# DAIRY DAY 1988

# DAIRY DAY - 1988

## MANAGING THE HIGH-PRODUCING HERD

### PART 3: "Producing High Quality Milk"

**Morning Session - Manhattan Firestation Headquarters**

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| 9:00 | Registration - View Poster Displays* |
| 9:45 | Welcome - Dr. Jack Riley |
| | Dean Walter Woods |
| 10:00 | Producing High Quality Milk - Dr. John Shirley, KSU |
| 10:15 | Animal Drugs and the Milk Supply - Robert Wilson, FDA - Kansas City |
| 10:55 | Milk Quality: A Veterinarian's Viewpoint - Dr. David Reid, Hazel Green, WI |
| 11:40 | Why High Quality Milk? A Marketing Viewpoint - Harold Roberts, KSU |

**Noon      Lunch      View Poster Displays***

**Afternoon Session - Manhattan Firestation Headquarters**

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| 1:00 | Kansas Mastitis Council Annual Meeting |
| | Quality Milk Awards |
| 1:30 | Tours |
| | KSU Dairy Teaching and Research Center |
| | KABSU, 1401 College Avenue |
| | Kansas DHIA Lab, 628 Pottawatomie |
| | View Poster Displays* |

**\*Poster Displays:**

1. Milking Management Clinics - J.R. Dunham and E.P. Call

2. EBS and More --- DHIA - D.W. Sukup

3. Use of GnRH for Repeat Breeders - J.S. Stevenson

4. Effect of Maturity at Harvest and Conservation Method on Yield and Chemical Composition of Winter Cereal Forage - S. Azimi and K.K. Bolsen

5. AI ReproFresher Clinics - E.P. Call

6. Feed Analysis by NIRS - A Demonstration - L.H. Harbers and G. Garcia

7. Soybeans Interseeded with Grain Sorghum as a Forage for Growing Cattle - K.K. Bolsen, J.E. Shirley, and S. Esmail

8. Comparison of Metabolic Changes in Normal vs Mastectomized Periparturient Beef Cows - J.C. Kube, J.E. Shirley, T.D. Smith, and R.A. Frey

9. Small Intestinal Starch, Dextrin, and Glucose Digestion in Steers - K.K. Kreikemeier

10. Inoculant Effects on Rate and Efficiency of Fermentation in Whole-Crop Wheat Silages - R.A. Hart, K.K. Bolsen, F. Niroomad, A. Laytimi, and L. Nuzback

11. Bovine Recombinant Interleukin-2 Enhances Resistance to Bovine Herpesvirus-1: Dose Response Trial - P.G. Reddy, F. Blecha, J.L. Morrill, and H.C. Minocha

# FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 1988. Dairying continues to be a viable business and contributes significantly to the total agricultural economy of Kansas. Wide variation exists in the productivity per cow, as indicated by the production testing program (DHIA) in Kansas. Nearly one-half of the dairy herds and dairy cows are enrolled in DHIA in Kansas. Our 1988 DHI program shows that tested cows average 15,837 lb milk compared with 9,925 lb for all nontested cows. This means that dairy cows enrolled in DHIA average more income over feed cost ($1,144/cow) than nontested cows ($634/cow). Much emphasis should be placed on furthering the DHIA program and encouraging use of its records in making management decisions.

With our herd expansion program, which was begun in 1978 after we moved to the new Dairy Teaching and Research Center (DTRC), we peaked at about 210 cows. The herd expansion was made possible by the generous donation of 72 heifers and some monetary donations by Kansas dairy producers and friends. Herd expansion has enabled our research efforts to increase, while making the herd more efficient. Our rolling herd average is approximately 17,200 lb, despite many research projects that may not promote production efficiency.

The excellent functioning of the DTRC is because of the special dedication of our staff. Appreciation is expressed to Richard K. Scoby (Manager, DTRC), Gregory Kropf (Asst. Manager, DTRC), Dan Umsheid, Mary Rogers, Charlotte Kobiskie, Bill Hanson, Robert Resser, Kathy Snyder, Becky Wolfe, and Lloyd Manthe. Special thanks are given to Neil Wallace, Natalie Brockish, Tammi DelCurto, Lois Morales, and Cheryl Armendariz for their technical assistance in our laboratories.

As demonstrated, each dollar spent for research yields a 30 to 50 percent return in practical application. Research is not only tedious and painstakingly slow but expensive. Those interested in supporting dairy research are encouraged to consider participation in the Livestock and Meat Industry Council (LMIC), a philanthropic organization dedicated to furthering academic and research pursuits by the Department. More details about LMIC are provided later in this publication. Appreciation is expressed to Charles Michaels (Director) and the Kansas Artificial Breeding Service Unit (KABSU) for their continued support of dairy research in the Department. Appreciation also is expressed to the College of Veterinary Medicine for their continued cooperation. This relationship has enabled us to develop cooperative research and establish an exemplary herd health program.

J.S. Stevenson, Editor
1988 Report of Progress

# BIOLOGICAL VARIABILITY AND CHANCES OF ERROR

Variability among individual animals in an experiment leads to problems in interpreting the results. Although the cattle on treatment X may have produced more milk than those on treatment Y, variability within treatments may indicate that the differences in production between X and Y were not the result of the treatment alone. Statistical analysis allows us to calculate the probability that such differences are from treatment rather than from chance.

In some of the articles herein, you will see the notation "P<.05". That means the probability of the differences resulting from chance is less than 5%. If two averages are said to be "significantly different", the probability is less than 5% that the difference is from chance or the probability exceeds 95% that the difference resulted from the treatment applied.

Some papers report correlations or measures of the relationship between traits. The relationship may be positive (both traits tend to get larger or smaller together) or negative (as one trait gets larger, the other gets smaller). A perfect correlation is one (+1 or -1). If there is no relationship, the correlation is zero.

In other papers, you may see an average given as 2.5 ± .1. The 2.5 is the average; .1 is the "standard error". The standard error is calculated to be 68% certain that the real average (with unlimited number of animals) would fall within one standard error from the average, in this case between 2.4 and 2.6.

Using many animals per treatment, replicating treatments several times, and using uniform animals increase the probability of finding real differences when they exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals. In all the research reported herein, statistical analyses are included to increase the confidence you can place in the results.

# CONTENTS

# MANAGING THE HIGH-PRODUCING HERD. III.
# PRODUCING HIGH QUALITY MILK.

### J.E. Shirley

Progress in the dairy industry over the past 30 yr can be defined as a movement toward fewer farms, more cows per farm, fewer total cows, more milk per cow, a gradual decline in total annual milk production from 1950 through 1975 followed by a sharp increase through 1985, a decrease in per capita consumption, and an increase in milk quality.

In 1950, 3,648,000 farms reported milk cows, whereas in 1985, the number of farms reporting milk cows had declined to 273,620. The average herd size increased from 5.8 cows in 1950 to 40.3 cows in 1985. During this same period, annual milk production per cow increased from 5,302 lb (1950) to 13,016 lb (1985). Per capita consumption of fluid milk and milk products declined from 740 lb milk equivalent in 1950 to 540 lb in 1975. Per capita consumption of milk was relatively constant from 1975 to 1981, then increased sharply from 542 to 582 lb between 1981 and 1985. This increase in per capita consumption corresponded with increased USDA donations and increased promotion of dairy products by producers.

Competition for fluid intake capacity of consumers is a never ending challenge. The dairy industry has lost ground over the past 20 yr to everything except coffee, fruit juices, whiskey, and water. Per capita consumption of fluid milk in 1965 was estimated to be 26.0 gallons, but by 1986 it had decreased to 20.3 gallons. Comparable figures for soft drinks show an increase from 17.8 gallons (1965) to 42.1 gallons (1986); beer intake increased from 15.9 to 23.9 gallons. Water consumption dropped from 72.4 gallons in 1965 to 41.2 gallons in 1986, whereas the intake of coffee decreased from 37.8 to 25.4 gallons. Consumer intake of fruit juices and distilled spirits remained relatively constant during this period. Consumption of fluids does not appear to be totally price-related because the current price of milk in Manhattan, Kansas is $1.79 per gallon, soft drinks (sale price) are $2.06 per gallon, premium beer is $6.83 per gallon, and tap water is essentially free.

The present marketing program effectively promotes the nutritional value of dairy products and relates milk with good health. Advertising creates a product image and, therefore, has a positive long-term effect on sales only if the product lives up to the image. Our challenge at the farm level is to ensure that milk leaves the farm free of antibiotics, low in bacteria and somatic cells, and free of off-flavored components.

Offering only high quality milk for sale is the only effective way to support the advertisements your dollars purchase. The 1988 Dairy Day program addresses some of the concerns consumers have about milk quality and offers guidelines useful to the producer of high quality milk.

# ANIMAL DRUGS AND THE MILK SUPPLY

### Robert W. Wilson[1]

The makers of the laws, rules,and regulations governing the production and processing of milk have recognized that milk is the primary diet of the very young and old. This fact mandates that it should be produced and processed in a manner to protect and maintain it in a pure, safe, and unadulterated condition.

To determine adulteration of any milk product, one must first understand the legal definition of that product. In general, milk is defined as "the lacteal secretion of healthy cows that is practically free from colostrum." Anything that alters the product from the intent of this definition constitutes adulteration.

Milk that is further processed also is covered by one of several "Standards of Identity." These are contained in the "Code of Federal Regulations" (CFR's), Title 21; Sections 131, 133, and 135. Any deviation from these standards is considered a violation.

The various regulatory agencies of the country have routinely sampled and tested milk products to assure that they meet these standards. The tests have included those for sediment, added water, pesticides, antibiotics, somatic cells, and bacteria. Now we are entering an era of eliminating sulfamethazine (Sulfas) and other unacceptable drugs from the milk supply. Few, if any, of the drugs administered for the cure or prevention of diseases in animals would be an acceptable residue in the milk supply.

Attention was first focused on the Sulfas by the pork industry, when several foreign countries refused importation of meat because of sulfa residues. At about that time, research was conducted by a manufacturer of laboratory equipment, indicating that the Sulfas were a major contaminate in the milk supplies of this country. So much attention was drawn to this research that it prompted the Food and Drug Administration's (FDA) "Center For Veterinary Medicine" to collect and analyze its own samples.

Forty-nine samples were collected representing different plants. These samples were representative of the product sold in 10 different cities, including Kansas City. Sulfamethazine was the only drug analyzed and was found in 36 of the 49 samples. Many of the concentrations were very low, but were still considered significant because there was no legal use of sulfamethazine in lactating dairy animals.

Sulfamethazine is of special importance, since it is a suspected carcinogen. Congress, in passing the "DeLaney Amendment", has mandated that nothing that can produce cancer in laboratory animals shall be added to food.

[1]Regional Milk Specialist, Food and Drug Administration, Kansas City, MO.

While the upcoming FDA program appears to focus on sulfamethazine, it will attempt to eliminate all unacceptable drug residues from the nation's milk supply. It will do this in the following manner.

1) Encourage practicing veterinarians to follow the CFR's and drug labels when prescribing drugs for lactating dairy animals. Dr. G.B. Guest, Director, FDA, Center for Veterinary Medicine, has released a letter noting, among other things, that "veterinarians have a significant role in the production of safe and wholesome animal-derived foods."

2) Issue memoranda of interpretation to State regulatory agencies informing them of the necessity for the program. These memos also point out what is considered to be satisfactory compliance in the use and storage of the various drugs found on dairy farms.

3) Enlist the aid of American dairy farmers both directly and through their association with the various marketing cooperatives and many national organizations. One of the foremost of these organizations would be the "National Conference on Interstate Milk Shipments."

4) State milk sanitation compliance ratings and FDA check-ratings made under the provisions of the "Cooperative State/PHS-FDA Program for the Certification of Interstate Milk Shippers" will stress the proper use and storage of animal drugs.

5) States will be encouraged to institute a sampling and testing program that will detect drugs in the milk supply.

## Use and Storage of Animal Drugs

Only those drugs that have label indications for use on or in dairy animals will be permitted to be stored in milk houses, milking barns, or adjacent areas. Some judgment may be necessary to identify these drugs. It would be obvious that drugs whose labels only mention dogs, cats, swine, poultry, horses, beef cattle, or other animals should not be stored in any of the three areas stated above.

In the field, we have noted calf bolus products that have been labeled for both "beef and dairy calves" and those just labeled for "calves". Considering the age of the animal being treated, I see no problem with these.

Also noted in the field have been "uterine boluses," which contain Sulfas that are not acceptable for use in dairy animals. I am not aware of a reason to administer a uterine bolus to a non-lactating animal. These types of drugs should not be permitted in the dairy. This is not to say that all "uterine boluses" are unacceptable. Look at the label and see if it gives instructions for use and milk disposal time.

Those drugs labeled "not for use in lactating animals" will probably be acceptable in non-lactating animals. If the label is not clear, check your CFR's. Be sure to be alert when using this type of drug on non-lactating animals to ensure that they are not used too close to freshening. All labels will give a slaughter-withholding time, so the drug should not be administered after that amount of time prior to freshening.

Another similar situation is the drug labeled "not for use in female dairy cattle of breeding age." The drug will give a slaughter-withholding time and should not be used for this length of time prior to breeding age.

Labels of veterinarian-prescribed drugs must meet the "EXTRA LABELING" requirements of the CFR's. This will require the veterinarian's name and address to appear on the label. Also required are the directions for use of the drug and any precautionary restrictions. The veterinarian assumes the responsibility for any drug residue in the milk.

After you are satisfied the drug is one that can legally be on a dairy farm, you must then consider storage. Storage is simpler than determining the status of the drug. All you have to do is determine if the drug is for lactating or non-lactating dairy animals. The two must be segregated from each other during storage. You will have to use judgement in determining what is acceptable segregation. Different shelves in a refrigerator, different shelves in a cabinet, or opposite ends of a long shelf with something stored between could be acceptable; each situation will have to be evaluated.

In general, what we are seeing in the field today is not acceptable for storage of drugs. Everything seems to be thrown on a shelf, in a cabinet or in a refrigerator with labels missing or not readable. There has been no effort to discard out-of-date drugs and we see them with expiration dates up to 5-yr old. In short, we would recommend storing drugs in a neat, orderly condition, so we can evaluate what is available.

### Inspections, State Ratings, and FDA Check-Ratings

The State participates in the "COOPERATIVE STATE/PHS-FDA PROGRAM for the CERTIFICATION of INTERSTATE MILK SHIPPERS," which requires substantial compliance with the standards of the program. This means the State must have an inspectional program and enforce the sanitation standards of the program.

