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Louisiana Dairy Report

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2004 Louisiana Dairy Report

Editor

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TO DAIRY PRODUCERS AND READERS OF THE LOUISIANA DAIRY REPORT

We are very pleased to provide you with a copy of the 2004 Louisiana Dairy Report. This report is a joint effort of the dairy science faculty in the Department of Dairy Science on the LSU campus in Baton Rouge, those at the Hill Farm Research Station in Homer, and those at the Southeast Research Station in Franklinton. We hope this report will give you some insight into our programs and provide you with useful information.

The LSU Agricultural Center and the LSU College of Agriculture have the mission of providing comprehensive programs in research, extension and teaching related to the various agricultural commodities to the citizens of Louisiana. The units cooperating in this report are charged with discovery and application of new knowledge through research in dairy science and the transfer of this knowledge through on-campus classroom instruction and adult education programs.

The dairy industry is one the major agricultural industries of Louisiana. Total income from milk and animal sales to Louisiana dairy producers in 2003 was $71.8 million. Processing and retail sales added $111.4 million to the on-farm value of milk. The total economic contribution to the state's economy from dairying, including value-added and animal sales, was more than $183 million.

We hope you will find this report informative and useful. Please feel free to contact the faculty involved with individual reports if you need additional information or help in their areas of expertise.

Sincerely,

Bruce F. Jenny	W. Allen Nipper	Michael E. McCormick
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Table of Contents

Topical Papers

AN INDUSTRY APPROACH TO INCREASING THE CONSUMPTION OF DAIRY PRODUCTS

Bridget Lyons, Undergraduate Student, Department of Dairy Science

Got soda? Yes, that's right, soda. Believe it or not, today's American youth are asking for soda rather than milk. Why is it a problem? It's a problem because of the lack of dairy product consumption by today's American youth. For example, NBC nightly news reported on a teen-age boy who broke his arm and went to the doctor to have his bone set. Once the arm had healed and the cast was removed, the boy broke another arm within a month. According to his doctor, this young man did not satisfy his requirements for calcium, so his bones were weak and unhealthy. As a result, his parents began to incorporate dairy foods into the family's daily diet.

As this story shows, there is a lack of knowledge concerning the consumption of dairy foods and its importance to our nutritional well-being. According to research conducted by the USDA, the consumption of soda has steadily increased in the past 40 years while the consumption of milk has continually declined. In related research at the Mayo clinic in Rochester, Minn., there has been a 42% increase in fractures in kids and young adults. The researchers at Mayo found a direct link between the kids drinking more soda and less milk and an increase in fracture rates. The researchers are concerned that today's youth are not receiving the recommended amount of calcium in their diets, with the result being weaker bones, more fractures and possibly osteoporosis later in life.

Providing Americans with the appropriate recommendation of nutritional needs, the U.S. government's Food Guide Pyramid recommends 2-3 servings of dairy products each day. This amount increases for teens, young adults, pregnant and nursing women and women who want to prevent osteoporosis; all of whom need at least 4 servings of dairy products a day. This information shows that dairy products are an essential part of our health and nutritional needs.

Milk and dairy products offer a range of well-known health benefits, the best-known being calcium. In addition to being rich in calcium, milk and other dairy products contain important nutrients for bone health such as vitamin D (if fortified), phosphorus and magnesium. Drinking milk also increases one's likelihood of getting enough vitamin A, folic acid and vitamin B_{12}. While there are many sources of calcium, the relationship between milk consumption and calcium intake is so strong that the likelihood of achieving the recommended level of calcium increases by 25% to 37% with each ounce of milk consumed.

Some may feel that, as an industry, we should not have to worry about consumers getting proper amounts of calcium. But, by taking action to promote increased consumption, we are indeed helping ourselves by selling more milk and dairy products. In 1984, the Dairy Check-Off Program was implemented. Dairy producers pay 15 cents per hundredweight into the program that is supported by 80,000 farmers. This money is used for educational programs, product ingredient and nutrition research, and marketing and advertising campaigns. Through the Check-Off, the industry is working to increase dairy product demand and strengthen dairy's overall image. The producer-funded Check-Off created an industry-wide, unified marketing plan to focus dollars and eliminate waste. The plan includes specific demand-building partnerships with leading branded product manufacturers and national restaurant and retail chains. The Check-Off also works with other dairy organizations to increase dairy demand. Since its implementation 20 years ago, dairy product consumption per capita has increased 11%.

Check-Off funds continually finance research concerning the improvement of current products, as well as the testing of new products. Some of the current research is a direct result of the increased consumption of sodas, because a number of the newest products on the market are carbonated dairy-based beverages. These dairy drinks contain at least 51% milk. Researchers across the country are working hard to find new ways and configurations to make

milk more appealing to young consumers with products that incorporate creative flavors, innovative packaging and grab-n-go, single-serve containers. Through Check-Off funds, products are targeted toward younger consumers in hopes of making milk more appealing to this age group. The products include Refreshing Power Milk, Hyper Cow, E-Moo and Sip “Ahh” flavored Straws.

Check-Off funds also aid in the continued education of consumers. The dairy industry recognizes that there is a lot of flawed information available to consumers. Our best plan of action is to provide solid nutritional facts of milk and dairy products. Tom Gallagher, chief executive officer of Dairy Management Inc.™ (DMI), which manages the national dairy Check-Off on behalf of America’s dairy producers, says, “Kids – as both current and future consumers – are the single most important audience to increase overall fluid milk consumption.” The dairy industry is doing its part to keep the importance of nutrition on the top of everyone’s priorities through programs funded by the Check-Off. Some of these programs allow nutritionists to go into the school systems and encourage milk consumption among young consumers. With the help of lesson plans such as the “Milk from Cow to You” and “Cows and Calcium” that are available to teachers nationwide, students are able to learn early of the importance of milk in the daily diet. The Why Milk (www.whymilk.com), Dairy Spot (www.dairyspot.com), Got-milk (www.gotmilk.com) and the Moomilk (www.moomilk.com) Web sites are all excellent sources of nutritional information. They are a great way for students to learn about the dairy industry. The sites are kid-friendly and can be great resource tools for teachers as well.

Americans average about 1.6 servings of dairy products per day, not nearly the 2-3 servings recommended by the Food Guide Pyramid. The “3-A-Day of Dairy” program promotes healthy diets and helps increase demand for dairy products. Through “3-A-Day of Dairy,” a Check-Off funded nutrition-based marketing and education campaign, the dairy industry is urging Americans to consume at least 3 servings of dairy each day. Other promotional campaigns, such as the “Ah, the Power of Cheese” and the “Got Milk?” ads, are still a big hit. Check-Off funds are continually coming up with new celebrities to feature in the ads, which can be seen in popular magazines, on billboards and television, and heard on the radio.

All of the above-mentioned facts are positive signs of progress, and we now see a new trend beginning. This trend can be observed in several of the major fast-food restaurant chains. Wendy’s and McDonalds now offer milk with their kids’ meals. In all test markets from this past fall, the industry received a positive response to this choice. A survey of parents in these test markets found that most parents are very pleased that milk is finally a choice for their children’s meals. If this positive response continues to grow, expect to see milk on the menus of children’s meals at all eateries.

The dairy industry has realized that there is a deficiency of consumer awareness concerning the importance of incorporating dairy products into their daily lives. With the consumption of dairy products continuing to decline, the dairy industry must persist in efforts to promote its products. The research, marketing and educational programs funded by the dairy Check-Off are steps in the right direction for increasing consumer awareness of the importance of dairy products for health and well-being.

Think about that the next time you lift a soda can to your lips instead of a glass of cold, refreshing and nutritious milk. Do you really think that’s the best choice? Got Milk?

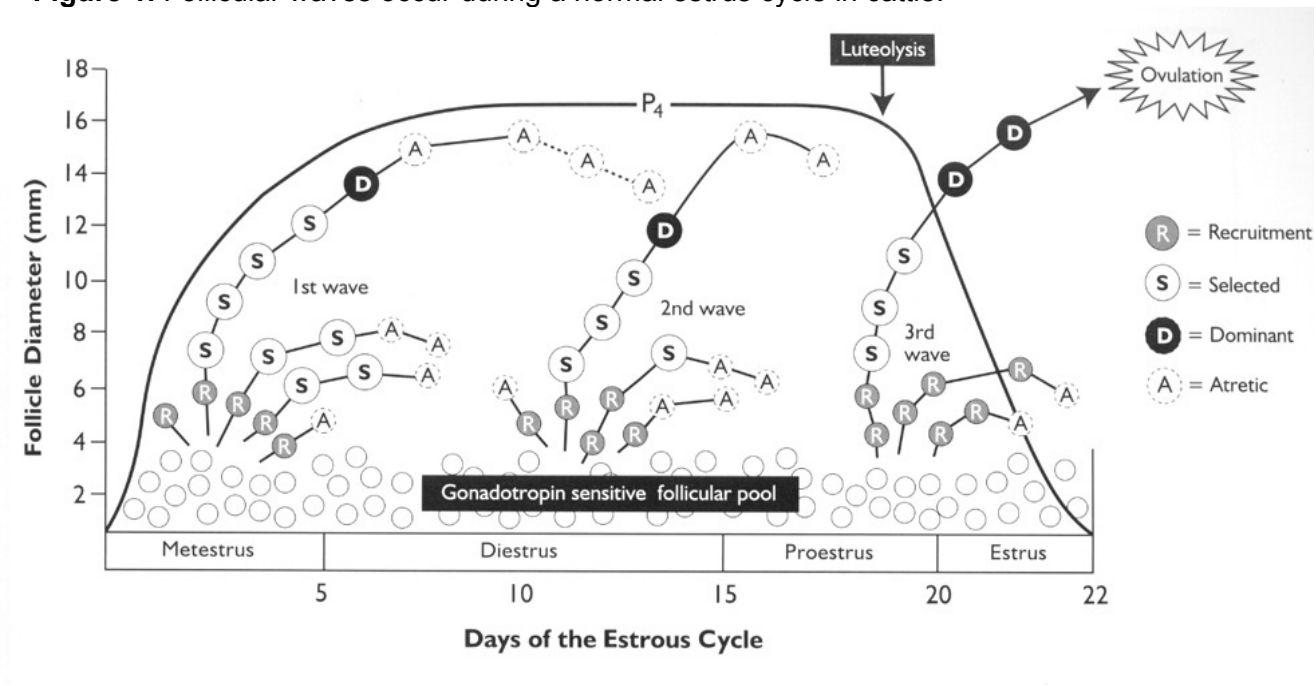
MANAGING AN OVULATION SYNCHRONIZATION PROGRAM USING PCDART

Gary Hay, Professor, and Justin Roberts, Undergraduate Student, Department of Dairy Science

Ovulation synchronization is the use of exogenous hormones to induce the onset of ovulation in cattle. Ovulation synchronization is a common practice on many U.S. dairy farms. It can increase profitability on a dairy farm by reducing the average days to first breeding and consequently the average days open on the farm. It can also improve labor efficiency by reducing the need for heat detection.

In cattle, ovarian follicles are produced in waves during a normal 21-day estrus cycle. Normally three follicular waves are produced during one estrus cycle. These follicular waves continue to be produced but do not mature during the luteal phase of the cycle. The follicle that is present at the beginning of luteolysis, or regression of the corpus luteum, becomes dominant and begins to mature. Once this follicle matures, ovulation occurs, releasing a mature ovum or egg from the ovary. The optimum time for artificial insemination is about the time of ovulation.

Figure 1. Follicular waves occur during a normal estrus cycle in cattle.

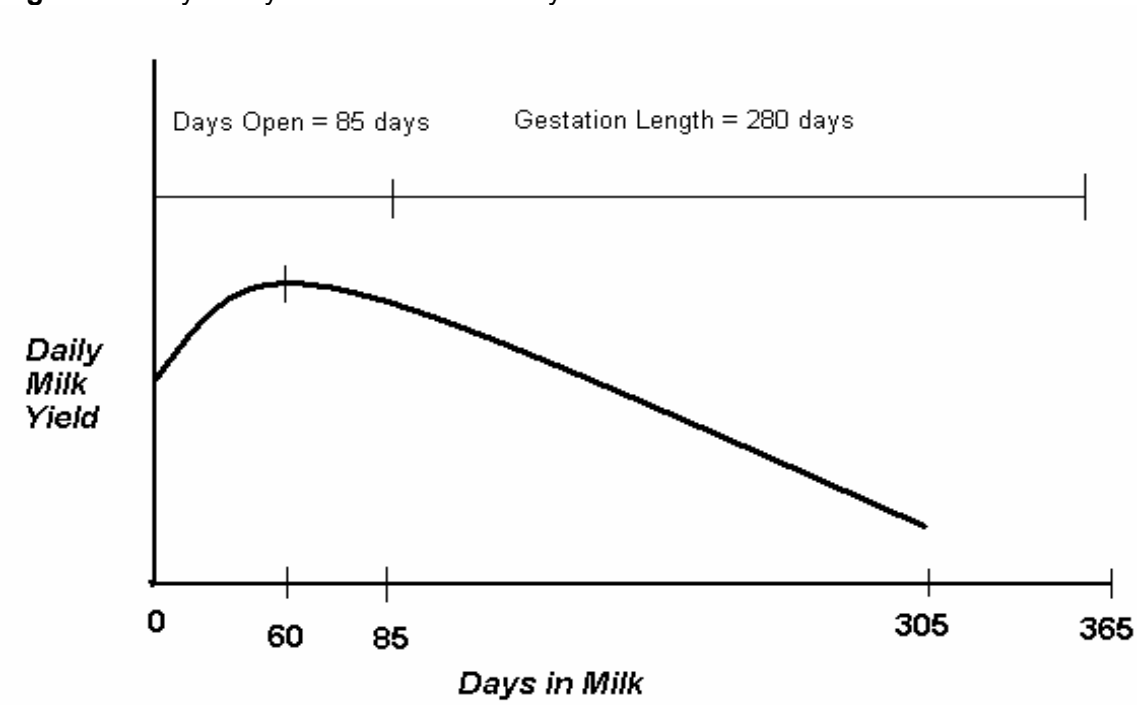


Senger, P. L., Pathways to Pregnancy and Parturition, Current Conceptions, Inc., Pullman, Wa. 1999

Traditional estrus or 'heat' detection methods rely on visual observation of estrus to determine the optimum time of breeding. Estrus normally occurs 8-16 hours prior to ovulation. Breeding cows 12 hours after the onset of estrus should maximize the probability of pregnancy. However, visual detection of estrus requires that **ALL** potential breeding animals be observed carefully and often to detect the onset of estrus. So, traditional estrus or 'heat' detection in dairy herds tends to be time consuming and labor intensive. As a result of time and labor constraints, traditional heat detection tends to be very inefficient on many farms. Missed heats lead to longer days to first service, longer days open and longer calving intervals. Longer calving intervals

reduce income on the farm because cows in late lactation produce much less milk than cows in the early and middle stages of lactation. The longer a cow is in milk, the lower her daily milk production will be.

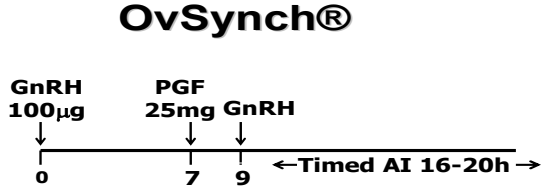
Figure 2. Daily milk yield decreases as days in milk increases.



Hay, Gary M., Reproductive Management Using DHIA and PCDART, PCDART Producer Training, Baton Rouge, La. 2001.

Ovulation synchronization reduces the labor needed for estrus detection by allowing the producer to control the timing of ovulation. Ovulation synchronization requires precise control of both follicular and luteal events. This requires specific hormonal treatments be given to individual animals at specific time intervals. For example, one common protocol used for ovulation synchronization is called OvSynch. OvSynch is a 10-day program in which cows receive injections of both gonadotropin releasing hormone (GnRH) and prostaglandin (PGF). The program starts with an initial injection of GnRH to stimulate follicle growth. This is followed seven days later by an injection of PGF to stimulate luteolysis. GnRH is given two days later to stimulate ovulation followed by artificial insemination 16-20 hours later.

Figure 3. Ovulation synchronization protocol.



