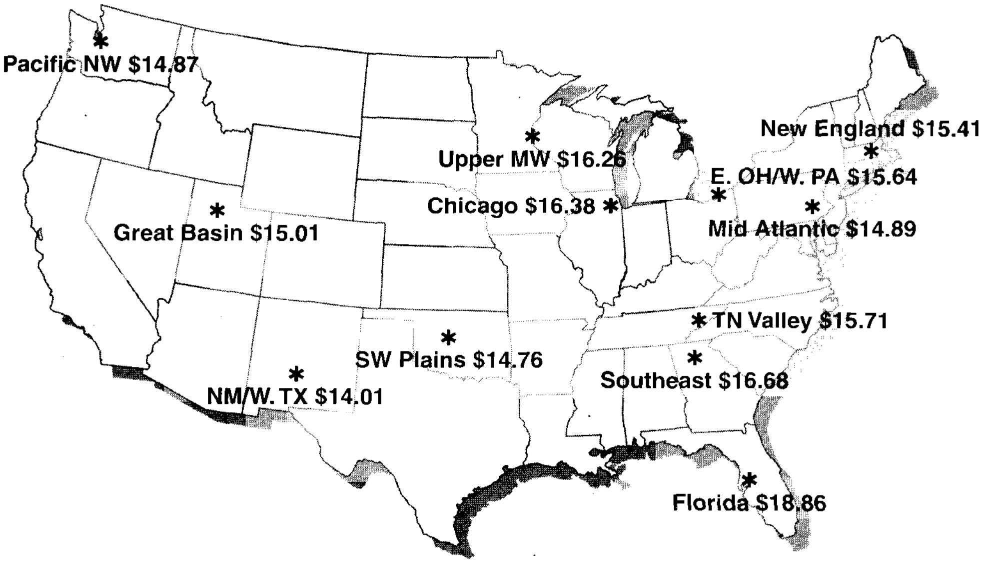


DAIRY DAY 1996

Report of Progress 771

Agricultural Experiment Station
Kansas State University, Manhattan
Marc A. Johnson, Director

The 1996 Annual

KSU DAIRY DAY

Friday, October 25, 1996, Pottorf Hall — CICO Park
(Riley County Fairgrounds), Manhattan

8:00 A.M.	**Registration - Visit Exhibits** John Shirley, KSU, Program Chairman
10:10	**Welcome** - Jack Riley, Head, AS&I, KSU
10:15	**Herd Expansion -** J.F. (John) Smith, KSU
10:30	**MUN - A Management Tool -** J.R. (Dick) Dunham, KSU
10:45	**Synchronization Programs -** J.S. (Jeff) Stevenson, KSU
11:00	**BLV Eradication -** J.E. (John) Shirley, KSU
11:15	**Quality Milk Awards** - J.R. (Dick) Dunham, KSU
11:30	LUNCH (Courtesy of Monsanto) (Ticket at Registration) ***** Visit Exhibits *****
12:45 P.M.	Key Note Speaker - **Robert Cropp, Univ. of Wisconsin** **How Should Milk Be Priced in the Future?**
1:30	**Future Contracts for Milk: How Will They Work?** Robert Cropp, University of Wisconsin
2:30	**Adjourn - Visit Exhibits**
3:00	**Tour - Dairy Teaching Research Center (DTRC)**

"A special "THANKS" to the exhibitors who support KSU Dairy Day"

FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 1996. 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 (Heart of America Dairy Herd Improvement Association [DHIA]). The Heart of America DHIA began business on January 1, 1995, by combining three labs into one. It is now testing about 125,000 cows per month from Kansas, Nebraska, Oklahoma, Arkansas, North Dakota, and South Dakota. A comparison of Kansas DHIA cows with all those in the Heart of America DHIA program is illustrated below.

Comparison of Heart of America Cows with Kansas Cows

Item	HOA	KS
No. of herds	1,248	399
No. of cows	107,328	33,037
Milk, lb	17,827	18,443
Fat, lb	643	672
Protein, lb	576	593
IOFC, $	1,173	1,133
SCC, × 1000	349	367

Ref: Heart of America 1995 DHIA Summary

Most of this success occurs because of better management of what is measured in monthly DHI records. In addition, use of superior, proven sires in artificial insemination (AI) programs shows average predicted transmitting ability (PTA) for milk of all Holstein AI bulls in service (January, 1996) to be +1,165 lb compared to non-AI bulls whose average PTA was +93 lb of milk. More emphasis should be placed on furthering the DHIA program and encouraging use of its records in making management decisions.

Based on comparisons (next column) from 1994 to 1995 using the Dairy Herd Analyzer, better nutrition reduced loss in income over feed cost by $9 per cow, improved genetics reduced the loss by $4 per cow, but milk quality had not effect. Reproductive performance increased the loss by $3 per cow in the face of a hot 1995 summer. In summary, a net reduction in losses of $10 per cow was achieved from 1994 to 1995.

We are proud of our new 72-cow tie stall barn that was constructed in 1991 through the generous support of Pharmacia & Upjohn, Clay Equipment Company, and Monsanto Company and under the direction of Dr. John Shirley. This new facility gives us the ability to expand our research efforts in various studies involving nutrition and feeding, reproduction, and herd management. The excellent functioning of the DTRC is due to the special dedication of our staff. Appreciation is expressed to Richard K. Scoby (Manager, DTRC); Donald L. Thiemann (Asst. Manager, DTRC); Michael V. Scheffel (Research Assistant); Daniel J. Umsheid; Mary J. Rogers; Charlotte Boger; Becky K. Pushee; Lesa Reves; Tamara K. Redding; Lyle Figge; Kerrie Powell; Gregory Brown; and William P. Jackson. Special thanks are given to Neil Wallace, Natalie W. Brockish, Betty Hensley, Cheryl K. Armendariz, and a host of graduate and undergraduate students for their technical assistance in our laboratories and at the DTRC.

Comparison of 1994 to 1995 with the Dairy Herd Analyzer

Losses	1994	1995	± from 1994
Nutrition, $	332	323	–9
Genetics, $	37	33	–4
Milk quality, $	99	99	+0
Reproduction, $	152	155	+3
Net change, $			–10

Ref: Heart of America 1995 DHIA Summary

Each dollar spent for research yields a 30 to 50% 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 the LMIC are found at the end of this publication).

J. S. Stevenson, Editor
1996 Dairy Day Report of Progress

CONTENTS

Page

Milk Marketing

How Should Milk Be Priced in the Future? 1
Futures Contracts for Milk: How Will They Work? 6

Nutrition and Management

Using the Somatic Cell Count Report 13
Milk Urea Nitrogen: A Nutritional Management Tool 17
Coping with Summer Weather: Management Strategies to Control Heat Stress 20
Planning Milking Facilities for Dairy Expansion 23
Performance of Lactating Dairy Cows Fed Alfalfa Haylage Treated with Bacterial Inoculants at the Time of Ensilation 26
Performance of Young Calves Supplemented with Vitamins C and E and Beta-Carotene 30

Health

Reducing Bovine Leukosis in Dairy Cattle 33
Flotation Therapy for Downer Cows 38
Preventive Health Programs for Dairy Cattle 42
Lameness in Dairy Cattle 46

Reproduction

Hormonal and Behavioral Characteristics Associated with the Onset of Radiotelemetric-Detected Estrus 51
Success of Several Programmed AI-Breeding Protocols Including OvSynch 54

Dairy Foods

Probiotic Frozen Yogurt Containing High Protein and Calcium 58
Factors Affecting Titratable Acidity in Raw Milk 60

Index 63

Acknowledgments 64

Biological Variability and Chances of Error 65

The Livestock and Meat Industry Council 66

Front cover: Projected September 1996 milk mailbox prices for 12 selected federal orders by Ken Bailey, Dairy Economist, University of Missouri.

HOW SHOULD MILK BE PRICED IN THE FUTURE?

Bob Cropp[1]

Summary

Milk pricing will continue to change. Clearly, the dairy industry will continue the trend toward MCP. The federal dairy price support program will terminate at the end of 1999. Changes will occur in federal order pricing. The FAIR ACT of 1996 requires some changes. Pricing provisions must be market oriented. The U.S. dairy industry must be competitive internationally. Federal order provisions must provide less rather than more regulation. Federal order prices must be minimum prices allowing for industry pricing above those prices. Markets are national. Hence, California should be a part of the same pricing system. Compacts such as the Northeast Interstate Compact should not be allowed.

(Key Words: Milk Marketing, Milk Price.)

Introduction

This paper discusses how milk may be priced in the future. In this discussion, the requirements for changing the federal government's role in milk pricing, as specified under the Federal Agricultural Improvement and Reform Act of 1996 (FAIR), are presented. I also present my own opinions as to how milk should be priced in the future.

Multiple Component Pricing

Let's start with the less difficult topic, multiple component pricing (MCP). MCP is pricing milk on the basis of two or more of its components. Butterfat is retained as one of these components with the addition of protein or solids-not-fat. MCP may be distinguished from fat-skim pricing, that is, pricing milk on the basis of its butterfat content with the remaining value assigned to the skim portion. Fat-skim pricing has been used to price milk under federal milk marketing orders. Thus, all of the discussion on MCP is directed at amending federal milk marketing orders to recognize MCP. Federal milk marketing orders require that regulated Grade A milk plants pay producers at least established minimum prices according to how milk is used. These milk plants may pay producers prices above these minimums, but not below. (Cooperatives may pay their producers less than the minimum, but competition among other milk plants in reality prevents this. Cooperatives must pay competitive prices.) Hence, milk plants have no problem paying premiums for above average milk composition, but may violate the established minimum price if discounts for below average milk composition, other than butterfat, are applied.

Why the interest in MCP? Major shifts in consumer demand for beverage milk and manufactured dairy products over the years have reduced the value of butterfat relative to the value of solids-not-fat in milk. Consumers continue to switch from whole milk to low fat or skim milk. Although the consumption of all cheese has shown strong growth in the last two decades, the largest growth has come in "other" varieties, primarily Italian, which have considerable lower butterfat content than traditional American varieties.

[1]Dairy Marketing and Policy Specialist, Department of Agricultural and Applied Economics, and University of Wisconsin Cooperative Extension-Madison, University of Wisconsin, Madison.

With this shift to lower butterfat beverage milk and manufactured dairy products being consumed, the dairy industry experienced a growing problem with surplus butterfat during the mid-1980s and until the last 3 years. This surplus butterfat was manufactured into butter and sold to the government under the federal dairy price support program. Under this program, the price of milk is supported at a set level through Commodity Credit Corporation (CCC) purchases of butter, nonfat dry milk, and cheddar cheese at specified prices. These specified prices are to enable a manufacturer selling at these prices to pay its producers at least the support price. In the case of butter and nonfat dry milk these are joint products. Hence, the Secretary of Agriculture has the discretion to set the CCC purchase prices of butter and nonfat dry milk at a level that will generate sufficient plant income to pay the support price. Because butter was the only real product in surplus and being purchased by the CCC and because of the concern over government program costs, the Secretary reduced the support price on butter from $1.0925 per pound in 1990 to $.65 per pound in July, 1993. Correspondingly, the CCC purchase price for nonfat dry milk was increased from $.79 per pound to $1.034 per pound. Because butter was in surplus, its value followed the support price down. And because the butterfat differential received by producers is based upon the price for butter, the butterfat differential declined from about 13 cents in 1990 to less than 6 cents in 1994. The result of all of this was a shift in the relative value of butterfat and skim in 100 pounds of milk. For example, in 1990, butterfat constituted 49 % and skim 51% of the value of milk. In 1994, butterfat accounted for only 20% of the value and skim 80%.

With butterfat constituting a relatively low value in milk, both producers and processors showed increased interest in testing for and paying on the basis of butterfat and either protein or solids-not-fat. The color breeds pushed the hardest to amend federal milk marketing orders to recognize MCP. However, MCP is not a breed issue, because producers are paid on the basis of pounds of components and not on percent of components. The first federal order to adopt MCP was the Great Basin order in Utah. This was followed by the Middle Atlantic order in 1992; the Indiana, Ohio Valley, and Eastern Ohio-Western Pennsylvania orders in 1993; the Pacific Northwest and the Southwestern Idaho-Eastern Oregon orders in 1994; and the Chicago regional, Upper Midwest, Iowa, Nebraska-Western Iowa, Eastern South Dakota, and Michigan orders in 1995. Other orders have proposals or are considering adopting MCP.

The May 1995, Market Administrator's Report (Market Administrator's Office, Tulsa Oklahoma, *Multiple Component Pricing Programs Applicable to Federal Milk Order Producers*, May 1995 Update, May 1996) shows that MCP procedures were applicable to more than 79% of the dairy farmers marketing milk under federal orders during May 1995. Thirty of the 38 federal orders in operation during May 1995 reported the use of either federal order or industry-sponsored MCP programs. More than 42% of the producers marketing milk under federal orders during May 1995 received an MCP adjustment to their milk pay price.

Not all federal order MCP programs are the same. In regions where a major use of milk for manufacturing is cheese, protein is the component tested for and paid to producers. In other regions where the production of nonfat dry milk is an important use, solids-not-fat is the component. Some orders use a two component system--butterfat and protein or solids-not-fat, and others use a three component system--butterfat, protein, and other solids (lactose and ash). In all, the value of butterfat per pound is unchanged from the fat-skim payment method, which is based on the value of Grade AA butter. But rather than paying a butterfat differential, producers are paid a price per pound of butterfat sold. The value of protein is determined differently among orders. All use the Basic Formula Price (BFP) and decompose it into component values. So in some federal orders, the value of butterfat in the BFP is subtracted, and all of the residual is assigned to the protein or solids-not-fat content. In other orders, the protein value is derived from the price of cheese, and both the butterfat value and the protein value are subtracted from the BFP, with the residual value going to other solids.

In none of the federal order MCP programs is MCP applied to the Class I use (beverage milk use). This is because the additional milk components do not yield more pounds of packaged beverage milk to sell. But the additional milk components do increase the yields of manufactured milk products that may be sold. Hence, producers under federal orders receive a value for the pounds of butterfat, protein, or solids-not-fat sold, plus the additional value received from a portion of their milk being utilized for Class I (beverage use) and Class II (soft manufactured use) and Class III-A(nonfat dry milk use, which is normally a lower value than the Class III price).

Milk quality adjustments are incorporated in some, but not all, of the federal order MCP programs. Under some programs, the level of somatic cell count is used to adjust the protein price per pound. In others, the somatic cell count is used independently and applied as a premium or deduction per hundredweight of milk.

Clearly, the dairy industry is moving away from fat-skim pricing to MCP. The 1996 FAIR ACT calls for the Secretary of Agriculture to consider an MCP program for manufacturing milk use under all federal milk marketing orders. It is not certain what the Secretary will recommend. But MCP is simply a more equitable milk pricing system for both dairy producers and milk plants. It prices milk on the basis of milk components and the market value of associated milk products produced from 100 pounds of milk.

Federal Pricing Programs

Historically, two federal programs affected farm-level milk prices, the federal dairy price support program and federal milk marketing orders. It should be recognized that some states have state milk pricing programs, the most significant being California's state order. The federal dairy price support program will soon be history. This program, which had its beginning with the 1949 Agricultural Act, terminates at the end of 1999. Since 1989, the price of cheese has been above support, except for a couple of months, and most recently butter and nonfat dry milk have been above support more of the time. Hence, farm-level milk prices have been above support every month since 1989. Therefore, the consequences of terminating the support program will be minor. Perhaps a little more price volatility may occur at times, but market forces and not the federal support program have been determining prices. Market forces will continue to provide an environment of price uncertainty and volatile prices. Dairy producers and milk plants must learn how to manage this price risk through the use of the new dairy futures and options.

The FAIR ACT of 1996 has provisions to expand exports of U.S. dairy products. The Act extends and fully funds the Dairy Export Incentive Program through 2002. It authorizes USDA to assist in forming export trading companies. And it authorizes the National Dairy Board to use funds for export market development. Without the federal dairy price support program, the prices of milk and dairy products will need to be at market clearing levels. With greater market access from GATT and NAFTA provisions, the U.S. dairy industry must be competitive on the world market. Without expanded dairy exports, the growth of the U.S. dairy industry would be limited.

Ever since the 1985 Agriculture ACT when Class I differentials were increased in most federal orders, with increases greater for federal orders East of the Rockies and more distant from the Upper Midwest, federal orders have been under attack, mainly from those in the Upper Midwest. The Upper Midwest claimed that these increases in Class I differentials were factors in expanding unnecessary milk production in the South and Southwest. In response to these concerns, the Secretary of Agriculture in 1990 held a national hearing. The final decision from this hearing brought with it no changes in Class I differentials and only minor other changes. As a result, the Minnesota Milk Producers sued the Secretary of Agriculture, claiming that he was not fulfilling his responsibility under the 1937 Act to change federal orders so as to meet the intent of the ACT. That lawsuit, initiated in the U.S. District Court for the District of Minnesota, was appealed to the federal appellate court, which sent it back to the U.S. District Court of

Minnesota, where the final decision is yet to be determined.

Federal orders became a very controversial issue in the 1995 farm bill debates. Regionalism was very evident, with the Upper Midwest proposing major changes in federal order pricing and other regions arguing to maintain a more or less status quo. The FAIR ACT of 1996 requires the Secretary of Agriculture to make some changes in federal orders and to consider other changes. These changes are to be implemented no later than April 1999.

Under FAIR, the Secretary of Agriculture is required to consolidate the existing 31 federal orders to no more than 14 and no less than 10 orders. California could be one of the 14 orders, if the initiative comes from California. It authorizes the Secretary to consider uniform MCP in designing a replacement for a new BFP. It also authorizes the Secretary to consider multiple basing points and fluid milk utilization rates in setting Class I prices in the consolidated orders. The ACT also authorized the Northeast Interstate Dairy Compact for a limited time (whenever the Secretary makes changes in federal orders, but no longer than April 1999), but the Secretary was required to determine if the compact was in the best public interest in the compact area. The Secretary has determined that it is in the best public interest. However, a lawsuit has been filed by the Milk Industry Foundation and joined by other interests to put an injunction against implementation of the compact. Hence, implementation is not certain.

Clearly, 31 federal orders are more than needed when one considers the distance both bulk milk and package milk moves. It is hard to determine market boundaries for beverage milk. We have been moving towards fewer orders with order mergers anyway. Back in the 1960s, there were as many as 83 orders. But as modern packaging and transportation technology improved, market areas expanded. However, drawing lines for 10 to 14 orders is no simple task. Class I utilizations differ widely among some orders, and, therefore, how they are combined has major implications for some producer prices. Tough decisions on order lines will need to be made. California should be part of this federal order pricing system. California is the leading milk producing state, the number one butter and milk powder producer, and second largest cheese producer. What California does impacts on the entire dairy industry.

Everyone is pretty much in agreement that a replacement is needed for the BFP. The supply of Grade B milk is simply declining and no longer can be used as the basis for determining the level of federal order class III prices (Grade A milk used for cheese) and as the mover for other classes. The choices are another competitive pay price that includes Grade A prices, some type of product price formula, the use of dairy futures, or MCP. I believe that the industry is moving towards MCP, and, therefore, an MCP alternative should replace the BFP. Regardless of which alternative is chosen, the replacement must set a minimum price and not be price enhancing. The market level for manufacturing use must be market clearing.

Determining Class I prices in the new orders is a much more challenging endeavor. Regionalism remains strong. But clearly, the single-point basing (Eau Clare, WI) can no longer be retained. The Upper Midwest is no longer the only major reserve supply of Grade A milk. Grade A milk no longer moves North to South in the same fashion as it did 30 or even 10 years ago. Class I differentials need not be the same among all orders, but more uniform than they currently are. Class I differentials need to recognize differences in milk supply-demand situations among regions. The Southeast requires higher differentials than other regions, because it is a high milk production cost region and a fluid milk deficit region.

We need to reexamine the overall purpose of federal milk orders, that is, to assure consumers of an adequate supply of Grade A milk for beverage purposes. To achieve this purpose, an adequate supply of Grade A milk produced nationally is needed, not self sufficiency in every region. Second, an incentive(s) must exist to allocate this Grade A supply of milk to Class I beverage use. We have been doing a pretty good job of producing an adequate supply nationally. But we have not always adequately or efficiently allocated this supply to Class I use. Class I differentials minus location adjustments all pooled to producers will not get the job done. Part of the differential should be allocated to transportation credits. These transportation credits will be paid to those milk plants and producers who directly ship milk for Class I use. Those who serve the Class I market must be better off than those who serve manufacturing uses. Care must be exercised in the use of transportation credits so as to only compensate the most efficient movement of Grade A milk to the Class I market.

Even with transportation credits, call provisions still may be required to allocate adequate supplies of Grade A milk for Class I needs. Market-wide service payments for balancing by manufacturing plants should also be considered. Transportation credits, market-wide service payments, and call provisions will better assure an adequate supply of Grade A milk for Class I needs than simply relying on Class I differentials that are entirely pooled to producers. The Southeast will always be short of Grade A milk for Class I needs and will need to seek supplies from reserve areas. Transportation credits and call provisions will lessen the burden that Southeast dairy cooperatives and their member-producers now experience in attempting to obtain adequate supplies of Grade A milk for Class I needs.

All federal order prices should be minimum prices. Federal orders should not regulate all pricing. Allowances are needed for industry or market forces in pricing. Cooperatives should be in a position to negotiate for prices above these minimum prices to compensate for functions and services performed. Currently, a lot occurs beyond federal order pricing. This is evident with the mailbox prices received by producers across the country. Although Class I prices increase with distance from the Upper Midwest for orders east of the Rockies, mailbox prices don't always follow the same pattern. Some of the highest mailbox prices exist in the Upper Midwest (see front cover).

FUTURES CONTRACTS FOR MILK: HOW WILL THEY WORK?

Bob Cropp [1]

Summary

The two new milk futures contracts offer dairy farmers and other buyers and sellers of milk and dairy products additional opportunities to manage price risk in an increasingly volatile milk price environment. The availability of these risk management tools is especially important given the market-oriented direction of federal dairy policy.

The CSCE and CME contracts differ somewhat in their specifications. Potential hedgers will need to evaluate which offers the best opportunity to lock in prices. Hedgers also should look at the cheese and nonfat dry milk contracts in determining the most appropriate risk management strategy. Strategies may involve using more than one futures market.