In addition, the State is responsible for conducting a sanitation compliance rating of each processing plant and one from each raw-milk source. These ratings are published quarterly and sent to anyone interested in importing milk. A 90% compliance rating is needed for most states to accept imported milk.

The FDA is responsible under the program to conduct check-ratings periodically to determine if the local state inspectors are enforcing the regulations. If it is determined that the exporting state is not meeting the criteria of compliance, the importing state may refuse to accept the milk.

Each item of sanitation on the inspection sheet is given a numerical value so an arithmetic-weighted average can be given the milk plant or raw-milk source. Ten points have been assigned the presence or use of an unacceptable drug (not labeled for use on dairy animals). Two points are deducted if a drug is not properly labeled. A raw-milk source could not tolerate many such violations and still continue to ship milk interstate or to a plant that is on a interstate list.

# QUALITY MILK: A VETERINARIAN'S VIEWPOINT

David A. Reid[1]

## Introduction

I would like to thank the organizers of this program for the opportunity to speak to you today on a subject that I feel is of the utmost importance to the dairy industry in the U.S. The problem to which I am referring is not the current devastating drought that has affected many of the dairy-producing areas in our country, but rather the repercussions of the dairy industry's inability to market a wholesome uncontaminated product that is viewed as such by a majority of the consumers in the U.S. I am sure that most of us here can remember the problems that occurred several years ago with contaminated Tylenol products that reached various market areas in the U.S. With the recent revelations that approximately 70% of the milk samples in several metropolitan areas, including Boston and Seattle, were contaminated with sulfamethazine, I fear that we in the dairy industry also could be faced with much more adverse publicity than what we have seen in the recent past. There has been at least one segment on 60 Minutes dealing with the potential contamination of milk products, along with articles in the Wall Street Journal. This publicity is definitely not what the dairy industry needs today. Currently, what publicity has been generated has not shaken the confidence that American consumers have in dairy products as a source of wholesome, uncontaminated, nutritional components of their diet. However, those of us that are involved in the dairy industry need to realize the potential devastation that could occur to our complete marketing system, if adulterated, contaminated milk is not removed from the market place.

## Residue Testing in Milk

For years, many of us have known that the dairy industry has operated on the principle that we can be saved by dilution. We take in some milk that might have low levels of contamination, we dilute it with vast amounts of uncontaminated milk, and we end up with no detectable residues in our milk products. The introduction of what is commonly referred to as the "Charm II" test will change all of this. The "Charm II" test is many times more sensitive than any of the current methods of detecting antibiotic or sulfa residues in milk. The publicity that has been generated with this test will necessitate more milk cooperatives and milk marketing plants to use this advanced technology to detect antibiotic and sulfa residues in farm bulk-tank milk. In order for the dairy industry to survive, it is imperative that we understand how some of these residues can be avoided in our milk at the farm level. Unfortunately, at this point in time, there are no inexpensive farm tests that we can use to detect the extremely low levels of residues that the "Charm II" and the FDA tests are capable of detecting. This creates a real problem because we may feel that there is no contamination on a particular farm. However, in fact, there may be a contaminated feed source, an inadvertent use of antibiotic, or an unobserved withdrawal time for certain drugs on the farm. However, these farms do not have residues that are red-flagged with the conventional tests that are now being utilized. Therefore, this milk is mixed into the processing channels, and it may not be until the product is actually on the shelf in consumer form before the

[1]Rocky Ridge Veterinary Service, Hazel Green, WI.

contamination is found. At that point, it is too late because the damage has been done, with the product already in the marketplace. There lies the problem, as I see it for the dairy industry.

## What Must We Do?

We certainly could stand here and complain about the adoption of these new sensitive tests by those in the industry who can afford the technology. However, before we make our complaints very loud and vocal, I think there are many things that we as dairy producers and dairy veterinarians can do to help ensure that we are not contributing to antibiotic contamination of milk because of sloppy, on-farm, medication procedures.

There is a fundamental change in the attitudes of both dairy producers and veterinarians that I see as necessary to help resolve the potential nightmarish problems that we face with antibiotic residues. It is simple and easy to understand the change that we need. We need to change our attitudes when it comes to disease problems in cows. Diseases need to be prevented and not treated. I stand here today as a veterinarian who offers a service to clients in southwest Wisconsin, northern Illinois, and eastern Iowa that I call Quality Milk Production Management and Consultation. Basically, I go to farms and I analyze milking equipment, milking procedures, and other aspects of dairy management that contribute to quality milk production. What is astounding to me is to look back in the literature and see that 25 and 30 yr ago approximately 50% of the cows in the U.S. were infected with mastitic organisms in one or more quarters. The National Mastitis Council (NMC) currently estimates that the percentage is nearly the same today as it was then. There is also a very conservative estimate on the part of the NMC indicating that the average dairy cow in the U.S. is losing $181 per yr because of mastitis. The technology, research, and the data are at hand to help control mastitis. However, the adoption of this information has been very slow to trickle down and become a part of everyday management on most dairy farms. So, the first step that we can take to help reduce the residue problems is to prevent disease rather than relying on the treatments available to cure the disease once it is diagnosed.

## Field Observations

I find myself in a position of being on many dairy farms in the course of my routine work. It is appalling to see some of the drugs and products that are available on many dairy farms in the upper midwest. I am sure that if we were to visit every dairy farm in Kansas, we certainly could find some real problems with the medications that are on the farms, along with the conditions under which these antibiotics and treatment products are stored. I will admit that the few approved drugs for use in lactating animals in many cases are certainly not the most effective antibiotics to use. My point is to not discourage or condemn the extra-label use of antibiotics, but to use extra-label antibiotics in a reasonable and well thought-out treatment program that hopefully will ensure that contaminated milk is not mixed into the normal processing channels. My advice to you is to work closely with your veterinarian and to observe the withdrawal times that he recommends. All of us here know that in many cases veterinarians come to your farm and use drugs in an extra-label manner and leave written directions to hold the milk for x number of milkings. If you, in fact, send that milk to your milk-processing plant and request an antibiotic test on it, you will find that, in many cases, within a matter of 2 days, the milk test will be negative for antibiotics, even though the withdrawal time may have been 12 days. What do you do? You sell the milk. This is certainly a problem that we face today. The tests that we have available at the local level will have nowhere near the sensitivity of some of the newer tests about which we are speaking. Without adequate cow-side or milk-plant tests of the same sensitivity, we really

have a problem in maintaining an uncontaminated milk product for the consumer. There certainly is no way that the use of antibiotics can be eliminated from the average dairy farm in this country. However, drugs could and should be used in a wise and well thought-out manner. You should not use drugs without a label that tells both the milk withdrawal and the meat withdrawal times that must be observed prior to marketing these products. If your veterinarian mixes a specific prescription-type item for use in a certain individual cow on your farm, be sure to find out exactly what is the necessary withholding time. In many cases, the veterinarian may not have an accurate answer, and the time interval that he recommends may, in fact, be more than is necessary, but it needs to be observed. Do not cut corners in sending the product to market prior to the recommended holding time.

## Product Availability for Lactating Cows

As a practicing veterinarian, I have many concerns about the availability of approved drugs with which to treat lactating animals. It is my opinion that we need to have milk and tissue residue withdrawal times established for products, even if they are not approved in lactating animals. It is common knowledge that many products are being used in food-producing animals to treat certain specific illnesses, but we do not have good clinical data to give us accurate withdrawal times. Many times veterinarians are faced with the unenviable task of coming up with a withdrawal time when there are no adequate data available. Most veterinarians tend to adopt recommended withdrawal times for which there is some evidence to suggest what is correct. Withdrawal time is a problem that veterinarians face after having had considerable training in the use of drugs and the preparation of drugs for use in animals. What about the mixtures that I see put together on the desk in the barn office? There may be as many as four or five active ingredients, including a corticosteroid and possibly some other products that would help the diffusion of the drug through the mammary tissues. What kind of a withdrawal time do we put on that type of a product? To me, the obvious answer is that we shouldn't use this type of a product. We should limit the use of intramammary drugs to the minimal amount of extra-label use with which one can get by. Dairymen would be well advised to use commercially prepared mastitis tube treatments and not to rely on either homemade products or even products that are routinely manufactured or put together for that use by practicing veterinarians. The potential problems with the contamination of these products with yeast and fungi and then the concurrent contamination of mammary tissues with these organisms warrant great concern. But of even greater concern is how do we arrive at effective withdrawal times for what I would call "bath-tub mixtures." I do not feel there is any way to come up with an adequate withdrawal time for this type of product.

## The Bottom Line

The production of quality, uncontaminated milk demands that: 1) drugs be used only when necessary; 2) the treatments used have a prescribed withdrawal time; and 3) these treatment products be stored on the farm in a manner such that they cannot contaminate the milk supply. The ultimate responsibility for uncontaminated milk leaving the farm lies with the dairy producer and his veterinarian. I realize that the technology in some areas is way ahead of the technology that is available on the farm. However, rational, well thought-out drug-treatment programs can reduce dramatically the amount of adulterated milk that enters the marketplace. I firmly believe that producing uncontaminated milk remains the most important issue facing the dairy industry today.

I would like to close with a quotation from a talk presented recently by John Adams at the National Mastitis Council's summer meeting in Tampa, Florida. "We cannot fail in this challenge, for the failure will be reflected in adverse consumer and government reaction. Our

failure will lead to the loss of needed drug products and loss of consumer confidence in our product. Let us all continue to work together so that we are able to continually reassure consumers that our milk supply is the safest it can possibly be! Our number one business as cooperatives is marketing milk for the highest return for our dairy farmer members. We cannot market contaminated products!"

# ANALYSIS OF REPRODUCTIVE LOSSES IN KANSAS DAIRY HERDS

## E.P. Call

## Summary

Poor reproductive efficiency renders a large economic hardship on Kansas dairy producers. An analysis of DHIA Holstein herds indicated an annual average loss of $117 per cow or $8,540 for the average herd. The early detection of potentially problem breeders is necessary to reduce significantly these hidden or "not-out-of-pocket" losses.

## Introduction

Reproductive losses are insidious because open cows and those with elongated calving intervals are not sick or debilitated. There is also the belief that cows open beyond 3 mo will produce more milk during that lactation. However, cows with extended calving intervals have reduced milk per day of herd life and spend a greater percentage of time in the decline of lactation, when the conversion of feed into milk is less efficient and less profitable.

## Procedures

Reproductive traits of 562 Kansas Holstein herds, which were enrolled in production testing (DHIA) for more than a year in July, 1988, were evaluated and compared with accepted standards of reproductive excellence. The categories were: 1) projected calving interval; 2) average days dry; 3) services per conception; and 4) average age at first calving (lactation 1).

The economic appraisals used to estimate reproductive losses were: 1) calving interval - $1 per day from 375 to 395 days; $3 per day beyond 395 days. 2) days dry - $3 per day less than 45 days or more than 60 days; 3) services per conception - $2 for each 0.1 increase over 1.7; and 4) age at first calving - $30 per mo beyond 24 mo.

## Results and Discussion

Projected calving intervals averaged 405 days and resulted in a $50 per cow loss. Days dry averaged 66 days, which calculated to be an $18 yearly loss, whereas losses from services per conception (2.0) were $6. With an average age at first calving of 28 mo, the economic impact of delayed freshening was $43. The average size of the herds studied was 73 cows, and the annual loss for the average herd was calculated to be $8,541. For all the herds, the estimated loss was $4,800,042. Projected to all herds in Kansas, the economic loss would exceed $11,000,000.

The economic impact of reproductive losses in the Kansas Dairy Industry justifies the implementation of management practices to reduce this monetary hardship. The paramount need is to become acutely aware that a problem exists because most of the losses are hidden or "not out-of-pocket" expenses. A preventative herd health program (PHHP) is justified, including a routine (monthly) visit by a competent veterinarian. The early recognition of potentially problem cows is the basis for reducing the economic hardship of lowered reproduction efficiency.

# MILKING MANAGEMENT CLINICS

## J. R. Dunham and E. P. Call

### Summary

Thirty Milking Management Clinics have been conducted at various on-farm locations. The clinics have demonstrated that good milking techniques can result in an additional 1891 lb milk yield/cow in a 10-mo lactation and an increased milk flow rate of 0.9 lb/min. Additional demonstrations include: 1) teat dipping techniques, 2) proper sanitation programs, 3) antibiotic sensitivity culturing, 4) residue avoidance programs, 5) dry cow treatment techniques, and 6) milking equipment evaluation.

### Introduction

Modern milking management often overlooks the physiology of the dairy cow. Although cows milked per hr is a measure of milking efficiency, many producers fail to take advantage of the milk let-down hormone--oxytocin. Thus, milk harvest is incomplete or milk flow per min is reduced because of improper stimulation for milk let-down or waiting too long before machine attachment to achieve the maximal benefits from oxytocin.

Other practices that need to be improved in many dairy operations include: 1) sanitation, 2) antibiotic sensitivity culturing for treatment programs, and 3) milking machine maintenance and evaluation.

### Procedures

County Extension Agricultural Agents are encouraged to host a milking management clinic. The on-farm demonstration requires a cooperator to provide four to six mid-lactation cows that can be milked in a parlor that will accommodate 20 to 30 dairy producers.

After a discussion of milk secretion, milk let-down, and preparation procedures, the demonstration is conducted. Two or three cows are prepared for milking, and the milking machine is attached one min after initial preparation commences. Two or three other cows are prepped in the same manner and allowed to stand 5 min before the milking unit is attached. Both groups are milked, and the milk produced is measured. This is noted as initial milk. Then the cows are injected with 2 ml oxytocin (20 u/ml). The cows are milked again after 2 min to measure the amount of milk not harvested (residual milk).

Following the milking demonstration, good sanitation procedures are demonstrated in which bacterial culture plates are used to illustrate the amount of bacterial growth on teat ends with various sanitation programs. In addition, a discussion of programs for mastitis treatment is held, and an evaluation of the milking system is demonstrated.

### Results and Discussions

Results of the milking demonstration are shown in Table 1. These demonstrations have shown that milk production can be increased 3 lb per milking by using good cow preparation techniques (normal prep) compared to advanced prep cows. This is equivalent to 1891 lb milk

in 305 days. Milk production is improved because cows are milked out more completely when the full benefit of oxytocin is utilized with proper timing in cow preparation. In addition milking time can be reduced by improved milk flow rate (0.9 lb/min) with normal cow preparation. Dairy producers have tended to prep too many cows before attaching the milking unit and, therefore, the effect of oxytocin on milk let-down is reduced. Furthermore, many producers do not spend at least 30 sec in cow preparation for maximal stimulation for milk let-down.