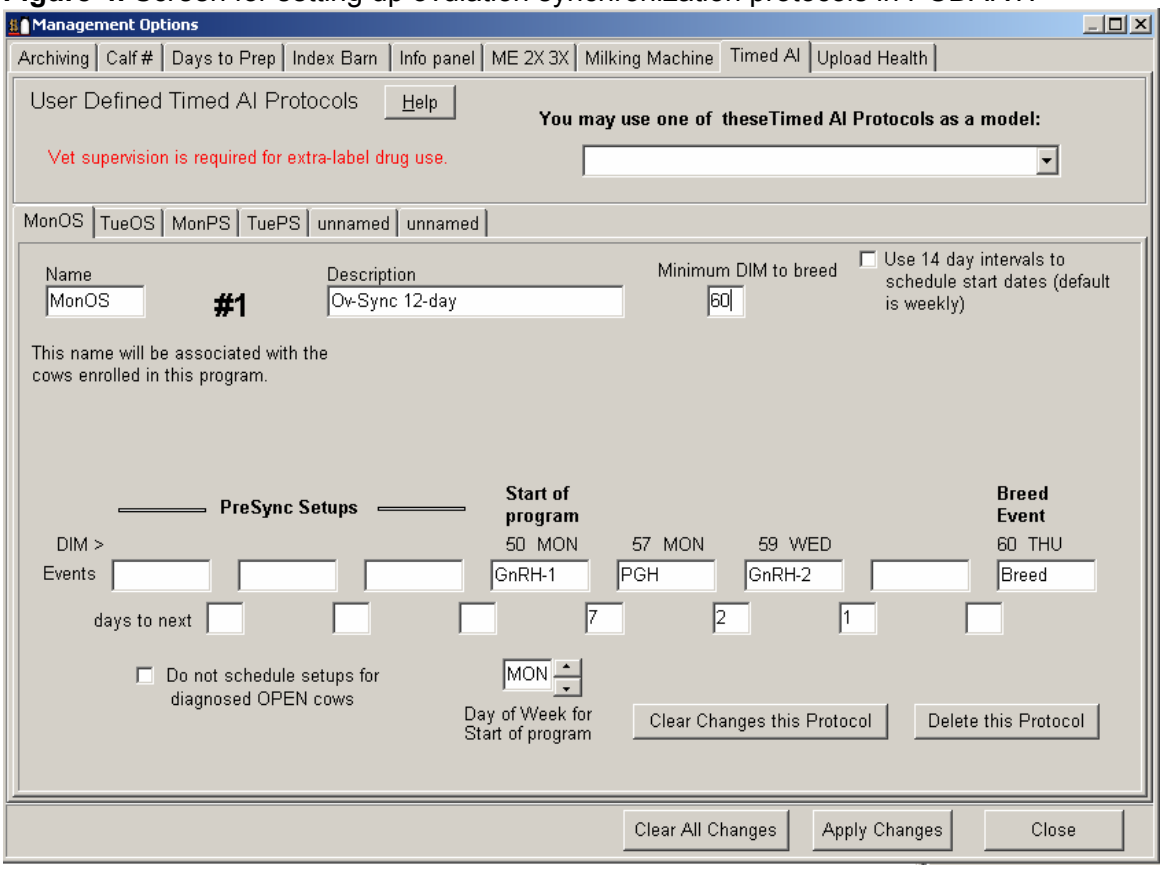
Roberts, Justin. Managing an Ovulation Synchronization Program with PCDART, ADSA-SAD, St. Louis, Mo., 2004

One disadvantage of using ovulation synchronization is the difficulty in coordinating the several events associated with the protocol on a large number of animals in a dairy herd when different animals require different events on a particular day. Another disadvantage of using ovulation synchronization is the need to keep accurate records on which events were given to which animals during a given time frame. There would be no way of knowing which event an animal should receive at which time without this information. This would quickly render the program unmanageable and ineffective.

PCDART is a computerized record keeping system for managing dairy herds. PCDART can be used to manage all the information recorded on individual animals such as milk production, breeding, calving, etc. PCDART can also be used to manage ovulation synchronization programs. PCDART has several advantages for use in an ovulation synchronization program:

- Producers can use predetermined ovulation synchronization protocols that are built into the program or they can design their own protocols.
- Producers can choose which day of the week to begin a protocol.
- Producers can use multiple protocols in a herd.
- Producers can select a minimum days in milk on which cows are eligible to start a protocol.
- PCDART can inform the producer which cows are eligible to be synchronized.
- Producers can select which cows to synchronize.
- Producers can remove cows from the protocol at any time.
- PCDART automatically removes a cow from a protocol list when a breeding is recorded on the cow, to avoid giving further injections to the animal.

Figure 4. Screen for setting up ovulation synchronization protocols in PCDART.



Once a synchronization protocol is set up, run PCDART report 134 to produce a list of cows eligible to be synchronized.

Figure 5. PCDART report 134 'Cows Eligible to Enroll in OvSynch'.

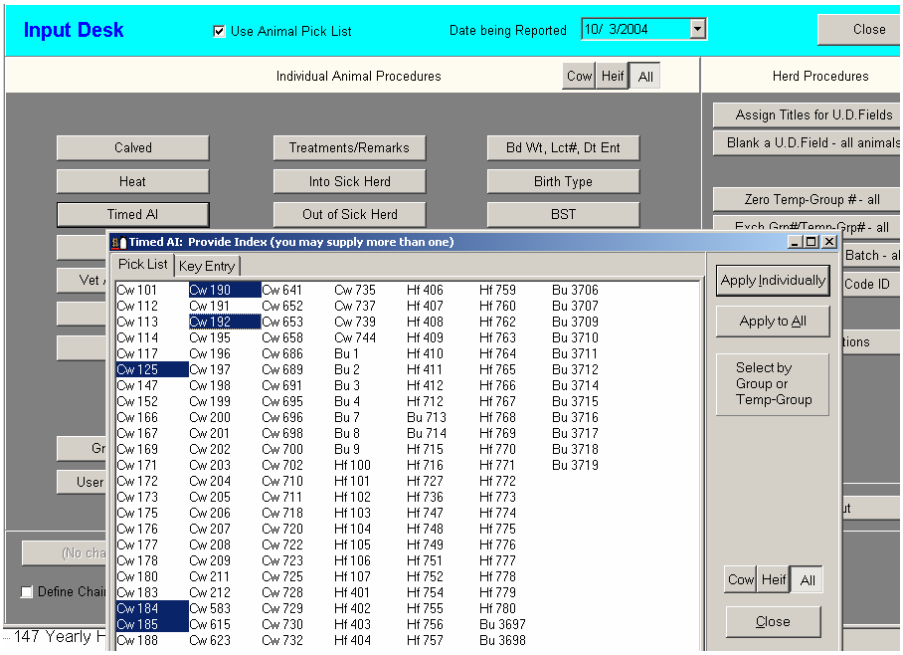
134 Timed AI Eligible to Enroll into MonOS

Grp	Index Name	DIM	Reproduc Date	cd	Mon 10/04/04
0	125	203	05/17	N	GnRH-1
0	184	656	06/04	N	GnRH-1
0	185	270	06/03	N	GnRH-1
0	190	139			GnRH-1
0	192	554	02/27	N	GnRH-1
0	196	327	06/25	N	GnRH-1
0	197	312	05/22	N	GnRH-1
0	198	305	06/06	N	GnRH-1
0	201	317	06/06	N	GnRH-1
0	204	298	06/03	N	GnRH-1
0	206	314	06/25	N	GnRH-1
0	209	297	06/25	N	GnRH-1
0	212	235	04/29	N	GnRH-1
0	623	224	06/25	N	GnRH-1
0	652	209	06/26	N	GnRH-1
0	686	199	06/25	N	GnRH-1
0	698	327	06/05	N	GnRH-1
0	700	185	06/25	N	GnRH-1
0	725	52			GnRH-1

19 cows

Using the list of cows in report 134, choose the animals to be synchronized. Next, go to the Input screen and click on the Timed AI button. This will open a pick list from which cows to be synchronized can be selected.

Figure 6. Enrolling cows on OvSynch in PCDART



Once animals are enrolled on the synchronization protocol, run PCDART report 136 on the first day of the week. Report 136 creates weekly reports showing which cows receive which hormonal treatments or breeding on a given day during the coming week.

136 Timed AI (Weekly "To Do")

LSU DAIRY - 72170003

Ref: 10/03/2004

Grp	Index Name	TAI progrm	Reproduc Date	cd	Sun 10/03	Mon 10/04	Tue 10/05	Wed 10/06	Thu 10/07	Fri 10/08	Sat 10/09
0	125	MonOS	05/17	N		GnRH-1					
0	184	MonOS	06/04	N		GnRH-1					
0	185	MonOS	06/03	N		GnRH-1					
0	190	MonOS				GnRH-1					
0	192	MonOS	02/27	N		GnRH-1					
	5 cows										

The entire enrollment process can be repeated once a week to start new animals on the protocol as they become eligible based on their days in milk.

Ovulation synchronization can be an excellent tool for improving profitability on a dairy farm by reducing the labor involved in heat detection, decreasing calving intervals and decreasing the amount of time cows spend in late lactation. PCDART can simplify the process and greatly reduce the amount of time needed to manage an ovulation synchronization program. This gives producers the ability to use their time more efficiently and greatly improves the overall potential for success from an ovulation synchronization program.

For more information on managing an ovulation synchronization program using PCDART, contact Dr. Gary Hay at (225) 578-4411.

EFFECT OF PREPARTUM ANTIBIOTIC THERAPY IN HEIFERS ON MILK PRODUCTION AND MASTITIS POSTPARTUM

L.K. Fox[1], A.A. Borm[1], K. E. Leslie[2], J.S. Hogan[3], S. M. Andrew[4], S.P. Oliver[5], Y.H. Schukken[6], W.E. Owens[7] and C. Norman[7]

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INTRODUCTION

Heifer mastitis has been recognized as a syndrome for more than 60 years; however, only within the last 20 years have many research groups focused on studies of this potentially costly disease. Traditionally, heifers were viewed as most likely untouched by mastitis pathogens. Mastitis was viewed as a disease complex of the lactating or involuted mammary gland and a rare problem of the underdeveloped gland of the heifer. It was known that heifers would develop mastitis infections during the postpartum period, but it was not clear if such infections would have a deleterious impact on milk production (King, 1967). Even if a heifer had mastitis at parturition, it could not have been known if this was a peripartum problem or one that occurred earlier in mammary development. Work at Louisiana State University (Trinidad et al., 1990) clearly established that mammary glands of heifers could be colonized and/or infected before breeding or early in gestation. A subsequent and more comprehensive study that included Louisiana, California, Vermont and Washington states indicated that approximately 25% to 35% of heifers had intramammary infections, or colonizations with mastitis pathogens, as early as the first trimester of their first pregnancy (Fox et al., 1995). Thus, it would appear that heifers are prone to prepartum intramammary infections.

The prevalence of these infections and the impact these infections have on dairy production will be discussed. Control of prepartum intramammary infections is to be addressed. One control element for prepartum antibiotic therapy in heifers is intramammary therapy. A later entry of this report will discuss preliminary results from a seven “state” project addressing the efficacy of prepartum antibiotic therapy on cures of intramammary infections and milk quality and quantity.

EFFECTS

A review of literature discussing the effects of mastitis in dairy heifers was made by Nickerson and coworkers in 1995. The fact that much of the mammary secretory cells or parenchyma is developed during the first pregnancy suggests that any intramammary infection at that time would have the potential to be most deleterious. Indeed, Nickerson and coworkers report that histological examination of mammary parenchyma in heifers with preterm intramammary infections was marked by inflammation. Characteristics were leukocyte infiltration, reduced parenchyma to stroma ratios, ductular hyperplasia and micro abscess formation with infection. With such damage, it would be expected that milk secretion would be adversely affected by intramammary infections prepartum in heifers. Hallberg and coworkers (1995) reported that such infections had a significant affect on appearance of the lacteal secretion both pre- and post-calving. These researchers also reported that milk somatic cell count increases are associated with a more serous quality to the lacteal secretion.

EPIDEMIOLOGY

Table 1 is a summary of several studies that examined the prevalence of heifer mastitis, by pathogen type.

Table 1. Prevalence (% of mammary quarters)[1] of mastitis in heifers at first parturition

Study	Number sampled	Type of sample	No infection	CNS	CPS	Env.	Other
Nickerson et al. 1992	600	Q	58.4	27.9	8.0	4.2	1.4
Cook et al. 1992	525	C	43.0	43.0	6.0		8.0
Oliver et al. 1992	41	Q	55.4	39.0	0.6	4.9	
Pankey et al., 1991	382	Q	81.7	11.4	0.7	4.8	1.7
Roberson et al., 1994	828	C	54.0	39.0	8.0	13.0	
Myllys, 1995	236	Q	61.1	28.8	4.7	4.6	0.8
Oliver et al. 2003	332	Q	54.5	45.5	1.0	8.0	

[1]Percentage of mammary quarters (Q) or mammary glands, composite (C) that have an intramammary pathogen (CNS, coagulase negative staphylococci; CPS, coagulase positive staphylococci; ENV, environmental pathogens, streptococci non-agalactiae and gram negative rod shaped organisms; and other pathogens).

From Table 1 it is clear that the most prevalent group of mastitis pathogens associated with intramammary infections (IMI) of heifers at parturition are the coagulase negative staphylococci (CNS). On average it would appear that the environmental pathogens are a bit more prevalent than coagulase positive staphylococci (CPS). But in some studies more than 5% of heifers had contagious mastitis at calving.

In a broad study on heifer mastitis involving four distinct national regions, samples were collected from 1,583 heifers (Fox et al., 1995). Only two mammary quarters per heifer were sampled prepartum, and all quarters were sampled at parturition. Again the CNS were the most prevalent pathogen type causing IMI both pre-and postpartum. Prevalence of CNS and CPS mastitis infections tended to be lower postpartum than prepartum, and environmental mastitis increased between the time periods. There were seasonal and area effects influencing mastitis at calving. Louisiana had the highest rate of mastitis infections, especially CPS. These types of infections were most prevalent in the warmer months. Vermont had the lowest prevalence of mastitis infections. Older heifers and heifers infected during late gestation were more likely to be infected. Also, the simple act of collecting samples prepartum influenced the infection rate postpartum. There were more mastitis infections in the sampled mammary quarters postpartum than in the control quarters postpartum.

Myllys (1995) examined clinical mastitis infections in heifers pre- and postpartum. Clinical mastitis by CNS was the most prevalent agent and CPS the next most prevalent agent.

In total these studies demonstrate that CNS mastitis infections are the most prevalent, but major mastitis pathogens such as CPS and environmental organisms contribute significantly to heifer mastitis. Season and location clearly affect heifer mastitis.

CONTROL

Given that warmer climates, Louisiana vs. Vermont as an example, and warmer weather (summer season) influenced the prevalence of CPS mastitis in heifers, the Louisiana research group investigated the role of flies on heifer mastitis (Owens, et al., 1998; Nickerson et al., 1995). Work from this research group strongly suggests that flies have the potential to contribute to the dissemination of CPS mastitis in heifers, and that fly control can have a significant affect on reducing heifer mastitis with this pathogen. Yet the review of data also indicates that CPS can be associated with measurable heifer mastitis problems in areas and seasons that are not affected by significant fly problems. Thus flies are not the only risk factor associated with heifer mastitis.

Roberson and coworkers (1994a and 1994b) studied the risk factors for CPS mastitis in heifers. In both studies, herds were divided into two groups; herds with high prevalence (>10% of the herd with CPS mastitis) and herds with low prevalence (<5% of the herd with CPS mastitis). The assumed risk factors, housing pre-weaned heifers together and feeding mastitic milk, were not associated with an increased risk of heifer CPS mastitis. Many body sites on heifers, some other than the mammary gland, were sampled. On average, heifers from high prevalence herds were more likely to be colonized on body sites sampled than heifers from low prevalence herds. Twice as many heifers from high prevalence herds had CPS on the udder skin or the muzzle than did heifers from low prevalence herds. Some of these isolates were of the same type as those CPS found in the mastitic milk of the lactating herd. Yet some were unique types to the heifer and of unknown origin; none of the environmental samples had those unique types. Environmental sites included the bedding, insects, housing, water, feedstuffs, hands of workers, non-bovine animals, air and equipment were sampled. More environmental sites from high prevalence herds had CPS than from low prevalence herds. Thus taken together, it would seem that residence in a high prevalence herd was a risk factor for CPS mastitis. Yet the investigators of these studies found that although heifer CPS mastitis at calving was greater in high prevalence herds, the difference was not significant. Thus it does not appear that the lactating cow is a primary reservoir for the spread of CPS mastitis among heifers. The lactating cow appears to contribute, but there are other significant sources of infectious organisms. Colonization of the mammary gland skin with CPS at breeding age increased the risk of mastitis by these pathogens more than threefold over those with no colonization of the skin at this time. Again, this suggests that the young heifer herself may play a significant role as a reservoir of this disease. The investigators of these studies concluded that there was no single control strategy that could be tested to reduce CPS mastitis of heifers at calving; however, perhaps regular disinfections of the mammary skin of breeding age heifers would have some merit. But such a practice might be of economic significance only on herds suffering from a high prevalence of heifer mastitis by CPS.

The focus of the discussion has been on the prevalence of heifer mastitis by CPS. Heifer mastitis by environmental pathogens is significant. Sanitation controls this mastitis pathogen in lactating cows. Keeping the housing confines for heifers as clean and dry as possible may be the best method of control of this aspect of the disease complex. Yet the pathogen type with the highest prevalence for heifers with mastitis is the CNS. Control of this pathogen type in lactating cows has not been readily achieved. It is known that dry cow therapy and post-milking teat asepsis can control this mastitis agent only in part. Perhaps antibiotic therapy in heifers can contribute to control of heifer mastitis.

CONCLUSIONS

Treated heifers have fewer intramammary infections at calving. Yet positive effects of such treatment have to offset costs. One study by Oliver et al. (2003) suggests an approximate 990-lb gain in milk during the first lactation with treatment. Contamination of milk postpartum by antibiotics may be a concern that must also be studied. However, at present the data to support this practice is equivocal, and such treatment constitutes extra-label use of drugs. Therefore, the use of intramammary therapy cannot be uniformly recommended at this time, and, if practiced, should be done so in close consultation with the attending herd's veterinarian.

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WHAT IS SO IMPORTANT ABOUT PHOSPHORUS IN DAIRY DIETS?

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INTRODUCTION

In recent years, persistent signs of nutrient pollution accumulation in fresh and coastal waters have resulted in the development and enforcement of broader regulations (USEPA, 2000, USEPA, 2004a). Such effort has brought a different public and news media attention onto farming systems over the entire United States – a less humble kind of debate than that farmers had enjoyed for generations.