Key in any hedging decision is the basis, especially the predictability of the relationship between cash and futures prices. Hedgers should compare the alternative contracts in terms of which yields the most predictable basis given the type of hedge and the specific market conditions affecting their business.

(Key Words: Milk Futures, Hedging.)

Introduction

In June 1993, the Coffee, Sugar and Cocoa Exchange (CSCE) introduced futures and options contracts for cheddar cheese and nonfat dry milk. For more on the cheddar cheese contract, see *Futures and Options Trading in Cheese: Basic Principles for Hedgers*, Bulletin No. A3593, University of Wisconsin-Extension, Cooperative Extension, October 1993. (This bulletin also provides a detailed discussion of hedging and basis calculation.) These new contracts provided the opportunity for dairy industry participants -- dairy farmers, manufacturers, distributors, and others -- to manage price risk in an era of increasingly volatile dairy markets.

Expanded, risk management opportunities now exist via futures and options contracts for Grade A milk. On October 10, 1995, the Commodity Futures Trading Commission approved Grade A milk futures and options contracts for both the CSCE and the Chicago Mercantile Exchange (CME). The CSCE began trading these contracts on December 12, 1995. The CME announced a starting date of January 11, 1996.

This paper discusses these new milk futures contracts, focusing on their potential uses for hedging.

What Is the Purpose of Futures Contracts?

Futures contracts are marketing tools for managing price risk. Using futures to manage price risks is not new. Futures contracts for grains have been traded for about 130 years. Today, more than 100 different commodities are traded on U.S. futures markets.

The federal dairy price support program provided a relatively high floor (safety net) under manufacturing milk prices directly and under Grade A milk prices indirectly. That program requires USDA's Commodity Credit Corporation to purchase unlimited quantities of surplus butter, cheddar cheese, and nonfat dry

[1]Dairy Marketing and Policy Specialist, Department of Agricultural and Applied Economics and University of Wisconsin Cooperative Extension-Madison, University of Wisconsin, Madison.

milk at specified prices that enable manufacturers of these products to pay the support price. Thus, the program provided price protection for milk and dairy products. For many years, there was little price risk and, therefore, no interest in dairy futures as a risk management tool.

But all that has changed. The federal price support level for milk was cut from $13.10 per hundredweight in 1981 to $10.10 per hundredweight in 1990, where it remains today. (The support price was raised to $10.35 per hundredweight on January 1, 1996, under provisions of the 1990 Food, Agriculture, Conservation and Trade Act. New dairy legislation is being debated that will likely change the support price.) At this low level of price support, market forces -- not the federal support program -- determine cheddar cheese and nonfat dry milk prices most of the time. And for the past 2 years, even butter prices have usually been above support. Indeed, manufacturing milk prices (as measured by the M-W price and the more recent Basic Formula Price) have not been at support since 1988.

A market-driven system has created uncertain and volatile dairy product prices and milk prices. Dairy producers, milk processors and marketers, and buyers of fluid milk and dairy products now are exposed to major price risks. As a result, there is increased interest in dairy futures and options contracts as tools to manage this price risk.

The risk of price change is reduced through the *hedging* on the futures market. Hedging is taking opposite transactions in the cash and futures markets. By taking opposite transactions, losses (gains) on the cash market can be offset by gains (losses) on the futures market. With these offsetting losses and gains, hedging enables the users of futures markets for price protection to realize close to their price objectives.

Why Grade A Milk Futures and Options Contracts?

Cheddar cheese and nonfat dry milk futures and options have been used since their inception in June, 1993 as risk management tools by dairy farmers, milk processors and marketers, and buyers of cheese and milk powder. But the interest has been limited, and trade volume has been disappointing.

Cheddar cheese and nonfat dry milk futures and options may be used by both buyers and sellers to protect themselves against changes in the prices of these manufactured dairy products. But these same contracts can be used to reduce the risk of a change in farm-level milk prices. This is because the *base price* and *mover* of Grade A milk prices under all federal milk marketing orders is the Basic Formula Price (BFP). (The Basic Formula Price has been used since May 1995 as the federal order Class III price and Class II and Class I price mover. From 1961 until May 1995, the M-W price served that role. Both price series are based on pay prices by [unregulated] Grade B plants in Minnesota and Wisconsin.)

The BFP is the grade B price paid to producers by butter, milk powder, and cheese plants located in Minnesota and Wisconsin adjusted by a product price formula for the same three products. Because about 85 percent of the grade B milk in Wisconsin and 65 percent in Minnesota are used to make cheese, cheese is the major determinant of the BFP. About 90 percent of the change in the BFP may be explained by changes in cheddar cheese prices. With such a strong relationship, dairy producers and buyers of farm-level milk can use cheese futures and options contracts to reduce the risks from changing milk prices. Dairy cooperatives have successfully used cheese futures contracts to offer cash forward price contracts to their producer members. (Alto Dairy Cooperative has been offering their producers cash forward contracts hedged through the CSCE cheddar cheese futures since August, 1994. Since then, Swiss Valley Farms and Dairylea Cooperative have made cash forward contracts available to producers, and others may do so.)

About 80 percent of all grade A milk is priced under federal milk marketing orders. But prices for grade A milk not priced under a federal order and prices for Grade B milk have similarly strong relationships to cheese prices. In California, for example, a state order is used to price grade A milk. But prices for cheese, nonfat dry milk, and butter are used in a formula to calculate the minimum pay prices to the state's dairy producers.

Protecting milk prices via cheddar cheese futures contracts is a "*cross hedge*" (cheese prices against milk prices) and not a "*direct hedge*" (milk prices against milk prices). Although the price relationship between cheddar cheese futures and milk is high, the price relationship between milk futures contracts and milk prices should be even higher. This is because other factors besides cheese prices influence milk prices.

Further, dairy producers and fluid milk bottlers may have more interest in a direct hedge. Dairy producers normally don't manufacture cheese. Therefore, dairy producers may relate better to milk prices than cheese prices. And, because futures contracts are deliverable, dairy producers are in a position to deliver milk but not cheese. The same is true with fluid milk bottlers. Bottlers are interested in purchasing grade A milk for bottling. Bottlers do not sell or purchase cheese.

Dairy cooperatives and other dairy companies who wish to offer cash forward price contracts to dairy producers may find the grade A milk futures preferable to cheese futures. Even if the milk purchased by the cooperative is used to make cheese, the grade A milk futures provides for a direct hedge, so producer milk prices are protected with grade A milk futures. Cheese prices would not need to be converted to milk prices, which is necessary when using cheese futures to offer cash forward contracts to producers.

The Basis

Success in reducing price risks through hedging hinges on the *predictability of the relationship between the cash price and the futures price.* In this case, we are talking about the relationship between the cash market price and the futures price for Grade A milk. The relationship between the cash price and the futures price is referred to as the *basis.*

Successful hedges are possible only if the basis relationship is known and predictable. That's because the net outcome of a hedge is equal to the change in the basis. The likelihood of the basis being different at the time the hedge is placed and when it is removed or offset is referred to as *basis risk.* If the basis is exactly the same at placement and offset, then the net outcome will be equal to what was anticipated when the hedge was set. If the basis changes, the net outcome will be either better or worse, depending on the direction in which it changed from what was anticipated earlier when the hedge was set.

The level of basis is immaterial, i.e., it makes no difference whether the cash price for milk is, for example, $1.00 per hundredweight higher or $1.00 per hundredweight lower than the milk futures price. What does matter is that this relationship is predictable and stable. If it is, then losses (gains) on the cash market will be offset closely by gains (losses) on the futures market.

The good news is that the basis is normally more predictable than cash prices. Therefore the risk exposure from a change in the basis is less than the risk of changing cash prices.

Contract Specifications of Milk Futures

The contract specifications for grade A milk futures contracts for the NY CSCE and the CME are given in Table 1. Some significant differences exist between the two contracts.

The biggest distinction between the CSCE and the CME grade A milk contracts is the delivery point. The CSCE contract requires delivery ***from*** an approved plant or facility in the Madison, Wisconsin district of the Chicago Regional federal milk marketing order. The buyer is responsible for picking up the shipment and assuming all transportation costs from that point. The CME requires delivery ***to*** a CME-approved facility within the borders of Wisconsin and Minnesota or located in that portion of surrounding states included in the Chicago Regional or Upper Midwest Federal Milk Marketing orders. The seller assumes all transportation costs to the buyer's facility,

Table 1. Contract Specifications: Milk Futures Contracts, CSCE & CME

Contract Specification	CSCE	CME
Commodity	FOB delivery of Grade A milk with 3.5 percent butterfat content from an approved plant	FOB delivery of Grade A milk with 3.5 percent butterfat content to an approved plant
Trading unit	One tanker load	One tanker load
Delivery unit	One tanker load; allowable variation 48,000 to 50,000 pounds	One tanker load; allowable variation 3%
Trading hours	9:15 AM to 2:00 PM NY time	8:00 AM to 1:00 PM
Delivery months	All 12 months of the year	Feb., Apr.,Jun., Jul., Sept., Nov.
Price quotation	Dollars and cents per hundredweight	Same
Minimum fluctuation	$.01 per cwt., equivalent to $5.00 per contract	$.025 per cwt., equivalent to $12.50 per contract
Daily price limits	From previous day's settlement price, $.50 per cwt. with variable limits effective under certain conditions. No price limits on 2 nearby months, with no limits on 3rd. nearby month from first day of a delivery month until the last trading day of the delivery month	From previous day's settlement price. No trading at a price more than $1.50 per cwt.
Standards	Grade A raw milk with 3.5% butterfat content	Same
Delivery points	From Interstate Milk Shippers (IMS) certified plants, receiving stations, or transfer stations located in the Madison, WI district of Chicago federal order	To CME-approved facilities within borders of Wisconsin and Minnesota or that portion of surrounding states included in the Chicago or Upper Midwest federal orders
Delivery	Pickup by the buyer from the seller's plant	Seller to buyer's facility
Last trading day	Six Exchange business days prior to the last Exchange business day of the delivery month	Seven Exchange business days prior to the last Exchange business day of the delivery month
Notice of delivery	First Exchange business day following last trading day	Same
First and last delivery day	First Exchange day following notice day up to the last Exchange business day of the delivery month	Buyer and seller shall select a day so that delivery can be made by the last calendar day of the delivery month. If no agreement is conveyed to the Clearing House, the Exchange will chose a delivery date from calendar days beginning 4 days after notice of no agreement and ending on the last calendar day of the delivery month

except that the buyer will be assessed a standard freight rate per mile for each additional mile the milk is hauled over and above the distance between the seller's facility and either Eau Claire or Fond du Lac, Wisconsin. The excess hauling cost will paid to the seller.

Both the CSCE and the CME specify that grade A milk deliveries be from or to, respectively, a facility regulated under a federal milk marketing order. Federal milk marketing orders use classified pricing and set minimum pay prices for milk according to use class. Class III-A is skim milk used for nonfat dry milk. The minimum price is established via a nonfat dry milk product price formula. Class III is grade A milk used to make cheese. The minimum price for class III is the current month's Basic Formula Price (BFP). Class II is grade A milk used for soft manufactured dairy products (yogurt, cottage cheese, ice cream, etc.) and is based on the BFP 2 months previous plus $.30 per hundredweight. Class I is grade A milk used for beverage purposes and also is priced using the BFP 2 months previous plus a class I differential that varies with distance from Eau Claire, Wisconsin.

Deliveries of milk under both contracts will be subject to federal order pricing rules. The federal order class specification for both contracts is Class III. Class III-a, Class II, and Class I price differentials will apply to the delivery settlement price. In other words, those taking delivery will be responsible for any additional costs associated with higher uses (Classes I and II) or any reduced cost if the milk is used for Class III-A and the federal order Class III-A price is less than the Class III price.

What Will the New Milk Futures Contracts Price?

Because the new milk futures contracts price Class III milk and the minimum Class III price in all federal orders is the Basic Formula Price (BFP), it would seem logical to assume that the contracts will "price" the BFP; that is, that futures prices will represent the expected value of the BFP for the delivery month.

However, the actual value of Grade A milk used for Class III purposes seldom matches the BFP. In Wisconsin and other Midwestern states, intensive competition for milk elevates Grade A milk prices well above minimum blend prices, implying plant costs for Grade A milk used for manufacturing higher than the BFP.

Under the CSCE milk contract, with delivery points in the vicinity of Madison, eligible plants likely would not be willing to supply milk for delivery at the BFP if they were obligated to pay producers more. The cost to acquire milk for delivery would be at least the Grade A cost to the plant for Class III milk.

The CME contract price could be affected in a different way. The CME contract specifies plants regulated under the Chicago and Upper Midwest orders as destinations for delivery. Contract sellers bear all or most of the cost of delivery to the destination. The milk can originate from eligible Grade A milk plants anywhere in the U.S. This raises the possibility that the CME milk contract will price "distressed" milk; i.e., milk volume that temporarily exceeds plant capacity in some region. Distressed milk moving to Wisconsin for manufacturing typically sells at a discount to the BFP. (Distressed Grade A milk from regulated plants is subject to federal order minimum pricing rules. But dairy cooperatives, which are exempt from paying minimum producer blend prices, account for most interorder shipments of milk in excess of local manufacturing capacity) Suppliers are willing to incur large hauling costs in order to find a home for the milk. The possibility that the CME contract will price distressed milk poses a potential problem for hedgers, because the basis may be more difficult to predict.

From what we know so far, the futures contract is definitely not pricing the BFP. Early on, the CSCE contract apparently was pricing the Grade A price for milk used for manufacturing, about $.70 to $.90 per hundredweight about the BFP, with about a $.30 discount for the CME. But as we approached June 1996, contract prices of $17 to $18 per hundredweight for delivery months of July, August and September clearly were not the BFP. But instead, the futures price was reflective of the spot shipments of Grade A milk from Wisconsin to deficit fluid markets in the South; a BFP of about $14 plus a plant “give-up” charge of $3 to $4.

In the hedging examples below, we assume that the CSCE and CME milk contracts price the BFP. If that is not the case, then hedgers will need to account for deviations in establishing basis.

Hedging with the Milk Futures Contracts - Some Examples

Dairy Farmer Hedge

A simplified dairy farmer hedge is illustrated below, in which a dairy farmer sells 2 April milk contracts to hedge expected April Grade A milk production of 100,000 pounds. Given specific on-farm conditions with respect to milk composition, size of herd, milk quality, etc.; buyer conditions with respect to the buyer's premium structure (plant volume, quality, protein, etc.); and milk utilization by class in the federal order market, the farmer has determined that a $13.00 BFP correlates to a Grade A milk price of $14.00. That price looks favorable compared to production costs, so the farmer attempts to lock the price in through a short hedge. In case I, with a constant basis, the lower cash market price from a lower BFP is offset by futures market gains. In cases II and III, offsets are not exact, because the basis at the time the hedge was lifted was different from what was expected at the time the hedge was placed. Net gains are experienced with a strengthened basis, and losses are incurred when the basis weakens.

The farm-level Grade A price associated with a particular BFP was merely specified in this example (Table 2). In reality, considerable analysis would be necessary to derive the basis, and there would be several sources of basis risk. The minimum federal order blend price varies with utilization by class as well as with the BFP; hence the blend price relative to the BFP is not constant. A plant's base pay price relative to the federal order blend price varies with product mix, extent of competition, and premium structure. Farmers' butterfat and protein tests, somatic cell count and other quality variables, herd size, and a host of other factors cause actual pay prices to deviate from base pay prices.

Cash Forward Contracts

Milk plants may use dairy futures as a means to offer cash forward contracts to dairy farmers. This is illustrated in Table 3. Let's assume that in January a cheese plant offers dairy farmers a cash forward contract for April milk at $14.00 per hundredweight. This price is protected by selling in January an April Grade A milk futures at $13.00. The cheese plant estimates its basis at $1.00. This includes a $.75 pool draw from the federal order and a $.25 premium. So the $1.00 basis added to the $13 futures price enables the plant to offer the $14 cash forward price contract.

In April, the dairy farmer delivers milk to the cheese plant. The April milk price has declined to $13.00, but the cheese plant is obligated to pay the cash forward price of $14.00. The cheese plant buys an April Grade A futures at $12.00 and incurs a $1.00 gain from the futures market. The basis was unchanged at $1.00. Adding the $1.00 gain to the market price enables the cheese plant to pay the cash forward contract price of $14.00. If the reverse had occurred and the April milk prices had increased, the cheese plant would still pay the $14.00 cash forward price. The cheese plant would not be able to pay more, because it would incur a loss on the futures market. The cheese plant offers a cash forward contract to dairy farmers and hedges its obligation in Grade A milk futures.

Table 2. Example of a Dairy Farmer Hedge

Date	Cash Market	Futures Market	Basis
Jan. '96	Dairy farmers expects to sell 100,000 pounds of Grade A milk in April. Price expectation based on April futures price is $14.00	SELL 2 Apr. milk contracts @ $13.00	$1.00
Case I: Futures price decline/No basis change			
Apr. '96	Sell 100,000 pounds of milk @ $13.00.	BUY 2 Apr. milk contracts @ $12.00.	$1.00
Gain/(Loss)	($1.00)	$1.00	
Net Gain	$0.00		
Case II: Futures price decline/Basis weakens			
Apr. '96	Sell 100,000 pounds of milk @ $13.00.	BUY 2 Apr. milk contracts @ $12.50	$.50
Gain/(Loss)	($1.00)	$.50	
Net Gain	($0.50)		
Case III: Futures price increase/Basis strengthens			
Apr. '96	Sell 100,000 pounds of milk @ $15.00.	BUY 2 Apr. milk contracts @ $13.50	$1.50
Gain/(Loss)	$1.00	($.50)	
Net Gain	$.50		

Table 3. Example of a Cash Forward Contract

Date	Cash Market	Futures Market	Basis
Jan.'96	Plant offers price contract to Grade A patrons. Will pay $14.00 base price (3.5% butterfat) for April milk. Contract price is derived as follows: $13.00 BFP + .75 Pool Draw + .25 Premiums $14.00	Plant sells April Grade A milk contracts @ $13.00	$1.00
April'96	April milk is $13.00, but plant pays contract price of $14.00	Plant buys April Grade A milk contracts @ $12.00	$1.00
Gain/(loss)	($1.00)	$1.00	

USING THE SOMATIC CELL COUNT REPORT

J. R. Dunham

Summary

High-producing dairy herds can consistently average a somatic cell count (SCC) <200,000. Herds with consistently higher averages can decrease SCC and realize higher profits. The SCC report discloses the pitfalls that need to be addressed before improvement can be made.

(Key Words: Somatic Cell Count.)

Introduction

Mammary gland health and milk quality have a direct effect on a dairy's profit. In fact, these are the most costly health problems on dairy farms. Yet, many producers are unaware of losses from mammary health because subclinical mastitis, which is not visually observed, is the most common problem. In most cases, a high somatic cell count (SCC) is the only indication that mammary health and milk quality need to be improved.

The SCC is an excellent evaluation of mammary gland health and milk quality. Since 1980, most DHIA programs have provided SCCs for dairy farmers. The SCC program has proven to be very popular and useful. However, misunderstanding still exists about the interpretation and use of the SCC reports. This review will suggest recommendations for using the SCC information to develop a profile for managing mammary health and milk quality.

Terminology

SCC reports show the counts in thousands of cells per milliliter and linear score (LS). The cell count is more easily understood by producers and field representatives. The LS is a logarithm conversion of the SCC and is not as well understood.

The herd average SCC is a weighted average and corresponds to the bulk tank SCC, whereas LS correlates with the amount of milk loss per cow per day. Figure 1 shows the relationship of LS to milk loss. First lactation losses are half those of older cows.

Herd average LS is not weighted by pounds of milk from each cow, because milk loss is not related to production level of each cow. Example: two cows with an LS of 4 would have a calculated production loss of 3 lb per day regardless of their individual production level. Yet one cow could be producing twice as much milk as the other and would be contributing twice the number of cells to the SCC average. Therefore, both SCC and LS are useful measures of udder health.

Herd Average SCC

Figure 1 shows the herd average SCC for the last six test dates and the current average for the top 25% of herds in the Mid-States area. The history of the last six test dates shows the trend of the mammary health profile. A realistic goal for a herd is to have consistently an average SCC <200,000.

Individual Cow SCC

An SCC report for individual cows (Figure 2) shows each cow's SCC for the last six test dates. The profile for each cow is useful for selecting potential mammary health culls. Cows with several consecutive high counts should be considered for culling. However, a cow with an occasional high count may be self-curing (spontaneous recovery). Cow number 2024 in Figure 1 is an example of a spontaneous recovery. This indicates that the cow's somatic cells were able to control the mammary infection.

During the early days of SCC reports, dairy farmers selected cows with several high counts to double dry treat at dryoff. This practice has not proven to be effective. The most recent SCC history is most useful for selecting culls.

Milk Loss

Figure 1 shows the milk loss per cow per day and for the herd. The loss is converted to dollar values according to milk price. Milk loss is determined by the LS average for the herd. This section illustrates the economic impact of subclinical mastitis in the herd.

Animals over 300 SCC

Cows with SCC >300,000 are shown in this section of the SCC report (Figure 2). These animals are assumed to be infected with mastitis-causing pathogens and most have subclinical mastitis. Those with an asterisk are new on the list since the previous test day.

This section illustrates the effects of weighted average SCC and LS. The percentage contribution value in Figure 2 indicates each of the high SCC cow's contribution to the herd's average SCC. Cows 2030, 2294, and 2293 each have a 7.9 LS with comparable SCC. However, cow 2294 is contributing 7% to the total herd SCC average, whereas cows 2030 and 2293 are contributing only 1%. Obviously, cow 2294 is producing much more milk than the other two cows.

This report is useful to indicate from which cows to save milk to feed calves. Five of the first seven cows listed on the report contribute 41% of the herd average. Hence, if this milk is used for feeding calves, quality premiums could be increased.

Some dairy farmers have used this list to select cows for antibiotic treatment in an attempt to lower herd average SCC. However, treating lactating cows to lower SCC is not usually worthwhile and, in most cases, will be futile. Dry cow treatment has been shown to be the only effective antibiotic treatment program to lower SCC.

Lactation Average

This section of the SCC Report (Figure 1) illustrates the effects of lactation number on SCC. Almost every herd's report will show that SCCs of 1st lactation cows are lower than those of 2nd lactation cows, which are lower than those of 3+ lactation cows.