Although reports from producers after attending a clinic are only testimonials, several have reported improved milk production and(or) shorter milking time after improving their cow preparation techniques. Other comments include lower somatic cell counts after improving sanitation practices, such as drying udders and using pre- and post-milking teat dips. Using lactating and dry cow mastitis treatments, which are based on antibiotic sensitivity, seems to be a more common practice.

Table 1. Summary of 30 Milking Management Clinics

| Item | No. cows | Milk (lb) | | | Milk harvested (%) | Milk flow (lb/min) |
| --- | --- | --- | --- | --- | --- | --- |
| | | Initial | Residual | Total | | |
| Normal prep | 61 | 32.0 | 1.5 | 33.5 | 95.5 | 4.9 |
| Advanced prep | 61 | 29.0 | 4.6 | 33.6 | 86.3 | 4.0 |
| Difference | | +3.0 | -3.1 | -0.1 | +9.2 | +0.9 |

# TIMING OF PARTURITION IN DAIRY CATTLE

## J.S. Stevenson

## Summary

A recent survey of calvings of dairy heifers and cows revealed that fall calvings occurred in a nonrandom pattern. The survey was conducted in a large 5,000-cow herd in which pregnant females were watched 24 hr/day. Fewer ($P<.005$) calves (42%) were born during the night-time hours of darkness (6 p.m. to 6 a.m.) than during daylight hours (58%). The time of day when calving occurred was unrelated to the duration of pregnancy or to any of the climatic variables measured, including daily temperatures (highs or lows), barometric pressure, relative humidity, precipitation, average wind velocity, or percentage of sunshine. Although some reports and popular opinion have suggested that time of calving might be influenced partly by prevailing weather conditions, our data fail to support this notion. We are unable to explain the observed nonrandom pattern of calving, except that it might be influenced by other management routines on the farm.

## Introduction

Calving is a critical time for the cow and her newborn calf, because death losses are greatest during or shortly after birth for both the cow and calf. This is also a time of potentially severe debilitating injury to the cow. Difficult calving or dystocia occurs in about 6 of every 100 calvings. It is significantly higher in heifers than cows and declines in severity with increasing age. The implications of difficult calving for the cow are many. It increases her risk for retained placenta, infections of the reproductive tract, poor fertility in general, milk fever, and cystic ovaries. Information regarding the expected time of calving would be a useful management tool. If assistance at calving could save more future replacement heifers and reduce the incidence of calving difficulty and trauma for the cow, then both cow and calf would be better off, and potential income of the dairy producer would be increased.

## Procedures

Holstein cows (n=579) and heifers (n=345) located in a 5,000-cow herd (Tuttle, OK), which calved from September 23 through December 17, 1985, were utilized in this study. Cattle were held on Bermuda pasture dry lots with fence-line feed bunks. At least one person was available 24 hr/day to assist and care for dry cows and heifers at calving time. Clocktime was recorded when each one calved and entered in an IBM computer spread sheet, which contained breeding, calving and treatment histories of each cow or heifer. Cows were fed in the afternoon (3 to 4 p.m.) a complete diet consisting of 5 lb corn, 2 lb cottonseed hulls, 5 lb bermuda hay, 10 lb corn silage, and .25 lb meat and bone meal, in addition to having constant access to a grass hay.

Daily climatological data corresponding to the calving dates of all cattle in the study were obtained from the National Climatic Data Center in Asheville, NC. Climatic data were measured at the Will Rogers World Airport located in Oklahoma City, OK (latitude 35° 24'; longitude 97° 36'; and elevation = 1285 ft). The dairy farm was located about 20 miles southwest of the airport. Information obtained included maximal and minimal daily temperatures, precipitation (water equivalent), average daily barometric pressure, average daily wind velocity, average percentage of sunshine, and relative humidity at 6 a.m.

## Results and Discussion

The distribution of calvings for each hour of the day is illustrated for heifers and cows in Figure 1. If calving occurred randomly, then one would expect 4.2% of the cows or heifers to calve during each hour of the day. The pattern of calving was quite similar for heifers and cows. However, heifers had two peak hours of calving at 6 a.m. (6.4%) and 1 p.m. (7.2%), whereas cows had three peaks at 7 a.m. (6.4%), noon (6.9%), and 3 p.m. (5.9%). It is interesting that more (P<.005) calvings occurred between 6 a.m. and 6 p.m. (58%) than between 6 p.m. and 6 a.m. (42%), corresponding to daylight and darkness. The sun rose, on the average, at 6:43 a.m. and set at 5:33 p.m. during the study.
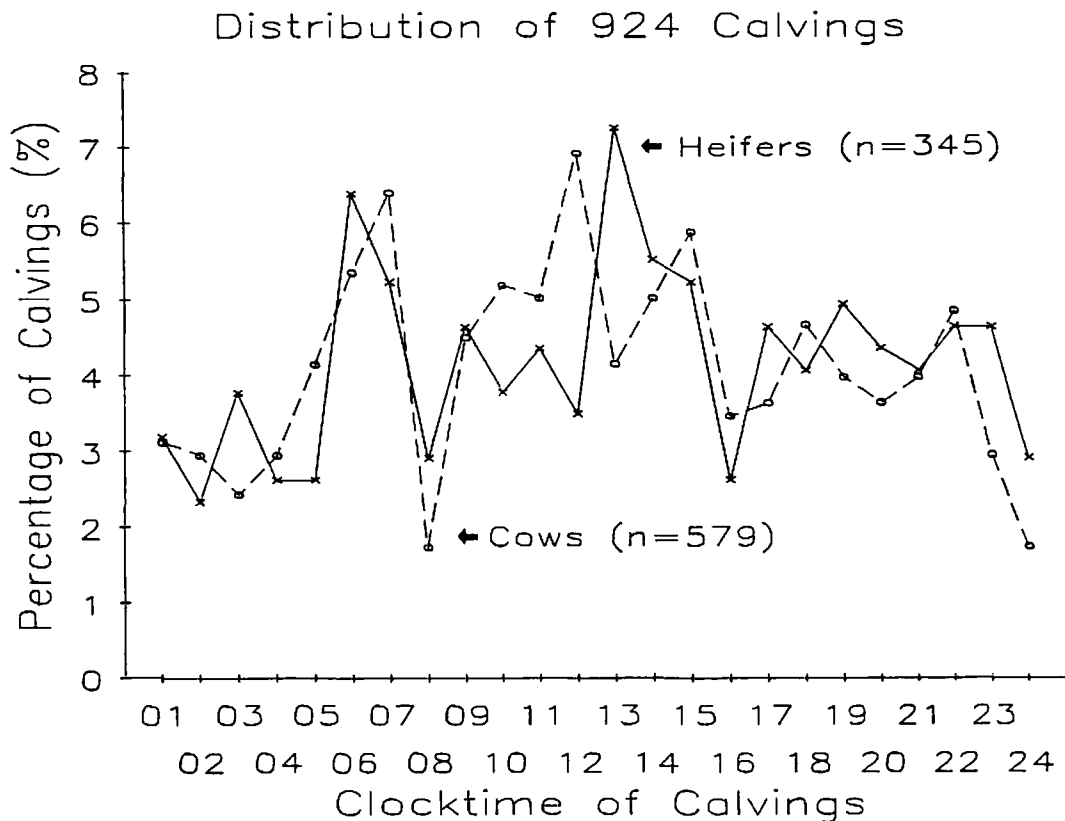


Figure 1.    The Percentage Distribution of 924 Calvings, including 345 Heifers and 579 Cows, during the Fall of 1985.

There appeared to be little relationship between the climatological variables measured during 7 days preceding calving and the onset of calving. Changes in the barometric pressure and amount of precipitation during the week before parturition are shown in Figure 2. Barometric pressure was lowest 4 days before calving, and calving occurred during a period of increasing pressure. These results are in agreement with two previous studies in which calving occurred during a period of rising barometric pressure that generally followed the passage of a warm front. The average amount of rainfall was fairly constant prior to calving.

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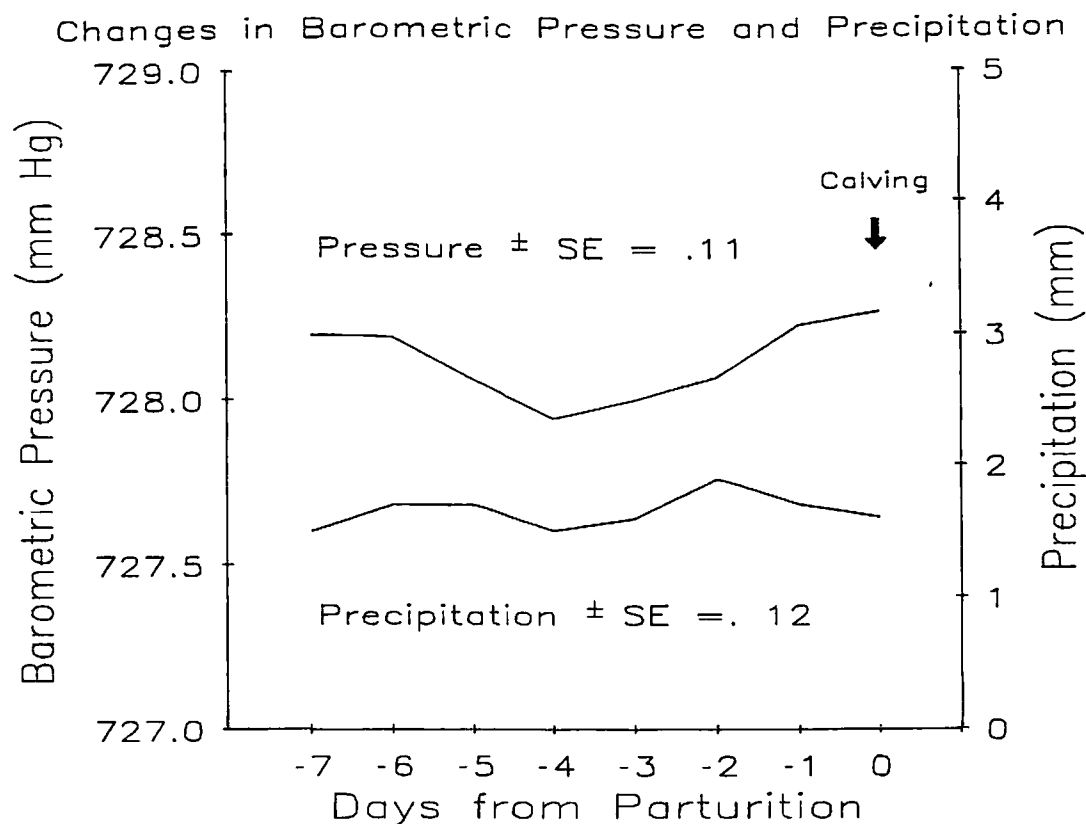## Changes in Barometric Pressure and Precipitation



Figure 2.    Changes in Average Barometric Pressure and Average Precipitation (Water Equivalent) during the Week Preceding Calving (Parturition).

Changes in wind velocity, percentage sunlight during daylight hours, and relative humidity is illustrated in Figure 3. Wind velocity averaged 12 mph (19 km/h) and humidity averaged 82%. Neither of these climatological measures changed appreciably during the week before calving. Percentage sunlight declined from 73 to 68% during the week before parturition.

Changes in daily temperatures are illustrated in Figure 4. Daily temperatures fluctuated on a daily basis from average highs of 64°F (18°C) to average lows of 45°F (7°C). Daily temperatures declined slightly preceding calving.

Some observations of altered times of calving have been reported by various producers and researchers over the last 8 yr. It had been suggested that feeding pregnant cattle in the late afternoon to late evening hours might increase the proportion of calvings that occurred during the daylight hours. In this study, springing heifers and dry cows were fed around 3 to 4 p.m. Furthermore, 58% of the calves were born during the daylight hours. It is possible that changing feeding times might allow for more daylight calvings when assistance of labor could be more readily available. This change in management might be helpful for dairy producers who maintain pregnant cows only in drylot and provide all fed at a feed bunk. Although these findings are preliminary, they are in agreement with other unpublished observations and reports.
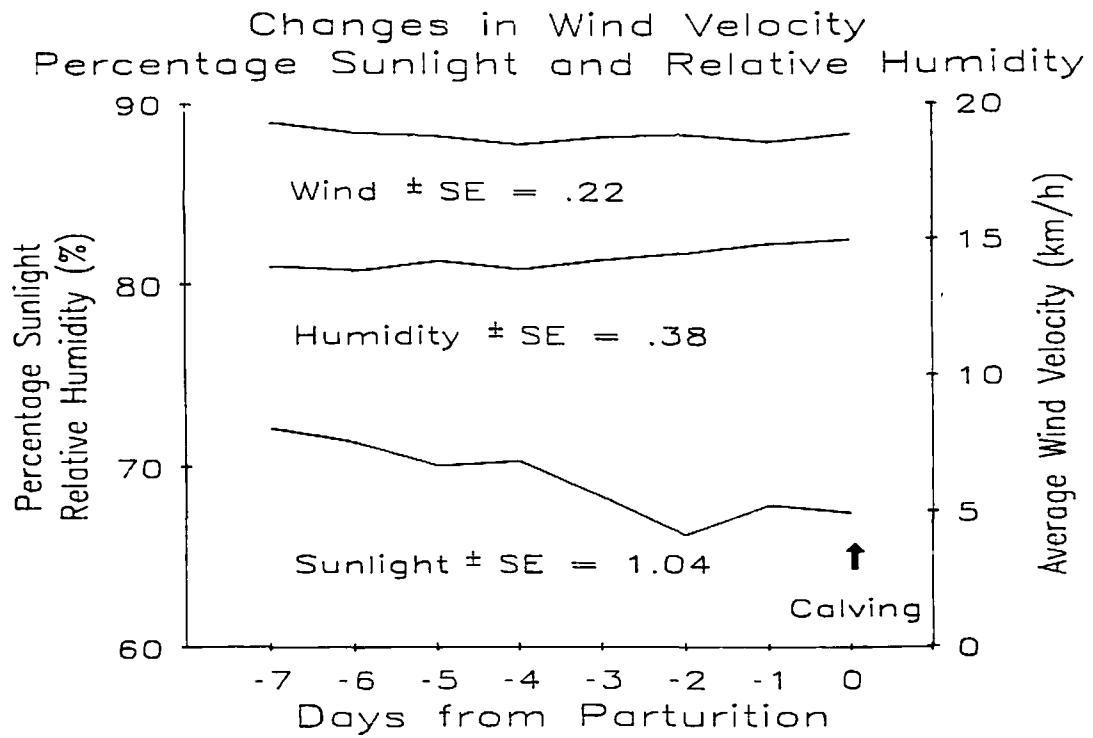
## Changes in Wind Velocity
## Percentage Sunlight and Relative Humidity