In this article we examine some of the facts and fictions of feeding phosphorus (**P**) to dairy cows that contributed to the present situation.

ROLE OF NUTRIENTS IN EUTROPHICATION – A PROBLEM

Anthropogenic nutrient over-enrichment of water bodies, often referred to as cultural eutrophication, allows for blooming (fast growth) of algae, cyanobacteria, some of which are toxin-producing, and water plants. The sequence of events following cultural eutrophication culminates with the depletion of dissolved oxygen, which causes death and decomposition of algae and fishes, causing the water to reek. The resulting malodor and high levels of toxins limit water quality for human recreation and consumption.

The most important nutrients involved with eutrophication, frequently called “limiting nutrients,” are nitrogen, P and silicon. The partial importance of each limiting nutrient is site- and/or region-specific. In general, nitrogen is limiting in coastal waters, and P is associated with freshwater cultural eutrophication (Correll, 1998), but both, N and P, may contribute to the over-enrichment of estuaries such as Lake Pontchartrain.

LINK TO AGRICULTURAL P

Major P discharges have been minimized through legislation enforced since the 1960s and designed to eliminate point source pollution. Those were mostly untreated industry and sewage treatment plants effluents. Less visible P sources, also called non-point sources, were grossly overlooked for many years because these are small contributors when considered individually. Examples of non-point sources include runoff from construction sites, suburban lawns and agriculture. Nonetheless, the latest lists of impaired waters sustain the indication that nutrients are among the top three causes of impairment (USEPA, 2004b).

Dr. Larry Satter from the University of Wisconsin stated that “phosphorus present in eroded soil particles and P solubilized in surface water running off fields high in P content are the major sources of P entering our lakes and streams, causing them to turn green with algae and other plant and microbial growth.” Some states are recommending management practices based on P thresholds in soil. Others are developing site-specific models, or “P indexes,” to assess the potential for P loss (Sharpley et al., 2001). Whether soil P is increased from excessive land application of fertilizers or animal manure, agriculture, and particularly the livestock industry, is regarded as an important non-point source of P.

PHOSPHORUS IN THE DIET OF DAIRY COWS

Cows are able to convert relatively low quality feedstuffs into a nutritious food for human

consumption. Unfortunately, the efficiency of that conversion is limited. For every 100 parts of P fed to a cow, we can at best hope for a third to be turned into milk or stored as the cow's body grows. The remaining is excreted in feces and urine.

Many experiments were carried out to determine P requirements of lactating dairy cows. Valk and Sebek (1999) fed cows producing approximately 16,000 pounds of milk per lactation diets containing 0.24, 0.28 and 0.32 % P in the dry matter (DM) for almost two lactations. Only the two highest P levels were adequate. Cows fed the lowest dietary P content had lower intake during the first dry period and lower milk production in the subsequent lactation. In another study, cows were fed 0.31%, 0.40% and 0.49% P in the TMR DM (Wu et al., 2000). Milk production over the lactation averaged more than 24,000 pounds but was not different among treatments. Milk yield of cows fed 0.31% P dropped at a faster rate after 175 days in milk. In a follow-up study using similar dietary P concentrations, production performance was similar, but cows on the 0.31% dietary P group had low plasma and bone P concentration (Wu et al., 2001). Brintrup et al. (1993) fed 0.33% and 0.39% P in diets to lactating dairy cows over two lactations and found higher milk yield with low P treatment. Therefore, it appears that P requirement of high producing dairy cows should fall between 0.28% and 0.32%. A requirement is different than recommended feeding level. The latter usually contains a margin of safety added onto the requirement. The NRC (2001) recommended a range between 0.32% and 0.42% P in dairy cow diets depending on a variety of animal and feed factors such as milk yield and level of DM intake and P availability in the feed.

Mineral P supplementation is justified only if the requirement of the animal is not met from the other feedstuffs in the diet. Yet, for several years, we have fed extra P to meet our expectations of reproductive performance from dairy cows. This is based on the myth that feeding diets with higher than recommended P content will improve reproduction. The fact is that P affects reproduction only if cows are not supplied with enough to meet their requirements. Earlier studies showed improved reproductive performance on cows fed poor-quality feedstuffs when P supplements were available (Theiler et al., 1927, Theiler and Green, 1932, Hignett and Hignett, 1951). A recent comprehensive study (Lopez et al., 2004a) investigated the effect of feeding P in excess of recommendations on reproductive performance of 267 high producing dairy cows. Estrous duration and behavior, and conception and pregnancy rates among other reproductive parameters, were evaluated by radio-telemetry, weekly ultrasonography and weekly blood progesterone levels. None of those characteristics were found to be different between the two treatments (0.38% or 0.58% P). When the cows from that study were divided into a high producing and a lower producing group and their blood analyzed for estradiol concentration, it was observed that the high producing group had lower plasma estradiol concentrations (Lopez et al., 2004b). That may explain why level of milk production is negatively correlated with low reproductive performance.

The Forage Quality Laboratory at the Southeast Research Station analyzed 446 samples of TMR for P in more than five years (Figure 1). The P content averaged 0.49% (± 0.09) of the DM. For this article we assumed that the TMR samples submitted were the only source of nutrients available to the dairy herd. The good news is that dietary P fell from the initial average of 0.51% in 1999 and 2000 (Figure 2). Another positive conclusion derived from the dataset was that most diets are above the risk of underfeeding P, since only 5% of submitted TMR samples were below 0.32% P. Some of those TMRs could have been for feeding young stock that have a lower P requirement or supplemented with other forages. The bad news is that the drop in P content has stabilized at 0.48% since 2001. Worse yet is that 78%, or 348 of the 446 samples, were above the NRC's (2001) maximum recommended P of 0.42% of the dietary DM. We should also point out that TMRs containing extremely high P concentration are still being fed in 2004 just as it was at the beginning of this dataset in 1999 (Figure 2).

QUICK CALCULATIONS

Let us consider that the difference between 0.42% P and the median (half) of those samples in the excess P range being 0.09% of P and assume 44 lb/cow/day of dry matter intake. The other information necessary is that the average number of cows in the 334 Louisiana dairy farms is 122 (LSU AgCenter Ag Summary, 2004). Dicalcium phosphate costs around $400 per ton and contains 19.3% P. Based on the above-mentioned figures, we can extrapolate that as much as 1,770 pounds of P, approximately $1,830, is over-supplemented yearly from an average dairy farm, and 295 tons of P could potentially be lost with current practices of feeding dairy cows in Louisiana.

REASONING FOR CHANGE

Feeding diets with excess P has high costs, not only directly related to P supplementation, but also indirect financial, social and environmental costs. In summary, among the benefits of feeding P according to NRC (2001) recommendations we conclude that:

1. Dairy cows fed diets containing between 0.35% and 0.42% P will be safely supplied.
2. We may save between $10 and $15 per cow per lactation by purchasing less P supplement (Wu et al., 2001).
3. Lower manure P requires less land to be spread on or allows for more cows in the herd when soil P is taken into account.
4. Lower manure P may reduce the need for fertilizer purchase by providing an N to P ratio closer to crop requirements (~7:1).
5. Along with management practices to reduce soil erosion, lowering manure P content will reduce P load into public waters from agriculture.

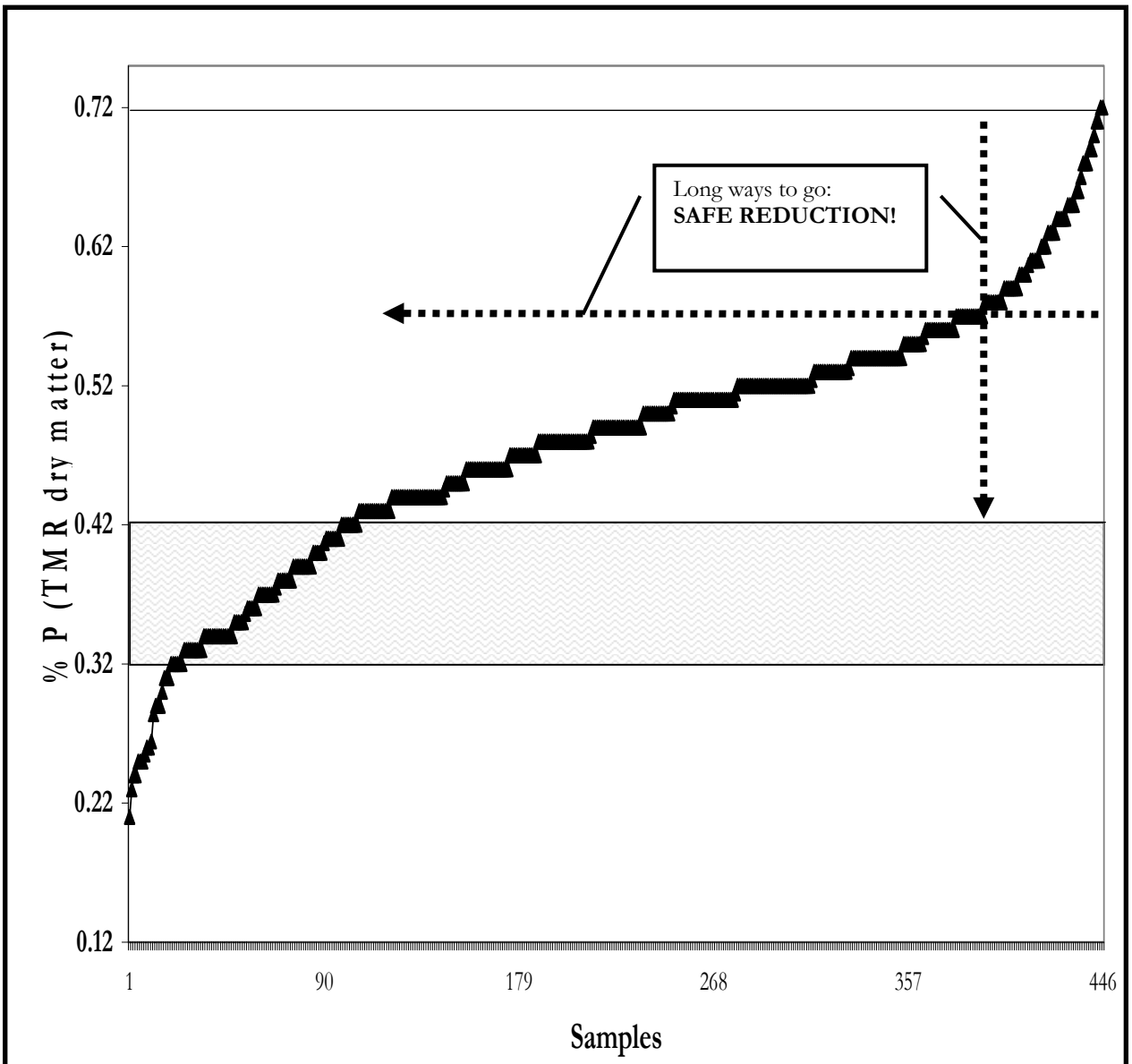

Figure 1. Phosphorus concentration of 446 Total Mixed Ration (TMR) samples submitted between 1999 and 2004 to the Forage Quality Laboratory, at the LSU AgCenter Southeast Research Station (Franklinton, LA). Shaded area represents NRC (2001) recommendation of dietary P content for lactating dairy cows. Dashed arrows indicate the amount of samples (horizontal) and TMR P concentration levels (vertical) in excess of NRC (2001) recommendation.

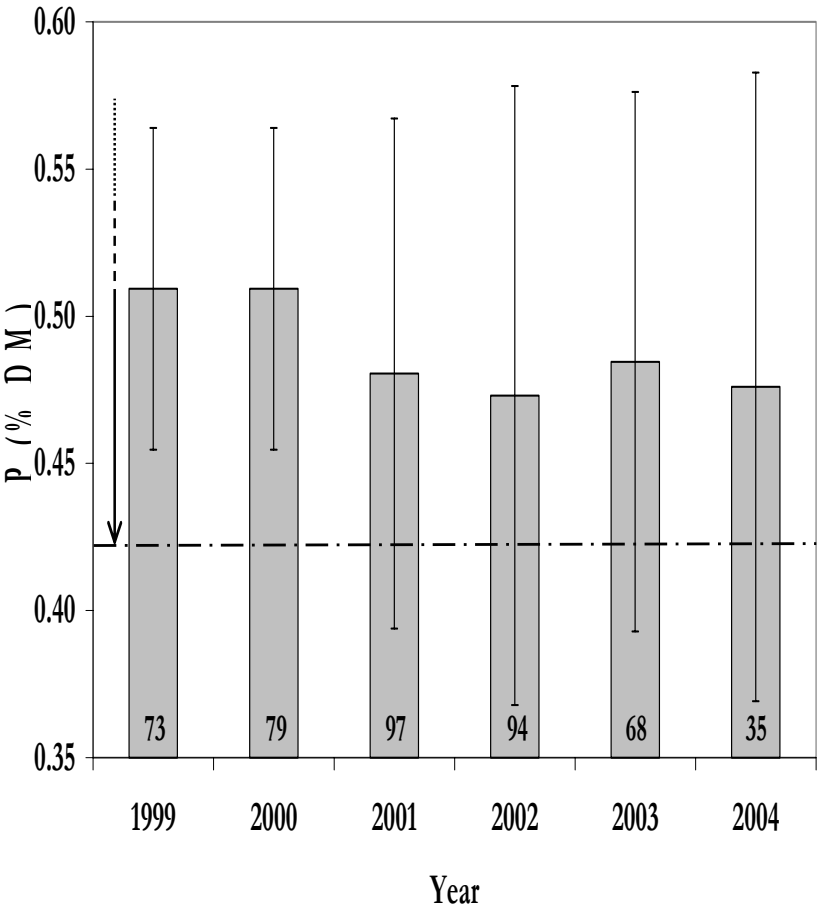

Figure 2. Average (± standard deviation) P concentration of Total Mixed Ration samples submitted to the Forage Quality Laboratory, at the Southeast Research Station – LSU AgCenter (Franklinton, LA), between 1999 to 2004. Upper P recommendation for lactating dairy cows (NRC, 2001). Arrow indicates potential for dietary P reduction.

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TAKE A LOOK AT FLUID MERIT DOLLARS (FM$) AS A SIRE SELECTION CRITERIA

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Introduction

Choosing the "right" sires to produce the most profitable daughters in an A.I. breeding program is always a challenge. It can be even more daunting than ever with so much information available today on so many traits. The USDA Dairy Sire Summaries now include three selection indexes that can be useful in simplifying sire selection. These are called Net Merit Dollars (NM$), Cheese Merit Dollars (CM$) and Fluid Merit Dollars (FM$).

What is a selection index?

A selection index is a tool that combines sire summary information or Predicted Transmitting Ability (PTA) on several different traits into one measure. A selection index accounts for the economic value of each trait in the index and the genetic relationships among all traits in the index. The value of a selection index comes from the fact that it optimizes genetic improvement for each trait in the index according to its potential economic value to the farmer. Two well-known examples of dairy sire selection indexes are the Type-Production Index (TPI) from the Holstein breed and the Jersey Performance Index (JPI) from the Jersey breed. Both of these indexes place a great deal of emphasis on production traits as well as overall conformation traits. Both are useful if a portion of your animals are being sold as breeding animals; however, if your income is solely generated from the sale of milk, the USDA merit indexes may be more appropriate as sire selection criteria.

Why use a selection index?

When you "select" a sire to breed to your cows, you don't just select his desirable characteristics, you select ALL of his characteristics. Attempting to set **minimum** levels of performance for numerous traits can be difficult, time consuming and extremely limiting. For example, if you attempted to "select" only sires that were above a certain minimum level for milk production, component production, type and calving ease, you might find very few bulls that meet all those criteria. An index can take into account all of these traits as well as other traits by weighing each trait, based on its economic value relative to the others traits in the index.

How do you use a selection index?

The first step is to identify your milk market; then choose the index that best matches that market. For example, JPI and TPI both focus on the value of milk used to manufacture cheese. The major difference among the USDA Merit$ indexes is the value each index assigns to milk protein. Cheese Merit$ places more emphasis on protein production than either NM$ or FM$. Fluid Merit$ places more emphasis on milk production than on protein or fat yield. Producers in Louisiana and Mississippi are paid for their milk based solely on skim and fat content of the milk. Therefore, **FM$** should be a more appropriate sire selection criteria in the Southeast milk market than either NM$ or CM$.

What other traits are included in the FM$ index?

Several production, as well as type, longevity, health and reproductive, traits are part of the FM$ index. These include Milk, Fat, and Protein yield as well as Productive Life (PL), Somatic Cell Score (SCS), Udder Composite (UDC), Feet & Leg Composite (FLC), Body Size Composite (BSC), Daughter Pregnancy Rate (DPR), Service Sire Calving Ease (SCE) and Daughter Calving Ease (DCE).

Production Traits

Production traits included in the FM$ index are milk, fat and protein. The relative value of each production in the FM$ index along with the relative value of each of the remaining traits in the index is given in Table 1.

Productive Life

Productive Life is measured as the number of months a cow is in production up to 7 years of age. For cows younger than 7, DHI information can be used to predict how many months she will produce by the time she is 7 years old. Only the first 10 months of each lactation contribute to months of productive life; and cows receive no additional credit for production past 7 years of age. PL contributes economic value to the dairy by lowering replacement costs and increasing the percentage of mature milking cows in the herd.