This section is very useful when evaluating problem herd situations. Even though the SCC rankings by lactation number in high SCC herds will be normal, those of first lactation cows may be too high and the following lactations will be higher. In this situation, the herd average SCC could be improved by freshening heifers with lower SCC.

The goal for SCC average of 1st lactation cows should be <100,000, and 5% or less of the heifers should have counts >300,000. If this is not the case, then heifers are likely becoming infected with mastitis-causing pathogens before calving. Look for wet and(or) unsanitary conditions in the springer lot.

The days in milk averages shown in Figure 1 are useful for evaluating dry cow programs and milking management. This is actually a stage of lactation profile for SCC.

The top 25% of herds show that the lowest SCC cows are 50 to 100 days in milk. Then the SCC increases slightly after 100 days. It also shows that cows in milk <50 days have lower SCCs than those in milk >300 days. In many high SCC herds, this is not the profile.

When the SCCs are higher for cows in milk < 50 days than for late lactation cows, suspect a problem during the dry period, Dry cow treatments may be ineffective. However, in many cases, high SCCs are caused by cows becoming infected as they approach parturition. If the SCC average is higher in cows during early lactation than during late lactation, usually, the average in 1st lactation cows also will be high.

To evaluate milking management, compare the SCC of cows in milk < 50 days with that of cows in milk 50 to 100 days. If the second group is higher, suspect a problem with milking management. A higher SCC indicates that the milking management program is stressful, and the cows respond with higher SCC after 50 days in milk. Usually, the SCC will increase with advancing stage of lactation.

Stresses causing higher SCC in cows as lactation advances can include poor milking techniques, poor sanitation in the parlor, and(or) faulty milking equipment. The first two situations are most common.

If milking management does not seem to be the cause of higher SCC as lactation advances, then the problem is probably narrowed down to the condition of lots and the housing system. Systems that do not provide dry and comfortable conditions in the feeding and lounging areas will cause high SCC.

In too many systems, cows do not use free stalls unless the weather is extremely severe. Look for conditions in the free-stall barns that may not be comfortable for cows. These include: condition of the free-stall surface and ventilation in the barn. Cows often will congregate in the alleys of the free-stall barn where air movement occurs. Of course, this area becomes sloppy, and high SCCs usually follow.

216 KSU DAIRY % J SHIRLEY 913 532-0941

MID STATES
SOMATIC CELL
DHIA-230

Herdcode	Breed	Sample Date	Mail Date	Assoc.	Fld Tch	Record Plan
48 85 0273	GH	01 15 96	01-18	485	11	01 DHI-APT

LAB DATE: 01-15

Lactation Averages	Your Herd	Animals > 400	% > 400
1st Lactation	101	5	7
2nd Lactation	147	3	7
3rd Lactation	208	9	14

Weighted Herd Average SCC By Sample Day						
Sampled 8-07	Sampled 9-07	Sampled 10-11	Sampled 11-07	Sampled 12-06	Sampled 1-15	Mid-States Top 25%
409	287	248	213	168	156	139

SCC Summary	Animals	Herd %	Mid States Top 25%
Below 100	122	69	66
100-200	24	14	16
201-400	13	7	9
401-800	7	4	5
Over 800	10	6	3

Days in Milk Averages	Your Herd	Mid-States Top 25%	Animals > 400	% > 400
Fresh Under 50 Days	160	127	7	18
Fresh 50 - 100 Days	203	114	4	10
Fresh 101 - 200 Days	128	143	3	5
Fresh 201 - 300 Days	119	147	2	10
Fresh Over 300 Days	139	189	1	6

New High Cows	
Number	%
9	6

Linear Score
Herd Avg
2.3

Milk Loss	Per Cow	Per Herd
Lbs/Day	1.2	207.8
Dollar	$0.15	$25.88

Relationship of Linear Score to Milk Loss			
Linear Score	SCC Range From - To	Estimated Milk Loss Lbs/Day	Estimated Milk Loss Lbs/Lact
0 - 2	9 - 71	0	0
3	72 - 141	1.5	400
4	142 - 283	3.0	800
5	284 - 565	4.5	1,200
6	566 - 1130	6.0	1,600
7	1131 - 2262	7.5	2,000
8	2263 - 4523	9.0	2,400
9	4524 - 9045	10.5	2,800

Animals Over 300 Somatic Cell Count											
Barn Name	SCC	Linear Score	% Contrib.	Barn Name	SCC	Linear Score	% Contrib.	Barn Name	SCC	Linear Score	% Contrib.
2155	4512*	8.5	12	1781	325	4.7	1				
2030	3014*	7.9	1	2297	314	4.7	1				
2294	3002*	7.9	7								
2293	2888*	7.9	1								
1824	2771	7.8	8								
1997	1857	7.2	8								
1994	1495*	6.9	6								
2256	1327*	6.7	1								
2274	970	6.3	2								
1811	855	6.1	2								
1766	716	5.8	3								
2285	708*	5.8	1								
2086	628*	5.7	2								
2143	573*	5.5	3								
2027	567	5.5	4								
1885	500	5.3	1								
1542	435	5.1	1								
2169	339	4.8	2								
2199	333	4.7	1								
2108	332	4.7	1								

Figure 1. Somatic Cell Count Averages and High Cow List

Herdcode	Sample Date	Lab Date	Mail Date	Page
48-85-0273	01-15-96	01-15-96	01-18-96	1

COMPUTER NUMBER	PREVIOUS 5 SAMPLE DAY SCC SCORES					CURRENT LACTATION						
	8-07	9-07	10-11	11-07	12-06	1-15	LINEAR SCORE	BARN NAME	LACT NO	FRESH DATE	DAYS IN MILK	MILK LBS
1792	44	59	59	25	18	161	3.7	1302	8	4-01	290	63.9
1944	1269*	507*	467*	348	DRY	DRY		1462	7	12-31	DRY	
1974	DRY	DRY	180	64	182	31	1.3	1486	7	10-02	106	85.3
1982	55	53	65	65	88	92	2.9	1488	6	10-26	447	50.8
1992	123	263	215	161	168	271	4.4	1504	7	7-01	199	46.7
2024	462*	887*	DRY	DRY	2544*	32	1.4	1527	7	11-21	56	42.6
2028	822*	114	3854*	418*	179	435*	5.1	1542	7	7-14	186	50.8
2036	215	3031*	2039*	DRY	DRY	DRY		1552	6	12-21	DRY	
2041	372	DRY	DRY	DRY	331	278	4.5	1558	6	11-21	56	54.8
2067	72	182	142	131	200	DRY		1585	5	1-05	DRY	
2091	99	53	13	38	75	263	4.4	1611	6	2-28	322	14.2
2108	294	11	17	15	12	27	1.1	1635	6	5-09	252	53.8
2125	91	4028*	DRY	DRY	177	18	.5	1652	6	11-26	51	109.6
2156	29	96	53	77	DRY	DRY		1690	5	1-09	DRY	
2178	XXX	34	67	DRY	DRY	46	1.9	1713	6	1-01	15	32.5
2217	146	154	219	DRY	DRY	DRY		1757	4	12-07	DRY	
2219	187	407*	DRY	DRY	111	96	2.9	1759	5	11-23	54	98.5
2221	906*	DRY	DRY	DRY	XXX	25	1.0	1763	5	12-02	45	128.9
2224	DRY	56	26	1965*	776*	716*	5.8	1766	5	8-17	152	81.2
2229	DRY	241	64	81	107	167	3.7	1771	5	8-13	156	50.8
2240	1781*	284	83	62	88	325	4.7	1781	5	8-05	164	40.6
2242	6131*	3899*	4783*	2705*	DRY	DRY		1783	4	11-23	DRY	
2268	228	92	181	167	137	85	2.8	1809	4	1-03	378	36.5
2270	2119*	614*	3590*	863*	1256*	855*	6.1	1811	4	1-09	372	44.7
2273	153	DRY	DRY	XXX	36	23	.9	1814	5	11-02	75	99.5
2283	310	477*	DRY	DRY	2692*	2771*	7.8	1824	5	11-14	63	54.8
2323	DRY	DRY	DRY	17	55	115	3.2	1867	4	10-11	97	95.4
2336	20	28	82	30	44	93	2.9	1880	4	7-06	194	56.8
2341	534*	939*	358	922*	972*	500*	5.3	1885	4	3-23	299	42.6
2568	DRY	DRY	497*	461*	761*	283	4.5	1889	4	10-01	107	93.4
2349	100	171	149	DRY	DRY	DRY		1893	3	10-04	DRY	
2355	131	5408*	2385*	80	67	64	2.4	1900	3	1-24	357	42.6
2357	114	324	DRY	DRY	87	16	.4	1902	4	11-27	50	95.4
2360	109	DRY	DRY	8	10	18	.5	1905	4	10-08	100	89.3
2365	182	DRY	DRY	24	24	150	3.6	1910	4	10-19	89	75.1
2373	80	112	16	38	49	131	3.4	1921	3	2-23	327	58.9
2377	6894*	1810*	1006*	21	9	4		1925	3	3-21	301	75.1
2378	DRY	358	99	75	23	134	3.4	1926	3	8-13	156	71.1
2384	300	DRY	DRY	DRY	9	5		1932	4	11-22	55	109.6
2393	84	96	433*	DRY	DRY	DRY		1941	3	2-08	DRY	
2400	22	19	37	68	DRY	DRY		1948	3	1-24	DRY	
2410	14	25	42	43	106	67	2.4	1960	3	6-10	220	62.9
2415	403*	361	422*	449*	304	DRY		1965	3	1-25	DRY	
2420	75	14	20	27	19	69	2.5	1970	3	7-16	184	36.5
2617	23	24	29	48	DRY	DRY		1971	3	2-23	DRY	
2424	DRY	DRY	194	76	15	95	2.9	1974	3	9-26	112	79.2
2441	32	15	12	119	25	53	2.1	1991	3	7-02	198	60.9
2443	DRY	DRY	80	64	51	79	2.7	1993	3	9-16	122	66.6
2444	163	354	377	DRY	DRY	1495*	6.9	1994	3	1-08	8	74.1
2446	528*	1916*	513*	290	207	DRY		1996	3	3-09	DRY	
2447	DRY	596*	1990*	5115*	1451*	1857*	7.2	1997	3	8-15	154	81.8
2455	230	271	DRY	DRY	71	DRY		2003	3	11-23	DRY	
2453	DRY	DRY	141	70	21	85	2.8	2004	3	10-03	105	65.6
2457	32	22	33	45	87	DRY		2007	2	12-17	DRY	
2458	DRY	DRY	42	23	8	12		2009	3	10-05	103	71.1
2460	43	150	106	91	59	56	2.2	2011	3	6-15	215	58.9
2461	37	33	16	32	34	73	2.5	2012	3	7-17	183	60.9
2462	42	75	DRY	DRY	DRY	15	.3	2013	3	12-08	39	74.7
2464	25	27	DRY	DRY	115	13	.1	2019	3	11-26	51	111.7
2465	120	DRY	DRY	34	33	40	1.7	2020	3	10-11	97	81.2

XXX=SAMPLE MISSING OR INSUFFICIENT *COUNT OVER 400,000

Figure 2. Somatic Cell Count Report for Individual Cows

MILK UREA NITROGEN: A NUTRITIONAL MANAGEMENT TOOL

J. R. Dunham

Summary

Milk urea nitrogen (MUN) analyses can be used to evaluate the nutritional status of dairy herds and for fine tuning the feeding program. MUN values >18 mg/100 ml indicate that dietary protein is being wasted and feed costs could be reduced with ration adjustments. Higher than desired MUN values also indicate the need for additional undegradable intake protein (UIP; bypass protein) in the ration. High MUN values can also indicate the need for more nonstructural carbohydrates (NSC) in the diet. MUN readings <14 mg/100 ml indicate dietary crude protein deficiencies or too much UIP in the ration. Reduced milk production or low milk protein tests can occur when feeding rations that produce low MUN tests. Poor reproductive performance may be the result of feeding rations that produce high MUN measurements. Conception rates may be reduced as much as 20 percentage points when MUN is >18 mg/100 ml.

(Key Words: Milk Urea Nitrogen, Nutrition Management, Conception Rates, Protein.)

Introduction

A new technology, milk urea nitrogen (MUN) testing, is available to dairy farmers to help manage the nutrition program. Until recently, blood samples had to be tested for blood urea nitrogen (BUN) for a similar evaluation. Now, through the DHI testing program, milk samples can be tested for MUN much more conveniently and at less expense.

Concentrations of MUN and BUN tend to be in equilibrium with each other. Thus, an analysis for MUN provides a good evaluation of the concentration of urea in blood.

The main source of urea in blood is from microbial protein digestion in the rumen. Ruminal microbes produce ammonia from digestion of degradable intake protein (DIP). This ammonia is used by the microbes to synthesize amino acids for their growth. If too much DIP is available, the concentration of ammonia will increase and be ruminal absorbed into the blood stream. Ammonia in the blood is converted to urea by the liver, causing BUN to increase. Urea is removed from the blood stream by the kidneys and is excreted in the urine. Hence, protein from the ration can be wasted if too much ammonia is released in the rumen. Some of the urea also re-enters the rumen via saliva.

Ammonia can increase in the rumen if the NSC content of the diet is too low. The ruminal microbes require a readily available source of energy, NSC, in order to grow, reproduce, and utilize ammonia. Thus, rations containing relatively low NSC will increase ruminal ammonia and MUN.

Research has shown that conception rates have increased as much as 20 percentage points when MUN was lower than 19 mg/100 ml. Apparently, the uterine environment is less than desirable for implantation of the embryo when MUN is high.

Low MUN concentrations usually indicate a protein-deficient ration. In addition, rations too high in undegradable intake protein (UIP) can cause low MUN readings. In either situation, the amount of DIP is too low and protein digestion in the rumen is depressed, resulting in less dry matter intake and milk production. Depressed milk protein tests usually are associated with low MUN values, low NSC intake, and(or) excess UIP in the ration.

Testing DHI milk samples for MUN can lead to more precisely balanced rations, higher milk protein tests, and improved reproductive efficiency.

When to Test for MUN

Most herds will not need to be tested for MUN every month. The best time to test the herd would be after significant ration changes, such as using different ingredients in the grain mix or different forages. An initial test is needed to determine normal or typical ranges in MUN values. Variation will be observed among cows, so averages for groups of cows or the herd will be the most meaningful. Using the EBS or PCDART program, cows should be grouped and averaged by stage of lactation. Cows in milk less than 50 days, 50 to 100 days, 101 to 200 days, and over 200 days would be one method to group MUN values.

Knowing the MUN concentration of cows in milk less than 50 days seems to be important for determining if protein feeding is adequate during the establishment of peak milk production. Cows in milk 50 to 100 days should be scrutinized to avoid MUN problems associated with poor conception rate. The MUN content for cows in milk 101 to 200 days is important for determining that dietary protein intake is not limiting production. High MUN readings indicate that cows in milk more than 200 days may be wasting protein.

Because MUN values are closely related to the ammonia concentration in the rumen, variation between the MUN readings of the morning and evening milkings can occur. This will depend somewhat on the feeding schedule. If a considerable difference occurs between morning and evening MUN, feeding more than once per day is recommended. Using the DHI-AP testing schedule will indicate the difference between milkings.

Interpreting MUN Tests

Group MUN averages will be more meaningful than evaluating individual cows, because considerable variation exists among cows. The desired range for average MUN is 14 to 18 mg/100 ml. Careful evaluation of test results should be made. If MUN tests are out of the normal range, ration reformulation is indicated. To be assured that dietary protein is not limiting production, however, MUN tests should be in the upper part of the normal range.

Interpretation of MUN test results and recommendations are given in Table 1.

Conclusions

MUN testing through the DHI program provides dairy farmers with the latest technology for nutritional management of dairy herds. MUN test results can be used as a guide for making ration changes to:

- ✓ reduce dietary protein wastage,
- ✓ detect dietary protein deficiencies,
- ✓ improve conception rates, and
- ✓ improve protein content of milk.

Although MUN testing will increase the cost of DHI testing, the benefits will outweigh the cost when it is used to adjust rations properly.

Table 1. Interpreting MUN Averages for Groups of Cows

Average MUN (mg/100 ml)	Interpretation	Suggested remedy
14 to 18	Ideal range. If average is in lower part of range, cows may benefit from more protein in the diet.	Consider increasing protein intake, if early fresh cows average in lower part (<50 days in milk) of range.
>18	Higher than desired. Dietary protein may be wasted and(or) conception rate reduced.	Consider reducing protein content of ration. Evaluate UIP content of ration. UIP should range between 35 to 40%. NSC content of ration may be too low. Replacing some byproduct feeds or milo with corn or wheat will increase NSC.
<14	Lower than desired. Expect milk production and(or) milk protein test to be depressed.	Increase protein in ration. Evaluate UIP content of ration. The UIP should be in the 35 to 40% range.

COPING WITH SUMMER WEATHER: MANAGEMENT STRATEGIES TO CONTROL HEAT STRESS

J. F. Smith and J. P. Harner [1]

Summary

Heat stress occurs when a dairy cow's heat load is greater than her capacity to lose heat. The effects of heat stress include: increased respiration rate, increased water intake, increased sweating, decreased dry matter intake, slower rate of feed passage, decreased blood flow to internal organs, decreased milk production, and poor reproductive performance. The lower milk production, and reproductive performance cause economic losses to commercial dairy producers. This review will discuss methods that can be used on commercial dairy farms to reduce the effects of heat stress on dairy cattle.

(Key Words: Heat Stress, Summer, Cooling.)

Measuring Heat Stress

The severity of heat stress usually is quantified by a temperature humidity index (THI). Both ambient temperature and relative humidity are used to calculate a THI. A THI above 72 is associated with heat stress in dairy cattle. The THI's at various temperatures and relative humidities are presented in Figure 1. Dairy producers can purchase a thermometer/hygrometer and use Figure 1 to determine the level of heat stress at different locations on the dairy.

Heat Loss in Dairy Cows

Dairy cows dissipate heat in several ways, including conduction, convection, radiation, and evaporative cooling. Conduction is based on the principal that heat flows from warm to cold. This method of heat loss requires physical contact with surrounding objects. An example of conductive cooling would be when a cow wades into a pond of water. Cooling by convection occurs when the layer of air next to the skin is replaced with cooler air. Radiation of body heat can occur when the ambient temperature is significantly cooler than the cow. At cooler temperatures, dairy cattle are efficient at radiating heat. Evaporative cooling occurs when sweat or moisture is evaporated away from the skin or respiratory tract. This is why dairy cattle perspire and increase respiration rates during heat stress. High humidity limits the ability of the cow to take advantage of evaporative cooling. When the ambient temperature is under 50 degrees F, nonevaporative methods of cooling account for 75% of the heat loss. At temperatures above 70 degrees F, evaporative cooling is the cow's primary mechanism for heat loss. Dairy producers can take advantage of the same mechanisms to cool dairy cows on the farm.

Water Availability

Providing access to water during heat stress is critical. Lactating dairy cattle will typically require between 35 and 45 gallons of water per day. Studies completed in climatic chambers indicate that water needs increase 1.2 to 2 times when cows are under heat stress. A water system needs to be designed to meet both peak demand and daily needs of the dairy. Making water available to cows leaving the milking parlor will increase water intake by cows during

[1]Department of Biological and Agricultural Engineering.

heat stress. Access to an 8-ft water trough is adequate for milking parlors with less than or equal to 25 stalls per side. When using drylot housing, we recommend having water troughs at two locations and 30 ft of trough perimeter per 100 cows or 80 ft of trough perimeter for 200 cows. In free-stall housing, one waterer or 2 ft of tank perimeter is adequate for every 15 to 20 cows. An ideal situation would be to have water available at every crossover between feed and resting areas.

Shades

Cows housed in drylot or pasture situations should be provided with solid shade. Research from Florida and Arizona indicates that when high-producing cows are exposed to direct sunlight and a THI exceeds 80 during daylight hours, shaded cows will produce approximately 4 to 5 lb of additional milk per day. Natural shading provided by trees is effective, but most often shades are constructed from solid steel or aluminum. Providing 38 to 45 square ft of solid shade per mature dairy cow is adequate to reduce solar radiation. Shades should be constructed at a height of a least 12 ft with a north-south orientation to prevent wet areas from developing under them. Using more porous materials such as shade cloth or snow fence is not as effective as solid shades.

Holding Pen

The holding pen is where dairy cows probably experience the most heat stress. Putting cows into a holding pen is similar to putting several large furnaces into a small area with the thermostat stuck on 100 degrees F. On most days, cows would benefit from shade over the holding pen and open-sided holding areas to provide ventilation. Installing fans will help ventilate the holding pen. The level of heat stress in the holding pen can be measured by holding a thermometer/hygrometer on a long rod over the top of the cows to determine the temperature and relative humidity. These values then can be used to determine a THI from Figure 1.

Cows can be cooled in the holding pen before milking. This method uses low volume sprinklers to wet cows and large fans to hasten evaporation of the water. In this way, cows are cooled as often as they are milked. Both spray and fans should be operated continuously using approximately 1000 CFM of air per cow per hour. Fans should be mounted overhead at a 30 degree angle from vertical, so that the air will blow down on cows. Water lines in front of the fans spray 7 to 10 gallons of water per hour at 125 to 150 PSI. Fans of 36- to 48-inch diameter are used most commonly. In an Arizona study, body temperature was lowered 3.5 degrees F resulting in 1.7 lb of extra milk per day per cow cooled in the holding pen. Fans and water spray should be used during the summer months whenever the ambient temperature exceeds 80 degrees F (day or night). There also is an advantage in using the fans only when the temperature is between 80 and 90 degrees F.

Exit Lane Cooling

Cows can be cooled as they exit the parlor. Typically three to four nozzles are installed in the exit lane, with a delivery of approximately 8 gallons of water per minute at 35 to 40 PSI. The nozzles are turned on and off with an electric eye or wand switch as the cow passes under the nozzles. If properly installed, the top and sides of the cow are wet but the head and udder will remain dry, so water will not interfere with postmilking teat dipping.