Figure 3.    Average Changes in Wind Velocity, Percentage Sunlight during Daylight Hours, and Relative Humidity during 7 Days before Calving.
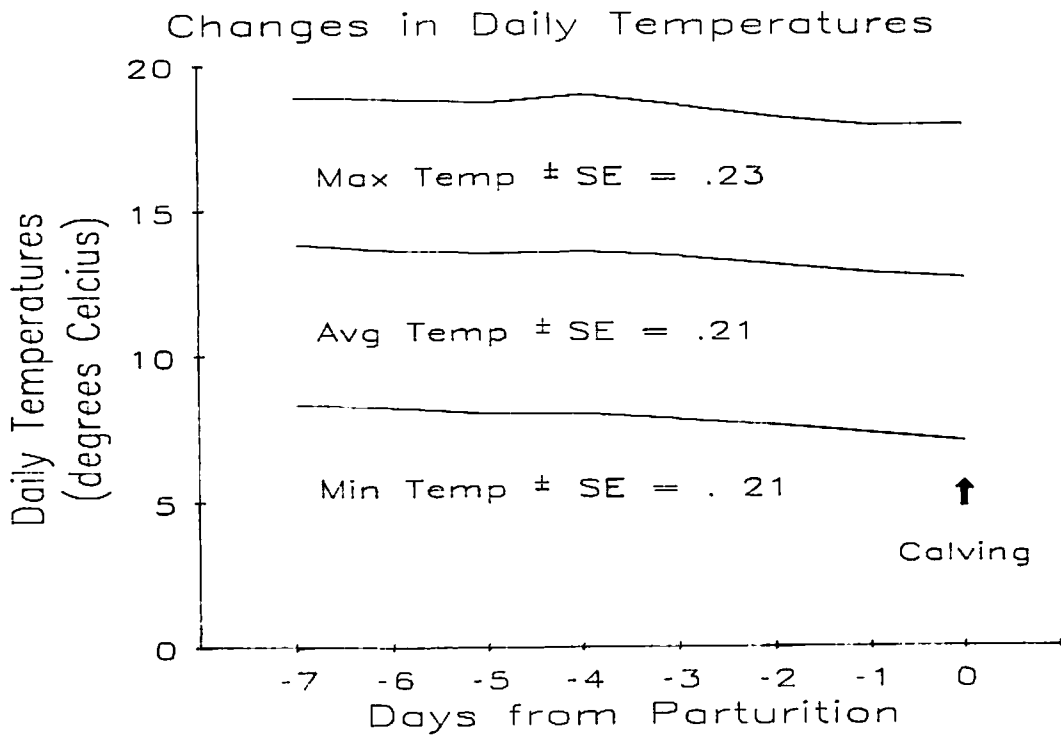
## Changes in Daily Temperatures



Figure 4.    Changes in Daily Maximum, Minimum, and Average Temperatures during the Week before Calving.

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# DOUBLE INSEMINATIONS AND TREATMENT OF REPEAT BREEDERS WITH GONADOTROPIN-RELEASING HORMONE

J.S. Stevenson, E.P. Call, R.K. Scoby,
and A.P. Phatak[1]

## Summary

An experiment was conducted in one Kansas and five California dairy herds to determine if double inseminations with and without treatment with 100 $\mu$g gonadotropin-releasing hormone (GnRH) would improve conception rates of repeat-breeding dairy cattle (n=723). Both lactating cows and virgin dairy heifers were assigned randomly to treatments as repeat breeders, if they had failed to conceive to at least two previous services. Cows inseminated once and treated with GnRH had the best conception rates (41%), which were higher (P<.01) than those of cows inseminated once without GnRH treatment (32%) and higher (P<.01) than those of cows inseminated twice without treatment with GnRH (33%). Cattle bred twice that received the GnRH treatment had intermediate rates (37%). We conclude that treatment of repeat breeders with GnRH at the time of insemination (only one service given according to the am-pm, pm-am rule) improved conception rates.

## Introduction

We have demonstrated in three previous experiments that conception rates of repeat breeders are improved significantly when 100 $\mu$g GnRH or Cystorelin® are administered intramuscularly immediately after insemination. Our first experiment in 1981 included 97 cows at our KSU Dairy Teaching and Research Center (DTRC). A second study in 1986 also conducted at KSU included 115 cows. In both Kansas studies, conception rates were improved from either 51 to 66% or 39 to 54%. In a third study of 513 cows in Oklahoma, we reported that conception rate was improved from 36 to 47% after GnRH treatment of repeat breeders.

In our present experiment, we wanted to test whether or not double inseminations would increase conception rates of repeat breeders. Many have suggested that one cause of repeat breeding is delayed ovulation. That is, the interval from the onset of standing estrus to ovulation of the egg or ovum is much longer in repeat breeders than the normal 24 to 30-hr period. Therefore, a second insemination given about 12 hr after the first AI might prove beneficial. The purpose of our study was to compare a double-insemination treatment to a control single insemination. In addition, we included two more treatments in which GnRH was given at insemination in one-half of the cows assigned to either the single or double-insemination groups.

## Procedures

Repeat-breeding, lactating cows and virgin heifers were assigned randomly to four treatment groups: 1) Single AI + no injection; 2) Single AI + 100 $\mu$g GnRH; 3) Double AI + no injection; and 4) Double AI + 100 $\mu$g GnRH. We administered Cystorelin® (CEVA Laboratories, Inc., Overland Park, KS) intramuscularly to cows in the appropriate treatments

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immediately following the single insemination or after the first AI of the double-insemination groups. Inseminations were based on the am-pm, pm-am rule. Cows were observed for estrus either two or three times daily.

Cows were utilized in five California herds (Foster Farms) and in one Kansas dairy farm (KSU DTRC). The study was conducted in the fall and winter of 1987-88 in the California herds and year-round in our KSU herd (1986-88). Conception rates were determined by palpation of the uterus per rectum beginning 40 days after the last service.

### Results and Discussion

Table 1 summarizes the results of the experiment in each of the six herds. All six herds had a numerical increase in conception when treated with GnRH immediately after a single AI. However, only four of six herds showed a numerical improvement when treated with GnRH after the first of two inseminations (Double AI). It is unclear why administering a second insemination would negate the positive effect of GnRH.

Table 1. Conception Rates in Six Herds Involved in the Field Trial

| Herd[a] | Single AI | | | | Double AI | | | |
|---|---|---|---|---|---|---|---|---|
| | No injection | | GnRH | | No injection | | GnRH | |
| CA-1 | 17/52 | (33)[b] | 23/54 | (43) | 18/46 | (39) | 15/46 | (33) |
| CA-2 | 15/42 | (36) | 19/42 | (45) | 17/65 | (26) | 23/62 | (37) |
| CA-3 | 19/50 | (38) | 23/50 | (46) | 20/48 | (42) | 21/48 | (44) |
| CA-4 | 13/48 | (27) | 20/48 | (42) | 16/48 | (33) | 18/48 | (38) |
| CA-5 | 32/106 | (30) | 54/140 | (39) | 30/96 | (31) | 37/96 | (39) |
| KS-1 | 22/69 | (32) | 25/64 | (39) | 19/58 | (33) | 20/62 | (32) |

[a]The California herds were Foster Farms and the Kansas herd was our KSU DTRC herd in Manhattan.

[b]Percentages.

Table 2 presents the overall results of this large field trial. Cows given GnRH after a single AI had higher (P<.01) conception rates than those receiving no injection and inseminated either once or twice. This result rejects the notion that a double insemination would help improve conception rates of repeat breeders and confirms our earlier recommendations for utilizing GnRH at insemination. Cows receiving both the GnRH treatment and double AI had conception rates that appeared to be higher than those of noninjected controls, but were statistically similar. Combining results across treatments showed that a double AI was not better than a single AI (35 vs 37%), and the injection of GnRH increased (P<.01) conception rates compared with noninjected controls (39 vs 33%).

Table 2. Combined Results of the Field Trial

|  | Single AI | | Double AI | |
|---|---|---|---|---|
|  | No injection | GnRH | No injection | GnRH |
| Number | 118/367 | 164/398 | 120/361 | 134/362 |
| % | 32.2[a] | 41.2[b] | 33.2[a] | 37.0[a,b] |

[a,b]Percentages with unlike superscripts differ (P<.01).

This experiment provides evidence for the continued recommendation of the GnRH treatment to improve conception rates of repeat breeders. Given the cost of GnRH, we continue to recommend its use only at third or greater services. Now coupled with the results of this experiment, we recommend that cows treated with GnRH receive only one insemination, because two inseminations either with or without GnRH were not better than a single AI plus GnRH treatment.

# EARLY POSTPARTUM LUTEAL FUNCTION AFTER TREATMENT WITH PROGESTIN AND(OR) GONADOTROPIN-RELEASING HORMONE IN DAIRY CATTLE

M.O. Mee and J.S. Stevenson

## Summary

Progestin (Norgestomet®) and(or) repeated low-dose infusions of GnRH (Cystorelin®) influenced the lifespan of the first corpus luteum after an induced ovulation. Holstein cows (n=32) were assigned at calving to four groups. Cows were treated with blank ear implants (days 2 to 9 after calving) and saline infusion (48 hr on days 10 and 11), progestin ear implants and saline infusion, blank implants and GnRH infusion, or progestin implants and GnRH infusion prior to a GnRH-induced ovulation (day 12). Four primiparous and four multiparous cows were assigned to each treatment. Fewer cows treated with progestin/GnRH ovulated in response to the GnRH challenge. However, short cycles (<17 days in duration) were prevented in all cows (n=16) treated with progestin. In addition, all multiparous cows treated with blank implants and GnRH infusion had normal cycles. Results of this study suggested that progestin and GnRH may have altered follicular development, thereby preventing the short-lived corpus luteum and inducing a normal estrous cycle as cows overcame anestrus early postpartum.

## Introduction

The early postpartum period in cattle is characterized by ovarian inactivity. Dairy cows begin to cycle within 14 to 28 days after calving, but are not observed in heat until 35 to 42 days postpartum because only 50% of cows express heat before the first postpartum estrous cycle. The first corpus luteum formed after calving is frequently short-lived, resulting in ovarian cycles much less than 21 days in length. Studies with beef cows have demonstrated that treatment with progestin for 9 days beginning at weaning or before a gonadotropin-induced ovulation reduced the incidence of short cycles. Likewise, early postpartum dairy cows treated with low-dose injections of gonadotropin-releasing hormone (GnRH) every 2 hr for 72 hr had normal cycles after an induced ovulation. These studies suggested that treatment with progestin or regular synchronous injections of GnRH appear to be necessary for ovarian cycles of normal duration (18 to 24 days). Therefore, the objectives of this study were: 1) to determine the effect of progestin and(or) low-dose infusions of GnRH on the duration of the first ovarian cycle and 2) to further examine the role of progestin and pulsatile GnRH on maintenance of the corpus luteum.

## Procedures

Thirty-two lactating Holstein cows in the KSU dairy were assigned at calving to four treatments (Table 1). Cows were implanted in the ear with either 0 (blank) or 6 mg norgestomet for 6 days. Twenty-four hours after implant removal, cows were infused with either saline or 2 $\mu$g GnRH every 2 hr for 48 hr. Following the infusion period, all cows were injected i.v. with 50 $\mu$g GnRH to induce the first ovulation.

Table 1. Assignment of Cows to Treatments

| Treatment | No. cows[a] |
|-----------|-------------|
| Blank/Saline | 8 |
| Progestin/Saline[b] | 8 |
| Blank/GnRH[c] | 8 |
| Progestin/GnRH[b,c] | 8 |

[a]Four primiparous and four multiparous cows were in each treatment.
[b]Norgestomet (6 mg) implant in the ear for 6 days beginning 2 days after calving.
[c]GnRH (2 $\mu$g) every 2 hr for 48 hr beginning 24 hr after implant removal.

Blood was collected daily from the day of implant until 30 days after calving, then thrice weekly until 60 days postpartum, and analyzed for concentrations of progesterone in serum. This enabled us to determine the duration of the first cycle and the number of cows ovulating in response to the 50-$\mu$g dose of GnRH.

## Results and Discussion

Results of this study are summarized in Table 2. Only 2 of 8 progestin/GnRH-treated cows ovulated in response to the ovulatory dose of GnRH, resulting in fewer ($P<.05$) progestin/GnRH-treated cows ovulating in response to GnRH compared with the blank/saline treatment (2 vs 6 cows). This result suggested that the progestin/GnRH treatment may have had a negative effect on growing follicles by preventing adequate follicular development.

Short cycles were prevented in all cows (n=16) treated with norgestomet. In fact, 7 of 8 (88%) of the progestin/saline-treated cows had a normal cycle duration (18 to 24 days), which was more ($P=.07$) than any other treatment. This is the first reported incidence of progestin preventing short cycles in early postpartum dairy cows.

Furthermore, all multiparous cows (n=4) given blank implants and GnRH infusion had ovarian cycles of normal duration (Table 2). These results suggested that progestin and GnRH may alter ovarian follicular growth, thereby preventing the short-lived corpus luteum and resulting in an ovarian cycle of normal duration.

Further research is necessary to investigate the role of progestin and GnRH in preventing the short cycle. It is still unknown whether the effect of progestin or GnRH in preventing the short-lived corpus luteum is altered by preovulatory secretion of gonadotropins or is a direct effect of treatments on the preovulatory follicle.