Somatic Cell Score

Somatic Cell Score is an indirect measure of the levels of both clinical and subclinical mastitis. SCS is easily measured through the DHI electronic somatic cell count (SCC) program. Sire selection to reduce SCS adds economic value to the dairy by reducing the incidence and costs of mastitis in a dairy herd.

Composite Traits

Udder (UDC), Feet & Legs (FCS) and Body Size (BCS) Composite Scores all are combinations of linear traits. Linear traits can provide additional information about potential incomes and expenses. Instead of trying to use PTAs for all 17 linear traits in a selection index, composite scores combine a subset of type traits based on the relative value of each trait.

Daughter Pregnancy Rate

Some bulls tend to consistently produce daughters that more readily conceive. Daughter Pregnancy Rate (DPR) is a measure of cow fertility inherited from the sire. There are several advantages of improved DPR: lower breeding costs, higher peak and total lactation milk production, and more heifers born for replacements.

Calving Ease Traits

Every lactation begins with a birth, and difficult births can lead to reduced production, delayed reproduction, early culling of the cow and even death of either the cow or the calf or both. Reducing the number of difficult births in a dairy herd can have both short-term and long-term impacts on income and expenses. Selection for calving ease traits will contribute to the economic value of a dairy herd by lowering the number of difficult births in the herd. Service Sire

Calving Ease (SCE) is a direct measure of a bull's ability to sire calves that do not contribute to calving difficulty in the cows with which the bull is mated. Daughter Calving Ease (DCE) is a measure of a bull's ability to sire daughters that exhibit less calving difficulty. Selection is important for both of these traits to reduce the effects of difficult calving in a herd.

Table 1. Relative weights assigned to various components of Fluid Merit$ from August 2003.

Trait	Relative Weight (%)
Milk	24.0
Fat	22.0
Protein	9.0
Productive Life	11.0
Somatic Cell Score	9.0
Udder Composite	7.0
Feet & Leg Composite	4.0
Body Size Composite	3.0
Daughter Pregnancy rate	7.0
Service Sire Calving Ease	2.0
Daughter Calving Ease	2.0

What level of Fluid Merit$ should be used for sire selection?

Table 2 shows the August 2004 USDA Sire Summary figures for FM$ for 607 active Holstein A.I. sires.

Average FM$	*+369*
70th Percentile (Top 30%)	*+448*
80th Percentile (Top 20%)	*+475*

The best way to use Fluid Merit$ as a sire selection criteria is to establish a minimum level for sires being considered for use in your herd. Setting a minimum selection criteria at the lower percentile (70th) will result in slightly lower genetic progress overall but will allow selection from a larger group of sires (182 vs 121). This may or may not also have the advantage of lowering semen costs. **Selecting sires in either the 70th or 80th percentile for Fluid Merit$ will ensure genetic progress for all the traits in the index relative to our current understanding of the economic importance of each trait.**

COCCIDIOSIS IN DAIRY CALVES

Cathy Williams, Associate Professor, Department of Dairy Science

The goal of a successful heifer rearing program is to provide the opportunity for the heifer to develop her full genetic potential for milk production at the desired age with minimal expense. The first and most important step is the development of the young calf, with the greatest expenses in heifer rearing usually occurring during the first three months of life. During this time, mortality and morbidity are highest along with high feed and labor costs. Good management practices are essential for proper growth and development of these young dairy calves and for keeping death losses to a minimum.

According to surveys conducted by the National Animal Health Monitoring System (NAHMS), as part of a National Dairy Heifer Evaluation Project, death losses in calves from birth through weaning averaged 8.4% in 1991 and 10.8% in 1995. The most prevalent causes of death in calves from birth through weaning are diarrhea (scours) and respiratory problems. The 1993 NAHMS survey indicated that 75% of calf deaths resulted from these two causes. Of these two major factors responsible for calf mortality, diarrhea was reported to be the primary cause of death, with 52% of death losses attributed to this disease alone.

There are many causes of scours in calves, including bacteria, viruses, protozoa and improper nutrition. Regardless of the cause, all types of scours can result in similar problems, including dehydration, electrolyte imbalance, poor growth and possibly death. Of the many causes of scours, coccidiosis has the highest incidence of occurrence in young dairy calves and is one of the top three most costly bovine diseases. Coccidiosis is caused by a protozoan parasite, and 13 species of coccidia are known to infect cattle. Of these 13 species, the two most common infectious coccidia organisms are *Eimeria bovis* and *Eimeria zurneii*. Not only does coccidiosis affect neonatal calves, but it also has proven to be a costly disease in weaned calves and calves up to 2 years of age.

Coccidiosis reduces feed consumption, body weight gain and feed efficiency in infected calves. Production losses from coccidiosis have been reported at $62 million annually, with mortality rates as high as 24% in calves less than 1 year of age. Coccidial organisms infect the epithelial cells of the gastrointestinal tract, and the damaged intestinal cells become unable to absorb nutrients. These injured tissues also become susceptible to secondary infections because the immune system is suppressed during the coccidial infection. Coccidiosis is transmitted by ingestion of sporulated oocysts from the environment. Calves may ingest these oocysts through contaminated feed and water, soiled pastures and even by licking the contaminated hair of another animal. Once ingested, these oocysts rupture and release numerous sporozoites that infect the endothelial cell lining of the small intestine and cause the damage. These sporozoites further develop and infect other cells in the intestine. They pass to the large intestine where they reproduce to form oocysts. These newly formed oocysts are passed back into the environment through the animal's feces. The incubation period of the *Eimeria* organism is 15 to 21 days, with an average of 17 days. Symptoms of disease are often observed after this incubation period. The clinical course of the disease is from four to 14 days, depending on severity of the infection.

Both clinical and subclinical forms of coccidiosis cause economic and health problems in dairy cattle. Subclinical coccidiosis is present in the animal before clinical signs may appear. Many times animals do not show clinical signs at all and are infected without the producer's knowledge. An estimated 95% of coccidial infections are subclinical, and 5% of infected animals show clinical signs of coccidiosis. Clinical signs are numerous, and animals should be monitored closely for early detection. The first and most obvious symptom of coccidiosis is

diarrhea (scours). In mild cases the feces may contain little or no blood; in severe infections the feces may be dark, bloody and contain small stands of intestinal mucosa. Other symptoms include dehydration, weakness, rough hair coat, anorexia, weight loss, arched back posture with straining to defecate and rectal prolapse. Secondary infections may occur because of suppression of the immune system. Death can result from the diarrhea, from hemorrhaging or from secondary complications such as pneumonia.

Once an animal has been diagnosed with coccidiosis, treatment may be necessary.; however, coccidial infections are difficult to treat because clinical signs appear after the life cycle of the organism is almost complete. Anticoccidial drugs are effective only during the early stages of the life cycle of coccidia, and, by the time symptoms are present, the oocysts have already passed the stage at which treatment would be most effective. Treatment should be given to calves at the earliest clinical signs to possibly reduce disease severity and decrease mortality. Treatments for coccidiosis include Amprolium and sulfonamides, and these drugs are most effective against coccidia during days 5 to 10 of the life cycle. Antibiotics also may be administered to reduce secondary infections; electrolytes and fluids should be given to control dehydration in these infected calves.

Since treatment is difficult and often ineffective because of the nature of the life cycle of the *Eimeria* organisms, prevention of coccidiosis is the best method of controlling this disease in calves. Colostrum is the key to calf health; it is the source of passive immunity for neonatal calves. Housing should be kept clean and dry, and feeding and watering devices must be kept free from fecal contamination. Stress caused by changes in feeding regimen or by excessive animal movement should be minimized. Additionally, older animals should be housed separately from growing calves to prevent possible spreading of coccidiosis. Older animals often have acquired resistance to the disease and may pass oocysts into the environment. Besides the use of recommended calf management procedures, coccidiostats in milk replacer and calf starter have been effective in preventing coccidiosis in young dairy calves. Decoquinate (Deccox®) prevents coccidia development during days 1 through 15 of the life cycle. When fed at 0.5 mg/kg of body weight, decoquinate has been effective in controlling the disease. Ionophores such as lasalocid (Bovatec®) and monensin (Rumensin®) kill the coccidia early in the life cycle. Both ionophores, when fed at 1 mg/kg of body weight, are very effective in preventing coccidiosis in dairy calves. Ionophores have an added benefit of increasing body weight gain and feed efficiency in these young animals.

Since it is virtually impossible to stop the spread of coccidia on the farm, use of coccidiostats is an excellent source of insurance against the disease. Providing this protection can minimize the economic losses from both the subclinical and clinical forms of coccidiosis. Ionophores may further improve calf performance because of their known effects of increasing weight gain and feed efficiency. The question is often asked as to which coccidiostat is best. Decoquinate, lasalocid and monensin are all effective in controlling coccidiosis in dairy calves. They can be included in both milk replacer and calf starter. Since young calves do not consume significant amounts of calf starter until 3 to 4 weeks of age, coccidiostats in milk replacer will provide an added advantage for these younger animals. The decision for selecting a coccidiostat should be made based on availability, price and ease of delivery. The herd veterinarian or consulting nutritionist may also help in deciding which product is best for an individual farm.

SUMMARY AND APPLICATIONS

Calf scours are a major cause of death in neonatal dairy calves. Of the many causes of scours, coccidiosis has a high incidence of occurrence in young dairy calves and is a very costly disease. Nutrition and management are critical in disease prevention, and the use of

coccidiostats has been proven to be very effective in controlling coccidiosis in young dairy calves.

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Research Reports

GERMICIDAL ACTIVITIES OF REPRESENTATIVES OF FIVE DIFFERENT TEAT DIP CLASSES AGAINST THREE BOVINE MYCOPLASMA SPECIES USING A MODIFIED EXCISED TEAT MODEL

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INTRODUCTION

Mastitis caused by *Mycoplasma* species is becoming recognized more frequently as veterinarians and laboratory personnel become familiar with the clinical symptoms of the disease and the culture technique needed to identify infections. *Mycoplasma* species are found as normal flora of cattle nasal mucous membranes, respiratory surfaces and the urogenital tract, as well as on teat skin. Because of the severity of clinical mycoplasmal mastitis, the lack of approved antimicrobial therapy, and because the organism is found in an opportune site on teat skin for development of intramammmary infection (IMI), proper udder hygiene is very important for reducing numbers of *Mycoplasma* species on teat skin (Laboratory Handbook, 1999). During mycoplasmal mastitis outbreaks, sanitary practices should be upgraded to include segregation of infected cows, teat dipping, and dipping milking clusters in a sanitizer between cows (Jasper et al., 1976). In the past, the effectiveness of various teat dips against mycoplasmas was not considered relevant. Not until Jasper et al. in 1976 (Jasper et al., 1976) tested seven teat dip and sanitizer products against *M. bovis* was there any research showing teat dip efficacy against *Mycoplasma* species. This study revealed that the chlorine, iodine and chlorhexidine teat dips tested were very effective against *M. bovis* on teat skin. Since that initial research more than 25 years ago, many new teat dips have been developed that have not been tested against *M. bovis*, the most common bovine mycoplasmal mastitis pathogen or any of the other *Mycoplasma* species causing mastitis. The objective of this study was to evaluate teat dips representing different teat dip classes against the three most common bovine mycoplasmal mastitis pathogens using a modified excised teat model (Philpot et al., 1978).

MATERIALS AND METHODS

Descriptions of the teat dips tested are found in Table 1. Teats that were used during each trial were collected from slaughtered dairy cows. Excess skin and tissue were trimmed, teats were washed in a mild detergent and warm water, rinsed in water, dried and dipped in 70% ethyl alcohol. Teats were discarded that had rough skin, chaps or abrasions. Teats were placed in plastic bags in a glycerin and water solution and frozen at -20°C until further use. The mycoplasmal strains used for each trial were *Mycoplasma bovis* American Type Culture Collection 25523; *Mycoplasma californicum* Willet 9978 received from R. N. Gonzalez, QMPS, College of Veterinary Medicine, Cornell University, Ithaca, NY; and *Mycoplasma bovigenitalium,* received from J. S. Cullor, University of California, Davis, CA.

For preparation of the challenge inoculum of each *Mycoplasma* species, six 10-ml tubes of mycoplasma broth, to which enrichment supplements of 20% inactivated horse serum and 2.5% yeast extract were added, were inoculated heavily with colonies actively growing on mycoplasmal agar. The mycoplasmal agar was supplemented with 10% inactivated horse serum, 1% yeast extract, 0.05% thallium acetate, 0.002% DNA and 1000 units/ml of penicillin.

The inoculum was incubated at 37°C in 10% CO_2 atmosphere for 72 hours. The optical density of the inoculum was determined, and the organism population was adjusted to approximately 1 x 10^8 colony-forming units (cfu)/ml of each organism by use of a standard curve made by data obtained from previous serial dilutions and standard plate counts. Serial dilutions of the challenge inoculum were made before each trial began and a standard plate count conducted on mycoplasmal agar. The teat dip quenching solution was letheen broth modified to contain 1% sodium thiosulfate.

Each trial used 10 teats for testing the products as well as the negative control. Frozen teats were thawed in warm water, dipped in 70% ethyl alcohol, dried with a paper towel and suspended by metal clips from a glass rod. Teats were dipped in the challenge suspension once to depth of approximately 15 mm and allowed to drain for 5 minutes, then dipped with the test product to a depth of approximately 30 mm and drained for an additional 10 minutes. For undipped negative control teats, the drainage time was 15 minutes.

Organisms were removed by rinsing each teat with approximately 5 ml of quencher expressed from a polyethylene wash bottle. The quencher was maintained at 5°C during each trial. The 5-ml rinse was collected in sterile blood cell-counter vials. Plating of the rinse was in 0.1-ml amounts on mycoplasmal agar. Rinses from negative control teats required plating at 10^{-4} to achieve countable plates, and rinses from teats dipped with the test products were not diluted before plating. Plates were incubated for seven days at 37°C in 10% CO_2 atmosphere and colonies were counted using a stereo microscope at 3x magnification. The geometric mean of colonies counted was determined, multiplied by 50 to express the total volume of rinse and then multiplied by the dilution factor to yield the total cfu recovered from the rinse of each teat. The total cfu recovered for each product tested was converted to log form, and this log value was subtracted from the log value for the negative control run to yield the log reduction (LR) in cfu for that product. In cases where organisms were not recovered from a teat, the value of 0.01 was substituted for zero in determining mean counts.

The same set of teats was used for each run within a trial. Between runs, teats were rinsed in warm water for 2 minutes with agitation, dried, rinsed in a 0.05% sodium thiosulfate solution for 1 minute, dried, rinsed in a solution containing 0.05% lecithin and 0.05% Tween 80 for 1 minute, dried, rinsed in warm water for 1 minute, dried, dipped in 70% ethyl alcohol, dried, and resuspended on the glass rod to air dry before commencement of the next run.

RESULTS

An effective teat dip should achieve a 3 and, preferably, a 4 or 5 LR of microorganisms using an excised teat model (Philpot et al., 1978). Data for the teat dips tested are presented in Table 2. All of the tested teat dips were efficacious against all of the *Mycoplasma* species, providing LR above 4. The germicides performed best against *M. bovigenitalium* with an average LR of 6.29. Average LR were 5.41 and 5.70 against *M. bovis* and *M. californicum*, respectively. It should be noted that the active ingredients in Effercept® Vet Sanitizing Teat Dip (sodium dichloroisocyanurate) and Uddergold® Plus (sodium chlorite and mandelic acid) are different, although both are classified as chlorine compounds. Both teat dips kill microorganisms by chlorination and oxidation of the cell and internal proteins, including enzymes (Boddie et al., 1994; Boddie and Nickerson, 1996).

Mycoplasmal microorganisms may seem to be fragile and easy to destroy under laboratory conditions; however, in the field they may be more resistant to teat dips because of their protection in milk and other organic materials (Bushnell, 1984). The ability of the tested strains to survive on the negative control teats in this assay for 15 minutes indicates these organisms can survive on teat surfaces long enough to be transmitted from cow to cow. *Mycoplasma bovis* was the most resistant to germicides of the common mastitis-causing species in this study. In a study of neutralization of germicidal activity of disinfectants by organic matter, a 2% iodophor and a chlorine product showed a low tolerance of organic matter including whole milk powder. A 1.6% chlorhexidine acetate and an anionic acid were only moderately affected by the presence of organic matter (Gelinas and Goulet, 1983). *Mycoplasma* can be introduced into a herd in ways other than mycoplasmal mastitis. Cows or calves with *Mycoplasma* pneumonia spread the disease to other herdmates and provide a reservoir of infection that could lead to mycoplasmal IMI (Bushnell, 1984). Teat dip use is only one tool to help eliminate *Mycoplasma* on teat skin. Cows and heifers purchased should be screened for mycoplasmal IMI and respiratory disease before entering the herd. Proper udder infusion procedures and sanitization of milk equipment will also reduce the spread of mycoplasmal IMI.

The spread of mycoplasmal mastitis does continue in herds where teat dipping isi practiced, but teat dip use can still be a good procedure for reducing the numbers of *Mycoplasma* on teat skin therefore reducing the rate of spread of mycoplasmal IMI.