Free Stalls

Free-stall housing should be constructed to provide good natural ventilation. Sidewalls should be 12 to 14 ft high to increase the volume of air in the housing area. The sidewalls should be able to open a minimum of 50% and preferably 75 to 100%. Fresh air should be introduced at the cow's level. Curtains on the sides of free-stall barns allows greater flexibility in controlling the ventilation. Because warm air rises, steeper sloped roofs provide upward flow of warm air. However, roofs with slopes steeper than a 6:12 pitch prevent incoming air from dropping into the area occupied by the cows. Roofs with slopes less than 4:12 may cause condensation and higher internal temperatures in the summer. Roof slopes for free-stall housing should range from 4:12 to 4:16. Providing openings in end walls and alley doors will improve summer ventilation. Gable buildings should have a continuous ridge opening to allow warm air to escape. The ridge opening should be 2 inches for each 10 ft of building width. Naturally ventilated buildings should be spaced a minimum of 50 ft apart.

Additional cooling in free-stall areas can be provided by adding fans and a sprinkler system. Free-stall bedding or sand must not become wet. Typically, a sprinkler system could be located over the lockups, and fans could be used over the free stalls, lockups, or both. The sprinkler system can be put on a timer to reduce water usage.

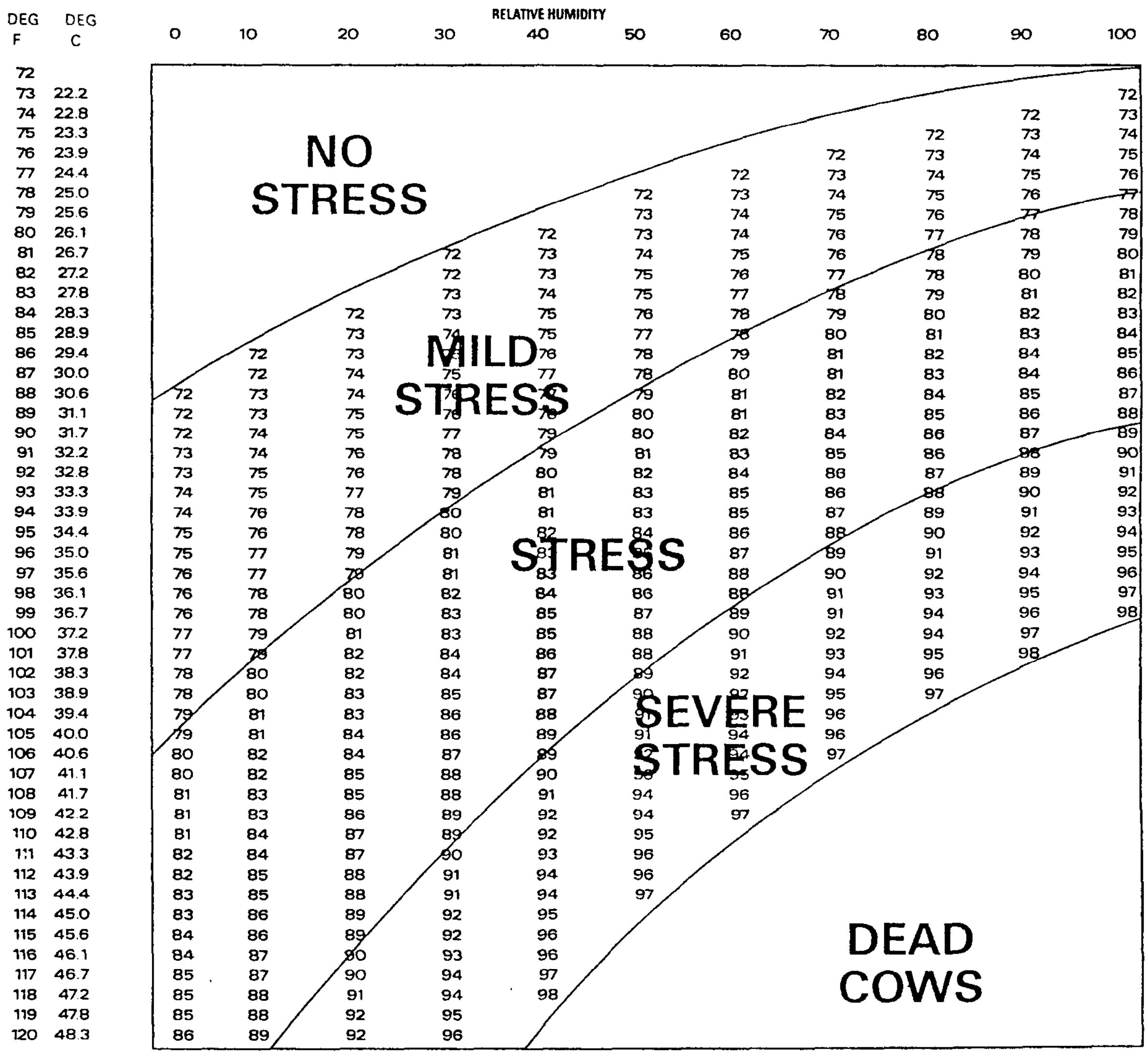


Figure 1. Temperature Humidity Index at Various Combinations of Temperature and Relative Humidity

PLANNING MILKING FACILITIES FOR DAIRY EXPANSION

J. F. Smith

Summary

Construction of a new milking center or remodeling existing milking parlors is a very important decision that can dramatically affect the labor efficiency and profitability of a dairy. Dairy producers should set reasonable goals for present and future needs. All options and configurations of the milking center should be considered and evaluated on a 15-yr planning horizon. Milking parlors should be designed to allow use of a full milking hygiene and add flexibility in management of the parlor.

(Key Words: Expansion, Milking Facilities, Construction.)

Introduction

Size of dairy farms is increasing in all regions of the U.S. In two of the largest dairy states, California and Wisconsin, mean herd size has increased 950 and 250%, respectively, since 1950. Dairy herds of 500 cows are common in all areas of the U.S., and herds over 1500 cows are common in the West and Southeast. Many dairy operators are considering expansion of existing facilities or construction of new facilities to increase efficiency or profitability.

In many dairy operations, the maximum herd size is determined by the daily capacity of the milking center or the land available for manure disposal. In many areas of the U.S., a lack of appropriate acreage on which to apply manure nutrients is one of the largest hindrances to dairy herd expansion. With state and federal environmental regulations continuously becoming stricter, this concern must be addressed seriously.

Constructing or remodeling a milking center is an important business decision that will have an impact on the volume and profitability of the dairy operation for many years. The milking center is the single most expensive facility in a dairy operation. Many large dairies will operate the milking parlor 18 to 20 hr per day to maximize their return on investment. Dairy owners or managers should plan expansion of the operation very carefully. It may be more economical to use hired labor and use the existing milking parlor during more hours per day than to construct a new parlor and reduce milking time to 4 to 5 hr per day. Milking parlor capacity should be determined for present and future needs. If expansion is planned for the future, new facilities need to be designed with the further flexibility in mind.

Financial Evaluation

A financial evaluation to determine the practicality of expansion is extremely important. Research indicated that 68% of expanded dairy operations experienced cash flow problems for 2 yr after expansion, and 34% of these farms had serious cash-flow problems.

Producers who want to expand need to consider: capital available for expansion; return on the dairy expansion compared with use of equity for other investments; and the cash flow benefits from the expansion. Producers typically are required to contribute 30% of the expansion cost in some form of equity.

Several factors can affect milking parlor performance, including the numbers of operators and detachers, operator routine, milking interval, construction, use of a wash pen, and premilking hygiene. Analysis of parlor capacity, capital cost, capital cost per cow, milk output per day, milk output per worker, labor cost per cwt of milk, and annual capital and labor costs should be considered along with cow throughput to maximize utilization of the milking parlor. All options concerning the milking center should be considered, including using an existing parlor during more hours per day, remodeling the existing parlor, constructing a new parlor, using multiple parlors, or adding a hospital barn to increase cow numbers.

During financial evaluation of a project, development of a preliminary facility design is necessary to estimate cost and performance of the expansion. This preliminary design would not have all of the information contained in a final design, but should be of sufficient detail to allow preliminary construction estimates for changes to existing facilities or construction of new facilities. The preliminary design also will be helpful to show the lending institution that the facility is designed properly.

The profitability over a 15-yr planning horizon must be considered carefully. Budgeting for a range of milk and beef incomes and labor and feed expenses will help avoid serious cash-flow problems.

Designing the Milking Center

Performance of milking parlors has been evaluated by time and motion studies to measure steady-state throughput. However, this does not include time for cleaning the milking system, maintenance of equipment, effects of group changing, and milking the hospital string.

The performance of various types of milking parlors has been published, and parlor performance in the U.S. ranged from 25 to 401 cows per hour. Throughputs ranged from 84 to 401 cows per hour in parallel and from 60 to 205 cows per hour in herringbone parlors. Performance within a parlor type or size may vary because of milking frequency, detachers, wash pens, premilking hygiene, number of operators, and operator routine. Whether the milking facility has been remodeled or is new construction also can affect parlor performance. Data collected in parallel milking parlors indicated that milking cows 3× per day versus 2× per day increased throughput by 8 to 10%. The use of detachers did not increase throughput with the same number of operators. Use of a wash pen increased throughput by 8 to 20%. Use of predip milking hygiene reduced parlor performance by 15 to 20%. The average number of cows milked per man hour decreased as the number of operators increased from one to four. If operators use a batch or territorial milking routine in large parlors, throughput can be reduced by 20 to 30%. Steady-state throughput is 10 to 12% higher in new parlors than in renovated parlors. Parlor performance also may be affected by future increased milk production per cow.

Milking parlor size should be large enough to allow flexibility to incorporate premilking hygiene routines. Milking parlors should be sized to incorporate different milking frequencies so that all cows can be milked once in 8 h when milking 2× per day, once in 6.5 h when milking 3× per day, and once in 5 h when milking 4× per day. Using these criteria, the milking parlor will be sized to accommodate the necessary cleaning and maintenance. Milking parlor operators often are put in situations in which the management goals are very difficult or impossible to attain.

Milking parlors need to be designed so that a group of cows can be milked in 30 to 60 min, depending on milking frequency. Observations on commercial dairy farms indicate that a group of cows should be milked in 60 min when milking 2× per day, in 45 min when milking 3× per day, and in 30 min when milking 4× per day to ensure comfort by minimizing time that cows stand on concrete and are kept away from feed. Group size should be divisible by the number of stalls on one side of the milking parlor to maximize parlor efficiency. Cows in the milking parlor can be turned over 4.3 to 4.5 times per hour with 2× per day milking and 4.8 to 4.9 times per hour with 3× per day milking. Observations of commercial dairies milking 4× per day indicate that cows can be turned over 6 times per hour. Considering the effect that milking interval has on group size, the desired milking interval should be determined early in the planning process.

Constructing the outer shell of a new milking parlor involves several options. If no future expansion is planned, the building can be constructed with no room for expansion. This is often done in situations in which acreage is not sufficient for expansion. When long-term plans include expansion, the shell can be constructed with room to add a second parlor or add stalls. If a second parlor is to be added at a later date, usually the two parlors could share a common equipment and milk storage facility. The additional space needed for expansion should be left in the front of the parlor to reduce cow entry time. Holding pens, wash pens, drip pens, and number of cows per group should be sized for the total number of cows that will be milked after the expansion. The building should be ventilated properly to maintain employee and cow comfort. Office, meeting room, break room, and rest room facilities should be incorporated to meet the needs of management.

Another option is to renovate an existing milking parlor if enough acreage is available to accommodate additional pens and waste management needs. If an existing milking parlor is to be updated to include these activities, appropriate measures must be taken to ensure that the waste management system can handle any expected increase in waste water. Storage ponds must be evaluated to guarantee that the proper storage time will be supplied. Finally, crop acreage must be evaluated to determine that the increased amount of manure nutrients will be taken up by the crops planted.

A herringbone parlor often is converted to a parallel or parabone parlor to increase the number of stalls without increasing building size. The distance between the front of the stalls to the wall of the parlor should be a minimum of 6 ft to take advantage of rapid exit stalls. Often exit lane width is too narrow, delaying exit from the parlor. The holding, wash, or drip pen usually needs to be expanded when a parlor is remodeled. The refrigeration system and milk storage may need to be increased to compensate for additional milk. The vacuum system also may need to be upgraded.

After the design of expanded facilities is complete, the financial position of the dairy with the estimated debt load should be reevaluated. Overall cow numbers, production goals, or debt structure may need to be modified.

Construction

Construction of a new facility or remodeling of an existing facility is a time-consuming process. In general, at least 4 to 6 mo are needed to construct a new facility. Because managers want to generate income as soon as possible, cows often are ready to calve before the milking center is complete. Adequate time should be allowed for construction delays from weather and other uncontrollable variables.

Dairy producers remodeling an existing barn need to consider how cows will be milked during renovation. Options include: leasing another facility; constructing temporary facilities; moving cows to another dairy during the construction; or remodeling one side of the parlor while milking cows on the other side. Everything possible should be done to minimize stress on the cows during this process and prevent losses in milk production.

PERFORMANCE OF LACTATING DAIRY COWS FED ALFALFA HAYLAGE TREATED WITH BACTERIAL INOCULANTS AT THE TIME OF ENSILATION

J. E. Shirley, M. V. Scheffel, and R. K. Scoby

Summary

Sixty Holstein cows averaging 65 days in milk at the initiation of a 13-week study were used to evaluate three alfalfa haylages. Haylages were treated at the time of ensilation with either a Pioneer experimental inoculant (Treatment A), no inoculant (Treatment B), or Pioneer brand 1174® inoculant (Treatment C). Cows fed A had greater peak yields and tended to produce more milk than cows fed B and C. Milk fat percentages were 3.7, 3.66, and 3.59 for A, B, and C, respectively. Greater milk yield and butterfat percentage translated into higher (P<.05) daily fat production by cows fed A compared to C but not B.

(Key Words: Lactating Cows, Alfalfa Haylage, Inoculant.)

Introduction

Alfalfa haylage is used commonly as a high protein forage on dairies throughout the U.S. and Canada. Lactating dairy cows fed alfalfa hay or haylage and corn silage in a 75:25 ratio outperformed cows fed other combinations of the two forages in a Wisconsin study. Harvesting alfalfa as haylage reduces field losses and drying time compared to hay. Conversely, alfalfa does not survive the fermentation process as well as corn silage unless well managed because it is lower in readily fermentable carbohydrates. Therefore, fermentation aids that improve nutrient availability and(or) reduce fermentation and feedout losses, should improve the nutritive value of the forage for livestock. The objective of this study was to determine the nutritive value of alfalfa haylage ensiled with bacterial inoculants.

Procedures

Sixty Holstein cows averaging 65 days in milk at the initiation of the 13-week study were used to evaluate three alfalfa haylages. Cows were blocked according to parity, days in milk, and average milk production during the 7 days immediately prior to treatment. Cows within blocks were assigned randomly to either haylage A (a Pioneer experimental inoculant), B (no inoculant), or C (Pioneer brand 1174® inoculant) to provide 20 cows per treatment. All cows were fed a similar total mixed ration (TMR) during a 14-day pretreatment period. Data collected during the 7 days immediately before treatment were used for covariate analysis. Diets were formulated to meet or exceed NRC requirements for 636-kg cows producing 44 kg of energy-corrected milk (Tables 1 and 2).

Experimental haylage, hay, grain mix, and whole cottonseed were mixed in a Roto-mix wagon and fed *ad libitum* as a TMR twice daily. Bunks were cleaned daily prior to the AM feeding. Milk production was recorded daily, and milk samples were collected weekly for analysis of milk components (AM and PM samples composited).

Body weights and condition scores were determined weekly. The average body weights during the first 2 wk and the last 2 wk on treatment were averaged and used to determine body weight change during treatment. All cows were observed daily to assess their health status. Forage samples were collected weekly and composited monthly for analysis (Table 3). Samples of each batch of grain mix were obtained and composited monthly for analysis (Table 3).

Haylage dry matter was determined weekly, and diets were adjusted accordingly. Dry matter feed refusals were determined weekly. Calculations of dry matter intake were determined weekly utilizing the corresponding dry matter of haylage and feed refusals and the monthly dry matter obtained for the dry feedstuffs.

Results and Discussion

Cows fed diet A (Pioneer experimental inoculant) tended to consume more dry matter, produce more milk, and gain more weight than cows fed B (control, no additive) or C (Pioneer brand 1174® inoculant) diets (Table 4). Persistency of lactation from week 2 to week 13 was similar across diets. Cows fed A had greater peak milk yields and consistently produced more milk throughout the study. Extension of the data over a 305-day lactation using the Dairy Herd Improvement formula (each pound of peak milk translates into 250 lb of total lactation yield) indicate that cows fed diets A, B, and C would produce 19,250, 18,646, and 18,315 lb of milk per lactation, respectively. Thus, the net return per cow receiving diet A would be $126 more than the returns for cows fed C, and $81 more than the return for those fed B ($13.50/cwt milk).

Milk fat percentages tended to be greatest in milk from cows fed A, intermediate from cows receiving B, and lowest for cows fed the C diet (3.7, 3.66, and 3.59, respectively). Greater milk yield and butterfat percentage translated into more (P<.05) daily fat production by cows fed A compared to C but not B (P = .30). Milk protein percentage was similar across diets, but yield was slightly higher from cows fed A compared to C (P = .11). Milk protein yield was consistently greater throughout the 13-wk study by cows on diet A, suggesting that alfalfa haylage treated with the experimental inoculant supplied more available protein or energy or both than the control and B-treated haylage. Interestingly, feed efficiency for milk production was similar across treatments, but cows fed A gained slightly more weight. This also supports the premise that the A diet improved the cow's protein status. Evaluation of protein status via total blood amino acid measurements is needed in future studies.

Dry matter intake decreased during weeks 3 and 4 in cows fed A, because the silo contained some inferior haylage resulting from 4-day lag period during the filling process. This depression in intake caused a decrease in milk production from which cows never fully recovered. This did not occur in the B and C haylages, because most of the deteriorated haylage was discarded. Another interesting aspect regarding dry matter intake during the 13-week study was the trend for differences in feed intake. We normally expect dry matter intake to remain relatively constant or decrease slightly during this stage of the lactation cycle. Cows fed diets A and B tended to fit the expected pattern, whereas those that received diet C had increased dry matter intake throughout the study. A plausible explanation for this observation was that the quality of C haylage improved as it was fed out of the silo. In other words, the haylage farthest from the top of the silo was of higher quality because of enhanced oxygen exclusion.

Table 1. Diet Composition (% of Dry Matter)

		Diet		
Ingredient	lb DM	A	B	C
Alfalfa hay	2.7	4.46	4.46	4.46
Alfalfa haylage	22.4	36.96	36.96	36.96
Whole cottonseed	5.4	8.91	8.91	8.91
Soybean meal (48% CP)	2.53	4.18	4.18	4.18
Distilled grain	1.08	1.78	1.78	1.78
Shelled corn	18.45	30.44	30.44	30.44
Meat and bone meal	1.246	2.06	2.06	2.06
Soyhulls	4.49	7.40	7.40	7.40
Wet molasses	.745	1.24	1.24	1.24
Dicalcium phosphate	.136	.22	.22	.22
Ground limestone	.476	.78	.78	.78
Buffer	.527	.87	.87	.87
Magnesium oxide	.136	.22	.22	.22
Trace mineral salt	.187	.32	.32	.32
Vitamins A, D, E	.0765	.13	.13	.13
Vitamin E	.0085	.014	.014	.014
Selenium	.0085	.014	.014	.014
Total dry matter	60.60	100.0	100.0	100.0

Table 2. Composition of Feed Ingredients

	Alfalfa silages				
Item	A	B	C	Alfalfa hay	Grain mix
Dry matter	39.8	40.1	41.0	87.8	87.0
Crude protein	17.65	17.70	17.45	18.6	14.8
Crude fat	1.95	1.95	2.05	1.28	3.56
Crude fiber	30.20	30.33	29.07	30.0	8.14
ADF	36.35	35.70	35.70	35.46	11.70
NDF	44.10	43.60	43.20	47.90	17.0
TDN	59.8	60.5	60.48	60.78	75.82
NE_L	.61	.62	.62	.62	.79
Ca	1.24	1.23	1.18	1.32	1.40
P	.33	.32	.31	.27	.62
Mg	.20	.20	.19	.16	.39
K	2.63	2.58	2.57	2.84	.85
S	.18	.18	.18	.25	.18
NaCl	.80	.76	.78	.45	.98

Table 3. Chemical Composition of Experimental Diets

	Diets		
Item	A	B	C
	% of dry matter		
Crude protein	16.66	16.67	16.58
Crude fat	4.32	4.32	4.36
ADF	23.8	23.6	23.6
NDF	30.8	30.6	30.5
NEL	.74	.74	.76
Ca	1.23	1.23	1.20
P	.50	.50	.49
Mg	.32	.32	.31
K	1.61	1.60	1.60

Table 4. Dairy Cow Performance with Three Alfalfa Haylage Diets

	Alfalfa silages		
Item[1]	A	B	C
No. of cows	20	20	20
Weeks on test	13	13	13
Initial wt., lb[2]	1201	1228	1246
Final wt., lb[3]	1287	1296	1316
Body wt. change, lb	86	68	70
Body condition score			
Initial	2.18	2.28	2.34
Final	2.16	2.27	2.38
DMI, lb/d	55.8	53.1	53.8
Milk yield, lb/day	74.5	71.9	70.8
Milk fat %	3.70	3.66	3.59
Milk fat, lb/day	2.8[a]	2.6[ab]	2.5[b]
Milk protein %	3.09	3.06	3.08
Milk protein, lb/day	2.3	2.2	2.2
FCM, 3.5%, lb/day	77.4	74.3	71.9
ECM[4], lb/day	77.2	74.1	71.7
SCC (× 1000)	139	147	60

[1]Values expressed as least square means.
[2]Average of weeks 1 and 2 of treatment period.
[3]Average of weeks 12 and 13 of treatment period.
[4]Energy-corrected milk.
[a,b,c]Values with different superscripts differ *P*<.05.

PERFORMANCE OF YOUNG CALVES SUPPLEMENTED WITH VITAMINS C AND E AND BETA-CAROTENE

R. H. Greenwood, J. L. Morrill, and J. R. Schwenke[1]

Summary

Newborn Holstein calves were used to investigate responses to supplemental antioxidants provided in daily milk allotments. Treated calves assigned to receive daily 100 IU of d-alpha tocopherol (vitamin E), 5 mg of beta-carotene, and 500 mg of ascorbic acid (vitamin C) in a 5-ml carrier. Control calves received the carrier alone. Additional vitamins C and E and beta carotene did not affect weaning age, weekly or total body weight gain, or dry feed intake. Supplementation of these antioxidants affected bull and heifer calves scour scores differently at different birth weights. Antioxidant supplementation increased the severity of scours during the first week for bull and heifer calves and the second week for bull calves but decreased the severity for heifer calves during the second week.