Table 2. Characteristics of Ovarian Function after an Ovulatory Dose of GnRH.

| Characteristics | Treatment | | | |
|---|---|---|---|---|
| | Blank/ Saline | Progestin/ Saline | Blank/ GnRH | Progestin/ GnRH |
| No. of cows ovulating after the 50-$\mu$g GnRH challenge | | | | |
| GnRH-induced (%) | 6(75) | 5(62) | 5(62) | 2(25)[a] |
| Delayed (%) | 2(25) | 3(38) | 3(38) | 6(75) |
| No. of cows with first cycles | | | | |
| <17 days (%) | 2(25) | 0(0) | 3(38) | 0(0)[d] |
| 18-24 days (%) | 4(50) | 7(88)[b] | 4(50)[c] | 3(38) |
| >24 days (%) | 2(25) | 1(12) | 1(12) | 3(38) |

[a]Different from Blank/Saline (P<.05).
[b]Different from other treatments (P=.07).
[c]All multiparous cows had normal cycles.
[d]Two cows failed to ovulate during the study.
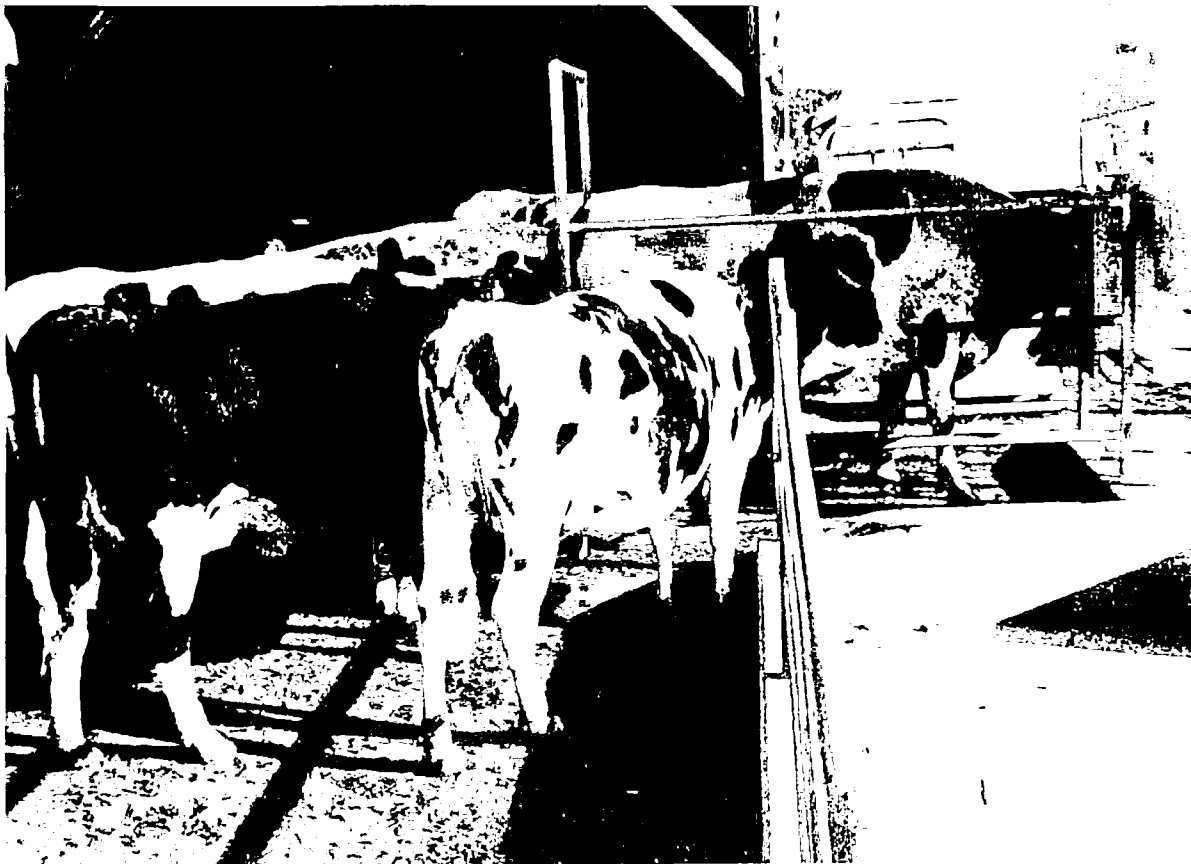


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# BOVINE RECOMBINANT INTERLEUKIN-2 ENHANCES RESISTANCE TO BOVINE HERPESVIRUS-1: DOSE RESPONSE TRIAL

P.G. Reddy[1], F. Blecha[1],
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## Summary

Twenty-five calves were allotted to five groups: controls that did not receive bovine recombinant interleukin-2 (rIL-2) and four groups that received 5 daily injections of rIL-2 at 11.4, 1.1, 0.11, or 0.011 μg/lb/day. On day 0 of the experiment, all calves received bovine herpesvirus-1 (BHV-1) vaccine and the first of the 5 daily injections of bovine rIL-2. All calves were infected with BHV-1 on day 21 of the experiment. Calves treated with 11.4 μg/lb/day had elevated rectal temperatures and mild diarrhea during administration of rIL-2. All other calves were normal. Compared to control calves, those treated with 11.4, 1.1, and 0.11 μg/lb/day had higher (P<0.05) serum antibody titers to BHV-1 and following challenge lower (P<0.05) BHV-1 titers in nasal secretions. Additionally, clinical disease as evidenced by nasal and ocular discharge was less severe. Cytotoxic responses against BHV-1-infected bovine kidney cells were increased (P<0.05) in calves treated with rIL-2 in a dose dependent manner. These data suggest that bovine rIL-2 at doses of 0.11 to 1.1 μg/lb/day for 5 days may enhance immunity against BHV-1 without causing adverse side effects.

## Introduction

Interleukin-2 (IL-2) is a glycoprotein secreted by a subset of T cells and large granular lymphocytes after stimulation with mitogen or antigen. This lymphokine induces the clonal expansion of activated T cells and B cells and activates natural killer cells.

Recently, we evaluated the use of bovine rIL-2 in bovine herpesvirus-1 (BHV-1)-vaccinated and -challenged calves. Our data indicated that bovine rIL-2 (11.4 μg/lb body weight) used in conjunction with BHV-1 vaccination enabled calves to withstand a challenge with virulent BHV-1 better than a vaccination alone, suggesting that bovine rIL-2 may be an effective adjuvant to immunization against viral diseases. However, the dose of bovine rIL-2 used in that study caused mild fever and diarrhea, which abated immediately after rIL-2 treatment was stopped.

The objective of the present study was to determine if a lower dose of bovine rIL-2 would enhance resistance to BHV-1 without causing adverse side effects.

## Procedures

Twenty-five Holstein or crossbred beef calves, 4 to 6 months old and seronegative for BHV-1, were used. The calves were allotted by weight to one of five treatment groups: controls that did not receive rIL-2 and four groups that received intramuscular injections of bovine rIL-2 at 11.4, 1.1, 0.11, or 0.011 μg/lb/day for 5 days.

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At the start of the experiment (day 0), calves were vaccinated with a modified-live BHV-1 vaccine (Norden Laboratories, Lincoln, NE) and their respective doses of bovine rIL-2 were administered intramuscularly. Bovine rIL-2 was administered daily for 4 subsequent days. Calves that did not receive bovine rIL-2 were injected intramuscularly with an equivalent volume of saline for 5 consecutive days. On day 21, all calves were inoculated intranasally (2 ml) and conjunctivally (1 ml) with $10^7$ PFU/ml of BHV-1.

## Results and Discussion

Treatment of calves with 11.4 $\mu$g/lb/day of bovine rIL-2 resulted in elevated rectal temperatures and mild diarrhea, but these signs subsided immediately after the last injection of bovine rIL-2. Calves in other rIL-2 treatment groups remained normal and healthy during the administration of rIL-2.

Following challenge with virulent BHV-1, calves that received 11.4, 1.1, and 0.11 $\mu$g/lb/day showed significantly lower ($P<0.05$) rectal temperatures on days 2 to 5 postinfection than control calves There was a similar trend with regard to clinical signs of BHV-1 infection, with nasal and occular discharges from rIL-2-treated calves being significantly less severe ($P<0.05$) than those from control calves.

Cytotoxic responses against BHV-1-infected bovine kidney cells by peripheral blood mononuclear cells (PBMC) from control calves remained low at all sampling times, whereas the cytotoxic response by PBMC from calves treated with rIL-2 increased in a dose dependent manner. Following rIL-2 injections, cytotoxic responses were significantly higher for PBMC from calves receiving 11.4, 1.1, and 0.11 $\mu$g/lb/day at all sampling times than for PBMC from control calves.

Calves treated with rIL-2 at 11.4 and 1.1 $\mu$g/lb/day had higher titers of ($P<0.05$) serum neutralizing antibodies to BHV-1 on days 10, 15, 21, and 25, and calves treated with 0.11 $\mu$g/lb/day had higher titers on days 15 and 21 ($P<0.05$), compared to control calves.

Shedding of BHV-1 in nasal secretions was significantly lower on days 1 to 6 postinfection in calves treated with 11.4 and 1.1 $\mu$g/lb/day and on days 3 and 4 postinfection in calves treated with 0.25 $\mu$g/lb/day, compared to control calves.

## Discussion

Interleukin-2 augmentation of antiviral immunity has been demonstrated by adoptive transfer of immune lymphocytes from IL-2-treated animals and treatment of cattle with bovine rIL-2. The present study, while indicating a dose response of calves to bovine rIL-2 administered in conjunction with BHV-1 vaccine, also demonstrated that augmentation of immunity is possible with a dose that would not cause any visible adverse side effects. Although the optimum dose required should be confirmed by field trials, this study and our earlier study clearly demonstrate the potential benefit of bovine rIL-2 as an immunoadjuvant to vaccines against the bovine respiratory disease complex (BRD).

Some concern has been expressed about the effectiveness of vaccines alone as a means to combat BRD, which according to current estimates is causing an annual economic loss in the range of $250 million to $1 billion. The efficacy of vaccines may often be compromised by colostrally acquired maternal antibodies and certain states of stress-induced immunosuppression. This suggests the need for additional ways to modulate the immunity of cattle to resist BRD, and our study indicates the practical value of immunotherapeutic use of bovine rIL-2.

# EFFECT OF ROUTE OF ADMINISTRATION OF LASALOCID ON RESPONSE OF YOUNG DAIRY CALVES

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## Summary

Forty newborn bull calves were assigned to one of four feeding groups. The feeds either contained lasalocid in milk (M), prestarter (PS), and starter (S); lasalocid in PS and S; lasalocid in S only; or no lasalocid. Calves were fed M at 8% of birth weight (bw) daily and offered PS to a maximum of 0.5 lb daily. When 0.5 lb of PS was consumed in one day the calves were fed M at 4% of bw daily. They were weaned when they consumed dry feed at the rate of 1.3% of bw. Daily feed intake and weekly weight gains of calves were evaluated. Blood serum samples were used to evaluate blood metabolites at wk 4, 8, and 12. We concluded that lasalocid in M, PS, and S supported greater feed efficiency and allowed earlier weaning with less animal variation than when lasalocid was delivered in PS and S, only in S, or not at all.

## Introduction

Feeding lasalocid to neonate calves through 12 wk of age has resulted in increased feed intake and weight gain. The greatest differences were observed during the last six wk. The lasalocid-fed group received lasalocid in the milk, prestarter, and starter, so it could not be determined from which part of the diet the lasalocid delivery was having the greatest effect.

Lasalocid-fed calves have shown metabolic signs of earlier ruminal development than control calves. The use of ionophores to encourage early feed consumption and early weaning may have economic and logistical advantages, because of decreased labor and feed costs associated with early weaning.

The objective of this study was to determine the most effective method of administering lasalocid. Three lasalocid treatment groups were used with one negative control group. A variable weaning program based upon dry feed consumption was used to allow for differing early feed consumption and differing days to meet requirements for weaning.

## Procedures

Forty Holstein bull calves were removed from their dams at 24 hr of age and fed colostrum until 3 d of age. The calves were then blocked by age, and calves within that block were randomly assigned to one of four treatment groups. Treatments were feeds with no lasalocid; feeds with lasalocid in starter (S) only; feeds with lasalocid in prestarter (PS) and starter; or feeds with lasalocid in milk, prestarter, or starter. The calves in the group receiving lasalocid in milk (M), prestarter, and starter received untreated prestarter and starter until 2 wk of age, then lasalocid-treated prestarter and starter. For the group receiving lasalocid in milk, it was delivered on days 4 through 14 to provide daily .45 mg/lb of body

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weight daily. Lasalocid concentrations in feed were 80 mg/lb in the prestarter and 13.2 mg/lb in the starter, with a target consumption of .45 mg/lb of body weight per day. Body weights were measured weekly.

Milk was fed at 8% of body weight daily divided into two equal feedings and prestarter was offered beginning on experimental day one. Milk was fed at this rate until the calf consumed 0.5 lb of prestarter daily. The afternoon feeding of milk was discontinued at that time, and as much starter as the calf would consume daily was mixed with 0.5 lb prestarter. When daily dry feed (prestarter plus starter) consumption was 1.3% of body weight the calf was weaned. Prestarter was discontinued at 5 wk of age. Calves were housed in individual hutches with straw bedding and given free access to water. Daily feed intake and weekly weight gains were recorded. Fecal scores were recorded twice daily. Serum samples were taken at 4, 8, and 12 wk for metabolic evaluation using the SMA-12 analysis, which measures a 14 blood metabolites.

## Results and Discussion

Table 1 shows weekly lasalocid intake for each treatment. The lasalocid intake varied by treatments across time, as was intended by the design of the experiment. The group receiving lasalocid in M, PS, and S reached the target of .45 mg/lb of body weight by the second wk, the group receiving lasalocid in PS and S reached the same point by wk 5, and the group receiving lasalocid in only S reached the target by wk 10. At week 7, calves in all three treatments were consuming similar amounts of lasalocid.

The group consuming lasalocid in M, PS, and S showed equal or greater ADG (Table 1) than the other three treatments for all 12 weeks. Calves receiving lasalocid in M, PS and S showed greater feed intake in the first 6 wk. The earlier gains seen in these calves may be attributed to lasalocid intake near .68 mg/lb during the first 6 wk. All treatment groups reached the same lasalocid intake from wk 7-12. Figure 1 shows the feed efficiency in lb of feed per lb of gain for all four treatments. Only dry feed consumption was used in these calculations. All lasalocid-fed groups had greater feed efficiency than the control group in wk 3-12. At 4 wk of age the nontreated control group had significantly higher fecal scores than the other three groups, perhaps indicating a beneficial effect of the lasalocid.

The group receiving lasalocid in M, PS, and S reached criterion for 1X feeding and weaning earlier than the other three groups (Figure 2). Blood metabolites reflected the stage of rumen development of the calves. The group that was weaned earliest showed decreased glucose and increased urea nitrogen at wk 4. Potassium concentrations at wk 12 were lowest for the group receiving lasalocid in all three feeds and highest for the control group.

Lasalocid delivered in all three feeds (M, PS and S) appeared to improve feed efficiency and rumen development and to decrease days to reach criteria for weaning compared to lasalocid delivery in PS and S or in S only.