CONCLUSIONS

Mastitis caused by *Mycoplasma* species is being recognized more frequently than in the past. *Mycoplasma* species are commonly found on nasal mucous membranes, respiratory and urogenital surfaces and teat skin. Udder infections are spread from cow to cow by physical contact and are precipitated by breakdowns in sanitation, equipment maintenance and udder infusion. Antibiotic therapy has been ineffective in controlling the disease. Proper sanitation, including pre- and postmilking teat dipping, good udder infusion techniques and culling of carrier animals, is essential in controlling this microorganism in a dairy herd. Data obtained during this study prove that several generic classes of teat dips are efficacious against the most common mycoplasmal mastitis species on teat skin.

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Table 1. Description of teat dips tested during excised teat study.

Product class	Product name	Active ingredients	Mixing instructions	Manufacturer
Chlorine Compound	Effercept® Vet Sanitizing Teat Dip and Spray	Sodium dichloroisocyanurate	4 tablets/1 gallon water	Activon Products, Fort Collins, CO
Chlorine Compound	Uddergold® Plus	Base: 0.64% Sodium Chlorite Activator: 3% Mandelic Acid	Mix equal amounts of base and activator	Alcide Corp., Redmond, WA
Chlorhexidine	Blue Ribbon Sanitizing Teat Dip	0.5% Chlorhexidine Gluconate	Use Undiluted	IBA, Inc., Millbury, MA
Iodine	Theratec® Pre and Post Sanitizing Teat Dip	0.5% Iodine	Use Undiluted	Westfalia-Surge, Inc., Naperville, IL
Peroxygen Compound	Oxy-Gard™ Sanitizing Teat Dip	0.5% Hydrogen Peroxide 1.7% Lactic Acid	Use Undiluted	Klenzade, Division of Ecolab, Inc., St. Paul, MN
Quaternary Ammonium	Smart Dip	Benzalkonium Chloride	Use Undiluted	Baca Enterprises, LLC, Fresno, CA

Table 2. Germicidal activity of various teat dips against *Mycoplasma* species.

Product	Germicide	*M. bovis* Log reduction from control	*M. californicum* Log reduction from control	*M. bovigenitalium* Log reduction from control
Effercept®	Sodium dichloroisocyanurate	4.79	5.84	6.27
Uddergold® Plus	0.64% Sodium chlorite 3% Mandelic acid	5.96	5.73	---[1]
Blue Ribbon	0.5% Chlorhexidine gluconate	5.15	---[1]	---[1]
Theratec®	0.5% Iodine	---[1]	6.68	6.42
Oxy-Gard™	0.5% Hydrogen peroxide 1.7% Lactic acid	4.60	4.38	6.00
Smart Dip	Benzalkonium chloride	6.56	5.88	6.49

[1]Complete kill of all microorganisms by the teat dip.

PRELIMINARY REPORT; SEVEN STATE STUDY: THE EFFECT OF PREPARTUM ANTIBIOTIC THERAPY ON POSTPARTUM MILK PARAMETERS

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MATERIALS AND METHODS

Cooperating herds from Experiment Stations in six states (Washington, Louisiana, Ohio, Tennessee, New York and Connecticut) and the province of Ontario in Canada, were enrolled for this study. Study animals included the primiparous cattle in enrolled herds.

Heifers, confirmed to be pregnant, uniquely identified and in good physical condition, were enrolled approximately two weeks before expected calving. At approximately two weeks before scheduled calving, 10-21days before the due date, duplicate aseptic mammary quarter secretion samples were collected from all heifers enrolled. These samples were submitted to the bacteriology laboratories associated with each participating site for determination of intramammary infection status. Heifers that had an even numbered identification number were assigned to receive treatment, and heifers that had an odd number identification served as untreated controls. Treated heifers received intramammary therapy with a commercial cephapirin sodium preparation (Cefa-Lak®, Fort Dodge Inc., Fort Dodge, IA) in each functional quarter (one tube/quarter), after meticulous teat-end preparation, and by the partial insertion method. The teat-end preparation was facilitated using a disinfectant before cleaning with a 70% alcohol swab. Following infusion, each teat was dipped in Stronghold® Dry Cow Teat Sealant (West Agro, Kansas City, MO) to protect the opened teats for these prepartum heifers. The current label instructions for Cefa-Lak is to infuse a single dose (tube) in an infected quarter and repeat 12 hours later. The proposed protocol for this study was to treat only once. It is acknowledged that this is not the label dose; however, this approach can be justified in three separate ways. These are mammary glands of heifers before calving rather than lactating cows. This dose has been efficacious in previous studies (Oliver et. al., 2002). Finally, most research would substantiate that perhaps more than 80%-90% of heifers are infected in at least one quarter at this time.

Composite samples were taken for residue testing at the farm (before inclusion in bulk tank) and for central lab testing (milking 3, 6 and 10). Samples were tested on farm alongside a known negative control, and milk was allowed into the bulk tank only after a negative sample. Composite samples for central lab testing were frozen. Accumulated samples were sent to Sheila Andrew at University of Connecticut for centralized residue analysis using different residue test kits. Results of both on-farm and central testing were recorded. The label withdrawal times for Cefa-Lak in lactating cows are 96 hours milk withholding and 4 days slaughter withholding post last treatment. Although withdrawal time is not known for heifers, many statements support this protocol. Heifers were treated 10-14 days prepartum, and past research substantiates this to minimize residues by three milkings post calving. Subsequently, all treated animals were confirmed residue negative through on-farm testing before milk was

allowed in the bulk tank. Most trial animals were tested at milkings 3, 6 and 10 and analyzed centrally.

Bacteriological Culture and Diagnosis

Milk samples (10 µl aliquot) were cultured on blood agar plates using standard NMC procedures. Briefly, identification of mastitis pathogens was done by presumptive identification, identifying gram-positive and gram-negative isolates, catalase test, CAMP reactions and lactose fermentation reactions. Isolation of three or more dissimilar colonies from quarter milk samples was considered a contaminated sample. For a sample to be considered from an infected mammary quarter pre-calving, the results of the duplicate sample were in agreement. If only a single sample was taken prepartum because of problems in obtaining adequate volume, or if one of the duplicate samples was deemed to be contaminated, then the single sample was used to designate infection. All postpartum samples had to be free of the infectious agent found in the prepartum sample for a mammary quarter to be considered cured. A single contaminated sample in the postpartum collection did not nullify results from that mammary quarter; however, if the last sample, the day 21 postpartum sample, was judged to be contaminated, then a follow-up sample was to be collected to confirm the mammary quarter's status as cured.

Somatic cell counts and daily production on test day, as well as the number of services per conception and days open, have been recorded for each treated and control animal from DHIA records. Additional variables will include clinical mastitis and other disease events. Important farm and cow level factors that may act as potential confounders were recorded and controlled for in the analysis.

RESULTS

Preliminary results suggest the treatment was effective in curing prepartum intramammary infections in heifers. There were approximately 2.5 times more cures in treated as compared to control mammary quarters. In control mammary quarters, approximately three times the number of prepartum intramammary infections were detected at freshening as was found in treated quarters. There were almost half as many new intramammary infections during the peripartum period in treated as compared to control mammary quarters.

Milk production and somatic cell count data were available for five herds. In two, treatment cows out-produced control animals during the first 200 days in milk of lactation, while in three herds, the control animals produced more milk than treated heifers. The lactation average milk somatic cell count was higher with treated heifers than control animals during the first 200 days of lactation in 1 herd, and the reverse in the other herds. Overall, somatic cell count and milk production differences among treatment groups were small.

DISCUSSION

Data from this study are consistent with previous research results. In the study reported herein, CNS were the major pathogen group associated with intramammary infections prepartum, similar to that reported by others (Trinidad et al., 1990; Oliver et al., 1992, 1997, 2003). Additionally, the cure rates in this study were similar to those seen in the aforementioned studies. The percentage of mammary quarters that were free of infections after parturition and through lactation was significantly lower in treated animals as compared to controls (Oliver et al. 2003). If milk somatic cell count data in the current study reflect intramammary infection status

then a similar finding would be seen; the positive effect of reducing the intramammary infection prevalence postpartum continues through the lactation.

Although the discussed results suggest peripartum treatment of heifers may be beneficial in terms of reduced mastitis in the first lactation, costs are associated with such treatment. They include the cost of the product, the cost of the labor associated with the product (administration of drug, monitoring milk for residues and isolation of cattle until milk is residue free), the costs of the residue kit and the risk of residue-laden milk contaminating the dairy's output. Oliver et al. (1992) reported that different peripartum therapies resulted in different patterns of residue contamination of milk of first lactation heifers. They reported that heifers treated with cephapirin sodium yielded a higher percentage of colostral samples with inhibitory substances than those treated with cloxacillin sodium, 85% vs. 17%. At three days, residues were detected in 25% and 0% of the cephapirin as opposed to cloxacillin-treated heifer mammary quarter milk samples. Logically, it would seem that timing of treatment relative to calving would affect the likelihood of residue-contaminated milk. Indeed, Oliver and coworkers (1997) point out that treatment in the early peripartum period results in a reduced risk of contaminating milk postpartum with antibiotics.

Oliver and coworkers also report on the positive aspects of such treatment. They indicate in their publication of 2003 that prepartum antibiotic treatment of heifers led to an approximate 450 kg gain in milk production during the first lactation. Such production gain would seem to offset potential costs and make the management strategy economically advantageous. Additional economic gains could be recouped with lower herd milk somatic cell counts and associated premium payments by milk handlers for lower cell count milk. A recent study by Schrick and coworkers (2002) indicates that prepartum antibiotic therapy of heifers did not result in improved reproductive performance, in contrast to what was observed previously in all cows (Schrick, et al., 2001). The current study has yet to include the analysis of reproductive performance during the first lactation.

CONCLUSIONS

Preliminary analysis of data from the current study clearly indicates that prepartum intramammary antibiotic treatment of heifers results in substantial cures of existing infections, and a reduction in new infections. Thus treated heifers have fewer intramammary infections at calving. Yet positive effects of such treatment must offset costs. One study by Oliver et al. (2003) suggests an approximate 450 kg. gain in milk in the first lactation with treatment. Preliminary results from the current study indicate there might be a slight gain in milk production with treatment. Contamination of milk postpartum by antibiotics may be a concern and will be studied; however, at present the data to support this practice is equivocal, and such treatment constitutes extra-label use of drugs. Therefore, the use of periparturient intramammary therapy cannot be uniformly recommended at this time, and, if practiced, should be done so in close consultation with the herd's attending veterinarian.

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NEW SEMEN SEXING TECHNIQUE PROVEN VIABLE

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A recent study confirmed there is a variation in the ratio of male to female calves as a result of variation in male- and female-producing sperm cells. It also proved Real-Time polymerase chain reaction (PCR) to be an accurate way to measure the amount of male- or female-producing sperm cells.

Each animal has two sex chromosomes. Females have two X chromosomes, whereas males have one X and one Y. When egg or sperm cells form, they contain only one of the two sex chromosomes. Since females have only X chromosomes, every egg contains an X chromosome. Sperm cells, however, have either an X or a Y chromosome. Therefore, when egg and sperm join, the sperm cell determines the sex of the offspring. In previous studies, scientists in the LSU Dairy Science Department discovered that male animals produce varying amounts of X and Y sperm cells each time they are collected.

Since artificial insemination is a common practice on many farms, an ability to use sexed semen could be very beneficial to companies selling semen to farmers who will use it to breed their animals. For example, dairy farmers could purchase semen that has a higher probability of producing female calves, which are much more profitable than male calves in a dairy setting.

The scientists conducting this experiment had three objectives. The first was to further prove the variation of X and Y sex cells in each lot of semen. Second, the researchers wanted to compare two similar methods of sexing semen to determine which was more accurate. Last, they wanted to apply the sex ratio lab tests to a real breeding situation to further prove the accuracy of their tests.

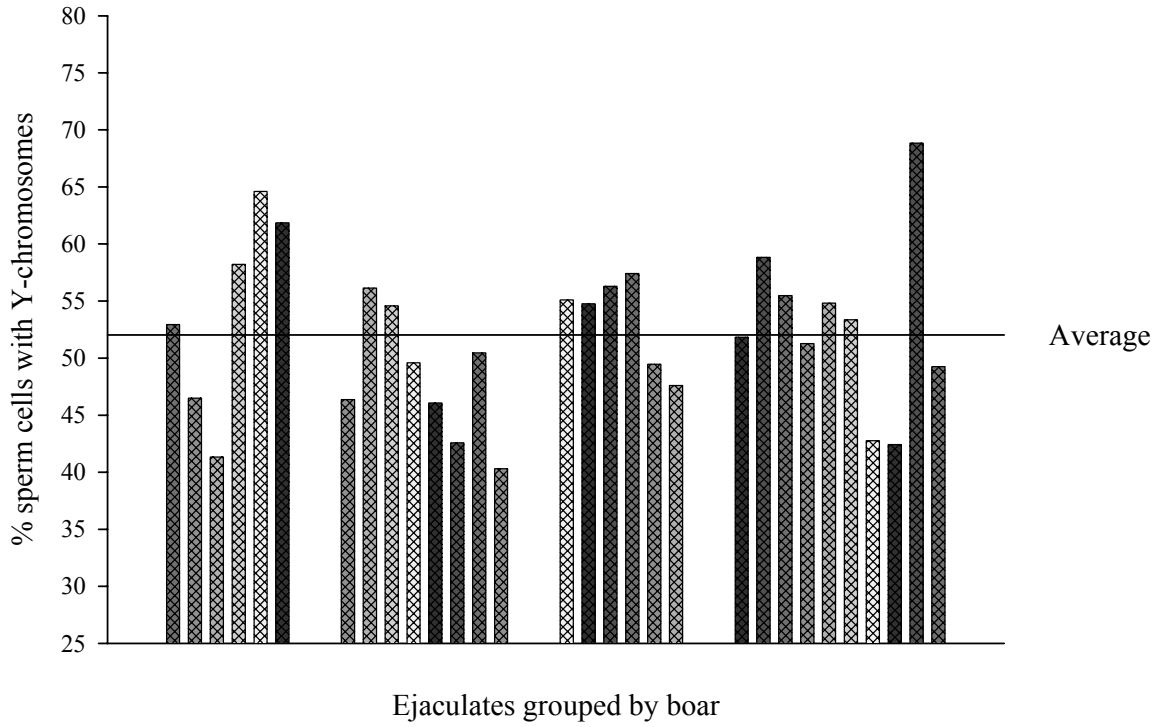
This study used two types of PCR to measure the variation in the ratio of X and Y sperm cells. Both procedures involve taking a sample of semen, isolating the DNA from it, replicating the DNA of interest (in this project, sections of the X and Y chromosomes) and then measuring the amount of that DNA. The main difference between the two techniques is that the older procedure, conventional PCR, measures the DNA *after* replication, whereas the newer process, Real-Time PCR, measures the amount of DNA *while* it is being replicated.

Pigs produce litters, unlike any other domestic farm animal. Since one lot of semen can fertilize multiple eggs in a female pig, that sow can give birth to several piglets from that one lot of semen. In a research project, more information provides more accurate results; therefore, the pig was the best animal with which to test the laboratory findings, even though the project was conducted within the LSU Department of Dairy Science.

Results of the experiment confirmed the variation in X and Y sperm cells, as displayed in the graph below. Real-Time PCR data showed one lot of semen having as little as 38% Y, and another contained as much as 64% Y. Monitoring and measuring this variation could allow commercial semen companies to market sex-evaluated semen. The scientists found significant variation in the sex ratio from litter to litter. Also, after the litter data was compared to the PCR data, scientists found that Real-Time PCR, the test that quantifies DNA while it is replicating, measured the sex ratio more accurately than conventional PCR.

Flow cytometry, another method for sorting spermatozoa by sex, is already being used; however, it sorts semen very slowly and damages many of the sperm cells in the process. The result of flow cytometry is high-priced, sexed semen with lower quantity and compromised quality. One of the main differences between flow cytometry and PCR is that flow cytometry

produces nearly 100% sexed semen, whereas PCR provides semen with a sex ratio. Practical application of PCR produces semen with a known sex ratio without compromising the quality or sacrificing the quantity of viable semen. Therefore, PCR provides farmers with high quality semen with which they alter the sex ratio of their animal crops.



LSU AGCENTER DAIRY VERIFICATION PROJECT: TREATING PRE-PARTUM DAIRY HEIFERS WITH DRY COW VS LACTATING COW ANTIBIOTICS

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INTRODUCTION

Recent research has identified treating dairy heifers with dry cow intramammary infusions approximately 60 days before calving as an economically viable management practice which can lead to lower post-calving intramammary infection rates, lower somatic cell counts and higher milk production during the first lactation. Another practice being studied is treating dairy heifers with lactating cow intramammary infusions approximately 14 days before calving. An extension demonstration project was initiated at the LSU AgCenter dairy farm during the fall of 2003 to further verify the results of previous research trials.

MATERIALS AND METHODS

Thirty-three Holstein dairy heifers were randomly assigned to one of three treatment groups based on their age and calving date. All 33 were scheduled to calve between November 2003 and April 2004. Treatment 1 was a control group with no prepartum intramammary treatments. Treatment 2 was a lactating treatment group with each animal treated approximately 14 days before calving with one infusion of a commercially available lactating cow intramammary product in each quarter. Treatment 3 was a dry cow treatment group with each animal treated approximately 60 days before calving with one infusion of a commercially available dry cow intramammary product in each quarter.