(Key Words: Antioxidants, Calf Performance, Scours Scores.)

Introduction

Researchers have reported that the antioxidants vitamin C, vitamin E, and beta-carotene enhance immune functions and decrease the severity of scours. Supplemental antioxidants may help overcome stresses to which newborn calves may be subjected, including poor housing environment, extended transportation, and changing environmental conditions. During incidents of disease or other stressful situations, requirements for antioxidants can exceed concentrations required for growth.

Vitamins C and E and beta-carotene appear to interact with each other. Vitamin C regenerates vitamin E, and beta-carotene complements vitamin E and has been shown to increase immunocompetance. Only a limited understanding exists of the interrelationship of these antioxidants when all three are supplemented together. Our objective was to monitor production responses of newborn calves when supplemented with a combination of vitamins C and E and beta-carotene.

Procedures

Forty newborn Holstein calves (25 bulls and 15 heifers) from the Kansas State University dairy herd were used during the fall of 1994 and early winter of 1995. Calves received colostrum soon after birth and transition milk for 2 more days, then were moved to individual hutches bedded with straw and remained there for the 8-wk experiment.

Calves were blocked by age and sex, and calves within blocks were assigned randomly to either a control or treatment group. All calves received daily milk at 8% of initial body weight, divided into two equal feedings. Treated calves received daily an antioxidant combination (Bioglan, Inc., Laguna, CA) that contained 100 IU of d-alpha tocopherol, 5 mg of beta-carotene, and 500 mg of ascorbic acid in 5 ml of carrier. The control group received only the carrier. The supplements were mixed with the afternoon feeding of milk until the calves were weaned. Calf starter (Table 1) was available to all calves in amounts comparable to daily consumption to ensure availability of fresh feed and ad libitum intake. Water was

[1]Department of Statistics.

always available when ambient temperature was above freezing and twice daily for at least 1 hr when temperature was below freezing.

Calves were weaned when dry feed intake exceeded 1.5 lb per day for 3 consecutive days; they had gained greater than or equal to 10 lb since placed on experiment; total dry feed intake was greater than or equal to 7 lb; they appeared healthy; and they had been on the experiment for at least 3 wk. All calves were vaccinated for IBR-PI3, *Pasteurella*, BVD, BRSV, and *Clostridium* spp. (SmithKline Beecham Animal Health Div., West Chester, PA) between birth and 6 wk of age.

Table 1. Ingredients and Chemical Composition of Calf Starter

Ingredient	-- % as fed --
Corn, ground	41.1
Soybean meal	17.9
Oats, ground	15.0
Brome hay, ground	15.0
Molasses	7.0
Coccidiostat[1]	1.3
Binder[2]	1.0
Limestone	.9
Dicalcium phosphate	.4
Trace mineralized salt[3]	.2
Vitamin premix[4]	.2
Selenium premix (.06% Se)	.03
Chemical composition	
DM, %	90.0
	-- % of DM --
Crude protein	15.0
Acid detergent fiber	8.2
Nondetergent fiber	16.7
Ash	7.7

[1]Provided 30 mg of Decoquinate (Deccox®; Rhône-Poulenc Ltd., Atlanta, GA) per lb of feed.
[2]Ameribond 2x®, Lignotech, Greenwich, CT).
[3]Contained 99% NaCl, .007% I, .24% Fe, .05% Mg, .032% Cu, .011% Co, and .03% Zn.
[4]Provided 1000 IU of vitamin A, 140 IU of vitamin D, and 32 IU of vitamin E per lb of feed.

Beginning weight, and weights at 2, 4, and 6 wk and on 2 consecutive days at 8 wk were recorded. Fecal scores (1 = firm to 4 = liquid) were recorded daily. Amount of starter consumed was determined daily and totaled weekly.

Results and Discussion

Weekly and total dry feed intakes and biweekly and total body weight gains are reported in Table 2. Ages at weaning were 28.5 and 29.7 days for calves assigned to treatment and control, respectively. Age at weaning, weekly or total dry feed intake, and biweekly or total body weight gain were not affected by antioxidant supplementation or gender. Others have reported that supplemental antioxidants had no effect on body weight gain, whereas one research group reported that calves that received supplemental vitamin E had more rapid weight gains.

Scour scores of heifer calves with lighter birth weights did not differ from those of control calves during the first week, but bull calves with lighter birth weights had more ($P<.01$) severe scours than control calves. Heifer calves with intermediate birth weights had more ($P<.01$) severe scours than control calves during the first week; bull calves with similar birth weights did not have as severe scours as the heifers, but scours were more ($P<.05$) severe for treated than control calves. Heifer calves with heavier birth weights had more ($P<.001$) severe scours than control calves during the first week, but bull calves with similar birth weight did not have scour scores different from control calves. During the second week of the experiment, antioxidant supplementation decreased ($P<.001$) the severity of scours for heifer calves with light and intermediate birth weights, but increased (P<.001) the severity of scours for bull calves of similar birth weights. Scour scores for bull and heifer calves with heavier birth weights and receiving the antioxidant combination were not different from scores of control calves of similar birth weights.

The decreased beneficial response of antioxidant supplementation in heifer calves of heavier birth weights during the second week could be related to the amount of antioxidant combination received. Because all heifer calves received the same quantity of the antioxidant combination, as body weight increased, the amount of the antioxidant combination received expressed as a percentage of body weight decreased.

The lack of benefit observed in these calves might have been due to adequate antioxidants available in their feedstuffs or because the amount of stress was low. In this experiment, calves were moved less than 200 yards to individual hutches and had ample bedding to keep them dry following birth.

Table 2. Averages of Total and Weekly Dry Feed Intake and Total and Biweekly Gains

	Dry feed intake, lb			Weight gain, lb		
Age, wk	Treatment[1]	Control[2]	SEM	Treatment[1]	Control[2]	SEM
1	3.1	2.6	5.5	—	—	—
2	4.0	3.1	5.5	2.4	2.6	1.6
3	7.7	7.3	5.5	—	—	—
4	16.7	14.1	5.5	17.6	14.3	1.6
5	32.8	27.9	5.5	—	—	—
6	40.7	38.5	5.5	24.6	24.9	1.6
7	63.6	49.7	5.5	—	—	—
8	54.3	54.3	5.5	27.9	28.6	1.6
Total	206.8	194.9	9.2	72.5	70.4	2.9

[1]Received daily 100 IU of d-alpha tocopherol, 500 mg of ascorbic acid, 5 mg of beta carotene in 5 ml of carrier until weaning.
[2]Received daily 5 ml of carrier alone until weaned.

REDUCING BOVINE LEUKOSIS IN DAIRY CATTLE

J. E. Shirley, J. F. Smith, G. L. Stokka,
R. K. Scoby, and T. Van Anne

Summary

Bovine leukosis virus (BLV) is a cancerous condition of tissues in which lymph nodes and lymphocytes are affected. Infected cattle may be identified by testing blood sera for BLV antibodies using the agar gel immunodiffusion (AGID) test that requires 2 days for processing. Most dairy farms have infected animals, but the condition is not considered important because less than 1% of infected cattle show clinical signs. However, many of these cows are culled because of poor milk production or reproductive performance. Procedures for reducing and(or) eliminating the disease are outlined. Results obtained at the Kansas State University Dairy Teaching and Research Center demonstrate that feeding only colostrum and whole milk from BLV-negative cows to newborn and young calves is an effective method of reducing the incidence of BLV in future generations.

(Key Words: Bovine Leukosis Virus, BLV-Free Colostrum.)

Introduction

Most foreign markets demand bovine leukemia (leukosis)-free heifers, semen, and embryos. Economically, this is a reason for concern, because most dairies in the U.S. have at least some cows that are infected. Isolation of the positive-testing cattle along with implementation of new management techniques, which reduce accidental blood exposure from seropositive to seronegative cattle, will reduce the prevalence.

General Description

Bovine leukosis, bovine leukemia, lymphosarcoma, and malignant lymphoma are names given to a retrovirus disease in cattle caused by the bovine leukosis virus (BLV). All of these terms refer to a cancerous condition of tissues in which lymph nodes and white blood cells (lymphocytes) are affected. Because lymph nodes to which white blood cells constantly circulate are located throughout the body, the disease may localize in many areas. True leukemias, where the entire body is affected, are rare. Most often, the condition develops in other organs, if not a lymph node, and is not expressed until the animal is an adult. Cattle with the adult or enzootic form of bovine leukemia are usually 4 yr of age or older, but it can occur as early as 2 yr of age. Many of these cows are culled because of poor milk production (over a period of a few days) and, in some instances, may show poor appetites followed by weight loss. Poor appetite may be due to throat tumors that lessen the ability to swallow. Because the signs of the disease vary, many of the cows infected may be identified as having another problem such as hardware disease, abomasal problems, and spinal cord injuries, especially affecting the rear legs. Abortions and infertility also may occur if the uterus or other reproductive organs are involved. An exploratory rectal palpation is the best diagnostic tool to locate internal tumors, if peripheral lymph node enlargement or exophthalmos are not observed. Bovine leukosis virus-infected cattle often are identified by testing sera for BLV antibodies using the agar gel immunodiffusion (AGID) test that requires 2 days to process. Most dairy cows are infected with the virus, but it often remains in a dormant state until the animal is stressed, such as during extremely hot or cold weather, parturition, or illness. BLV-infected cattle show clinical signs less than 1% of the time, but the number of cows being condemned at the slaughter plants is increasing, suggesting that the number of cows infected is increasing nationally.

Cattle become infected most often after contact with blood from an infected animal. Only .0005 milliliters of blood is needed for the virus to infect a lymphocyte of a healthy animal. Procedures such as injecting, castrating, dehorning, and rectal palpation can spread the virus, as well as blood sucking insects such as horse flies. Balling guns or any instrument that comes in contact with cattle should be sanitized properly after each use. Natural service with a bull also may contribute, because some blood may be transferred during copulation, so artificial insemination is preferred. Calves born to infected dams contract the disease at birth about 5% of the time. Also, any calf fed BLV-positive milk is at a greater risk of contracting the disease. Virus to antibody ratios can be used to determine if a BLV-positive cow will transfer the virus to her calf. Cows exhibiting high virus coupled with low antibody titer tend to transfer the disease to their offspring, whereas cows exhibiting low virus with a high antibody titer tend to transfer immunity to their offspring.

Breeders of registered cattle suffer the biggest economic loss if animals are found positive. Many countries and U.S. companies will not accept animals or animal products infected with the virus. Heifers or semen may be rejected, causing a large monetary loss to the heifer breeder or bull stud owner. Some countries also require dams producing embryos to be seronegative. The economic impact to commercial dairy producers includes reduced performance, treatment and diagnosis costs, on-farm death losses, condemned carcasses, and cost of replacements.

To date, little evidence exists that the disease is transmissible to humans. Pasteurization destroys the virus easily, and at room temperature, outside of living cells, the virus can live for only a few hours. Families that consumed raw milk containing the virus were studied and found to be free of BLV infection. Veterinarians and others who work closely with BLV-positive blood daily have not been infected.

Prevalence in U.S. Dairy Cattle

The National Animal Disease Center reported that the number of cows condemned at slaughter because of lymph node tumors (lymphosarcomas) tripled between 1975 and 1990 and is nine times that found in Denmark during the 1950's before leukosis control and eradication programs began. In 1992, only about 2% of the cows infected with BLV got lymph node tumors. The total number of animals infected with the virus has not been determined, but during the 1970s, about 20% of cows were estimated to be infected. In 1984, some states reported the prevalence of BLV-infected dairy cattle: Wisconsin (22.2%), Florida (47.7%), and Michigan (30%). Beef cows had lower rates ranging from .12 to 6.7%.

The increasing number of condemned carcasses suggests that current management of dairy cows is not preventing further BLV infections. Even though BLV is not easily spread from animal to animal, licking of blood and body secretions can contribute to its transmission. The higher the number of calves housed together, the greater the risk. Housing heifers in larger groups and calf management practices like gouge dehorning, eartagging, and branding can contaminate feed areas and other facilities with blood. Multiple use of the same needle during routine vaccinations, use of unsterilized needles, and not changing gloves during insemination or pregnancy testing also can increase the number of BLV-positive animals.

Elimination Program

Establishing new management and veterinary practices is key to controlling the disease, because no vaccine is available.

Blood testing is the first step, so BLV-positive animals can be identified and grouped separately. Serological test results from animals younger than 6 mo of age may show false-positive results because of colostral antibodies that are still present. Pregnant animals should be serotested at least 6 wk before parturition to prevent false-positive results from immunoglobulins being shifted to colostrum. The separation of infected animals alone will reduce incidence drastically when older BLV-positive cows are replaced by BLV-negative testing heifers.

Recommendations to reduce transmission of BLV follow:

✓ Only single-use disposable needles and palpation sleeves should be used and then discarded.

✓ A complete cleaning should be performed of all surgical instruments (those that come into contact with blood), such as for dehorning, castration, extra teat removal, tagging, and tattooing. These instruments also should be disinfected between uses.

✓ Biting insect numbers also need to be reduced.

✓ All cattle entering the herd should be tested for BLV and isolated for 30 to 60 days. These cattle should then be tested again at the end of the isolation period before entering the herd.

✓ Annual testing should be implemented for all animals. A 3- to 4-mo testing interval is preferred but may be impractical.

✓ Artificial insemination should be used for all breedings.

✓ Neither colostrum nor milk should be used from BLV-positive cows. Milk replacer or pasteurized milk should be fed to calves when BLV-free milk is not available.

✓ Intravenous tubes or needles, like those used to treat milk fever, should be stored in a disinfectant solution, such as Nolvasan, which is a good cold sterilizer.

✓ Calf delivery equipment also should be cold sterilized between uses.

✓ Do not use BLV-positive cows as recipients for embryo transfer. If a highly valuable donor is tested positive, implant embryos in BLV-negative testing cows and test the offspring of the donor to be sure they are BLV-free.

✓ Use smaller pen sizes for calves.

✓ Remove extra teats, insert eartags, and dehorn while calves are housed individually.

✓ Bloodless dehorning methods such as electric, hot iron, or caustic paste are recommended.

✓ Regularly clean feed and water containers to reduce blood contamination.

✓ Perform all veterinary procedures on BLV-positive cows last.

✓ Milk all BLV-positive cows last.

Complete eradication programs should be implemented by dairies that sell heifers, embryos, or semen so they can gain a BLV-free status. Some states have certification programs to identify BLV-free dairy herds. All states have some requirements in common such as: identification of sick animals by regular blood testing, establishing practices and procedures to prevent the spread of any blood or other fluids from BLV-positive to BLV-negative animals, and isolating infected from noninfected animals. Culling rates also may increase to rid the herd more quickly of positive cows and to reduce exposure of healthy animals.

Procedures

Limited published data exist on the incidence of BLV in U.S. dairy herds and even less on the incidence in Kansas herds. Further, information relative to the success or failure of recommended elimination procedures is lacking. A BLV testing and elimination program was initiated in the Kansas State University dairy herd in 1994 to provide data on the incidence of BLV and the effectiveness of using only colostrum and whole milk from cows exhibiting a negative BLV titer to feed heifer calves from birth to weaning.

All lactating cows and cows and heifers due to calve within 30 days were tested during May and June of 1994. The remaining cows and heifers were tested routinely when they were moved to the maternity area approximately 21 days before projected calving date. Colostrum and whole milk from cows testing negative were used to feed heifer calves, whereas colostrum and whole milk from positive-testing cows were fed to bull calves because they would leave the herd at an early age. Procedures to eliminate transfer of the virus by needle, artificial insemination, pregnancy checking, blood sampling, and other mechanical means were instituted in the mid 1980s. Transfer by insect vectors and animal contact remains a possibility.

Results and Discussion

Approximately 55% of the 180 cows tested for BLV in 1994 showed a positive titer. One hundred and eleven (111) cows and heifers were tested for the first time in 1995, and 33.3% tested positive. Eighty-eight heifer calves have been tested for the first time in 1996 (January to August 15), and only 21.5% tested positive. Sixty-five of the heifers tested in 1996 received colostrum and whole milk from cows with a BLV-negative titer and only 12.3% tested positive. The decline in the percentage of positive-titer cows tested for the first time in 1995 is attributed to the fact that most of these were first calf heifers, whereas the 1994 group contained primarily cows in their second or greater lactation. The rationale was that heifers tested prior to 24 mo of age may be infected but do not show a positive titer. To test this supposition, 70 cows that were negative when first tested were retested prior to their next parturition (Table 2), and 17.1% showed a positive titer. These data strongly support the recommendation that all BLV-negative cows should be retested annually to ensure a clean colostrum and milk supply for the next generation. Other studies have suggested that cows tested within 6 wk of parturition may show a false positive test. Our data do not support this suggestion. Thirty-five cows showing a positive titer on the first test were retested, with 33 testing positive and 2 testing negative. The two cows testing negative were confirmed positive with a third test.

The theory has been advanced that calves born to dams testing positive tend to be less susceptible to BLV than cows born to dams showing a negative titer. Results in Table 3 do not support this theory, because 19.4% of calves from positive dams tested positive by 24 mo of age, whereas only 3.8% of the calves from negative dams showed a positive titer. Some reports suggest that 5 to 10% of calves from cows showing a positive titer may acquire the virus by blood transfer during the birthing process. This could account for the increased number of positive titers in calves from positive dams in this study, because all calves reported in Table 3 received colostrum and whole milk from negative cows. However, definitive conclusions on this point should not be made from such a small sample population.

Table 1. Incidence of Bovine Leukosis Virus in the KSU Dairy Herd[1]

Year	No. tested 1st time	No. (+)	% (+)	No. (-)	% (-)
1994	190	104	54.7	86	45.3
1995	111	37	33.3	74	66.7
1996 (Jan - Aug)	88	19	21.5	69	78.5
Program heifers[2]	65	8	12.3	57	87.7

[1]All mature cows were tested in 1994, regardless of stage of lactation. Bred heifers tested 21 days prior to projected calving date. Figures for 1995 and 1996 include only bred heifers tested for the first time 21 days prior to projected calving date.

[2]Heifers that received colostrum and whole milk from (-) cows.

Table 2. Value of Retesting Cows Showing Positive and Negative Titers for Bovine Leukosis Virus[1]

	No. Tested	No. (+)	% (+)	No. (-)	% (-)
(+) 1st test	35	33	94.3	2	5.7
(-) 1st test	70	12	17.1	58	82.9

Table 3. Incidence of Bovine Leukosis Virus in Heifers Born to (+) and (-) Dams

	No.	(+)	% (+)	(-)	% (-)
Dam					
(+)	31	6	19.4	25	80.6
(-)	26	1	3.8	25	96.2
No previous test	8	1	12.5	7	87.5

FLOTATION THERAPY FOR DOWNER COWS

D. C. Van Metre [1], G. St. Jean [1], and J. Vestweber [1]

Summary

Cattle that become recumbent (unable to get up) as the result of calving difficulty, low blood calcium, traumatic injuries, or other disorders are prone to develop subsequent pressure damage of muscles, nerves, and areas of skin. The resulting medical problems that are secondary to prolonged recumbency may be more life-threatening than the initial medical disorder that caused recumbency. Flotation therapy is an effective means of physical therapy for rehabilitation of "downer" cattle. A description of flotation therapy and data from the first year of use of the flotation tank at the Veterinary Medical Teaching Hospital, Kansas State University, are presented.

(Key Words: Downer Cow, Recumbency, Flotation, Physical Therapy.)

Introduction

In cattle, prolonged recumbency resulting from metabolic, traumatic, or infectious diseases is a common challenge in veterinary practice. In many cases, the inciting cause or underlying disease process can be remedied or repaired, and the animal recovers function in all body systems except for one — it cannot stand without support. The classic "alert downer cow" is a frustrating result, and conventional modes of therapy for these cows are frequently unsuccessful. A 1982 study of alert downers in Minnesota found that only one third of affected dairy cows returned to production. The incidence was calculated at 21 cases per 1,000 cows at risk. The mortality rate of cows that become alert downers following postcalving milk fever ranges from 20 to 67%.

During belly or side recumbency, the cow's weight is focused on the downside limb muscles. Prolonged circulatory compromise to these muscles and their nerve supply occurs, creating nerve muscle damage. Muscle groups such as the triceps, tibialis, and biceps femoris frequently are involved. The radial, peroneal, and sciatic nerves that supply these muscle groups may be compressed against nearby bones, creating direct compressive nerve injury. Permanent loss of muscle and nerve function may occur if the patient is very heavy and/or the duration of recumbency exceeds several days. Severe pressure sores, weight loss, and environmental mastitis are frequent additional complications of prolonged recumbency.

On farms, treatment of downer cows is often limited to deep bedding, frequent turning to limit the duration of pressure on any one area, and good general nursing care. Therapy aimed at supporting the downer cow in a standing position has offered the most promise for rehabilitation. A variety of hiplifts, slings, and inflatable beds have been used by veterinarians and dairymen for years, with variable success. These methods have several limitations. Hip lifts are adjustable metal clamps that can be tightened onto the hook bones of the downer cow. The clamps then are attached to a hoist, and the cow is assisted to rise by direct lifting of the pelvic bones. This technique frequently causes pain and pressure sores over the hook bones, and many cows fail to support weight in the forelimbs when lifted this way. A sling is

[1]Department of Clinical Sciences.

a more effective means of supporting the cow, but the manpower required to fit the sling and hoist the cow into a standing position is often a limiting factor. Frequently, the cow can stand with sling support only for a brief period before the straps become displaced and it loses the necessary balanced support.

An inflatable mattress, constructed of thick rubber, is another method of assisting cows to rise. The cow is centered on the deflated mattress, and air is pumped into the mattress to lift the cow off the ground. These devices are difficult to use as a long-term means of support, because the cow frequently will shift its weight off the center of the supporting mattress and fall off to the side.