Table 1. Daily Lasalocid Intake (mg/lb of body wt/days) and Cumulative Average Daily Gain (ADG, lb/day)

| Age, wk | Lasalocid Delivery | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | M, PS, S | | PS, S | | S only | | None | |
| | Lasalocid | ADG | Lasalocid | ADG | Lasalocid | ADG | Lasalocid | ADG |
| 1 | 0.27 | 0.9 | 0.10 | 0.6 | 0.00 | 0.8 | 0 | 0.7 |
| 2 | 0.44 | 0.5 | 0.16 | 0.4 | 0.04 | 0.5 | 0 | 0.3 |
| 3 | 0.41 | 0.6 | 0.28 | 0.5 | 0.03 | 0.6 | 0 | 0.4 |
| 4 | 0.52 | 0.7 | 0.37 | 0.5 | 0.09 | 0.6 | 0 | 0.5 |
| 5 | 0.60 | 0.9 | 0.50 | 0.6 | 0.17 | 0.7 | 0 | 0.7 |
| 6 | 0.39 | 1.1 | 0.33 | 0.8 | 0.33 | 0.9 | 0 | 0.9 |
| 7 | 0.38 | 1.1 | 0.38 | 0.9 | 0.38 | 1.1 | 0 | 1.1 |
| 8 | 0.42 | 1.3 | 0.41 | 1.1 | 0.41 | 1.2 | 0 | 1.2 |
| 9 | 0.43 | 1.3 | 0.43 | 1.2 | 0.42 | 1.3 | 0 | 1.2 |
| 10 | 0.42 | 1.4 | 0.44 | 1.2 | 0.44 | 1.3 | 0 | 1.4 |
| 11 | 0.40 | 1.5 | 0.43 | 1.3 | 0.44 | 1.5 | 0 | 1.4 |
| 12 | 0.42 | 1.6 | 0.44 | 1.5 | 0.47 | 1.6 | 0 | 1.5 |
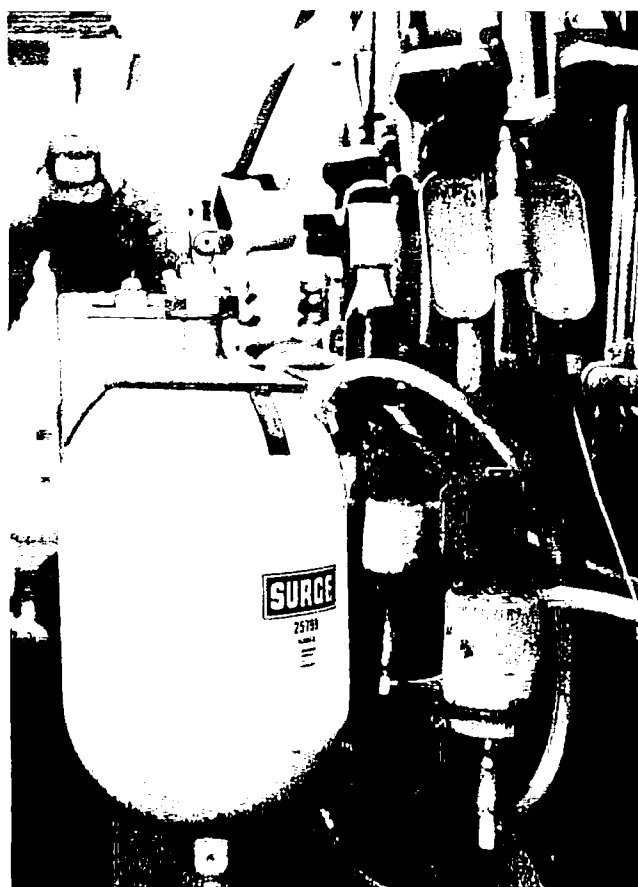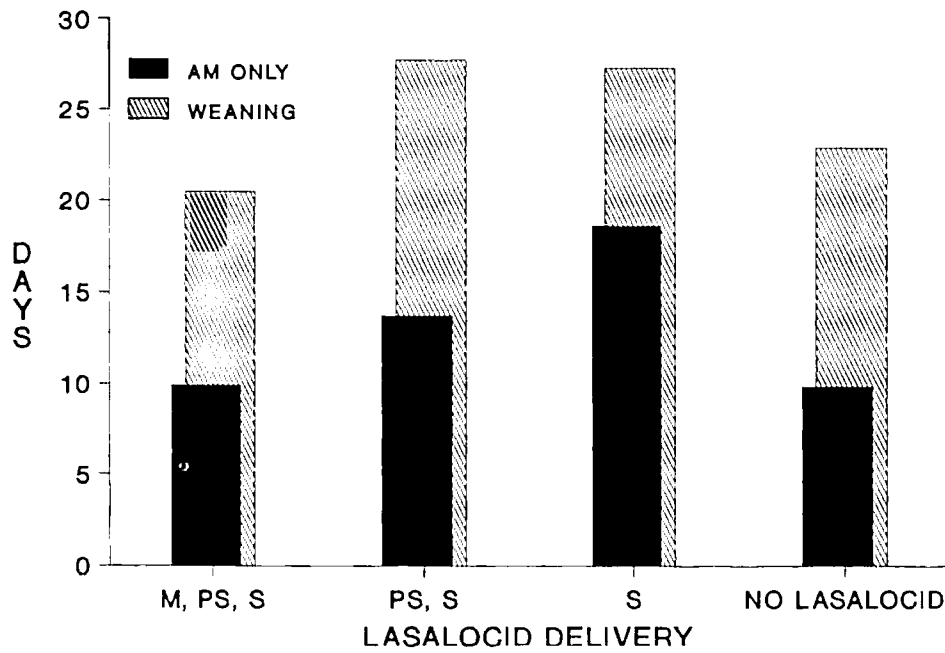
Figure 1. Feed Efficiency for Four Treatment Groups.
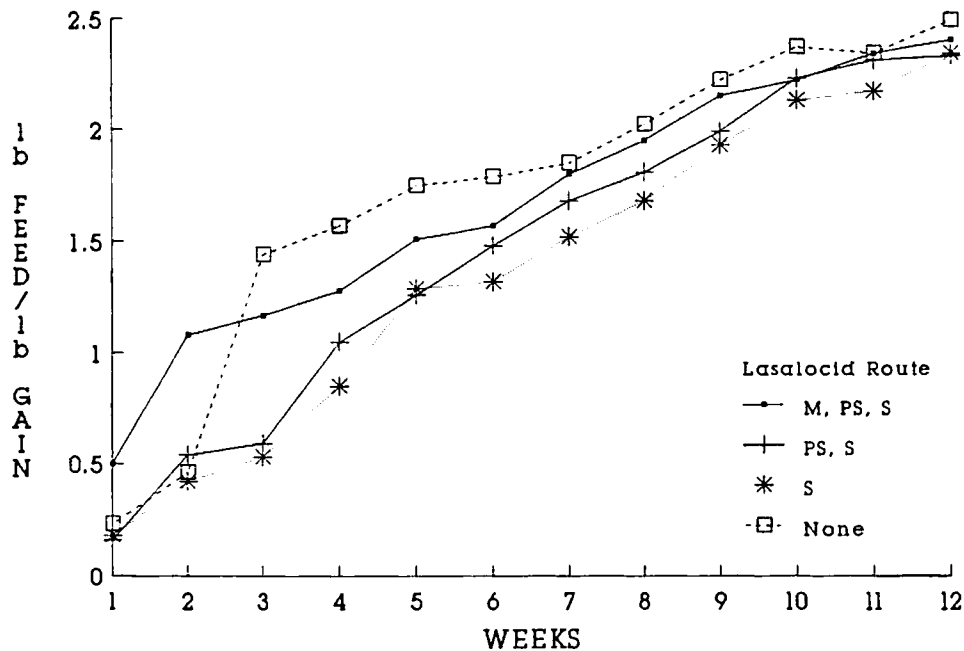


Figure 2.  Days to Reach Criterion for A.M. only Feeding and Days to Weaning for Four
Treatment Groups (M=Milk, PS=prestarter, S=starter).

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# THE EVALUATION OF RAPID METHODS FOR MONITORING FREE FATTY ACID LEVELS IN CHEESE

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## Summary

The amount of free fatty acids present in cheese is important to dairy processors because these compounds make a significant contribution to the overall flavor. In this study, the results obtained using three relatively rapid methods of determining free fatty acids concentrations in cheese were compared to those acquired by using a more laborious but accurate gas chromatographic technique. One method, the Extraction-Titration Method, was found to be superior to the others because of its simplicity and reliability. In addition, the values obtained by this method were found to closely correlate with short chain fatty acid concentrations of cheese as determined by gas chromatography.

## Introduction

The accurate determination of free fatty acid concentrations in cheese is important because of the significant contributions these compounds make to aged cheese flavor. Free fatty acids accumulate in cheese during the aging period as a result of the action of particular enzymes known as lipases, which are produced by the microorganisms involved in the aging process. Extensive activity of lipases on the fat of cheese will result in high concentrations of free fatty acids and may lead to off-flavors, a condition referred to as lypolyzed flavor. The short chain fatty acids, such as butyric acid, are thought to be most responsible for this defect in aged cheese flavor.

The determination of free fatty acids in cheese can be performed in several ways. The Acid Degree Value has been applied to cheese because it is a standard method for monitoring the fatty acid content in milk and cream. Detergent is used to disperse the protein, resulting in the liberation of the milk fat, a portion of which is withdrawn, dissolved in solvent, and quantitated by neutralizing with base. A major problem with this method is that the more water-loving short chain fatty acids are likely to be poorly represented in the fat portion withdrawn from the treated milk. The Copper Soap Method utilizes a nonpolar solvent system to extract the copper salts of fatty acids, which are measured by their absorption of ultraviolet radiation. This method also has been reported to incompletely extract and quantitate short chain fatty acids. Utilization of a more water-loving solvent system to recover short chain fatty acids results in the simultaneous extraction of organic acids, predominantly lactic acid, which is present in cheese in high concentrations as a result of bacterial fermentation. The Extraction-Titration method utilizes hydrochloric acid to liberate lipids for extraction into a solvent system and silicic acid to absorb interfering phospholipids. Acid washes are performed to remove organic acids, and the fatty acids are quantitated by neutralizing with base.

Most of the rapid methods described here were developed primarily to determine free fatty acids in milk. Dairy processors require rapid and inexpensive methods of determining free fatty acid concentrations in cheese as an index of sharpness or lypolyzed flavor. The objective of this study was to assess how accurately these rapid techniques would reflect short chain, long chain, and total free fatty acid concentrations in cheddar cheese as compared to the more time consuming but accurate gas chromatographic method.

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## Procedures

Mild, sharp, and extra sharp cheddar cheeses from the same processor were purchased at a local supermarket and frozen at -20 C until analysis. A gas chromatographic method was used as the way of obtaining the most accurate free fatty acid profile of the cheese. The gas chromatograph is an instrument that heats compounds until they are volatile and separates them on a long small diameter column of adsorbent material. Using this instrument, the researcher is able to quantitate each fatty acid individually. The three rapid methods simply give an indication of the total amount of free fatty acids in cheese without differentiating them by chain length.

The rapid methods employed were the Acid Degree Value method, the Copper Soap method, and the Extraction-Titration method. The basic concept involved in each method was described in the introduction. The values obtained from each of these techniques were compared to the results of the gas chromatographic profile for short chain fatty acids (4-10 carbons long), long chain fatty acids (12-18 carbons), and total fatty acids for mild, sharp and extra sharp cheeses. A statistical computer program was used to obtain correlation coefficients to describe the relationship between the values obtained by rapid methods and the gas chromatographic methods. For example, a correlation coefficient near 1.0 means that the rapid method is able to effectively reflect the pattern of free fatty acid levels as determined by gas chromatography for mild, sharp and extra sharp cheeses. Conversely, a lower value of 0.5 would indicate that the rapid method is doing a relatively poor job of monitoring free fatty acid concentrations for cheese of differing ages.

## Results and Discussion

The results obtained with Acid Degree method showed the least correlation with the gas chromatographic data, particularly for butyric acid ($C_4$) and short chain fatty acids in general (Table 1). Thus, this method is not recommended for monitoring free fatty acid concentrations as an index of cheese flavor. The Extraction-Titration Method yielded values that closely correlated with the concentrations of butyric and other short chain fatty acids as determined by gas chromatography. The mean values obtained with the Copper Soap Method did not correlate with the short chain fatty acid levels as well as those obtained with the Extraction-Titration Method. The inefficient extraction of the more water-loving short chain fatty acids by the relatively nonpolar solvent system used with the Copper Soap Method is the most likely explanation for this lack of correlation. We found the Copper Soap Method to be more complicated and less reliable than the Extraction-Titration Method. The Copper Soap Method, however, was more effective in reflecting the total and long chain fatty acid concentration of cheese.

The Extraction-Titration Method was found to be a simpler and more reliable method of monitoring free fatty acid levels in cheese and was the most effective method of those tested at reflecting short chain fatty acid concentrations. Since the latter class of fatty acids plays an important role in the production of lypolyzed flavor in other dairy products, this method may have an important advantage for analyzing free fatty acids as an index of cheese flavor.

Table 1.  Correlation of Values Determined by Gas Chromatography with Those Determined by Other Methods for the Fatty Acid Concentration of Cheddar Cheese of Various Ages

| Method | Correlation Coefficients $(r)^a$ | | | |
| --- | --- | --- | --- | --- |
| | Total | Short Chain[b] | $C_4$ | Long Chain[c] |
| Acid Degree Value | 0.739 | 0.561 | 0.470 | 0.750 |
| Extraction-Titration | 0.804 | 0.911 | 0.885 | 0.756 |
| Copper Soap | 0.908 | 0.807 | 0.726 | 0.898 |

[a]All values significant at $p < 0.01$.
[b]Short chain = $C_4 - C_{10}$
[c]Long chain = $C_{12} - C_{18}$

# SMALL INTESTINAL STARCH, DEXTRIN, AND GLUCOSE DIGESTION IN STEERS

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## Summary

Three Holstein steers (930 lb) were surgically fitted with abomasal and ileal cannulae, portal and mesenteric venous catheters, and an elevated carotid artery and used to study small intestinal starch digestion. Water, corn starch (66 g/hr), corn dextrin (66 g/hr), or glucose (66 g/hr) were continously infused into the abomasum. Small intestinal disappearance of corn dextrin (57 g/hr) and glucose (57 g/hr) were higher (P<.05) than that of starch (48 g/hr). The percentage of carbohydrate disappearance accounted for as net portal glucose flux was 52, 54, and 72% for corn starch, corn dextrin, and glucose, respectively. Small intestinal starch utilization in the bovine may be limited by starch granular characteristics, enzyme activity, and glucose transport across the small intestine.