Duplicate samples of mammary secretions were taken from each quarter of each animal in treatment 3 approximately 60 days before calving and immediately before treatment. Groups 1 and 2 were sampled about 14 days before calving and immediately before treatment for group 2. All animals were sampled five to 14 days postpartum. Samples were sent to the Mastitis Research Lab at the Hill Farm Experiment Station for analysis. Analysis consisted of identification of specific microbiological organisms in each quarter sample. Microbiological data was summarized as number of quarters with a detectable microbiological infection pre and post treatment. Milk production data was Peak Milk, Summit Milk and Projected 305-day Actual Lactation Milk Yield as calculated by the Dairy Herd Improvement Association (DHIA) records. Somatic cell count data (linear scores) from the first three DHIA test dates of the lactation were used to summarize effects of treatment on early lactation somatic cell counts.

Expected returns were calculated for each treatment group. Expected returns were calculated as the value of milk produced during the first lactation minus the cost of treatment. Value of milk produced was calculated as: (Projected 305-day Actual Production in hundredweights (cwt) X Milk Price). Milk price used was $15.00 per cwt.

Treatment costs were labor to infuse each animal plus the cost of medication. Labor costs were .20 hours X $10.00 per hour or $2.00. Medication cost for each animal

was $6.68 for both lactating and dry cow medication. Total cost for treatment of each animal was $8.68.

RESULTS

Microbiological Comparisons

	% Quarters Infected (All Organisms)		% Quarters Infected (Staph. Aureus)	
	Pre-treatment	Post-Treatment	Pre-treatment	Post-Treatment
Control	32.200	25.000	21.400	10.700
Lactation Treatment	25.000	15.625	6.250	9.375
Dry Cow Treatment	56.250	6.250	12.500	3.125

Average SCC (linear score) on the 1st 3 DHIA Test Dates

	1st Test	2nd Test	3rd Test
Control	5.0	3.6	4.5
Lactation Treatment	3.7	4.1	3.7
Dry Cow Treatment	3.6	2.8	3.4

Average Milk Yield (lbs) and Product Value Comparisons

	Peak Milk	Summit Milk	Proj. 305-day milk	Value
Control	18761	77	73	$2,814.15
Lactation Treatment	17840	71	69	$2,676.00
Dry Cow Treatment	20264	83	79	$3,039.60

Difference in Returns Over Costs

Dry Treatment vs Controls ($3,039.60 - $2,814.15) - $8.68 = $216.77
Lactating Treatment vs Controls ($2,676.00 - $2,814.15) - $8.68 = -$146.83
Dry Treatment vs Lactating Treatment
($3,039.60 - $2,676.00) - $0.00 = $363.60

SUMMARY

Microbiological results indicated that treating pre-partum heifers approximately 60 days before calving with a commercially available dry cow antibiotic substantially reduced the percentage of quarters infected post-partum over pre-treatment levels for both staphylococcus aureus and a combination of all organisms. Treating 14 days before calving with a commercially available lactating cow antibiotic slightly reduced the overall number of infections post-partum; however, the lactating cow antibiotic had little or no effect on the number of post-partum staphylococcus aureus infections. Control animals also exhibited lower post-partum infection rates for both staphylococcus aureus and a combination of all organisms, possibly indicating some rate of spontaneous cures in pre-partum infections. However, heifers treated with dry cow antibiotics had substantially lower post-partum infection rates than either controls or heifers treated with lactating cow antibiotics.

Heifers treated with dry cow antibiotics had an average of 6 pounds more peak and summit milk than controls and 12 and 10 pounds more peak and summit milk, respectively, than heifers treated with lactating cow antibiotics. Heifers treated with dry cow antibiotics were also projected to produce 1,503 pounds more milk during the first lactation than untreated controls and 2,404 pounds more milk than animals treated with lactating cow antibiotics. Heifers treated with dry cow antibiotics also exhibited lower test day somatic cell counts on the first three post-calving monthly DHIA test days than either heifers treated with lactating cow antibiotics or control animals.

Heifers treated with dry cow antibiotics were projected to produce an additional $216.77 return over treatment cost as compared to untreated controls and $363.60 return over treatment cost as compared to heifers treated with lactating cow antibiotics.

These results appear to verify previous research in indicating pre-partum intramammary treatment of dairy heifers with a commercially available dry cow medication tends to reduce the number of post-partum intramammary infections, increase early lactation milk yield, lower early lactation somatic cell counts and substantially increase profitability during the first lactation. Pre-partum treatment with a lactating cow antibiotic also appeared to verify previous research which has found very little benefit in lowering early post-partum infection rates, increased early lactation milk yield and lower early lactation somatic cell count.

EFFECTS OF PREPARTUM DIETARY ENERGY AND CALCIUM PROPIONATE ON TRANSITION DAIRY COW PERFORMANCE

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INTRODUCTION

Transition cow management has a great impact on the subsequent lactation. Accurate prediction of herd health disorders that commonly occur during this period of the lactation, such as ketosis, may play a role in reducing disease prevalence. The stress of milk synthesis during early lactation on the metabolic capacity of the cow may lead to ketosis in the high-producing dairy.

During early lactation, cows must use body fat as an energy source because they are unable to meet the energy demands of milk synthesis from dietary intake. Many high-producing cows experience this metabolic effect during early lactation to some degree. Many supplements have been used to improve performance and avoid clinical ketosis during early lactation. Calcium propionate (NutroCAL™, Kemin Americas, Des Moines IA) can work to alleviate ketosis, displaced abomasums and milk fever by providing propionate and calcium. During early lactation, dairy cows struggle to meet energy and calcium demands. Propionate has been used as a treatment for ketosis and has been shown to increase blood glucose levels. Feeding NutroCAL during the transition period may decrease the risk of developing ketosis.

A high plane of nutrition is needed after calving to supply the high demands of lactation. Often the cow cannot consume enough feed to meet her energy requirements and must rely on body stores. Abrupt changes to the diet of dairy cattle such as the change to a high-energy diet at calving result in alterations to the fermentation balance because of shifts in the proportions of microbial species present. Overfeeding cows during the dry period can increase their risk of developing ketosis during the transition period, however. Obese cows have a greater predisposition for developing fatty livers and have a harder time recovering metabolically from parturition, which can put the cows at greater risk for ketosis. Stokes and Goff, (2001) reported decreased incidences of ketosis when NutroCAL was fed during the entire transition period. It is unknown whether NutroCAL is able to compensate for overfeeding and allow overweight cows to avoid development of ketosis following parturition. Therefore, a feeding trial was designed to investigate the interactions of prepartum dietary energy concentration and NutroCAL on transition performance and incidence of ketosis in Holstein cows.

MATERIALS AND METHODS

Forty-one Holstein cows were grouped by parity (primiparous or multiparous) and anticipated parturition date and assigned to one of four treatments based on 105% (normal) and 145% (high) of prepartum dietary energy requirements with or without addition of 1/4 pound per day of NutroCAL (Kemin Americas, Des Moines, IA). Cows were fed treatment diets from 21 days prior to their anticipated parturition date until parturition. After calving, all cows were fed a standard lactation diet with NutroCAL supplementation continued as assigned prepartum. Feed intake was measured daily. Table 1 describes the composition (% of DM) of the diets.

Milk was sampled beginning three days after calving to avoid sampling colostrums, and production was recorded at each milking. Milk samples were analyzed for their

content of fat, protein and somatic cells by the Louisiana Dairy Herd Improvement Laboratory.

Blood samples were collected three times a week during weeks -3, -2, -1, 1, 2 and 3 relative to parturition. Plasma was isolated from blood samples and analyzed for glucose, NEFA, plasma urea nitrogen, BHBA (a ketone), insulin and thyroxine concentrations. Concentrations of cortisol and glucagon were measured at wk -1 and +1.

Samples of urine from each cow were collected three times a week during weeks -3, -2, -1, 1, 2 and 3 relative to parturition. Immediately after collection, urine pH was recorded and acetoacetate (a ketone) concentrations were measured using Ketostix® test strips (Bayer Corporation Diagnostics Division, Elkhart, IN). Urine samples were then frozen for later laboratory analysis of BHBA.

RESULTS AND DICUSSION

A high incidence of metabolic disorders and disease was observed in these cows (Table 2). More than 50% exhibited signs of at least one metabolic disorder or disease during the trial. All cases of ketosis were recorded as secondary to another condition. This may have decreased or even circumvented the ability of the NutroCAL to decrease the incidence of ketosis in these cows. There was no evidence that treatments were related to the incidence of disease or disorder

The dry matter intake (DMI) was not affected by dietary energy concentration, NutroCAL or their interaction (Table 3). Cows declined approximately 55% in DMI starting three days before parturition. Although cows declined in DMI more than expected prepartum, their postpartum DMI was in the range of expected values and should not have had a negative impact on milk production.

Supplemental NutroCAL tended to decrease milk production (Table 3). Cows supplemented with NutroCAL had a numeric decrease in DMI postpartum, which may have caused the tendency for decreased milk production. Neither dietary energy concentration nor the interaction of dietary energy concentration and NutroCal affected milk production. Milk fat percentage was not affected by prepartum dietary energy concentration, NutroCAL or their interaction. Supplemental NutroCAL tended to decrease milk fat production. Although there were no changes in milk fat percentage observed, there was a slight numeric decrease in milk fat yield. This is probably associated with the slight numeric decrease in milk yield.

Since there were no differences in milk fat percentage, milk fat yield or milk yield, 4% fat corrected milk was not affected by dietary energy concentration or the interaction of dietary energy concentration and NutroCAL; however, there was a tendency for NutroCAL to decrease 4% FCM production. This is most likely because of the numeric decrease in total milk production from cows fed NutroCAL.

Milk protein percentage and production were not affected by dietary energy concentration, NutroCAL or their interaction. It is unlikely that NutroCAL supplementation provided additional energy for milk protein synthesis in this study. It is more probable that any additional energy provided as NutroCAL was offset by the numeric decreases in DMI. Although dietary energy concentration was increased by substituting concentrate for forage, there was no effect of dietary energy concentration on milk protein percentage or production.

The SCCS was not affected by dietary energy concentration, NutroCAL or their interaction. The mean SCCS ranged from 3.1 to 4.3; however, a large incidence of uterine infections was observed in these cows and this systematic infection may have

been artificially increasing the shedding of somatic cells into the milk although we have no way to determine if this is true.

Mean urine pH was not affected by NutroCAL (Table 3) or the interaction of dietary energy concentration and NutroCAL, but the high-energy diet tended to decrease urine pH. Urine is a pathway that cows may use to remove excess ketones from blood. By week 3 postpartum urine acetoacetate concentrations of cows supplemented with NutroCAL began to fall while urine acetoacetate concentrations of cows not supplemented with NutroCAL were still rising. This suggests that supplemental NutroCAL allowed cows to recover faster from ketosis than when NutroCAL was not supplemented. Mean urine BHBA levels were not affected by dietary energy concentration (Table 4), NutroCAL or their interaction. There was an interaction of NutroCAL (Figure 1) with time for urine BHBA concentrations. The NutroCAL supplementation decreased levels of urine BHBA after 2 weeks postpartum. The transient drop and rise in urine pH, along with the lower urine acetoacetate and BHBA at week three, suggests that supplemental NutroCAL allowed cows to recover from ketosis more quickly than when NutroCAL was not supplemented.

Mean plasma BHBA and glucose concentrations were not affected by dietary energy concentration (Table 4), NutroCAL or their interaction. Prepartum concentrations of acetoacetate and BHBA in urine and BHBA in plasma were low (approached zero) but increased postpartum. This implies there were no cases of ketosis prepartum, but the incidence of ketosis increased postpartum. Though not significantly different, numerical differences in plasma BHBA concentrations were observed in this study. Cows supplemented with NutroCAL and fed high dietary energy concentration had lower plasma BHBA levels compared to those fed normal dietary energy concentration and not supplemented with NutroCAL. This suggests that cows fed high dietary energy concentration produced more ruminal propionate and thus were more metabolically adapted to use the supplemented propionate. Cows fed normal dietary energy concentration without proper transition to the lactation diet are less adapted to use supplemental NutroCAL.

Typically during the transition period, differences in blood and urine metabolites can be observed when comparing prepartum and postpartum concentrations. The metabolic adaptations that are necessary to accommodate the changes in nutrient partitioning associated with onset of lactation are mediated by endocrine regulation. Mean plasma NEFA, PUN, glucose, insulin and thyroxine concentrations changed to coordinate the metabolic response associated with calving and the onset of lactation (Table 5). Glucose concentrations decreased at the onset of lactation as less glucose became available to the body and large amounts of glucose were needed for lactose synthesis. During this time NEFA concentrations increased as body fat was mobilized to meet the cow's energy needs. Insulin concentrations decreased with the onset of lactation in response to lower glucose concentration and shift glucose availability to the mammary gland and away from the muscle and fat cells. Glucagon (Table 6) concentrations increased after parturition to aid in mobilizing glucose when energy supply was low relative to the body's demands. Glucose, NEFA, insulin, cortisol and glucagon concentrations were not affected by diet energy level or NutroCAL supplementation (Table 7).

SUMMARY AND CONCLUSIONS

Altering dietary energy concentration for the final 21 days prepartum had no major impact on milk production during the first 21 days of lactation. Similarly, feeding NutroCAL throughout the transition period had no major impact on transition milk production. The high incidence of metabolic disorders and diseases observed in this study may have masked any effects of the treatments on lactation performance. Cows fed NutroCAL appeared to recover from ketosis more quickly than cows not fed NutroCAL, but dietary energy concentration had no influence on recovery from disease. Long-term effects of dietary energy concentration and NutroCAL (longer than 21 days) on incidence of disease, milk production and reproduction should be evaluated. Our data represents weeks 1 through 3 postpartum, which may not have been adequate to demonstrate results from NutroCAL, because other research has been conducted over a longer period.

IMPLICATIONS

Neither prepartum energy nor NutroCAL had a great impact on transition milk production; however, NutroCAL appeared to help cows recover from adverse health problems more quickly than did cows that were not supplemented. NutroCAL supplementation and prepartum dietary energy level did not affect glucose metabolism in these transition dairy cows. Clinical health problems not related to dietary treatments of the experimental herd pre- and postpartum may have affected DMI, and therefore these data may not accurately reflect treatment effects on glucose metabolism.

Table 1. Composition (% of DM) of the normal prepartum energy, high prepartum energy, and postpartum (lactation) diets.

Ingredient	Normal energy	High energy	Lactation
Alfalfa hay	-	-	17.07
Bermudagrass hay	49.98	8.16	-
Corn silage	10.00	40.82	29.01
Ground corn	15.02	20.41	10.24
Protein concentrate[1]	25.00	30.61	29.01
Whole cottonseed	-	-	13.65
Sodium bicarbonate	-	-	1.02

[1] contained 22.16% corn, 56.16% soybean meal, 10.85% dolomitic limestone, 5.42% monocaclium phosphate and 5.42% trace mineralized salt.

Table 2. Incidence of disease or metabolic disorder observed in cows fed diets with normal or high prepartum dietary energy concentrations and with (+) or without (-) 1/4 pound per day of supplemental NutroCAL™ per day.

	Normal energy		High energy	
Disease or Disorder[1]	-	+	-	+
Laminitis	0	0	0	1
Fatty liver	0	0	0	1
Systemic infection	0	0	0	1
Ketosis	1	4	3	3
Milk fever	0	2	1	2
Retained placenta	1	2	1	3
Displaced abomasums	2	1	1	0
Metritis	3	3	2	3
Other	1	0	0	0
Total[2]	5	7	6	6

[1] A cow may be represented in more than one category. Consecutive recordings of a disease or disorder are considered one incidence for categorizing purposes.

[2] Number of cows that exhibited any sign of disease or disorder. Cows that exhibited signs of more than one disease.

Table 3. Least squares means of lactation performance and body weight of cows fed diets with normal or high prepartum dietary energy concentrations and with (+) or without (-)1/4 pound per day of supplemental NutroCAL per day.

	Normal energy		High energy	
Item	-	+	-	+
DMI, lb.; prepartum	20.9	17.8	21.8	19.4
Postpartum	27.7	22.7	29.3	23.8
Milk, lb.	58.5	45.8	55.7	50.8
4% FCM, lb.	58.1	47.8	58.1	50.4
Fat, %	4.1	4.3	4.3	4.2
lb.	2.4	1.8	2.4	1.8
Protein, %	2.7	2.7	2.9	2.8
lb.	1.5	1.3	1.8	1.3
SCS	3.1	4.3	4.1	4.3
BW, lb.; prepartum	1388.9	1495.8	1528.8	1476.9
Postpartum	1256.4	1288.1	1335.2	1322.2

Table 4. Least squares means of urine pH and metabolites in urine and plasma from cows fed diets with normal or high prepartum dietary energy concentrations and with (+) or without (-)1/4 pound per day of supplemental NutroCAL per day.

		Normal energy		High energy	
Item		-	+	-	+
Urine pH	Entire trial	8.0	8.0	7.9	7.7
	Prepartum	8.0	8.1	7.9	7.9
	Postpartum	8.0	7.9	7.8	7.7
Urine acetoacetate, mg/dL	Entire trial	15.2	17.6	16.2	12.2
	Prepartum	3.5	1.7	2.5	2.2
	Postpartum	25.7	35.4	29.1	23.9
Urine BHBA, mg/dL	Entire trial	6.6	15.7	18.1	8.8
	Prepartum	0.8	0.7	1.0	1.0
	Postpartum	12.1	32.8	35.2	17.7
Plasma BHBA, mg/dL	Entire trial	7.9	8.3	9.6	7.2
	Prepartum	6.1	4.5	5.5	5.8
	Postpartum	9.7	12.2	13.7	8.6
Plasma glucose, mg/dL	Entire trial	53.74	54.30	55.23	54.78
	Prepartum	56.91	58.32	60.24	57.57
	Postpartum	51.23	50.28	50.22	51.58

Table 5. Least square means for plasma metabolite and hormone concentrations.