Recently, portable flotation tanks for downer cows have been used with great success in California and Florida. The flotation tank takes advantage of the tremendous natural buoyancy of cattle to provide balanced support to the cowþs body. While supported by water, the cow can freely move all four limbs, thereby improving muscular strength and circulation. Similar methods of physical therapy are used widely in the human medical field in rehabilitation of patients with severe neural or musculoskeletal injuries. In September 1995, the Veterinary Medical Teaching Hospital at Kansas State University obtained a flotation tank for use in clinical cases.

Experiences with the flotation device at the University of California at Davis (UCD) are encouraging. Preliminary results of over 80 cases treated during 3 yr were presented at the summer veterinary conference at UCD in 1995. A treatment success was defined as restoration of the ability to stand and walk unassisted for a cow that was unable to stand. The success rate for all cases treated by flotation therapy was nearly 55%. The treatment success rate was nearly 80% for downer cattle that did not have a catastrophic injury (e.g., a vertebral fracture) or untreatable medical disorders (e.g., severe fatty liver). An average of 4 to 5 days of flotation was used in successful cases. Cows have been "floated" for up to 18 hr at a time and fed while standing in the tank. The most frequent flotation use was for recently calving heifers suffering from calving paralysis, followed by cows with prolonged or recurrent milk fever. Cattle, sheep, goats, and pigs suffering from a variety of muscular and skeletal disorders have been supported successfully in the float tank (with appropriate water depth adjustments). Successful flotation treatment was reported for toxic mastitis, metritis, and peritonitis cases that were alert after appropriate medical care but suffered from prolonged recumbency.

Procedures

The flotation tank is rectangular, approximately 7 ft long, 4 ft wide, and 5½ ft tall. Its capacity when empty is nearly 800 gallons. The long steel side walls are connected to a steel floor to form a solid single structure. The removable end doors are also steel but are lined by a rubber gasket. The doors fit into brackets on the main structure to form a waterproof rectangular tank. To place a cow into the tank, the doors of each end are removed. The cow is rolled or pulled onto a durable rubber sliding mat. The mat and cow are pulled onto the tank floor by a chain attached to a tractor. Thus, the transport mat becomes the floor of the tank once it and the cow are moved inside. This mat has a treaded surface to provide traction for the cow as she tries to stand.

Once the cow is centered on the tank floor, the tractor chain is detached from the mat and the doors are placed on each end. These are locked in place with large turn screws. The tank is filled with lukewarm water from a hose (or several hoses, to speed the process). Typically, an average-sized Holstein cow will not be able to stand until the water depth approaches approximately 4-5 ft. The tank is filled until the cow can stand comfortably. Apparently, very little effort is required for a cow to stand in neck-deep water, because cows that are unable to stand at all in a sling can stand in the flotation tank for several hours. The air content of the abdominal viscera imparts remarkable buoyancy to cattle; during flotation, an adult Holstein cow can be lifted off of her hind feet by a person lifting the base of the cow's tail.

Depending on the nature of the underlying disease, a cow may spend up to 10 hr in the flotation tank per day. Flotation therapy is apparently a relatively pleasant experience for cattle, because fractious range heifers are relatively calm when being treated. On cold days, it is important to periodically refill the tank with warm water to prevent chilling. A steady water level can be maintained by releasing water from a drain spigot located near the tank floor.

To remove a cow from the tank, the water is released via the drain spigot. Typically, the tank is positioned such that once the front door is removed, the cow can walk onto a surface with good footing and deep bedding. We have used a sand-filled hospital stall for this purpose, although any soft dirt or grass surface should suffice. Once the water is drained, the door is removed, and the cow is allowed to walk out of the tank at her own pace. Hobbles are placed on cows at risk for falling in a splay-legged position. If the cow becomes recumbent during drainage of the tank, the mat can be used again to slide the cow to its bedding area.

The flotation tank can be mounted easily on a 2-wheel trailer. This allows the tank to be transported to field locations close to any cow that becomes recumbent outdoors. When mounted on the trailer, the tank and trailer wheels are roughly 7½ ft wide, which makes it possible for the tank to be maneuvered into most barns or free-stall alleys. Once the cow is loaded into the tank, the tank can be hauled on the trailer to a level area for filling with water. However, the tank cannot be moved once it has been filled with water.

The main advantage of flotation therapy over sling support is that it provides uniform support for standing. No sites on the cow's body are subject to focal pressure from support straps. In addition, cows in the float tank can freely move the limbs to allow for strengthening of muscles and restoration of circulation to muscle beds and skin.

Results and Discussion

The cows treated by flotation therapy at the Veterinary Medical Teaching Hospital, Kansas State University, are listed in Table 1. The treatment success rate for all cows treated by flotation therapy was 47%, which is similar to the success rate experienced by veterinarians at UCD. If cows with catastrophic musculoskeletal and neurologic injuries (Cases 3, 7, 8, and 10) were excluded from the analysis, the success rate for this treatment increased to 63%. Obviously, the efficacy of this form of therapy is influenced by the status and primary disease of the patient selected for its application.

The size limitations of the current float tank are estimated to handle a 1800-lb Holstein cow. One might think that complications such as coliform mastitis would be frequent, but only one cow in the UCD series developed that disease during flotation therapy. When possible, the morning milking should be performed 2 to 3 hr prior to flotation, and a barrier teat dip should be applied. To the authors' knowledge, no drownings or cases of aspiration pneumonia have been caused by flotation therapy. This is due in no small part to careful case selection; only alert animals should be candidates for flotation therapy.

Flotation therapy appears to be most effective when initiated early in the course of recumbency. Cattle that are allowed to remain recumbent for prolonged periods of time are at greater risk of more extensive compression damage to muscles and nerves. In the cases treated by flotation at the UCD clinic, patients that were recumbent for >2 days prior to therapy required more days of treatment for complete cure than patients that had been recumbent for <2 days (unpublished data).

Flotation therapy appears to be a promising form of treatment for cattle suffering from prolonged recumbency. The duration and success rate of flotation therapy are determined by the nature of the underlying disease process and the duration of recumbency prior to initiation of therapy. When compared to conventional forms of therapy for downer cattle, flotation therapy can be maintained for longer periods of time with relatively less effort and time commitment by farm or hospital personnel.

Table 1. KSU Flotation Tank Patients, 10/1/95-9/1/96

Case	Duration of flotation therapy (diagnosis)
Wagyu cow	Floated 4 wk (unilateral pelvic fracture)*
Holstein heifer	Floated 1 day (difficult calving)*
Hereford heifer	Floated 4 wk (forelimb nerve injury obtained during birth)
Holstein cow	Floated 1 day (postcalving low-blood calcium)*
Holstein cow	Floated 5 days (postcalving low-blood calcium, secondary radial nerve paralysis)
Holstein cow	Floated 2 days (postcalving low-blood calcium, mastitis, pneumonia)
Holstein cow	Floated 3 days (spinal tumor)
Holstein cow	Floated 5 days (severe stifle injury)
Holstein cow	Floated 2 days (postcalving low-blood calving)*
Limousin cow	Floated 3.5 mo (multiple pelvic fractures)
Holstein cow	Floated 7 days (difficult calving, postcalving low-blood calcium)*
Holstein cow	Floated 5 days (postparturient hypocalcemia, peroneal nerve paresis secondary to difficult calving)*
Angus heifer	Floated 6 days (dystocia, down for 3 wk prior to admission - secondary muscle necrosis)
Angus cow	Floated 4 days (hepatic lipidosis/pregnancy toxemia)
Adult female llama	Floated 8 days (heat stress)*

*Denotes successful treatments (defined as ability to stand and walk at the time of discharge).

PREVENTIVE HEALTH PROGRAMS FOR DAIRY CATTLE

G. L. Stokka, J. F. Smith,
J. R. Dunham, and T. Van Anne

Summary

Always consult your veterinarian when making vaccination decisions. The most common errors are failing to give booster immunizations and doing so at the incorrect time. Animal comfort is a greater determinant of production than vaccinations, and to receive the full benefits of nutrition, genetic, and management programs, cow comfort must be maximized. This does not lessen the need for balanced rations that allow the immune system to respond efficiently to vaccines. More is not necessarily better. The best vaccination program for a dairy includes vaccines for the most probable infectious pathogens possibly found in the herd. This combination is different for each production unit based on disease problems and management practices that can be identified by your herd practitioner.

(Key Words: Health, Vaccination.)

Introduction

Each producer is urged to establish a herd-specific preventive health program in conjunction with a veterinarian who may provide a risk/benefit ratio and give realistic expectations for each vaccine. It is imperative that animals be healthy and unstressed at the time of immunization in order to maximize immunity obtained after vaccination. This review was designed to be used in consultation with a veterinarian in developing a herd-specific program.

Newborn Calves

Outlined in Table 1 is a suggested vaccination schedule and colostrum therapy for newborn calves. Four to 6 quarts of colostrum should be fed to all newborn calves within 24 hr of birth, with maximum colostral antibody absorption occurring in the first 6 hr. Ingestion of colostrum at birth provides antibodies from the dam. Neglecting colostrum feeding may lead to disease-stricken animals later in life.

Passive immunity is given to calves after intake of colostrum immediately following birth. The quality of the immunity can be improved when cows are vaccinated against various disease-causing organisms through the use of maternal vaccination procedures during the dry period. Colostral antibody protection decreases as the calf ages.

Other recommendations for care of newborn calves follow:

✓ Apply iodine to the navel as soon as possible after birth.

✓ In herds experiencing IBR-PI3 problems, giving intranasal IBR-PI3 at 2 to 3 days of age may be beneficial.

✓ Dehorning and castration should be performed by 2 to 3 wk of age.

✓ Tag or tattoo calves early to provide accurate identification of dam. Remember that brucellosis (bangs)-vaccinated heifers must be ear-tattooed.

✓ Calves should be housed in individual pens within a properly ventilated building or in calf hutches to prevent physical contact.

✓ Feed milk or milk replacer at 8 to 10% of body weight.

✓ Feed waste milk (excess colostrum, noncoliform mastitic milk, and unsaleable milk) when possible.

✓ High quality milk replacer can be fed when more economical than milk.

✓ Milk replacer should contain at least 15% fat and 22% protein and should be fed at or near body temperature.

✓ Maintain sanitary mixing and feeding containers for milk or milk replacer.

✓ Feed starter/grower rations to appetite, with 20% crude protein and a coccidiostat, starting at 3 days of age.

✓ Wean calves between 4 and 8 wk, if they are eating at least 1.5 lb of a starter ration.

✓ After 1 wk of isolation postweaning, sort calves into groups of six according to size, weight, and age.

✓ Monitor fly numbers, eliminate breeding areas, and control adult fly problems.

✓ Reduce heat stress with shade and cool, clean water.

✓ Scours cannot be corrected by vaccination alone. Suboptimal management practices also need to be corrected. Vaccination programs also are not successful when calves are raised on milk replacer rather that colostral milk from the dam.

Replacement Heifers

Suggested vaccination schedules for breeding-age heifers are outlined in Table 2. Consult your veterinarian when developing similar procedures.

Adult Cows

Recommended vaccination schedules for adult dry cows are outlined in Table 3. These vaccinations serve as boosters to initial immunizations that cows should have received during previous dry periods or before their first calving. Several of the recommended immunizations are designed to generate antibodies against scour-causing organisms. Because these antibodies are conferred to newborn calves via the colostrum, calves must be fed colostrum immediately after birth.

Other preventive health measures for cows are outlined in Table 4.

Bulls

Artificial insemination is ALWAYS preferred. If you choose to use clean-up bulls, purchase only virgin bulls, isolate and test them for disease, and follow a rigorous vaccination program such as that in Table 5. After isolation and a negative test for disease, evaluate semen before exposing bulls to breeding females.

Table 1. Vaccination Schedule for Newborn Calves (Birth to 6 Months of Age)

Age or time of administration	Disease/organism	Type of vaccine or therapy
0 to 6 hr	Passive protection	Colostrum
6 weeks	IBR-PI3-BVD-BRSV *Clostridium* spp.	Modified live virus Bacterin/toxoid-7-way
4 to 6 months[a]	Brucellosis	Strain 19 or RB51
6 months	IBR-PI3-BVD-BRSV *Clostridium* spp. Leptospirosis	Modified live virus Bacterin/toxoid-7-way 5-way bacterin

[a]Follow state and federal regulations. Replacement heifers should be immunized between 4 and 12 mo of age. Annual booster vaccinations are not needed. The RB51 vaccine is approved for use in Kansas.

Table 2. Vaccination Schedule for Replacement Heifers (Prebreeding to Calving)

Age or time of administration	Disease/organism	Type of vaccine
Pre-breeding: 10 to 12 months of age	IBR-PI3-BVD-BRSV	Modified live virus
	Clostridium spp.	Bacterin/toxoid-7-way
	Leptospirosis	5-way bacterin
	Vibriosis (optional)[a]	Bacterin
40 to 60 days before calving	IBR-PI3-BVD-BRSV[b]	Killed virus
	Leptospirosis[c]	5-way bacterin
	Calf scours:	
	Rota and Corona viruses[d]	Killed
	E. coli + *Clostridium perfringens*, type C and D[d]	Bacterin/toxoid
3 weeks before calving	Calf scours:	
	Rota and Corona viruses[d]	Killed
	E. coli + *Clostridium perfringens*, type C and D[d]	Bacterin/toxoid
Follow label directions	Coliform mastitis[e]	Bacterins

[a]Use Vibriosis vaccinations when using a herd bull.
[b]Annual booster is necessary.
[c]Vaccination is recommended every 6 mo if a problem exists.
[d]If scours exists, an annual vaccination is recommended.
[e]Cattle must not receive any other gram negative vaccines including: *Pasteurella*, *Salmonella*, *Brucella*, *Campylobacter*, *Haemophilus somnus*, *E. coli*, or *Moraxella bovis* bacterins within 5 days of mastitis vaccines.

Table 3. Vaccination Schedule for Adult Cows

Age or time of administration	Disease/organism	Type of vaccine
40 to 60 days before calving	IBR-PI3-BVD-BRSV[a]	Killed virus
	Leptospirosis[b]	5-way bacterin
	Calf scours:	
	Rota and Corona viruses[c]	Killed
	E. coli + *Clostridium perfringens*, type C and D[c]	Bacterin/toxoid
3 weeks prior to calving	Calf scours:	
	Rota and Corona viruses[c]	Killed
	E. coli + *Clostridium perfringens*, type C and D[c]	Bacterin/toxoid
Follow label directions	Coliform mastitis[d]	Bacterins

[a]Annual booster is necessary.
[b]Vaccination is recommended every 6 mo if a problem exists.
[c]If scours exists, an annual vaccination is recommended.
[d]Cattle must not receive any other gram negative vaccines including: *Pasteurella*, *Salmonella*, *Brucella*, *Campylobacter*, *Haemophilus somnus*, *E. coli*, or *Moraxella bovis* bacterins within 5 days of mastitis vaccines.

Table 4. Other Preventive Health Measures for Cows

Condition	Prophylaxis	Class of cattle	Time or circumstance
Acidosis	Sodium bicarbonate	High producers	High grain feeding: 1.5% of grain mix
Internal parasites	Morantel tartrate	Fresh cows	No withdrawal time
	Fenbendazole (5 mg/kg)	Fresh cows	No withdrawal time
Mastitis control	Monthly SCC	All milking cows	DHIA test day
	Check foremilk	All milking cows	Before each milking
	Teat dip	All milking cows	After each milking
	Dry treat	All cows	At dry-off
	Periodic milk cultures	Problem cows	Antibiotic selection Identify causative organisms
	Review milking procedures	All milking cows	When a problem exists
Foot problems	Foot trim	All milking cows	1 to 2 times annually
	Foot bath	All milking cows	Consult veterinarian
Reproduction	Uterus-ovary exam	Only problem cows	When observed
	Pregnancy check	All bred cows	35 to 40+ days postbreeding

Table 5. Vaccination Schedule for Herd Bulls

Age or time of administration	Disease/organism	Type of vaccine
At breeding soundness examination	IBR-PI3-BVD[a]	Killed virus
	Vibriosis (campylobacteriosis)[a]	Bacterin
	Leptospirosis[a]	5-way bacterin

[a]Annual booster is necessary.

LAMENESS IN DAIRY CATTLE

G. L. Stokka, J. F. Smith,
J. R. Dunham, and T. Van Anne

Summary

Foot problems are major concerns for dairies, and care should be taken to avoid promoting them. Preventive measures, with the aid of a veterinarian, must be followed if the problem is expected to be controlled. Feet should be trimmed or at least observed one to two times per year. High concentrate diets should be fed carefully to avoid acidosis. Cows should have limited time standing on concrete and should not be rushed when walking on any abrasive surfaces. Cows need a clean, comfortable environment in which to lie down. Lame cows need treatment early, and records should be kept on all cases.

(Key Words: Hoof Health, Lameness, Foot Rot.)

Introduction

Feet and leg problems in cows are major health concerns for many dairy farmers. Lameness results in poor performance and substantial economic loss. Nutrition and feeding, housing and environment, concurrent disease, genetic influences, and management factors can predispose cows to foot problems. The greatest incidence (90%) of lameness involves the foot, and of these, 90% involve the rear feet. The most frequent causes of lameness are: laminitis, claw disease, digital dermatitis, and foot rot. Because individual cows often have more than one cause for lameness at the same time, understanding the different types of lameness as well as the treatment and prevention protocols is important.

In 1995, the incidence of clinical lameness in cows was 35% for Florida Dairy Herd Improvement (DHI) herds. Claw problems (sole ulcers and white line disease) accounted for 63% of the reported cases. Digital dermatitis and foot rot accounted for 20% and 17% of the cases, respectively.

Tracking Lameness Problems

Record all lameness problems on the dairy. Use a form provided by your veterinarian for proper evaluation and diagnosis of each case. A case is considered to be new, even in a previously lame cow, if it occurs 28 days after a previous incident.

Economics

Economically, the results of foot disease are much greater than the treatment costs. Reduced milk yields, lower reproductive performance, increased involuntary culling, discarded milk, and additional labor costs account for the largest monetary losses. Studies in New York have shown lameness to be one of the most expensive health problems, at a cost of $90 per cow. Cows with feet problems are usually the same cows subsequently treated for mastitis or reproductive and other health problems. Keeping records on these cows and culling persistent problem cows may be advantageous.

Anatomy

Anatomical deformities can lead to an increased rate of lameness. Ideally, the conformation of the cow's foot should be short, steeply angled, high in the heel, and even clawed. The sole should be somewhat concave, with the majority of the weight placed over the hoof wall. Overly straight hocks, weak pasterns, sickle hocks, splay toes, or overlapping toes commonly are observed with an increase in the rate of lameness. Genetically, these traits have a low heritability in Holsteins (h^2=.08 to .16), so it is not a reliable tool for selection. When possible, select sires based on progeny tests. Phenotypically, the feet and legs of sires should be structurally correct to increase longevity of his daughters in the herd.

Outside claws of the cow's rear legs bear the burden of the continuously changing weight load, and this may be the reason they are damaged more often. The front feet are different in that they bear weight changes more evenly, and when problems do occur, the inside claw usually is affected. The cow's foot is protected by the hoof and its outer structures that do more than just bear weight. The hoof tissue is the first line of defense preventing foreign objects and pathogens from entering the area beneath the hoof, which is the nerve and blood-rich area called the corium (quick) or dermas that produces the hoof horn (wall). The health of the corium establishes the quality of the hoof horn produced. Laminitis, which impairs the health and function of the corium tissues, reduces the quality of the hoof horn formed and, thus, impairs its function. The coffin bone, sometimes affected by laminitis, is suspended within the corium; damage to this bone leads to other problems. The hoof wall is formed at the coronary band (a pink line near the top of the hoof that may appear soft and shiny) and grows at a rate of .2 inches per mo. The area where skin meets hoof is called the periople and, in the back of the hoof, makes up the horn of the heel. The sole is a separate structure made up of underlying corium (touching the ground). The boundary where the sole meets the hoof wall is called the white line. This line may not always appear white but does separate sensitive from nonsensitive hoof, with the area nearer the center being sensitive. This white line also is an important landmark, because it is soft and can be penetrated easily by foreign objects.

Hoof Trimming

Hooves should be trimmed or evaluated once or twice yearly to improve comfort and performance. One of the trimmings should be scheduled early in the dry period. Proper weight bearing on the hoof wall of the inside claw of the front feet and the outside claw of the back feet is especially important. Hoof trimming is stressful for cows. A 10% reduction in milk yield may occur after trimming. However, regular claw trimming may increase longevity of cows by one complete lactation.

Nutrition

Proper nutrition can reduce the number of foot problems. Most lameness problems occur within the first 100 days in milk. Furthermore, laminitis and other causes of lameness can depress feed intake and predispose cows to ketosis, abomasal displacement, and other metabolic disorders. Laminitis often is a result of poor nutrition, but usually no single factor can be blamed. A wide range of variables has been associated with laminitis including: metabolic and digestive disorders; stress associated with parturition; mastitis; metritis; hard or poorly bedded stalls; too little exercise; excessive bodyweight; and poor nutritional management.

Rations that cause acidosis are associated with laminitis. This problem is difficult to manage, because the largest percentage of diets fed to dairy cattle contain concentrates. Fiber, measured using neutral detergent fiber (NDF) and acid detergent fiber (ADF) values, must be at sufficient concentrations and have the right physical form and particle size. Increased particle size increases cud chewing and, therefore, increases saliva production and aids in efficient digestion. Silage should be chopped so that 25% of the particles on a weight basis are over 2 inches long.

Depending on the grain source, the nonstructural carbohydrates should not exceed 40 to 45% of the ration. Grains also must be processed properly to minimize ruminal upsets and maximize starch digestion. Feeding low NDF (below 27% of the ration dry matter) can predispose cows to lameness, metabolic disorders, and overall poor performance. At the very least, ADF should represent 21% of the dry matter fed. Feeding mature hay may be beneficial during times of high risk, because immature forages often do not provide enough fiber.

Having two feeding groups of dry cows can help implement transition rations. Cows expected to calve within 3 wk should be changed to a new diet to help alleviate ruminal stress at parturition. When cows freshen, do not move them quickly to a high grain diet. Even though cows are in a negative energy balance, make a gradual transition. As a preventive measure, all cattle should have rations balanced for calcium, phosphorus, and vitamins A and D for good bone and tissue health. Other helpful nutrient supplementation can come from zinc, copper, molybdenum, manganese, vitamin E. and biotin.