## Introduction

Previous experiments have been conducted at Kansas State University (Dairy Day, 1987) to evaluate small intestinal starch digestion in steers. In those experiments, 1) increasing the level of abomasal glucose infusion increased net portal glucose flux and 2) increasing levels of corn starch and corn dextrin infusion increased small intestinal disappearance. However, net portal glucose flux became maximal when they were infused at 20 g/hr. The present experiment includes the abomasal infusion of glucose, corn starch, and corn dextrin at a level known to exceed the digestive capacity of the small intestine (66 g/hr). Thus, the objective of this experiment was to evaluate the effect of carbohydrate complexity on small intestinal disappearance and net portal glucose flux.

## Procedures

Three Holstein steers (930 lb) were fitted with an elevated carotid artery, hepatic portal and mesenteric venous catheters, and abomasal and ileal cannulae. Steers were fed daily alfalfa hay at 1.5% of body weight. Treatments included the continuous infusion of water, corn starch (66 g/hr), corn dextrin (66 g/hr), or glucose (66 g/hr) into the abomasum. Treatments were randomized in an incomplete Latin square design, using three steers and eight infusion periods. Steers were infused with 250 ml of solution per hr, and each infusion period lasted 10 hr. The infusate contained tap water, carbohydrate, and Cr:EDTA as a fluid flow marker. Between hours 4 and 10 of infusion, ileal digesta samples were collected, and disappearance of carbohydrate within the small intestine was determined. Simultaneous blood samples were collected from the hepatic portal vein and carotid artery, and glucose flux across the small intestine was calculated. Portal plasma flow was determined by a primed continuous infusion of para-aminohippuric acid into the mesenteric vein catheter.

## Results and Discussion

Results are summarized in Table 1. Steers consumed daily 14 lb of alfalfa hay (dry matter basis) during the carbohydrate infusions. Fluid flowing past the ileum was similar

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among treatments and ranged from 1.6 to 2.0 l/hr. Small intestinal disappearance of corn dextrin and glucose was larger (P<.05) than that of corn starch. A portion of the infused corn starch and corn dextrin flowing past the ileum occurred as glucose (10-15%). This indicates limited active transport of glucose at distal sites of the small intestine.

Volatile fatty acids (VFA) flowing past the ileum were highest when starch was infused (P<.10). The increased VFA presumably resulted from microbial fermentation. Since starch infusion resulted in the highest amount of infused carbohydrate passing the ileum, perhaps the increased substrate availability increased microbial fermentation at distal sites within the small intestine.

No significant changes in portal plasma flow occurred across treatments. Net portal glucose flux was large and negative (-15.2 g/hr) when steers were infused with water. This indicates that glucose was metabolized by the gut for maintenance of normal functions. Net portal glucose flux became positive when each of the carbohydrates was infused (P<.05), was largest during glucose infusion (P<.05), and was similar for starch and dextrin infusions. An increased net portal glucose flux also was associated with an increased arterial glucose concentration.

Small intestinal carbohydrate disappearance accounted for by net portal glucose flux was 52, 54, and 72% for corn starch, corn dextrin, and glucose, respectively. The carbohydrate disappearance unaccounted for by glucose flux might be attributed to microbial fermentation or changes in gut metabolism. The relative importance of these processes may be critical in our overall understanding of small intestinal starch utilization in ruminants.

Table 1.    Effect of Abomasal Carbohydrate Infusion on Small Intestinal Disappearance and Net Portal Glucose Flux

| | Abomasal infusion | | | | |
| Item | Water | Corn starch | Corn dextrin | Glucose | SE |
| --- | --- | --- | --- | --- | --- |
| Daily feed intake, lbs | 14.0 | 13.9 | 14.5 | 13.9 | 0.5 |
| Ileal fluid flow, l/h | 1.8 | 2.0 | 1.7 | 1.6 | 0.2 |
| Ileal glucose flow, g/h[ab] | 0 | 1.7 | 1.3 | 9.1 | 0.6 |
| Ileal starch flow, g/h[abc] | 0 | 15.0 | 6.9 | 0 | 1.4 |
| Ileal VFA flow, mmol/h[d] | 44 | 56 | 44 | 35 | 5.0 |
| Portal plasma flow, l/h | 898 | 730 | 731 | 823 | 54.0 |
| Arterial glucose, mM[ab] | 3.9 | 4.2 | 4.3 | 4.5 | 0.1 |
| Net portal glucose flux, g/h[ab] | -15.2 | 9.9 | 16.1 | 26.0 | 4.5 |

[a]Water vs others, P < .05
[b]Starch + Dextrin vs Glucose, P < .05
[c]Starch vs Dextrin, P < .05
[d]Starch vs Dextrin, P < .10.

# EFFECTS OF PRODUCTION ON REPRODUCTIVE TRAITS IN KANSAS HOLSTEIN HERDS

E.P. Call

## Summary

The analysis of dairy herds to evaluate the reported negative effect of production on reproduction failed to identify a real relationship. Higher-producing herds excel in all areas of reproductive performance, except conception rate. Of greatest importance is the annual reproductive loss that is affected by the reproductive traits measured. As production per cow increased, the yearly dollar loss per cow declined from a high of $163 to $73 yearly in the group averaging 20,118 lb milk.

## Introduction

Reproductive inefficiency in dairy herds continues to be a perennial problem. Moreover, there exists a genetic antagonism between production and reproduction, in that higher-producing cows settle less efficiently than lower-producing cows. From a practical standpoint, some studies have suggested that sound management practices may overcome this negative genetic effect.

## Procedures

The study surveyed 546 Kansas Holstein herds that had been enrolled in a production testing program (DHIA) for more than one year in April, 1988. The herds were ranked by rolling herd average (RHA). RHA is defined as the average production per cow during the preceding 365-day period, including dry-cow days. Factors that affect RHA include percentage days in milk, summit milk yield, average days in milk, and average dry days.

## Results and Discussion

Table 1 notes the management and production characteristics of the herds surveyed. As expected, RHA increased as daily milk and summit milk yield increased. Average days in milk did not vary among groups. Milk price was stable across the study, whereas income over feed cost reflected greater efficiency at higher levels of production. It is noteworthy that the percent of cows identified by sire increased from 40% in the low group to 87% in the highest production group. Likewise, the higher-producing herds used a larger percentage of proven bulls (PD$), which was reflected in the average production merit of the service sires.

Table 2 examines the reproductive differences among groups. The negative genetic effect of production on reproduction was only evident in conception rate. The improvement in calving interval at the higher levels was due partly to earlier breeding (days to first breeding). The higher-producing herds had a definite advantage in cows not yet bred (open cows) in both categories: average days open and percentage of cows open greater than 120 days. Higher-producing herds had cows in milk a greater percent of the time, as noted by average days dry and percent of cows dry more than 70 days. Another favorable aspect of the herds producing more milk was the average age at calving of first-calf heifers.

Heat detection efficiency, as measured by the percentage of intervals occurring between 18-24 days, remains one of the real problems, regardless of the level of production. Although some

cows (8-10%) suffer embryonic abortion after 24 days, the major problem is failure to detect the repeat-heat period.

The reported genetic antagonism of production and reproduction apparently is overcome by more intensive management by producers with higher levels of production, especially in the area of cows not yet serviced. Veterinary examination and(or) milk progesterone testing of this class of cows coupled with synchronization of those cows eligible (presence of corpus luteum) is an effective way to minimize cows not yet bred. Estimates of yearly reproductive losses declined as production increased.

Table 1. Characteristics of Management and Production Aspects of 549 Kansas Holstein Herds Surveyed

| | Rolling herd average, lb | | | | |
|---|---|---|---|---|---|
| Item | 12,116 | 14,061 | 16,007 | 17,992 | 20,118 |
| No. of herds | 43 | 116 | 193 | 138 | 59 |
| No. of cows | 65 | 65 | 68 | 88 | 78 |
| Production, lb | | | | | |
| Daily milk | 41.3 | 47.0 | 52.0 | 57.2 | 63.5 |
| Days in milk | 179 | 176 | 179 | 179 | 174 |
| Summit milk yield | | | | | |
| Lactation -1 | 43.3 | 48.4 | 53.8 | 59.9 | 65.4 |
| Lactation- 2+ | 56.2 | 64.5 | 72.0 | 79.8 | 88.0 |
| Economics, $ | | | | | |
| Milk price | 11.54 | 11.65 | 11.77 | 11.77 | 11.82 |
| Income over feed cost | 791 | 956 | 1155 | 1340 | 1543 |
| Service sires | | | | | |
| Proven % | 45.9 | 51.1 | 60.7 | 73.1 | 75.6 |
| PD $ | +55 | +62 | +74 | +93 | +97 |
| Cows identified by sire, % | 40 | 56 | 74 | 80 | 87 |

Table 2.  Reproduction Characteristics of 549 Kansas Holstein Herds Ranked by Yearly Production per Cow

| Item | Rolling herd average, lb | | | | |
|---|---|---|---|---|---|
| | 12,116 | 14,061 | 16,007 | 17,992 | 20,118 |
| Calving interval, days | 410 | 404 | 409 | 405 | 399 |
| Cows not bred | | | | | |
| Days open | 127 | 114 | 98 | 89 | 71 |
| >120 days, % | 36 | 32 | 28 | 24 | 17 |
| Days to first breeding | 86 | 83 | 82 | 81 | 76 |
| Conception rate, % | | | | | |
| First service | 56.5 | 53.8 | 48.1 | 48.6 | 45.4 |
| First + second | 82.6 | 76.9 | 74.1 | 73.0 | 74.0 |
| Age at first calving, mo | 29 | 29 | 28 | 28 | 27 |
| Days dry | 75 | 69 | 64 | 63 | 61 |
| >70 days, % | 41 | 35 | 26 | 22 | 17 |
| Heats detected | | | | | |
| 18-24 days, % | 38 | 33 | 36 | 38 | 41 |
| >24 days, % | 56 | 60 | 64 | 59 | 53 |
| Estimated reproductive loss per cow, $ | 163 | 126 | 121 | 11 | 72 |

# NUTRIENT REQUIREMENTS OF DAIRY CATTLE REVISED

## J.R. Dunham

## Summary

The 1988 National Research Council's (NRC) Nutrient Requirements of Dairy Cattle have been revised. Adjustments have been made in the recommended requirements for net energy for lactation (NEL); crude protein (CP); calcium (Ca); phosphorus (P); and vitamins A, D, and E. In addition, suggestions are made for using undegraded intake protein (UIP) and degraded intake protein (DIP) for diet formulation.

## Introduction

The NRC subcommittee on Dairy Cattle Nutrition is given the charge to review research and modify feeding recommendations from time to time. The 1988 NRC Nutrient Requirements of Dairy Cattle were released recently as the most appropriate guide for formulating dairy cattle diets. Most of the revisions are rather minor, but should be used for adjusting feeding programs.

## Energy

The energy requirements for lactating and dry cows are designated NEL. The requirements for maintenance and milk production were unchanged. However, the 1988 publication provides an allowance for weight gain. When the NEL requirement is expressed on the basis of concentration of dry matter in the total ration, the recommendation is 0.76 Mcal NEL/lb for cows fresh from 0-3 wk. This recommendation indicates the importance of feeding high-energy rations soon after freshening.

The energy requirements for growing heifers is expressed on the basis of net energy maintenance (NEM) and net energy gain (NEG). Both energy recommendations were increased significantly.

## Protein

The recommended crude protein (CP) requirement for maintenance was increased by 10 to 25%, whereas the requirement for milk production did not change. Expressed as a percentage of the total ration dry matter, the CP recommendation is 17 to 18% for cows at high levels of milk production.

A recommendation is made for the first time for UIP and DIP. UIP has been referred to as by-pass or insoluble protein, whereas DIP usually was called soluble protein. The UIP content of the total protein is recommended to be from 36 to 42%. However, the subcommittee cautioned that the UIP content of feeds has not been measured extensively, and there may be great variations among samples of individual feeds.

## Calcium

A significant increase was made in the calcium (Ca) recommendations for maintenance and milk production of lactating cows and for maintenance of dry cows and growing heifers. These

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increased Ca recommendations are approximately 15% higher than previously. The subcommittee pointed out that the ratio of Ca:P is of little concern, provided the requirements for both are met. The recommendation for the Ca content of rations for heifers 3 to 6-mo old was increased by 30%.

### Phosphorus

The maintenance requirement for phosphorus (P) was unchanged but the recommendation for milk production was increased about 10%. The P requirement was reduced for dry cows by about 10%. The recommended P content of rations for heifers 3 to 12-mo old was increased 50 to 100%.

### Vitamins

The vitamin A requirement was unchanged, except for dry cows for which the recommendation was increased 25%. The recommended vitamin D requirement was increased 320% for lactating and dry cows. For the first time, vitamin E requirements were recommended for cows and growing heifers at the rate of 7 and 11 IU/lb of dry matter, respectively.

### Nutrient Requirements

The 1988 NRC Nutrient Requirements of Dairy Cattle are expressed in two forms: daily requirements and concentration per lb of dry matter. Tables 1 and 2 are abbreviated nutrient requirement recommendations. More detailed information may be obtained from "Nutrient Requirement of Dairy Cattle," Sixth Revised Edition 1988, National Academy Press, 2101 Constitution Ave., N.W. Washington, DC 20418.