	Prepartum			Postpartum		
	Week -3	Week -2	Week -1	Week 1	Week 2	Week 3
NEFA, mEq/L)	0.397	0.306	0.449	0.735	0.701	0.593
PUN, mg/dL	0.068	0.092	0.080	0.010	0.092	0.010
Glucose, mg/dL	58.62	57.87	58.29	53.79	49.13	49.56
Insulin, µIU/mL	4.383	3.517	2.874	2.454	2.459	2.589
Thyroxin, µg/dL	3.080	2.566	2.179	1.463	1.500	1.658

Table 6. Least square means for plasma glucagon and cortisol concentrations.

	Prepartum	Postpartum
Glucagon, pg/mL	609.31	808.72
Cortisol, µg/dL	0.735	0.666

Table 7. Least square means for plasma metabolite and hormone data from cows fed a normal or high energy diet with or with out (+) or without (-)1/4 pound per day of supplemental NutroCAL per day.

	Normal energy		High energy	
Item	-	+	-	+
NEFA, mEq/L	0.597	0.457	0.500	0.566
PUN, mg/dL	0.081	0.093	0.087	0.097
Glucose, mg/dL	54.3	53.7	54.8	55.2
Insulin, µIU/mL	3.379	2.701	2.960	3.137
Thyroxin, µg/dL	2.182	2.012	2.052	2.051
Glucagon, pg/mL	728.8	797.9	680.0	629.5
Cortisol, µg/dL	0.714	0.874	0.636	0.578

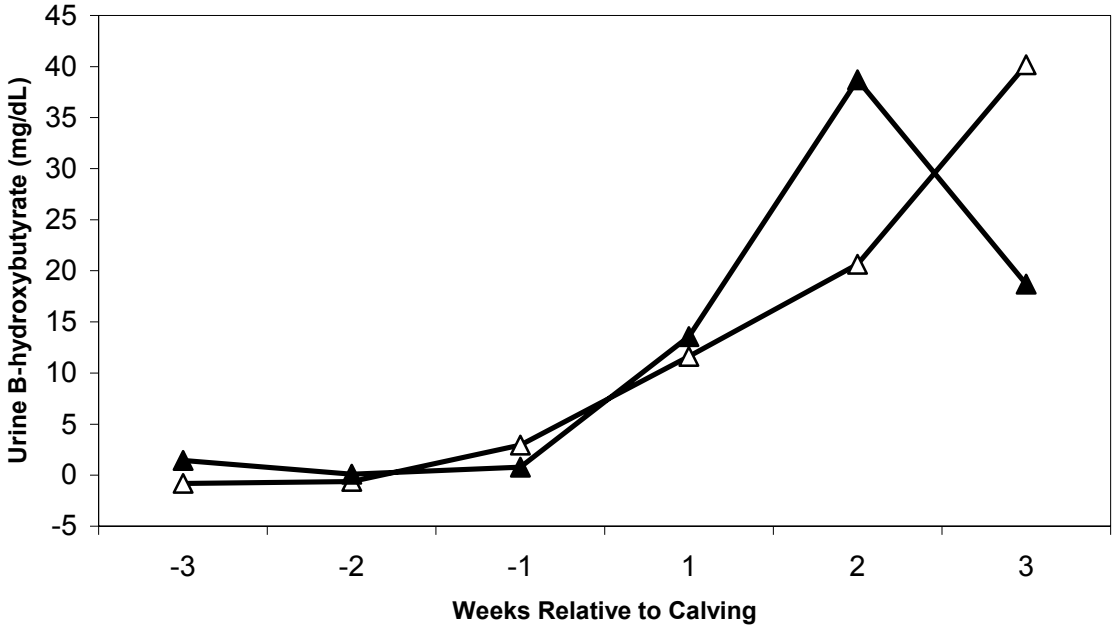

Figure 1. Mean urine BHBA concentrations from cows fed diets with (▲) or without (∆) 1/4 pound per day of supplemental NutroCAL™ per day.

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EFFECT OF ZINC AND RUMENSIN ON RUMINAL AMINO ACID DEGRADATION

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INTRODUCTION

Methionine and Lys have been identified as the first limiting AA for milk and milk protein production. Because of this, various strategies have been developed to protect these AA to prevent their ruminal degradation but still allow them to be absorbed at the small intestine. Because of the high rate of passage for soluble nutrients from the rumen of high producing dairy cows, significant amounts of AA fed in the free crystalline form may reach the intestine. Thus it may be possible to add dietary supplements that inhibit ruminal degradation of free AA and therefore increase the flow of these AA to the small intestine.

Supplemental Zn decreased the ruminal degradation of feed proteins and may interfere with ruminal proteolysis. Ionophores such as Rumensin® (Elanco Animal Health, Inc. Indianapolis, IN) also alter the ruminal degradation of feed proteins and peptides; however, feeds containing rumensin must be segregated from those fed to lactating dairy cows, lactating dairy goats and horses, since the product is not approved for use in those species. This experiment was designed to investigate the effects of Zn and rumensin on ruminal degradation of Lys and liquid 2-hydroxy-4-methylthiobutanoic acid (**HMB**; a methionine analog).

MATERIALS AND METHODS

Four nonlactating, mature Holstein cows (mean BW 1350 lb.) were surgically fitted with ruminal cannulas. All surgeries and animal handling were completed under protocols approved by the LSU Agricultural Center's Institutional Animal Care and Use Committee. The cows were used in a Latin square design experiment with 14-day periods.

Cows were fed complete mixed diets at restricted amounts once daily at 8 a.m. Diets consisted of 10 pounds (as fed) of a commercial chopped alfalfa hay (Bert & Wetta Larned, Inc.; Larned, KS.) and 10 pounds (as fed) of an experimental concentrate daily (Table 1). Diets were offered in restricted amounts to ensure complete consumption in a short period. Concentrates contained $ZnSO_4$ (to provide 500 mg/kg Zn in finished diet) and rumensin (to provide 40 mg/kg Rumensin in final diet) in a 2 x 2 factorial arrangement of treatments. Concentrates and alfalfa were sampled on the last day of each period and stored at room temperature until analyzed for DM, ash, N and minerals, and ADF and NDF.

On day 14 of each period, samples of ruminal fluid and whole blood were collected from each cow immediately before feeding. After these samples were collected, cows were fed and dosed through the ruminal cannula with Lys, HMB and Cr-EDTA. Every 30 minutes after dosing, for 8 hours, samples of ruminal fluid were

collected. For all samples of ruminal fluid, pH was immediately measured and the sample was frozen in liquid N until analyzed. Over the last 24 hours of each period, in situ disappearance of SBM and SoyPLUS® was measured.

RESULTS AND DISCUSSION

All concentrates were similar in percentages of DM, N, ADF, NDF and ash (Table 2). Cows usually consumed their allotment of diets by 10 a.m. Mean ruminal pH remained above 5.5 and was not affected by treatment (Table 3). Mean ruminal concentrations of NH_4^+ were not affected by treatment. Average ruminal concentrations of NH_4^+ were above 10 mg/dl at all sampling times. This is above the reported minimum for optimal ruminal fermentation, so it is unlikely that fermentation was impaired because of lack of available N. Ruminal concentrations of peptides averaged 15.0 m*M* and were not affected by treatments. This is well above the concentration of peptides suggested optimum for ruminal fermentation.

Mean concentrations of total VFA (Table 3) were not affected by addition of rumensin or Zn to diets. Increased Zn in the diet resulted in an increase in the proportion of propionic acid in ruminal fluid after feeding. Neither Zn nor rumensin affected the proportion of butyrate in ruminal fluid. Increased Zn in the diet tended to decrease the proportion of valeric acid (Table 3). Addition of rumensin to diets decreased the proportion of acetic acid and increased the proportion of propionate. Therefore, rumensin decreased the ratio of acetic to propionic acid. Inclusion of rumensin in the diet tended to increase the proportion of isovaleric acid. Because there were no changes in total VFA concentrations, the shift in the ratio of acetic to propionic acid indicates that addition of rumensin to the diets improved the fermentation efficiency by capturing more of the gross energy from the feed as VFA.

Fractional rate of disappearance of SBM DM from in situ bags increased and rate of disappearance of SoyPLUS tended to be increased by Zn in diets (Table 4). This was unexpected and is in contrast to data reported by Froetschel and coworkers (1990), who report that supplemental Zn decreased fermentation of AA in the rumen. Differences between our results and those reported previously may be related to differences in basal diet quality or supplementation levels. We have previously reported (Bateman et al., 2002) that the effects of Zn on ruminal fermentation and urea degradation were different when supplemented with alfalfa as compared to low quality forages. This may be related to differences in dietary protein content. Diets fed by Froetschel were 16% CP or lower, but our diets were approximately 19% to 20% CP. Additionally, rumensin has reduced ruminal Zn concentrations (Kirk et al., 1985). Our supplementation levels for Zn were much lower than those used by Froetschel (1990) and may have been further reduced through the interaction of the Zn and the rumensin in the rumen.

Rumensin did not affect fractional rate of disappearance of SBM or SoyPLUS. There were no interactions of rumensin and Zn in diets to alter the rate of disappearance of SBM or SoyPLUS from in situ bags. Fractional rate of disappearance of CP in SBM from in situ bags tended to increase when Zn was added to diets. Rumensin and the interaction of rumensin and Zn did not affect the fractional rate of disappearance of CP in SBM. The fractional rate of disappearance of CP in extruded SBM was not affected by Zn, rumensin or their interaction. Rumensin decreases protein degradation in the rumen (Bergen and Bates, 1984), but its impact on DM degradability is variable and seems dependent upon the basal diet. It is possible that the lack of impact of the rumensin on CP degradability in this experiment was caused by the lack of effects on DM degradability.

There were no effects of Zn or rumensin on the fractional disappearance of Lys or HMB from the rumen; however, addition of rumensin to low Zn diets tended to decrease the ruminal degradability while addition of rumensin to high Zn diets tended to increase the ruminal degradability. There was a negative relationship between ruminal passage rate and apparent degradability of Lys and HMB that may explain the lack of effect of Zn and or rumensin on ruminal degradability of Lys and HMB.

CONCLUSIONS

Feeding 500 mg/kg Zn did not alter ruminal metabolism of HMB or Lys but tended to increase the rate of passage of fluid from the rumen. This increase in rate of passage may influence ruminal degradability of protein sources and microbial efficiency. Rumensin and Zn interacted to alter ruminal degradability of Lys but not HMB. These data indicate that supplementing Zn greatly above requirements can be used to alter ruminal fermentation to capture increased feed energy as VFA. Additionally, these data reinforce the knowledge that providing rumensin to ruminants alter ruminal fermentation and increase the energy capture from the diet while improving the protein status of the host animal.

Table 1. Ingredient composition of concentrate mixtures fed to cows.

	- Zn		+ Zn	
Ingredient	- Rumensin	+ Rumensin	- Rumensin	+ Rumensin
	% of DM			
Ground corn	61.46	61.46	61.46	61.46
Soybean meal	34.40	34.40	34.40	34.40
Molasses	3.00	3.00	3.00	3.00
Rock phosphate	0.40	0.40	0.40	0.40
Salt	0.38	0.38	0.38	0.38
Trace mineral supplement[1]	0.04	0.04	0.04	0.04
Vitamin supplement[2]	0.03	0.03	0.03	0.03
Limestone	0.29	0.29	0.29	0.29
$ZnSO_4$	0	0	0.27	0.27
Rumensin® 80[3]	0	0.02	0	0.02

[1]Contains 8.44% Ca, 6.65% P, 4.33% Mg, 2.64% S, 3,373 mg/kg I, 125,873 mg/kg Mn, 85,324 mg/kg Zn, 16,195 mg/kg Fe, 642 mg/kg Co, and 24,369 mg/kg Cu.
[2] Contains 11,137 kIU vitamin A / kg, 2,784 kIU vitamin D / kg, 30,928 IU vitamin E / kg, and 680 mg/kg Se.
[3] Elanco Animal Health, Indianapolis IN, 46285

Table 2. Chemical analysis of concentrate mixtures and alfalfa hay fed to cows.

	- Zn		+ Zn		
	- Rumensin	+ Rumensin	- Rumensin	+ Rumensin	Alfalfa
DM, %	90.00	90.12	90.40	88.35	89.20
	% of DM				
Ash	5.18	4.92	4.59	5.12	10.37
N	3.488	3.518	3.016	3.333	2.923
NDF	11.43	12.24	10.96	12.39	41.29
ADF	3.94	4.02	4.79	4.49	34.31
Zn, mg/kg	113	101	644	588	17

Table 3. Least squares means for ruminal parameters of cows fed diets with or without 500 mg/kg supplemental Zn and with or without 40 mg/kg Rumensin.

	- Zn		+ Zn	
	- Rumensin	+ Rumensin	- Rumensin	+ Rumensin
pH	5.81	5.72	5.85	5.92
Peptides, m*M*	17.3	20.0	12.6	9.9
NH_4^+, mg / dl	21.2	20.0	22.0	21.1
Total VFA, m*M*	133.63	138.36	128.89	115.07
Acetate, mol %	59.14	54.35	57.98	56.93
Propionate, mol %	17.07	20.55	18.15	20.24
Isobutyrate, mol %	1.49	1.59	1.47	1.51
Butyrate, mol %	15.09	15.19	15.35	13.76
Isovalerate, mol %	3.50	4.18	3.44	4.08
Valerate, mol %	3.73	4.14	3.61	3.48
Ratio[1]	3.54	2.80	3.34	2.88

[1] Ratio of actetate to propionate in ruminal fluid.

Table 4. Least squares means for fractional disappearance rates of from the rumen of cows fed diets with or without 500 mg/kg supplemental Zn and without 40 mg/kg rumensin.

	- Zn		+ Zn	
	- Rumensin	+ Rumensin	- Rumensin	+ Rumensin
SBM DM K_d, %/h	3.2	4.4	5.1	6.2
SBM CP K_d, %/h	3.6	5.7	6.2	7.0
Ex. SBM DM K_d, %/h	2.0	2.2	2.9	3.2
Ex. SBM CP K_d, %/h	3.8	4.3	5.1	6.1
Fluid Passage, %/hr	10.1	14.5	13.7	16.0
Lysine K_d, %/ h	15.8	11.5	14.6	17.6
Lysine degradation, %	61.2	44.2	47.6	51.6
HMB K_d, %/ h	15.3	19.7	19.4	17.8
HMB degradation, %	60.7	57.1	57.4	50.9

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PREFERENCE FOR FORAGE OR CONCENTRATE IS AFFECTED BY PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE FEED

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INTRODUCTION

Under most production settings, livestock will not have many opportunities to select their diets; however, information to better predict which forages or concentrates would be selected will allow producers to choose forages or concentrates to use as supplements that will optimize nutrient intake and provide the greatest return.

Numerous factors may play a role in determining preference for different forages or concentrates. For forages, these include: stem to leaf ratio, degree of lignification, dry matter or other nutrient content, presence or absence of intrinsic anti-nutritional factors and taste. For concentrates, these include: physical form that the concentrate is presented in, nutrient content, presence or absence of intrinsic anti-nutritional factors and taste. By being aware of the impact that some of these factors have on the voluntary intake of forages or concentrates, producers can better choose among the many supplemental feeds available to provide the optimal nutritional aid for their animals.

MATERIALS AND METHODS

Two feeding trials using Spanish × Boar cross goat kids were conducted to determine relative preference for different forages or concentrates. The concentrate feeding trial was two experiments. In the first, eight kids were confined in 2 × 2 m pens and offered 100 g of dry matter (DM) from supplements based on corn, soybean meal, fish meal or molasses for two consecutive days (Table 1). The dry supplements were offered both as a meal and pelleted. Random combinations of two supplements were offered each day for a total of 21 comparisons. Each kid received two of the combinations for a total of 42 pair observations. The supplements were removed if one was consumed in its entirety or after 2 hours if neither was entirely consumed. Coastal bermudagrass hay was available except when supplements were offered; water was available at all times. The same kids were used in the second experiment. In this experiment, 100 g of DM from each supplement was offered to each kid for two consecutive days, and the time required for complete consumption was measured.

The forage feeding trial was a single experiment. Six Spanish × Boar cross goat kids were used in this experiment. The kids were housed and managed similar to those of the concentrate feeding trial. Forages compared were alfalfa hay (Medicago sativa), Coastal bermudagrass hay [Cynodon dactylon (L) pers], fresh-cut wheat (Triticum spp.), fresh-cut oats (Avena spp.), fresh-cut white clover (Trifolium repens), fresh-cut crimson clover (Trifolium incarnatum), fresh-cut mustard (Brassica campestris), fresh-cut turnip (Brassica rapa) and fresh-cut rape (Brassica napus). Fresh forages were harvested daily by hand clipping for feeding. During the experiment, each kid was randomly offered known weights of two forages simultaneously for two days. Each of the 36 pair combinations of forage were offered to each kid for a total of 216. After 3 hours, any forage that had not been consumed was removed and weighed, and intake of each forage was calculated. Mixed grass hay was provided after test forages were removed, and water was available at all times.