Further preventive measures to reduce acidosis and periparturient diseases include:

✓ Feed high energy rations with a buffer (especially in early lactation).

✓ Allow 2 ft per cow at the feedline.

✓ Provide a continuous supply of fresh feed to prevent slug feeding.

✓ Provide a comfortable environment to encourage cows to lie down for a minimum of 10 to 12 hr per day.

✓ Limit time cows spend standing in holding pens to no more than 3 hr per day.

Because nutrition plays a significant role in foot disorders, changes in the normal pattern of ruminal fermentation tremendously influence claw health. Feed a total mixed ration (TMR) to regulate concentrate-to-forage ratio. Closely observe changes in forage moisture content and modify rations accordingly. Successful feeding programs will maximize feed intake and minimize acidosis, while maximizing energy intake during early lactation.

Housing and Environment

Dairy cattle confined to concrete may have more feet and leg problems. Properly designed and bedded free stalls will encourage cows to lie down. Curb height over 6 inches should be avoided. Cows lying down for more than 10 hr are more content and have fewer claw problems. The number of free stalls should be 10% more than the total number of cows. Watch for behavioral changes caused by heat stress and flies and implement measures to reduce their effects. Providing time for cows to be on dirt or pasture may reduce lameness.

Movement of cows at a fast pace on rough or hard surfaces increases the incidence of lameness. Allow cows to go single file at their own pace to reduce foot abrasions. Wet concrete is 83% more abrasive than dry concrete, and new concrete is more abrasive than old, so special care should be taken when moving cows are on these surfaces. Grooving smooth concrete may be worth the cost in reducing lameness. Rubber mats placed in feedlines and traffic lanes also may prove beneficial.

Laminitis and Association with Claw Disease

Confinement of cows to hard surfaces alone can cause laminitis and claw disease, especially if cows were changed from dirt or pasture to concrete. The outside (lateral) claw of the rear feet and the inside claws of the front feet are affected most often by laminitis. Laminitis or founder is caused by a disturbance in blood flow in the corium that leads to a breakdown of the dermal-epidermal junction of the hoof. This is followed by laminar separation that allows the coffin bone in the foot to become misplaced, which compresses soft tissues and sets the stage for sole or toe ulcers (perforations). The lamina is the sensitive, hoof-tissue-secreting portion of the hoof that becomes inflamed, hence the name, laminitis. Cell death of the corium tissues (necrosis), hemorrhage (bleeding), and edema (swelling) especially of the corium follow laminitis.

Inflammation from laminitis has many causes such as metritis and mastitis, but acidosis is the leading predisposing factor by disrupting the blood supply and its contents to the foot. Clinical signs are observed in calves fed a diet too high in concentrate at 6 mo of age. This opens the door for more severe laminitis as the animal grows older.

Cattle with chronic laminitis (slipper foot) usually have overgrown, disfigured hooves. The coronary band is covered with a rough fringe of horn, and the hoof appears rippled. Because the outside claw of the rear foot is affected most often, cows tend to stand cow-hocked. Abnormal growth in chronic cows may lead to abnormal wear that predisposes the cow to many other lameness problems, such as sole ulcers, white line disease, and abscesses.

Sole ulcers, resulting from necrosis, expose the corium and can dehabilitate the cow. Maturity of the lesion may determine the ulcer's appearance. Together, excessive hoof-horn formation, movement of the coffin bone, and the production of softer solear horn predispose the outside claw to tremendous weight bearing and wear. This lesion occurs because of the increased pressure placed on the heel, and cows often are seen standing with their legs further back than normal. The pain and pressure of the ulcer can be helped with footblocks or shoes applied to the good claw. Never bandage or cut the ulcer or apply anything that will burn the granulation tissue and delay healing. If an ulcer is found in one outside hind claw, the other hind foot likely contains an ulcer, too. The incidence of sole ulcers can be reduced with regular foot trimming, because even weight distribution on the claws is maintained. Toe ulcers are ruptures of the white line caused by the toe bone (coffin) rotating. A ridge may be seen on the wall several months after change to a high concentrate diet. Animals with toe ulcers should not be used for breeding purposes and will be impaired for life.

Hemorrhage and necrosis of the corium are seen most often in the white line, the weight-bearing region of the sole or claw. The hemorrhage is not visible until it rises to the surface of the sole after a few weeks, indicating subclinical laminitis. Subclinical laminitis often is not noticed until after repeated episodes have occurred and it reaches the chronic form. If greater than 10% of mature cows are showing some signs of lameness in a 12-mo period and foot rot or digital dermatitis has been ruled out, then subclinical laminitis may be present. In addition, if 5% or more of the cows are experiencing sole ulcers in a time frame of l2 mo or less, subclinical laminitis may be present.

Cattle also may get what is called by many "white line disease" or subsolar abscesses that can cause acute lameness. Acute laminitis also is caused by grain overload. With white line disease, an abscess will occur in the heel, leading to severe destruction of the joints and tendons. This often is confused with foot rot, but the swelling is confined to the heel of a single claw not in both claws as with foot rot. Often, acutely lame cows show pain in all feet and stand with their front or hind feet extended foreward. Abscesses are caused more commonly by laminitis, because the white line is widened and softer and thus more penetrable. Laminitis also is associated with other diseases. Double souls, heel erosion, horizontal grooves and fissures, and vertical fissures (sandcracks) can occur.

Prevention of laminitis can be accomplished best by reducing ruminal acidosis and controlling periparturient diseases such as metritis and mastitis (see Nutrition section). There is no specific treatment for laminitis, but nonsteroidal, anti-inflammatory drugs are used to control the pain. Hoof over-growth is treated by continuous trimming. Ulcers and abscesses are treated by exposing the damaged area and allowing drainage.

Digital Dermatitis

Foot warts are known by a variety of names including: hairy heel warts; digital warts; strawberry foot; raspberry heel; verrucous dermatitis; digital warts; interdigital papillomatosis; Mortellarl or Mortellaro's disease; and digital dermatitis, which is the most accepted term. Although this is a disease associated with infection, predisposing factors are unknown and its incidence is increasing worldwide, making this a difficult health problem to control. Some closed herds have never developed the disease.

The earliest lesion detectable as digital dermatitis is a reddened circumscribed area typically on the bottom of the pastern (just above the division of the toes around the heels) on the rear feet; it may have hairs matted or erect around the edges to form a rim. This extremely painful disease can be seen occasionally in the front feet or on the front of the rear feet. Cows may stand on their 'tip toes' while trying to relieve the pain of weight on the heels. Purchased cattle (especially bulls) should be examined thoroughly, and if the disease is diagnosed, treatment should follow immediately.

Topical sprays are the least expensive treatment; can be applied directly; have less chance for contamination; and have less chance for residue but may be less effective than other treatments. Cleaning the area before topical sprays are applied is helpful, because the antibiotic is more effective if manure and other debris are removed. Use of antibiotics in treatment is an extra-label use. Consult with your veterinarian for specific implications. To control the disease, keep the herd as closed as possible. Footbaths are somewhat effective. Incidence of the disease is much more common in newly purchased cattle than in existing cows. This indicates that some immunity may exist for cattle previously exposed to the disease.

Foot Rot

Foot rot is a contagious, infective disease most often detected in confinement cattle. It is characterized by a necrotic, foul smelling lesion in the interdigital skin (between the claws) that may extend into the soft tissues of the foot, causing swelling and lameness. The organism thought to be responsible for foot rot (*Fusobacterium necrophorum*) originates in the gastrointestinal tract and is shed into the environment by feces. This bacterium can live freely in the soil or in the internal environment of the animal. A new, more severe form of the disease has been observed recently that may reach the upper leg and, if not treated immediately, has a grave prognosis for infected animals.

Reducing foot rot can be accomplished by housing cattle in dry, manure-free pens that have no debris. Other preventive measures include: footbaths, feed additives, and/or vaccines. Damaging factors leading to foot rot include: stubble fields, small rocks, abrasive surfaces, and high temperatures with high humidity. Isolating infected cattle may reduce the spread of the bacteria to the environment.

Treatment with injectable antibiotics has been successful with or without topical treatment of the wound. Other causes are likely present if the cattle have not responded after 3 days of treatment. The lesion should not be covered or bandaged, and the animal should be housed in a dry, clean environment to promote healing. Other diseases associated with infection besides digital dermatitis and foot rot include infection of the coffin joint and interdigital dermatitis (stable foot rot or scald).

HORMONAL AND BEHAVIORAL CHARACTERISTICS ASSOCIATED WITH THE ONSET OF RADIOTELEMETRIC-DETECTED ESTRUS

J. S. Stevenson, G. C. Lamb, D. P. Hoffman, and Y. Kobayashi

Summary

The objective of this study was to examine changes in ovarian steroids in relation to the onset of first standing estrus detected by pressure-sensitive rump-mounted devices (ABS HeatWatch® [HW]). Twenty Holstein heifers were treated with $PGF_{2\alpha}$ on days 5 to 8 (early) or 12 to 15 (late) of the estrous cycle to induce estrus. The following traits were different (*P*<.05) in early vs late heifers: serum progesterone before $PGF_{2\alpha}$ (2.3 vs 5 ± .3 ng/ml); interval from $PGF_{2\alpha}$ to estrus (HW devices: 42 vs 52.4 ± 2.8 hr or visual: 45 vs 57 ± 2.5 hr); interval (40.6 vs 57.8 ± 2.2 hr) from $PGF_{2\alpha}$ to estradiol-17β (E2) peak concentrations in blood serum (17.7 vs 12.3 ± 1 pg/ml) at estrus; duration of estrous cycle after treatment injection of $PGF_{2\alpha}$ (20 vs 21.4 ± .2 days); interval from onset of estrus to the peak in E2 (1.4 vs –5.4 ± 1.8 hr); and E2 peak associated with the first dominant ovarian follicle of the estrous cycle following the treatment injection of $PGF_{2\alpha}$ (2.2 vs 5.2 ± .6 pg/ml), respectively. Durations of estrus and standing events were similar regardless of when the corpus luteum was regressed during either the early or late luteal phase. When all sexual behavior was evaluated after 41 injections of $PGF_{2\alpha}$, the number of standing events (28.1 vs 16.1 ± 3.1) was greater (*P*<.05) in heifers after early-cycle regression of the corpus luteum. Results indicated that the number of standing events per estrus and concentrations of E2 during estrus were related to the duration of progesterone exposure before a $PGF_{2\alpha}$-induced luteolysis. The first standing event of estrus detected by the HW device corresponded closely to the peak in E2 and LH at the onset of estrus.

(Key Words: Standing Estrus, Hormones, Heifers.)

Introduction

The relationship between the timing of the first standing event associated with estrus and pituitary-ovarian hormonal secretions in cattle is based on some empirical evidence; textbook generalizations; and limited experimental evidence (i.e., frequent blood sampling and less frequent observation for estrus). The importance of identifying the beginning of estrus is critical to the proper timing of artificial insemination (AI) to achieve optimal conception in cattle. The timing of AI-breeding to achieve maximal conception is based on research conducted in the 1940's using freshly collected, liquid semen. From that research, the AM-PM, PM-AM rule of breeding was derived. Cattle should be inseminated in mid to late estrus, which means that those heifers and cows identified in heat during the early AM heat detection period should be inseminated approximately 12 hr later in the PM, and those first detected during the PM should be AI-bred the next AM. Using this procedure, the application of AI has served the cattle industry well. With the advent of radiotelemetry and other computer technology on the farm, we are better able to identify the onset of standing estrus and, therefore, correlate the internal hormonal secretions that are associated with the beginning of heat (increased estrogen or estradiol-17β; E2) and subsequent ovulation that occurs 25 to 30 hr after the preovulatory surge of luteinizing hormone (LH).

Using a model in which the interval between luteal regression and the onset of estrus is temporally different, based on administering

$PGF_{2\alpha}$ at two stages of the estrous cycle, we attempted to examine the relationships between the onset of standing estrus (and associated measures of sexual behavior) and changes in the secretion of luteal progesterone and surge increases in follicular E2 and pituitary LH.

Procedures

Pubertal Holstein replacement heifers were fitted with HeatWatch® (HW) rump-mounted radiotelemetric devices (American Breeders Service, DeForest, WI and DDX, Inc., Boulder, CO) that detect standing events associated with estrus. Heifers were given two injections of $PGF_{2\alpha}$ 14 days apart. A treatment of $PGF_{2\alpha}$ (third injection) was administered either 10 or 17 days after the second injection, corresponding to days 5 to 8 (early; n = 10) or days 12 to 15 (late; n = 10) of the estrous cycle. Blood samples were collected every 12 hr, beginning at the second injection until 7 days after the treatment $PGF_{2\alpha}$ to quantify serum concentrations of progesterone and E2. Blood also was collected via jugular catheters at 2-hr intervals for 48 hr, beginning either 12 or 24 hr after treatment with $PGF_{2\alpha}$, to assess changes in E2 and LH during estrus. Hormones were measured by radioimmunoassays. Heifers were observed visually for estrus 3× daily in addition to constant surveillance of standing activity by HW devices. The number and duration of standing events detected by the HW system were summarized, and relationships among timing of hormonal secretions and these behavioral traits were examined after the treatment injection of $PGF_{2\alpha}$.

Results and Discussion

Ten heifers per treatment averaged 11 mo of age and 778 lb of body weight at the beginning of the experiment. The average periods of the estrous cycle in which the $PGF_{2\alpha}$ treatment injection was administered were 7.7 and 14.1 days for the early and late groups, respectively. By design, the earlier-injected heifers (2.5 ± .3 ng/ml) had less (P<.01) blood serum progesterone than the later injected heifers (5 ± .3 ng/ml).

The duration of estrus and number and duration of standing events were similar in the 20 heifers (Table 1), regardless of the estrus-cycle day in which $PGF_{2\alpha}$ was injected. In contrast, when all 41 estrous cycles were examined in the 20 heifers, those injected early in the luteal phase of the cycle were more active and received more (P<.05) mounts when in estrus than heifers in which heat was induced later in the luteal phase (Table 1).

Table 1. Events Associated with Standing Estrus in Heifers Receiving PGF_{2a} Early or Late in the Estrous Cycle

Item	Early	Late	SEM
No. of heifers	10	10	–
Duration of estrus, hr	10.1	12.4	2.0
No. of standing events (all 41 cycles)	19.4 (28.1)	14.5 (16.8)[a]	3.5 (3.1)
Duration of stands, sec	3.5	3.6	0.3

[a]Different (P<.05) from early heifers.

Intervals to estrus and to peak concentrations of E2 and LH are summarized in Table 2. Early treated heifers received their first mount or stood for the first time in estrus 10 or 12 hr earlier than late-treated heifers, when detected by the HW system or by visual observation, respectively. Therefore, correlation of first-detected standing activities by HW and visual observation (3× daily or every 8 hr) was very good. Comparing hormonal events to the onset of estrus as detected by HW showed that concentrations of E2 reached a peak within 1.4 to 5.4 hr of the first standing event. Peak concentrations of LH followed the first standing event by 4.4 to 6.4 hr. The first standing event of estrus was highly correlated (r = +.79 and +.89) with the interval from $PGF_{2\alpha}$ to the onset of the E2 and LH surges, respectively. Increasing blood concentrations of E2 are produced by the ovarian follicle that will ovulate about 25 to 30 hr after the peak in blood serum concentrations of LH. The peak in E2 induces the sexual behavior associated with heat and triggers the preovulatory release of LH that causes the follicle to ovulate.

The excellent agreement of peak hormonal concentrations with the onset of first standing activity of heifers during estrus confirms earlier reports and assumptions. Insemination of cows and heifers during mid to late estrus seems to be appropriate to achieve maximal conception based on these findings. Recent research to determine the optimal timing of the HW system by researchers at Virginia Tech confirmed that AI-breeding should be done about 10 to 12 hr after the first standing event is detected by the HW system. Because the duration of heat averages 10 to 12 hr, insemination of cattle near the end of estrus should produce the best conception rates.

Conclusions

Duration of progesterone exposure (stage of the estrous cycle and maturity of a dominant follicle) before $PGF_{2\alpha}$-induced regression of the corpus luteum was related to: 1) interval to estrus (estrus occurred earlier when injections were given earlier in the estrous cycle); 2) interval to estrual surges of E2 and LH (well correlated with the onset of heat); 3) concentration of estrual E2 surge (greatest in heifers with the most standing activity); and 4) number of standing events during estrus (greatest in heifers when injections were given earlier in the estrous cycle).

Table 2. Intervals to Onset of Estrus and Peaks in Estradiol (E2) and LH in Heifers Receiving $PGF_{2\alpha}$ Early or Late in the Estrous Cycle

Item	Early	Late	SEM
$PGF_{2\alpha}$ to estrus, hr			
Heat Watch (continuous)	42.0	52.4[a]	2.8
Visual detection (3× daily)	45.0	57.0[b]	2.5
$PGF_{2\alpha}$ to E2 surge, hr	40.6	57.8[b]	2.2
$PGF_{2\alpha}$ to LH surge, hr	46.4	58.8[b]	2.7
Serum E2 surge, pg/ml	17.7	12.3[b]	1.0
Serum LH surge, ng/ml	10.3	11.6	0.7
Duration of LH surge, hr	13.6	15.2	1.6

[a]Different (P<.05) from early heifers.
[b]Different (P<.01) from early heifers.

SUCCESS OF SEVERAL PROGRAMMED AI-BREEDING PROTOCOLS INCLUDING OVSYNCH

J. S. Stevenson, K. E. Thompson, and Y. Kobayashi

Summary

In Experiment 1, four programmed AI-breeding treatments were tested. The so-called OvSynch program, which requires no heat detection before a fixed-time insemination, decreased conception rates compared with a similar treatment in which inseminations occurred after detected estrus (30 vs 51%). The traditional two-injection prostaglandin program produced greater conception rate for cattle inseminated after a detected estrus (53%) than after one fixed-time insemination was given in the absence of estrus (31%). A similar protocol of two prostaglandin injections plus an injection of gonadotropin-releasing hormone (GnRH or Cystorelin®) before one fixed-time insemination produced lower conception rates (33%) than when cattle were inseminated after detected estrus (53%). In Experiment 2, the OvSynch program was retested with the interval between the $PGF_{2\alpha}$ and the second GnRH injection being 48 hr (36 hr in Experiment 1). Conception in 27 cows on the OvSynch48 program with timed insemination (37%) was comparable with 43% in 21 cows on a similar program without the second GnRH injection but inseminated at estrus.

(Key Words: OvSynch, Synchronized Estrus, Conception Rates.)

Introduction

Since prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) was demonstrated to be effective in controlling the estrous cycle for programmed breeding, attempts to develop estrus-synchronization systems for lactating dairy cows and dairy heifers to accommodate fixed-time inseminations have met with limited success. Conception rates following $PGF_{2\alpha}$ usually produced the best results when inseminations were performed after observed signs of heat. Our early attempts to use fixed-time inseminations at first services in lactating dairy cows demonstrated that conception rates were less than desirable.

Follicular development must be controlled and synchronized with the regression of the corpus luteum after $PGF_{2\alpha}$ in order to reduce variation in the intervals to estrus. Precise control of follicular development with the regression of the corpus luteum should allow improved conception rates associated with one fixed-time insemination. Such a synchronized ovulation protocol (OvSynch) has been tested. A first injection of GnRH is administered 7 days before $PGF_{2\alpha}$, and a second injection of GnRH is given 36 to 48 hr after $PGF_{2\alpha}$ to cause ovulation of the dominant follicle via GnRH-induced release of luteinizing hormone (LH). The objective of this study was to compare conception rates achieved in heifers and lactating cows using two versions of the OvSynch AI-breeding protocol with a standard two-injection, prostaglandin protocol commonly used on dairy farms.

Procedures

Experiment 1. Four treatments were used (Figure 1). Treatments A and B were similar. One injection of GnRH (100 µg of Cystorelin®) was given 7 days before one injection of $PGF_{2\alpha}$ (25 mg of Lutalyse®). In treatment A, cattle received a second injection of GnRH 36 hr after $PGF_{2\alpha}$ and then received one fixed-time insemination 18 hr later, whereas cattle in treatment B were inseminated according to the AM-PM rule at the detected estrus after $PGF_{2\alpha}$.

Treatments C and D were similar. All cattle received two injections of $PGF_{2\alpha}$ 14 days apart. In treatment C, cattle received one injection of GnRH 36 hr after the second injection of $PGF_{2\alpha}$ and received one fixed-time insemination 18 hr later. In the last treatment, cattle were inseminated at the detected estrus after $PGF_{2\alpha}$ according to the AM-PM rule, or in the absence of detected estrus, one fixed-time insemination was given at 72 (heifers) or 80 hr (cows) after the second $PGF_{2\alpha}$ injection.

Treatments were applied randomly to replacement heifers (minimum body weight of 800 lb and 12 months of age) and to lactating cows (minimum of 60 days in milk) before first services. Cow and heifers were grouped in 3-wk breeding clusters beginning in July, 1994, and the experiment continued until February, 1996. Conception rates were determined by palpation of the uterus and its contents between 38 and 52 days after insemination.

Experiment 2. Treatments A and B were repeated in lactating cows except that the second injection of GnRH was administered 48 hr after $PGF_{2\alpha}$ (Figure 2). Lactating cows (minimum of 60 days in milk) before first services were grouped in 3-wk breeding clusters beginning in March, 1996, and the experiment is ongoing. Conception rates were determined by palpation of the uterus and its contents between 38 and 52 days after insemination.