Table 1.    Daily Nutrient Requirements of Dairy Cattle

| Live weight (lb) | Energy | | | Protein | | | Minerals | | Vitamins | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NEM (Mcal) | NEG (Mcal) | NEL (Mcal) | CP (lb) | UIP (lb) | DIP (lb) | Ca (lb) | P (lb) | A (1,000 I.U.) | D |
| - - - - - - - - Small-Breed Growing Females - - - - - - - - | | | | | | | | | | |
| 300 | 3.43 | 1.58 | | 1.26 | 0.67 | 0.33 | 0.040 | 0.023 | 5.77 | 0.90 |
| 500 | 5.03 | 2.05 | | 1.60 | 0.62 | 0.73 | 0.047 | 0.033 | 9.62 | 1.50 |
| 700 | 6.47 | 2.46 | | 2.07 | 0.61 | 1.14 | 0.052 | 0.039 | 13.46 | 2.10 |
| - - - - - - - - - - Large-Breed Growing Females - - - - - - - - - - | | | | | | | | | | |
| 300 | 3.43 | 1.81 | | 1.29 | 0.79 | 0.35 | 0.043 | 0.025 | 5.77 | 0.90 |
| 500 | 5.03 | 2.30 | | 1.82 | 0.72 | 0.73 | 0.050 | 0.035 | 9.62 | 1.50 |
| 700 | 6.47 | 2.74 | | 1.94 | 0.68 | 1.11 | 0.055 | 0.041 | 13.46 | 2.10 |
| 900 | 7.81 | 3.15 | | 2.52 | 0.67 | 1.50 | 0.063 | 0.046 | 17.31 | 2.69 |
| - - - - - - - - - - Maintenance of Mature Lactating Cows[1] - - - - - - - - - - - | | | | | | | | | | |
| 900 | | | 7.27 | 0.879 | | | 0.036 | 0.026 | 31.0 | 12.0 |
| 1100 | | | 8.45 | 1.082 | | | 0.045 | 0.031 | 38.0 | 15.0 |
| 1300 | | | 9.57 | 1.275 | | | 0.053 | 0.037 | 45.0 | 18.0 |
| 1500 | | | 10.66 | 1.461 | | | 0.061 | 0.043 | 52.0 | 20.0 |
| - - - - - - - - - Maintenance of Mature Dry Cows - - - - - - - - - | | | | | | | | | | |
| 900 | | | 9.45 | 1.536 | | | 0.059 | 0.036 | 31.0 | 12.0 |
| 1100 | | | 10.98 | 1.753 | | | 0.072 | 0.044 | 38.0 | 15.0 |
| 1300 | | | 12.45 | 2.034 | | | 0.086 | 0.052 | 45.0 | 18.0 |
| 1500 | | | 13.86 | 2.305 | | | 0.099 | 0.060 | 52.0 | 20.0 |
| - - - - - - - - - Milk Production - Nutrients/lb of Milk - - - - - - - - - - | | | | | | | | | | |
| Fat (%) | | | | | | | | | | |
| 3.5 | | | 0.31 | 0.079 | | | 0.0030 | 0.0018 | | |
| 4.0 | | | 0.33 | 0.086 | | | 0.0032 | 0.0020 | | |
| 4.5 | | | 0.36 | 0.092 | | | 0.0035 | 0.0021 | | |
| 5.0 | | | 0.38 | 0.100 | | | 0.0037 | 0.0023 | | |

[1]To allow for growth of young lactating cows, increase the maintenance allowances for all nutrients except vitamins A and D by 20% during the first lactation and 10% during the second lactation.

Table 2.  Recommended Nutrient Content for Dairy Cattle in the Total Ration Dry Matter

| Cow wt (lb) | Fat (%) | Wt gain (lb.d) | Lactating cows Milk yield (lb/day) | | | | | Early lactation (wk 0-3) | Dry pregnant cows | Growing heifers 3-6 mo | 6-12 mo | >12 mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | 5.0 | 0.50 | 14 | 29 | 43 | 58 | 74 | | | | | |
| 1,000 | 4.5 | 0.60 | 18 | 36 | 55 | 73 | 91 | | | | | |
| 1,300 | 4.0 | 0.72 | 23 | 47 | 70 | 93 | 117 | | | | | |
| 1,500 | 3.5 | 0.82 | 26 | 52 | 78 | 104 | 130 | | | | | |
| **Energy** | | | | | | | | | | | | |
| NEL, Mcal/lb | | | 0.65 | 0.69 | 0.73 | 0.78 | 0.78 | 0.76 | 0.57 | | | |
| NEM, Mcal/lb | | | | | | | | | | 0.77 | 0.72 | 0.63 |
| NEG, Mcal/lb | | | | | | | | | | 0.49 | 0.44 | 0.37 |
| **Protein** | | | | | | | | | | | | |
| CP, % | | | 12 | 15 | 16 | 17 | 18 | 19 | 12 | 16 | 14 | 12 |
| UIP, % | | | 4.5 | 5.4 | 5.7 | 6.0 | 6.3 | 7.2 | | 8.9 | 5.4 | 3.2 |
| DIP, % | | | 7.9 | 8.8 | 9.7 | 10.4 | 10.4 | 9.7 | | 4.5 | 6.2 | 7.0 |
| **Fiber (minimum)** | | | | | | | | | | | | |
| CF, % | | | 17 | 17 | 17 | 15 | 15 | 17 | 22 | 13 | 15 | 15 |
| ADF, % | | | 21 | 21 | 21 | 19 | 19 | 21 | 27 | 16 | 19 | 19 |
| NDF, % | | | 28 | 28 | 28 | 25 | 25 | 28 | 35 | 23 | 25 | 25 |
| **Minerals** | | | | | | | | | | | | |
| Ca, % | | | 0.43 | 0.53 | 0.60 | 0.65 | 0.66 | 0.77 | 0.39 | 0.52 | 0.41 | 0.29 |
| P, % | | | 0.28 | 0.34 | 0.38 | 0.42 | 0.41 | 0.49 | 0.24 | 0.31 | 0.30 | 0.23 |
| Mg, % | | | 0.20 | 0.20 | 0.20 | 0.25 | 0.25 | 0.25 | 0.16 | 0.16 | 0.16 | 0.16 |
| K, % | | | 0.90 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 0.65 | 0.65 | 0.65 | 0.65 |
| Na, % | | | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.10 | 0.10 | 0.10 | 0.10 |
| Cl, % | | | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.20 | 0.20 | 0.20 | 0.20 |
| **Vitamins** | | | | | | | | | | | | |
| A, IU/lb | | | 1,450 | 1,450 | 1,450 | 1,450 | 1,450 | 1,800 | 1,800 | 1,000 | 1,000 | 1,000 |
| D, IU/lb | | | 450 | 450 | 450 | 450 | 450 | 450 | 540 | 140 | 140 | 140 |
| E, IU/lb | | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 11 | 11 | 11 |

# ERRORS IN HEAT DETECTION ARE COSTLY

## J.S. Stevenson

## Summary

Attention to heat detection will decrease reproduction losses and costs associated with extended calving intervals and high culling rates. Errors in diagnosing heat (errors of commission) and missed heats (errors of omission) are the major errors of a heat detection program. Priority must be given to heat detection to improve reproductive efficiency and reduce the costs of reproductive failure on dairy farms.

## Introduction

Since the advent of artificial insemination in the 1930's, the biggest deterrent to a cost-effective reproductive program in dairy herds is proper heat detection. There are two aspects of heat detection that are important. The first is accurate diagnosis of estrus (accuracy), and the second is identifying all possible heat periods (efficiency). One may be quite accurate in diagnosing estrus, but still have a major heat detection problem because too many heats go undetected. The first type of problem could be classified as errors of commission and the second problem as errors of omission.

Reproductive losses in dairy herds cost producers over $600 million annually. Most recent studies show that it costs dairy producers $3 to 4 per day for every day a cow is not pregnant after 100 days in milk. For each cow that is sent to slaughter for reproductive failure, it costs another $300-350, which is the difference between her salvage value and the cost of a good replacement heifer. Good heat detection is the key to reducing these losses by increasing pregnancy rates and decreasing calving intervals.

## Signs of Estrus

As cows are coming into heat, many will show various types of behavior that should alert us. Cows will: 1) stand and bellow, 2) smell other cows, 3) attempt to ride other cows, but not stand, 4) show evidence of a moist, reddened, and slightly swollen vulva, and 5) have clear mucous discharge from the vulva. These type of pre-estrual behaviors may persist for several hours before standing estrus occurs.

The onset of heat is defined as the first time a cow stands firmly to be ridden by another cow. Typical behavior during estrus includes: 1) standing to be ridden, 2) frequent bellowing, 3) nervousness or excitable behavior, and 4) riding other cows. Remember that 60-70% of the cows that are mounting or riding cows frequently are in estrus. Watch them closely to determine when they stand.

When cows are no longer in estrus or going out of heat, they will: 1) not stand to be ridden, but may attempt to mount, 2) smell other cows, and 3) have clear mucous discharge from the vulva.

The best time to inseminate cows or heifers is during mid to late estrus. If cows are checked twice daily, then inseminate those cows in the p.m. that were observed in the a.m. of the same day. If cows were first detected in heat during the p.m., then inseminate them the next a.m. This constitutes the a.m.-p.m., p.m.-a.m. rule of breeding cows, and adherence to this rule should realize the highest conception or nonreturn rates.

## Errors of Commission

A recent study demonstrated that some dairy producers are breeding a substantial number of cows that are not in heat. The study involved eight dairies and over 800 cows, which were checked shortly after breeding by means of a milk progesterone test kit. Those cows with high milk progesterone were not diagnosed accurately in estrus. If milk progesterone is high, that means that the cow has a functional corpus luteum and cannot be in heat. Conversely, remember that low milk progesterone does not necessarily mean that the cow is in heat. Milk progesterone is low for 7 to 8 days after the corpus luteum regresses, during estrus, and until the new corpus luteum forms and begins secreting progesterone on the fifth day after heat.

The breeding errors (mistakenly inseminating cows that have high milk progesterone) ranged from 2% in the best herd to 32% in the worst. In over 800 inseminations, 13.5% were given to cows with high milk progesterone. These types of errors occur when: 1) the identity of cows is misread or confused, 2) when cows are ridden when not truly in heat, and 3) heat detection aids are misused or misinterpreted (false positives). Care should be exercised when watching cows to be certain that the right cow is submitted for insemination. Do not rely solely on heat detection aids, because chalk marks and heat detection patches can be activated falsely.

## Errors of Omission

It is generally believed that 50% of the heats go undetected on most dairy farms utilizing artificial insemination. Over 90% of the cows that are reported not to have been observed in heat are cycling normally but not seen in estrus. These errors of omission are the most costly part of heat detection programs. Someone should be assigned to be responsible for the heat checks and AI program. Cows and heifers eligible for breeding should be watched at least twice daily in addition to casual observations during the day when feeding, scraping lots, and moving cows to and from the milking parlor. Cows show estrus best after moving and mixing and will show about four times more mounting and standing behavior on dirt or pasture lots than when confined solely on concrete. Access to small dirt exercise or pasture lots can help increase the efficiency of heat detection. When more than one cow is in heat on the same day, the amount of mounting activity increases several times. The use of prostaglandins (Lutalyse® and Estrumate®) can help the heat detection program because it increases the number of cows and heifers that are in heat concurrently on the same day. Good heat detection is an important job on the dairy farm and should be given its proper priority to reduce the costs of reproductive failure.

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# CAUSE AND CONTROL OF
# HYDROLYTIC RANCIDITY
# IN RAW MILK

## Ike J. Jeon

## Introduction

One of the common and important off-flavors in milk is hydrolytic rancidity or lipolyzed flavor. The rancidity results from hydrolytic cleavage of fatty acids from milk fat by the enzyme lipase and their release as free acids. The release of these acids in milk, even in very small amounts, imparts a bitter taste and a sharp, unpleasant aroma. The off-flavor is often described as "goaty", "butyric", "soapy", and "bitter." The term "bitter", however, is ambiguous because bitter flavors can occur from the result of protein breakdowns. Nevertheless, both farm and dairy plant problems may lead to its development. Once an objectionable level is reached, no processing technique will eliminate it.

## Conditions Favoring Rancidity Development

The enzyme lipase is not normally active as the milk leaves the cow. However, several conditions are known to make the enzyme active. Interactions between milk fat globules and the enzyme are believed to be crucial. Like an electric motor activating machinery, these interactions activate the enzyme and cause the rancidity reaction to take place. The conditions favoring enzyme activations are: 1) agitation and foaming; 2) cooling to refrigeration temperatures, rewarming to 60 to 90 F, and recooling to refrigeration temperatures; 3) homogenization; 4) mixing raw and homogenized-pasteurized milk; and 5) presence of excessive residual detergents and/or sanitizers.

Milk from individual cows is known to differ in its tendency to develop rancid flavor. Milk is generally resistant to the development of the flavor, but milk from some cows is very susceptible to the activation treatments. Such milk is so susceptible that cooling alone causes rancidity. This kind of milk is not too common, but the phenomenon is known as "spontaneous" rancidity development. Several conditions are thought to stimulate production of milk highly susceptible even to mild activation treatments. These include: 1) Advanced lactation. Breeding schedules that allow most of the herd to come into late lactation at the same time pose a potentially serious rancidity problem. 2) Mastitis. 3) Dry winter feed. This is one reason why the off-flavor often occurs in winter. Milk from cows on pasture generally is less susceptible to rancidity. 4) "Heat" periods may cause an increase in susceptibility, but this is of short duration. 5) Any illness that results in a sudden drop in production may be followed by rancidity problems.

## Control Measures

Whether or not these five factors are present to encourage rancidity development, controls must be continuously applied. The following measures are recommended.

1)      Use only inflations that are in good condition. Cracks or holes permit entry air that can cause turbulence. Agitation and foaming result.

2) When installing pipeline milkers, keep the pipeline as close to the cows as possible. Air entering at the "claw" and bubbling up the milk hose is potentially hazardous. Pipelines above cows require long hoses and allow agitation to take place over a longer period of time.

3) If "in-line" strainers are used, be sure joints on either side are airtight before milking. Lines "broken" at this point at each milking may not be properly tightened.

4) Keep pipeline joints on the vacuum side airtight. Any leak is a source of trouble.

5) Minimize the number of "risers" in the line. When milk is raised to a higher level, turbulence and foaming occur if the line is not filled with milk. Risers in a "full" line will not be serious sources of activation.

6) Do not operate pumps and releaser systems continuously, if a full head of milk is not available at all times. Automatic control systems can be installed to activate pumps or releasers only when the milk jar is full. After the jar is emptied, the pump and releaser automatically shut off.

7) Minimize or eliminate splash as milk enters cans or bulk tanks.

8) Keep milk cold. The most common cause of rancidity is agitation and foaming, and the reaction progresses much faster at warm temperatures. Milk coming from a cow at body temperature is highly reactive. Rapid cooling is essential.

9) Shut off vacuum while transferring milking machine to the next cow. Keep sufficient vacuum to prevent milking machines from falling off cows.

10) Feed adequate levels of good quality feed. Undernourished cows may produce susceptible milk.

11) Avoid excessive residual detergents and sanitizers in the system at the time of milking.

# ACKNOWLEDGEMENTS

# The Livestock & Meat Industry Council, Inc.

The Livestock and Meat Industry Council, Inc. (LMIC) is a nonprofit, educational and charitable corporation, which receives and distributes funds that play an important role in programs of the Department of Animal Sciences and Industry. The council is controlled by industry people. Funds generated by the LMIC help accomplish many teaching and research goals.

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The Council's individual projects are numerous. The LMIC recently funded research in the Departments of Agricultural Engineering and Animal Sciences and Industry to study sulfur dioxide as a grain preservative. Funds from the Harry Burger Student Enrichment Fund help support the dairy judging team. The LMIC helped fund the research that led to the development of lasalocid by scientists in the Department of Animal Sciences and Industry.

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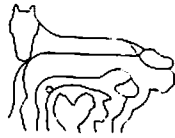
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