
<td>&lt;100 cows: Wayne Stout, Stony Point</td>
<td>100-250 cows: Triple R Dairy, Waynesville</td>
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<td>&gt;250 cows: Dwayne Myers Dairy, Jonesville</td>
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<tr>
<td>1998</td>
<td>&lt;100 cows: Wayne Stout, Stony Point</td>
<td>100-250 cows: Triple R Dairy, Waynesville</td>
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<td>100-250 cows: Ralph Ross and Sons Dairy, Waynesville</td>
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<td>&gt;250 cows: Dwayne Myers Dairy, Jonesville</td>
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<tr>
<td>2000</td>
<td>&lt;100 cows: Ruffus Holland and Sons, Olin</td>
<td>100-250 cows: T.C. and Charles Williams, Union Grove</td>
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<td>&gt;250 cows: Dwayne Myers Dairy, Jonesville</td>
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<tr>
<td>2001</td>
<td>&lt;100 cows: Wayne Stout, Stony Point</td>
<td>100-250 cows: Ralph Ross and Sons Dairy, Waynesville</td>
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<td>&gt;250 cows: Dwayne Myers Dairy, Jonesville</td>
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<td>2002</td>
<td>&lt;100 cows: Wayne Stout, Stony Point</td>
<td>100-250 cows: H. Dean Ross, Waynesville</td>
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<td>&gt;250 cows: H.C. Meyers, Jr. (Myers Farms, Inc.), Union Grove</td>
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<td>2003</td>
<td>&lt;100 cows: Randy Lewis, Snow Camp</td>
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<td>&gt;250 cows: H. Dean Ross, Waynesville</td>
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The North Carolina Dairy Producers Association, which was officially organized in February 1996, each year recognizes at their annual meeting one or more individuals for their outstanding contributions to the dairy industry of the state. Printed below is a listing of the recipients.

1997 – Dr. Fred Knott

1998 – W. Clyde Daniels

1999 – Dr. Frank D. Sargent


2001 – J. D. Brooks

2002 – Dewitt Hardee and W. Chester Lowder


2004 – Dr. Lon W. Whitlow

2005 - Franklin Teague

2006 – Kenneth E. Vaughn
55th Annual North Carolina Dairy Conference Agenda

Wednesday, February 15

1:00 - 5:00 p.m.
Dairy Foods Safety and Quality Conference
- Ellis/Overman Room

2:00 p.m.
NC Dairy Youth Foundation Board Meeting
- Suite 102

2:00 p.m.
NC ADA/SUDIA Board Meeting
- Steele Room

7:00 p.m.
North Carolina Dairy Producers Association
10th Annual Meeting and Board Reorganization Meeting
- Steele Room

Thursday, February 16

55th Annual North Carolina Dairy Conference Program

8:30 a.m.
Registration and View Exhibits

10:00 a.m.
Morning Session: Steele Room
Chair: Norman Jordan Jr., President
NC Dairy Producers Association

10:00 a.m.
SUDIA Annual Report – Cheryl Hayn, General Manager, and Eric McClain, Northern Area Manager

10:45 a.m.
Presentation of Don Wesen Quality Milk Producer Awards - Kay Sigmon, NC Milk Sanitation Program Asst. Branch Head, and Norman Jordan Jr., NCDPA President

10:50 a.m.
NCSU Dairy Research Reports
Drs. Mitch Hockett, Steve Washburn, Kevin Anderson and Mark Alley

11:30 a.m.
Presentation of the Marvin E. Senger Distinguished Dairy Farmer Award
- Dr. Roger McCraw, Head, Department of Animal Science, NCSU

Noon Luncheon Session:
- Jackson & Overman Rooms
Chair: J.D. Brooks, President, NC Dairy Youth Foundation
- Buffet Lunch

“What the Southeast Dairy Industry Will Be Like in 2015”
- Dr. Greg Bethard, G & R Dairy Consulting, Wythesville, VA

- Dairy Youth Foundation Report and Raffle
- View Exhibits

2:00 p.m.
Afternoon Session: Steele Room, Chair: Wayne Lutz, Vice President, NC Dairy Producers Association

2:00 p.m.
“Milk Marketing Update”
- Dr. Geoff Benson, NCSU

2:10 p.m.
“Using Decisive™ Semen in a Herd’s A.I. Program”- Dr. Thomas Bailey, DVM Lead Technical Services Reepresentative Monsanto Decisive™ Semen Program

2:45 p.m.
NCSU Dairy Research Reports
Drs. Scott Whisnant, Vivek Fellner, Brinton Hopkins, and Lon Whitlow

3:25 p.m. Adjourn