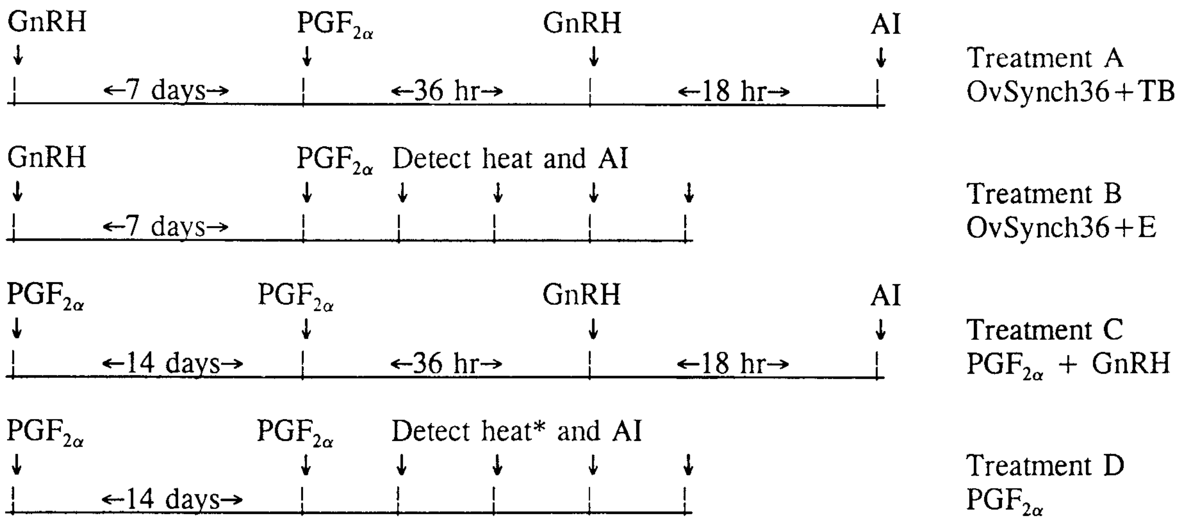
Results and Discussion

Experiment 1. Conception rates achieved in each of four treatments are summarized in Table 1. Conception rate after OvSynch36 + timed insemination was less (P=.01) than that after insemination at estrus (treatments A vs B). Conception rate after two injections of $PGF_{2\alpha}$ was greater (P<.01) when inseminations were performed at estrus (treatment D) than after one fixed-time insemination in which ovulation was induced by GnRH after the second $PGF_{2\alpha}$ injection (treatment C) or after one fixed-time insemination at 72 or 80 hr in the absence of detected estrus (treatment D).

Experiment 2. Although conception rates in lactating cows after OvSynch48 + timed insemination seem to be similar to those after a similar treatment + inseminations at estrus (Table 2), only a limited number of cows have been tested. Of 29 cows in the latter treatment, only 21 were detected in estrus during 5 days after $PGF_{2\alpha}$ (72% heat detection rate). Conception rate of the remaining 8 cows inseminated at estrus induced by another $PGF_{2\alpha}$ injection given 14 days was 37%. One advantage of the OvSynch protocol + timed insemination is that its success is independent of heat detection rate.

Conclusions

Recommended use of the OvSynch protocol is to administer GnRH on Monday, followed by $PGF_{2\alpha}$ on the following Monday at milking time (5 PM); the second GnRH injection at 5 PM on Wednesday (48 hr later); and inseminate cows on the next morning (Thursday) between 8 and 10 AM (Figure 2). If you do not want to use the timed insemination, give GnRH (Monday) and follow it with $PGF_{2\alpha}$ in 7 days (Monday) and watch for heat. For inseminations with this system, follow the AM-PM rule when heat is detected. Do not use this protocol in replacement heifers, because results are inferior to what can be achieved with a $PGF_{2\alpha}$ protocol.



*In absence of detected heat, heifers were inseminated at 72 hr and lactating cows at 80 hr after the second $PGF_{2\alpha}$ injection.

Figure 1. Treatment Protocols for Experiment 1.

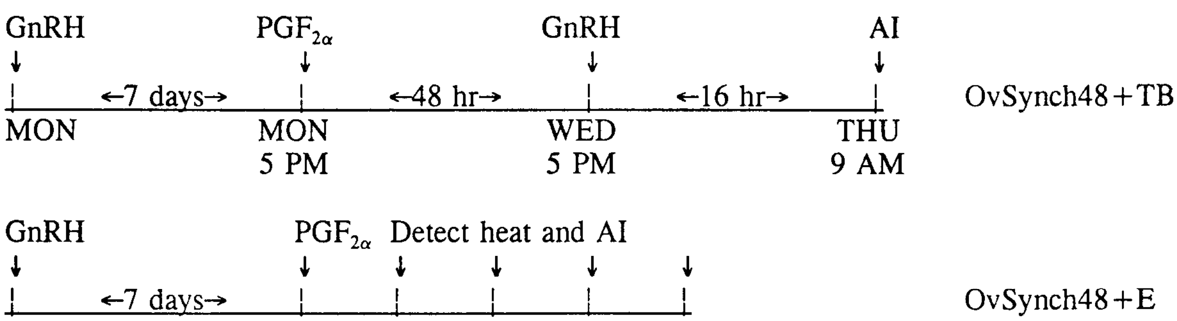


Figure 2. Treatment Protocols for OvSynch48 in Experiment 2.

Table 1. Conception Rates after Various Programmed AI-Breeding Treatments in Replacement Heifers and Lactating Cows (Experiment 1)

Treatment	No.	%
A: OvSynch36 + TB (AI at a fixed time)	98	30[a]
B: OvSynch36 + E (AI at estrus)	85	51
C: Two injections of $PGF_{2\alpha}$ + TB (AI at fixed time)	90	33
D: Two injections of $PGF_{2\alpha}$ (AI at estrus or at 72 or 80 hr)	148	42
AI at estrus	73	53[b]
AI at 72 or 80 hr	75	31[c]

[a]Different (*P*=.01) from treatment B.
[b]Different (*P*<.01) from treatment C.
[c]Different (*P*<.01) from treatment D (AI at estrus).

Table 2. Conception Rates after OvSynch48 in Lactating Cows (Experiment 2)

Treatment	No.	%
OvSynch48 + TB (AI at a fixed time)	27	37
OvSynch48 + E (AI at estrus)	21	43

PROBIOTIC FROZEN YOGURT CONTAINING HIGH PROTEIN AND CALCIUM

M. S. Forbes, I. J. Jeon, and K. A. Schmidt

Summary

A new frozen yogurt manufacturing procedure that is easily adaptable to the current practices of the frozen yogurt industry has been developed with probiotic culture and ultrafiltrated milk. The ultrafiltrated milk was heated to 185 degrees F for 35 min to obtain a desirable gel structure when fermented with the traditional yogurt culture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. Probiotic cultures (*Bifidobacterium* and *Lactobacillus* spp.) were added to the yogurt mix just before freezing. The yogurt mix was frozen to an 85% overrun and hardened at -20 degrees F. The frozen product contained viable culture organisms at greater than or equal to 10^7 cells per gram and was stable for 6 mo. The frozen yogurt also contained twice the amount of protein, three times as much calcium, and nearly one-third less lactose than similar commercial products. The new product had excellent flavor, body, texture, and overall quality.

(Key Words: Frozen Yogurt, Ultrafiltrated Milk, Probiotic Bacteria.)

Introduction

The evolution of frozen yogurt has covered a span of over 25 yr, and the product has grown into a multimillion dollar segment of the dairy industry. Future sales of frozen yogurt are predicted to grow at an annual rate of 3.7% through 1998. Although the early years of frozen yogurt production resulted in a product that did not meet consumer expectations relative to flavor and body/texture, progress has been made and several higher quality products are now on the market. However, over this quarter century, very little progress has been made in the creation of a standard of identity for frozen yogurt. Thus, great variation still exists in quality and definition (cultured vs. uncultured). Consequently, consumers are looking for a frozen yogurt that is healthy, nutritious, and good-tasting, and, at the same time, is representative of what is expected in a frozen yogurt.

According to the standard of identity recommended by the International Ice Cream Association, frozen yogurt should have high levels (greater than or equal to 10^7 cells/g) of viable lactic acid bacteria and a titratable acidity of at least 0.3% (as lactic acid) in the finished product. Our objective was to develop a new type of frozen yogurt that meets not only the recommended standard but also contains a high level of probiotic bacteria and calcium. To achieve this objective, we utilized ultrafiltrated milk and probiotic lactic acid bacteria cultures. Our specific objectives were to: 1) formulate a frozen yogurt with ultrafiltrated milk that contains high contents of protein and calcium but low lactose; 2) optimize a manufacturing procedure that can be adapted easily to the frozen yogurt industry; and 3) maintain a combined population of probiotic bacteria and traditional yogurt cultures of at least 10^7 cells per gram in the finished product.

Procedures

Skim milk was ultrafiltered to a solids level of 20% using an Abcor Model 1/1 Sanitary Pilot Ultrafiltration Unit. The ultrafiltrated milk was adjusted to 4% milkfat by adding cream. Part of the milk was cultured with yogurt bacteria until a titratable acidity of 1.3% was reached. The yogurt was then homogenized (1700 psi, 108 degrees F) and cooled to 35 degrees F. The other part of the ultrafiltrated milk was adjusted with cream and solids (nonfat dry milk, cane and corn sugars, and stabilizer) to create a base mix. The mix was pasteurized at 185 degrees F for 30 min, cooled to 165 degrees F, homogenized at 1700 psi, and further cooled to 35 degrees F. Then the fermented portion of ultrafiltrated milk (15%) was blended with 85% base mix to attain a total solids content of 36%. Probiotic bacteria cultures (*Bifidobacterium bifidum* and *Lactobacillus acidophilus*) were added at the same time as flavoring material (vanilla) and color (caramel). After mixing for 15 min, the yogurt mix was frozen in a continuous freezer to an overrun content of 85% and immediately placed in a hardening room (-20 degrees F for 24 hr). The frozen yogurt samples were tempered to 40 degrees F for 24 hr before evaluation of chemical, physical, microbiological, and sensory characteristics.

Results and Discussion

When ultrafiltrated milk was fermented with yogurt culture, a strong lumpy gel was formed, which was overcome by heat treatment. Heating the milk at 185 degrees F for 35 min before fermentation was found to be essential for giving a "blendable" (smooth, peanut butter-like) gel structure. Fermentation of the ultrafiltrated milk to a titratable acidity of 1.3% was sufficient to attain a recommended acidity (.3%) in the yogurt mix when the two portions (fermented and base mix) were blended in a 15:85 ratio. The use of the traditional yogurt cultures to ferment the culture portion and addition of *B. bifidum* and *L. acidophilus* to the mix immediately before freezing are unique in this process.

The probiotic culture organisms added were stable in the finished product at acceptable levels (greater than or equal to 10^7 cells/g) for up to 6 mo. Use of ultrafiltrated milk in the manufacture of the product resulted in a high protein, high calcium, frozen yogurt. Protein level in the product averaged 9.32%, representing approximately a 100% increase over average commercial products in the same fat category. Calcium content (.35%) was approximately threefold higher than that for similar commercial products. Lactose content (2.3%) was 39% lower than the average of selected commercial samples. Sensory analyses indicated that the product possessed positive attributes when compared to commercial samples. For overall flavor, our yogurt samples scored a mean of 8 on a 10-point scale, whereas commercial sample means ranged from 6.0 to 7.1. In body and texture, our samples scored the highest (8.1), with commercial samples scoring as low as 5.2. Our samples had a mean value of 8.2 for overall quality, whereas the commercial samples ranged from 5.7 to 7.0. Individually, no heavily criticized defects were detected in any of our samples. These sensory results suggest that our product should be highly acceptable to consumers.

Frozen yogurt attributes such as high protein, high calcium, and the presence of a high level of probiotic bacteria can be very desirable to consumers. In addition, the reduced lactose level of the product, as well as potential high activity of the enzyme lactase from probiotic organisms, also may be attractive to individuals who have lactose intolerance or maldigestion problems.

FACTORS AFFECTING TITRATABLE ACIDITY IN RAW MILK [1]

K. Schmidt, J. Stupar, J. Shirley, S. Adapa, and D. Sukup [2]

Summary

The value of titratable acidity (TA) as an indicator of raw milk quality has been challenged recently, because milk is refrigerated within minutes after it leaves the cow until it reaches the consumer. Also, high milk protein may interfere with the test or confer falsely high TA values. Samples of milk containing <2.8% protein to >3.8% protein were used to examine the impact of protein on TA. The effects of milk age and bacterial counts also were investigated. Titratable acidity increased as milk protein content increased but the influence of bacterial populations and age were much more dramatic. As bacterial counts increased, TA values surpassed an acceptable level (upper maximum at .17%) for the KSU Dairy Processing Plant. At the same time, as raw milk increased in age, TA increased to the upper level of acceptability (.17%). Thus, TA appears to be a valid method of evaluating raw milk quality even though it can be influenced by the protein content.

(Key Words: Titratable Acidity, Raw Milk Quality.)

Introduction

Raw milk quality is an important issue to both dairy farmers and processors, because it affects the end product use and, hence, economic value. Currently, raw milk quality is determined by fat, protein, total solids content, bacterial counts, and somatic cell count (U.S. Department of Health and Human Services, 1993). Titratable acidity is not one of the pay factors listed on the milk check but has a strong economic impact, because it is one of the criteria used to determine whether or not raw milk enters the food chain as a premium-priced fluid product.

Titratable acidity (TA) is a rapid test (90 seconds to perform) indicating raw milk quality and provides an indirect measure of the acid content in milk. Generally, as milk acid content increases, TA values increase. All milk has a base acid content attributed to proteins, minerals and dissolved gasses.

Milk acid content is increased by the bacteria that convert lactose to lactic acid. When this occurs, a dramatic increase in TA value is observed. At the same time, milk has a strong buffering capacity (resisting a change in the acid or alkali content) because of its protein content. Because these proteins resist a change in the acid or alkali content, they, too, contribute to the “acidity” of milk.

Titratable acidity has been used for many years to indicate whether milk has undergone bacterial degradation (acid production) or temperature abuse or is aged. Because raw milk refrigeration is mandated by law, bacterial degradation and temperature abuse are no longer as prevalent as they once were. Thus, TA values are fairly predictable, and high quality raw milk has a relatively steady TA value ranging between .14 to .17% (expressed as lactic acid).

Today, two major factors impact the TA of raw milk: age and protein content. Raw milk

[1] The authors acknowledge and thank Mr. Mike Scheffel and others at the KSU Dairy Teaching and Research Center for their assistance in obtaining raw milk samples.

[2] Heart of America DHI, Manhattan, KS.

can be several days old before it is processed, because manufacturing centers are larger and fewer in number. Thus, as milk ages, bacteria grow and subsequently decrease raw milk quality. Dairy cows are selected for increased milk protein content that tends to increase the TA value such that the TA range of acceptable raw milk may change. Thus, it is appropriate to study factors that have the greatest effects on the TA of raw milk.

Procedures

Raw milk was obtained from the KSU dairy herd and kept cold (<45 degrees F) until testing. Milk samples were divided in half with one half used to determine somatic cell count (SCC) (Bently Model #500; Bently Instruments, Inc., Chaska, MN) and protein and fat contents (Bently Model #2000-M Infrared Analyzer) by the Heart of America Dairy Herd Improvement Laboratory, Manhattan, KS. The other half was used to determine pH, TA, and bacterial counts by total aerobic plate counts (TPC) using approved methods at the KSU Dairy Processing Plant. All tests were done in duplicate, and at least three replications were conducted for all trials.

Trial 1. Effect of Protein Content. KSU Holstein cows were selected and grouped based on their milk protein content. Cows were grouped into four categories: high >3.8%, med-high (3.2-3.4%), med-low (3.0-3.2%), and low (<2.8%). At least 10 cows were placed into each group. Milk samples were obtained and analyzed within 24 hr.

Trial 2. Effect of Raw Milk Age. Raw milk from KSU Holstein cows was obtained, mixed, and then held at 43 degrees F. Starting at 6 hr and every 24 hr later, milk was tested for up to 5 days (96 hr).

Trial 3. Effect of Microbial Content. Raw milk from KSU Holstein cows was obtained and analyzed for total aerobic counts. Milk was evaluated for quality after creating three categories; low (~1,000 cfu/ml), medium (~1,000,000 cfu/ml), and high (~10,000,000 cfu/ml) microbial numbers.

Results and Discussion

Table 1 shows the effect of protein content on the TA values of raw milk. These values clearly indicated that as protein content increased, so did the TA value. It is important to note that, although the protein content varied over 1%, whereas the TA values differed by only .03%.

Overall, the quality of these raw milk samples was relatively similar. The pH values varied somewhat but are consistent with the protein and solids contents of these milk samples. Because protein and fat contents increased simultaneously, the increased TA value was expected. Total plate count (TPC) values were similar, indicating good control over temperature and a sound sanitation program at KSU.

Table 2 shows the results of milk age on the TA of raw milk. As can be seen from this table, TA value increased as the raw milk aged. Within 5 days, the TA value increased from .15 to .17%. At the same time, bacterial counts (TPC) increased dramatically (560 to >120,000 cfu/ml). This trial demonstrated that, even at refrigerated temperatures (43 degrees F), TA increased over time, most probably because of microbial growth. The other factors (protein content, fat content, and pH) remained constant during this 5-day period.

Table 3 shows the effect of bacterial counts (TPC) on the TA of raw milk. As the microbial populations increased, the TA value increased dramatically. This dramatic increase illustrates the historic implication of using TA as an indication of undesirable bacterial growth in milk. The first two samples shown in Table 3 may be considered acceptable as Grade A milk, if TA and pH values are disregarded as quality factors. However, the third sample contained too many bacteria to be considered for Grade A milk processing. The pH of this third sample also indicated that the milk proteins were destabilized, making it unsuitable for any manufactured milk product.

From the point of view if a processing quality program, these data indicate the importance of considering several factors when assessing raw milk quality. As bacterial counts and TA values increase and pH decreases, raw milk becomes more unsuitable for production of milk or a milk product that has desirable flavor, odor, appearance, and shelf life. Quality of the finished product can be only as good as the quality of the incoming raw materials. Therefore, processors often set acceptable limits or ranges on fat content, protein content, TPC, pH, and TA to determine what raw milk will be accepted into the processing plant.

Conclusions

This work shows that the factor having the greatest effect on the TA value of raw milk is bacterial content. As bacterial numbers increase, the quality of raw milk decreases and the TA value increases. Protein content can influence the TA value significantly, but not to the extent of bacterial numbers. Therefore, to control the bacterial numbers in raw milk, it is important to emphasize thorough cleaning and sanitizing procedures around all milk contact surfaces and to maintain milk at a low temperature (<43 degrees F) at all times.

Table 1. Effect of Protein Content on the Titratable Acid (TA), pH, Total Plate Counts (TPC), Fat Content, and Somatic Cell Counts (SCC) of Raw Milk

Category	Protein, %	TA[1]	pH	TPC[2]	Fat, %	SCC[3]
High	3.86 ± .34	.18 ± .01	6.83	2.3	4.28 ± .32	139 ± 97
Med-high	3.25 ± .19	.16 ± .02	6.90	3.7	3.90 ± .35	95 ± 104
Med-low	3.12 ± .16	.15 ± .02	6.90	1.7	3.25 ± .29	143 ± 111
Low	2.58 ± .09	.15 ± .01	6.87	1.5	3.25 ± .17	16 ± 6

n = 12.
[1]Expressed as % lactic acid.
[2]Multiplied by 1,000.
[3]Multiplied by 1,000.

Table 2. Effect of Raw Milk Age on the Titratable Acid (TA), pH, Total Plact Counts (TPC), Fat Content, Protein Content, and Somatic Cell Counts (SCC)

Age, hr	TA[1]	Protein, %	pH	TPC[2]	Fat, %	SCC[3]
0	.15 ± .01	3.00 + .24	6.58	.56	3.93 ± .25	153 ± 156
24	.15 ± .02	2.97 ± .25	6.59	.57	3.78 ± .34	123 ±105
48	.16 ± .01	2.98 ± .24	6.60	6.2	3.78 ± .39	117 ±102
72	.16 ± .02	2.96 ± .20	6.63	99	3.77 ± .37	122 ±104
96	.17 ± .02	2.98 ± .24	6.59	120	3.79 ± .36	129 ±109

n = 3.
[1]Expressed as % lactic acid.
[2]Multiplied by 1,000.
[3]Multiplied by 1,000.

Table 3. Effect of Microbial Counts on the Titratable Acid (TA), pH, Total Plate Counts (TPC), Fat Content, Protein Content, and Somatic Cell Counts (SCC) of Raw Milk

TPC[1]	TA[2]	pH	Protein %	Fat %	SCC[3]
1.3	.17 ± .01	6.66	3.76 ± .02	3.70 ± .21	96 ± 14
310	.24 ± .02	6.25	3.73 ± .38	4.20 ± .68	177 ± 77
1800	.60 ± .20	4.90	3.30 ± .03	3.50 ± .01	209 ± 13

n = 3.
[1]Multiplied by 1,000.
[2]Expressed as % lactic acid.
[3]Multiplied by 1,000.

ACKNOWLEDGMENTS

Appreciation is expressed to the following organizations for their support of dairy teaching, research, and extension at Kansas State University:

21st Century Genetics, Shawano, WI
American Breeders Service, DeForest, WI
Associated Milk Producers, Inc., Wichita, KS
Eli Lilly and Co., Greenfield, IN
Heart of America Dairy Herd Improvement Association (DHIA), Manhattan, KS
Hoffmann-LaRoche, Nutley, NJ
International By-Products, Des Moines, IA
Iowa Limestone, Des Moines, IA
Jet-Pro Co., Atchison, KS
Kansas Agricultural Experiment Station, Manhattan, KS
Kansas Artificial Breeding Service Unit (KABSU), Manhattan, KS
Kansas Grain Sorghum Commission, Topeka, KS
Kansas Soybean Commission, Topeka, KS
Kemin Industries, Inc., Des Moines, IA
Midwest Solids, Atchison, KS
Miley Equipment Co., Emporia, KS
Monsanto Company, St. Louis, MO
National By-Products, Omaha, NE
Pharmacia & Upjohn, Kalamazoo, MI
Pioneer Hi-bred International, Inc., Des Moines, IA
Rota-Mix, Dodge City, KS
Rhône-Merieux, Athens, GA
Select Sires, Plain City, OH

Appreciation is expressed to Eileen Schofield, Associate Editor of the Kansas Agricultural Experiment Station for editing; to Valerie Stillwell, Brandy Nowakowski, and Diana Loomis for typing the contents of this publication; and to Bob Holcombe for the cover design. The following departments at Kansas State University are recognized for their cooperation and contribution to our dairy research program:

Biological and Agricultural Engineering
Clinical Sciences
Statistics

Contribution No. 97-115-S, from the Kansas Agricultural Experiment Station, Kansas State University, Manhattan 66506. Trade names are used to identify products. No endorsement is intended, nor is any criticism implied of similar products not named.

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.

Agricultural Experiment Station, Kansas State University, Manhattan 66506-4008

SRP 771 October 1996