RESULTS AND DISCUSSION

Kids preferred supplements based on corn or soybean meal over those based on fish or molasses (Table 2). They also preferred supplements based on fish meal over those based on molasses. Kids preferred pelleted supplements over those offered as a meal or liquid but preferred supplements fed as meal over those offered as liquid. Kids required less time to consume 100 g of DM from supplements based on corn or soybean meal than they did for supplements based on fish meal or molasses. Kids consumed pelleted supplements faster than supplements fed as a meal or liquid; however, they did consume supplements offered as a meal faster than those fed as a liquid.

Kids consumed larger amounts of wheat, oats and rape than other forages but consumed more DM form alfalfa and bermudagrass hay than from the fresh forages (Table 3). Kids consumed more DM from wheat and oats than from clovers or Brassica's but consumed more DM from Brassica's than from clovers.

Previous researchers (Illius et al., 1999) reported that rate of intake was the factor responsible for determining which forage would be consumed by goats offered different forages. This idea agrees with our data for concentrate supplements. Goats consumed pelleted supplements and supplements based on corn or soybean meal faster than other supplements. They also preferred those same supplements. Although the rate of consumption of the supplements appears to explain the differences in preference, other characteristics of the feeds, such as texture and composition, were probably also playing an influence. It is also possible that a combination of factors was influencing the kids' preference for the different supplements. There was a dramatic difference in DM and protein content of the supplements. Additionally, fish meal has a distinctive odor and is recommended to be introduced gradually to avoid refusal (MacGregor, 2000). Once animals are acclimated to fish meal, however, they generally will consume it. Therefore, if opportunities exist for choosing supplements for kids, pelleted supplements based on corn or soybean meal should be given preference over those based on fish meal or molasses to maximize nutrient intake by the kid.

Goat kids consumed more fresh forages than hay but more DM from hay than from fresh forages. This also agrees with the theory of Illius et al. (1999). Kids maximized their rate of intake when offered fresh forages to obtain the maximal amount of nutrients in the given period. When offered forage stored as hay, however, they did not need to consume feed as rapidly to ingest similar amounts of nutrients in the same period. Consumption of the fresh forages by goat kids was not constant. They consumed more oats and wheat forage than clovers or brassica species. This may have been related to the larger amount of DM contents of the oat and wheat forage as compared to the clovers and brassica species. The DM content of the clovers and brassica species, however, does not explain the differences in voluntary intake between these two groups of forages. Factors that may have been affecting voluntary intake of these fresh forages include: fiber digestibility, plant protection chemicals such as the glucosonilates of the brassica species, and nutrient content.

SUMMARY AND CONCLUSIONS

Goat kids exhibited preferences among concentrate supplements and forages when offered choices. Kids preferred supplements that allowed them to ingest the maximal amounts of nutrients in the shortest amount of time. Pelleted concentrates were preferred by kids over concentrates offered as meals or liquids. Kids consumed more DM from forages that had higher DM content. When choices of fresh forages were offered, kids chose species that had higher DM content and greater ruminal

degradability. Further research to better define factors limiting forage intake by goats is warranted. More detailed chemical composition (sugar, amino acid and phenolic contents) of forages should be investigated to determine the intrinsic factors that inhibit intake by goats. Also, the role of physiological state (growth, maintenance, reproduction or lactation) in determining forage preference by goats should be investigated.

IMPLICATIONS

Preference for different feeds can be exploited when choosing supplements to provide nutrients during periods of low forage availability. To optimize nutrient intake from the supplements, choose forages or concentrate mixtures that allow rapid rates of intake. To limit nutrient intake (without using physical feed restriction), choose forages or concentrates that need a greater amount of time to consume large amounts of DM.

TABLE 1. Ingredient composition (% as fed) of supplements evaluated in concentrate preference trial.

	Supplement			
Ingredient	Corn base	Soy base	Fish base	Molasses base
Corn	94.5	42.5	52.5	
Soybean meal		52.0	17.0	
Fish meal			17.0	22.3
Molasses	3	3	3	75.9
Urea				1.8
Trace mineral salt	1	1	1	
Dicalcium phosphate	1	1	1	
Bentonite	0.5	0.5	0.5	
Vitamin A, D, & E, g/kg	0.25	0.25	0.25	0.25

TABLE 2. Relative preference for and time (min.) required by goat kids for consumption of 100 g of DM from supplements.

Item	Relative preference	Time for consumption
Base Feed		
Corn	64.79	5.38
Soy	68.48	4.56
Fish	34.26	10.50
Molasses	18.52	17.50
Texture		
Ground	43.87	10.21
Pellet	67.82	3.42
Liquid	18.52	17.50

TABLE 3. As fed consumption of various forages (g/day) and forage DM, ash, NDF, ADF, and CP (g/day) by goat kids.

Item	As Fed	DM	Ash	NDF	ADF	CP
Alfalfa hay	260.3	235.5	21.2	110.3	80.3	48.8
Bermudagrass hay	213.8	195.1	16.1	138.8	60.3	34.2
Wheat	559.8	97.4	11.9	48.5	23.3	23.3
Oats	589.4	113.1	14.3	51.1	23.5	20.0
White Clover	48.4	8.5	1.0	3.0	1.7	2.0
Crimson Clover	87.6	15.7	2.0	5.1	2.8	3.4
Rape	569.6	79.1	9.2	15.8	9.2	14.5
Mustard	264.9	31.5	3.5	5.8	3.7	4.7
Turnip	299.1	36.6	6.0	8.1	4.9	10.9

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PREDICTING FEED PROTEIN FLOW TO THE DUODENUM

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INTRODUCTION

Numerous factors have been suggested as affecting passage of microbial and feed protein (RUP) to the small intestine of ruminants; including feed intake; forage to concentrate ratio in the diet; source, quality and amount of carbohydrate and crude protein in the diet; ruminal pH; associative effects of feeds; frequency of feeding; forage and grain processing; forage conservation methods; micronutrient supply; feeding buffers, salts and ionophores; and environmental conditions. Because many variables affect degradability of protein in the rumen, RUP content of a given feed is not constant in all feeding situations. Bateman et al. (2001a) reported that prediction models underestimated the mean passage of feed crude protein to the small intestine of dairy cows. The underestimation of feed protein passage to the small intestine of dairy cows eating large amounts of feed was attributed to an overestimation of degradability of individual feed proteins.

The objectives of this work were to: 1) evaluate some tabular values for the RUP content of feeds for their ability to predict feed protein flow to the small intestine of lactating dairy cows, and 2) to develop an equation that could be used to modify tabulated RUP values to better predict feed protein flow to the small intestine of lactating dairy cows.

MATERIALS AND METHODS

Model development

A data set was constructed from research trials published between 1979 and 1998. Tabulated values for RUP were from published sources. The RUP intake was calculated by multiplying CP intake from each N containing feed in the diet by the RUP percentage of that feed and then summing intakes of RUP from all feeds in a diet. The calculated RUP intake was assumed to be equal to passage of RUP to the small intestine and was compared with passage of nonammonia nonmicrobial nitrogen (NANMN) to the small intestine after dividing estimated passage of RUP by 6.25.

Two forms of equations (linear and nonlinear) were developed to adjust RUP values of individual feeds as a function of DMI. Equations were developed that adjusted published RUP values to maximize the R^2 when the observed passage of NANMN was regressed against the predicted passage of NANMN. Bias in prediction was determined when the slope of the regression line between the prediction residuals (measured – predicted values) and the predicted values differed from zero.

Model evaluation

A second data set was constructed from research trials published between 1998 and 2003. Calculations for estimating flow of RUP were similar to those used in model development.

Subtracting the measured passage of NANMN from the predicted passage of NANMN generated residuals of prediction for the individual observations. These residuals were statistically analyzed using the mean square prediction error (**MSPE**). This analysis allows the MSPE to be subdivided into proportions of 1) error of predicting

the mean (mean bias), 2) systematic errors in the prediction function that can be corrected through a linear adjustment (slope bias), and 3) error in prediction because of random variance around the line of perfect prediction (dispersion).

RESULTS AND DISCUSSION

There was a positive linear relationship between measured and predicted passage of NANMN to the duodenum; however, a linear bias was indicated by the regression of residuals (measured – predicted) for NANMN and predicted passage of NANMN to the duodenum. Using tabular values to predict flow of NANMN at the small intestine produced a root mean square prediction error (**RMSPE**) of 89.34 g of NANMN/d and a standard error of prediction (**SEY**) of 43.07 g of NANMN/d. Distribution of the errors contained in the MSPE analysis is presented in Table 1. These data indicate that tabulated values for the RUP contents of feeds did not accurately predict the measured passage of RUP to the duodenum of cattle and are in agreement with previous evaluations (Bateman et al., 2001a; Bateman et al., 2001b).

Decreasing the RUP content of feeds by 4 percentage units per multiple of maintenance energy intake resulted in an RMSPE of 70.00 g of NANMN/d (Table 1) and a SEY of 57.01 g of NANMN/d. The increase in the slope of the regression between predicted and measured passage of NANMN compared with that of Figure 1 along with the decrease in the RMSPE indicates that increasing the RUP content of feeds by 4 percentage units for each multiple increase in MEI above maintenance improved the accuracy of prediction of passage of NANMN to the duodenum compared with the tabular values. This adjustment removed most of the mean bias, but a significant slope bias remained. To correct the linear bias, an adjustment factor based on maintenance CP intake (MCPI) was developed. The following equation was developed for adjusting the RUP contents of feeds, expressed as a percentage of CP, per multiple of MCPI above maintenance.

$$RUP_{adj1} = 100 - [(RDTP \times MPIAF) + NPN] \qquad \text{Equation 1}$$

Where:

RUP_{adj1} is the adjusted percentage of RUP in CP of a feed used to predict passage of CP to the duodenum, **RDTP** is the percentage of ruminally degradable true protein in a feed, **MPIAF** is an adjustment factor for MCPI of cows, and NPN is expressed as a percentage of CP. Ruminally degradable true protein was calculated as:

$$RDTP = 100 - RUP_{tab} - NPN \qquad \text{Equation 2}$$

where: RUP_{tab} is the tabulated percentage of RUP for an individual. The adjustment factor for MCPI was calculated as:

$$MPIAF = 1 - \{0.13 \times [(DMI/2.5) - 9.56]\} \qquad \text{Equation 3}$$

Where: DMI is the measured or expected DMI for the cows and is expressed in kilograms per day, the 2.5 represents the kilograms of DM needed to meet the CP requirement for maintenance of a 650 kg mature cow when the diet contains 17% CP, and the 0.13 and 9.56 are constants.

When applying the adjustment of equation 1 to individual feeds, both slope and mean bias were lowered (Table 1). Equation 1 has a SEY of 52.01 g of NANMN /d and a RMSPE of 99.35 g of NANMN/d. At low DMI, however, equation 1 will predict negative RUP values for some feeds and at high DMI equation 1 will predict RUP values for some feeds in excess of 100% of CP. This suggests that a linear adjustment based on maintenance protein intake was inadequate for adjusting tabulated RUP values of feeds

and that the actual relationship between the RUP content of feeds and feed intake may be nonlinear.

A nonlinear adjustment equation was considered to prevent adjusted RUP values from going outside the biologically possible range of 0 to 100% of CP. An S-shaped curve was chosen to represent the RUP content of a feed as DMI was increased. Iteration was used to determine values for the parameters of the nonlinear curve that maximized the R^2 for the regression of predicted and measured NANMN to the duodenum under the condition that the slope of this regression did not differ from unity while the intercept did not differ from zero. This process resulted in the following equation being accepted for predicting an adjusted RUP as a percentage of the CP in a feed at a specific DMI:

$$RUP_{adj2} = \frac{100 - NPN}{1 + e^{-\left(\frac{DMI - c}{7.18}\right)}} \qquad \text{Equation 4}$$

where $c = 27.36 - 0.1253 \times RUP_{tab}$

Equation 4 eliminated both linear and mean bias from the prediction of NANMN passage to the duodenum and maintained the RUP_{adj2} values in the biologically allowable range of 0 to 100% of the CP. Equation 4 had an SEY of 69.29 g NANMN /d and a RMSPE of 104.63 g of NANMN/d (Table 1). Therefore, adjustments to the RUP content of feeds using equation 4 were only slightly superior to those using equation 1 and were slightly inferior to adjusting the RUP content of feeds by 4 percentage units for each multiple increase in maintenance energy intake in their ability to predict flow of NANMN at the small intestine; however, use of equation 4 was concluded to be most optimal because its predictive ability was similar to the other approaches considered and it maintained predicted RUP values in the biologically valid range of 0 to 100% of CP.

Use of equation 4 to predict passage of NANMN to the duodenum in the experiments represented in the evaluation data set did not eliminate the bias of prediction. The mean predicted flow of NANMN to the duodenum differed from the mean measured flow indicating that equation 4 was not making satisfactory adjustments to tabulated RUP values for the evaluation data set. The evaluation data set produced an SEY of 56.30 g/d with a RMSPE of 82.71 g/d. The MSPE analysis of the residuals from the evaluation of equation 4 (Table 1) indicated that 47.32% of the error was attributable to inaccurate prediction of the mean passage of NANMN to the duodenum, 28.38% of the error was correctable through a linear function of the measured and predicted passages of NANMN at the duodenum, and the final 24.30% of the error was random variation. Failure of the equation to remove all bias should not necessarily be considered evidence that the equation is incorrect. Any bias should be evaluated in relation to reported measurement errors to determine its potential impact on the predictive ability of the model. It is likely that differences in the type of diets represented in the model evaluation and model development data sets were negatively affecting the apparent predictive ability of the model.

Figures 1, 2, 3, 4, 5 and 6 present apparent predicted RUP content of selected feeds at different levels of DMI. Apparent predicted RUP contents of cereal grains as intake increases from 0.5 to 5 × maintenance energy intake (6.6 to 66 lb DMI) are presented in Figure 1. Similar information for oil seed meals are presented in Figure 2. Apparent predicted RUP contents of oil seeds at differing multiples of maintenance energy intake are presented in Figure 3, and similar data for forages are presented in Figure 4. Figure 5 presents the apparent predicted RUP content as estimated by equation 5 for by-product feeds, and Figure 6 is a similar representation for animal protein meals. All of the example feeds exhibited the expected sigmoidal shape to their apparent predicted RUP content curve. At low DMI, most the CP in most feed is

degraded, resulting in a low apparent RUP content of that feed. At high DMI, however, most of the CP in most feed is not degraded in the rumen but passes to the small intestine, resulting in a high apparent RUP content of that feed. At high DMI, a large amount of degradable CP is supplied from feeds that have large quantities of NPN such as corn silage or legume forages and smaller amounts of degradable CP are supplied from other feeds. The amount of RDP and RUP that is supplied from these feeds when diets with a typical forage content are fed to lactating dairy cows at high DMI appears adequate to support microbial protein synthesis and the predicted passage of RUP to the small intestine.

CONCLUSIONS

Current tabular values for the RUP content of feeds do not allow accurate prediction of NANMN passage to the duodenum of lactating dairy cows. Tabular values for RUP can be adjusted using either a linear or nonlinear function of DMI to better predict passage of NANMN. A nonlinear function relating RUP to DMI agreed better with the underlying biology of lactating dairy cows than did a linear function because estimated RUP values for individual feeds remained within the biologically possible range of 0 to 100% of CP. Both of the equations developed for adjusting tabular RUP values of feeds better predicted the passage of NANMN to the small intestine than did tabular values. The nonlinear equation was able to eliminate the bias in predicting flow of NANMN to the small intestine, but it was not able to completely remove the variation around the line of prediction. This is an indication that, while the concept of adjusting tabulated RUP values based on DMI is correct, other factors are influencing the apparent RUP content of feeds. When more data for cows consuming larger amounts of DM become available, this equation should be reevaluated for its ability to properly adjust RUP values of feeds reported by NRC. Furthermore, as other data become available that quantify the effects of factors other than DMI on the apparent RUP values of feeds, they should also be incorporated into an adjustment equation to better predict passage of NANMN to the duodenum.

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Bateman, H. G., J. H. Clark, R. A. Patton, C. J. Peel, and C. G. Schwab. 2001b. Prediction of crude protein and amino acid passage to the duodenum of lactating cows by models compared with in vivo data. J. Dairy Sci. 84:665-679.

Table 1. Precision of predictions for flow of NANMN to the small intestine of cattle by various models as measured by the mean square prediction error (MSPE) criterion.

Prediction[1]	RMSPE[2], g/d	Percentage of MSPE attributable to: Mean bias	Slope bias	Dispersion
		(%)		
Tabulated values	89.34	36.87	41.70	21.43
4% linear reduction	70.00	5.04	62.36	32.60
Equation 1 adjustment	99.35	0.00	27.11	72.89
Equation 4 adjustment	104.63	56.69	28.14	15.18
Equation 4 evaluation	82.71	47.32	28.38	24.30

[1] Values correspond to the following: Tabulated values = prediction of NANMN using tabled values for the RUP content of feeds; 4% linear reduction = prediction of NANMN after reducing tabled values for the RUP content of feeds by 4% for each multiple of maintenance energy intake (12 lb DMI) above maintenance; Equation 1 adjustment = prediction of NANMN using equation 1; Equation 4 adjustment = prediction of NANMN using equation 4; Equation 4 evaluation = prediction of NANMN for the evaluation data set using equation.

[2] Root mean square prediction error; a measure of precision of the predictions where smaller numbers indicate more accurate prediction.

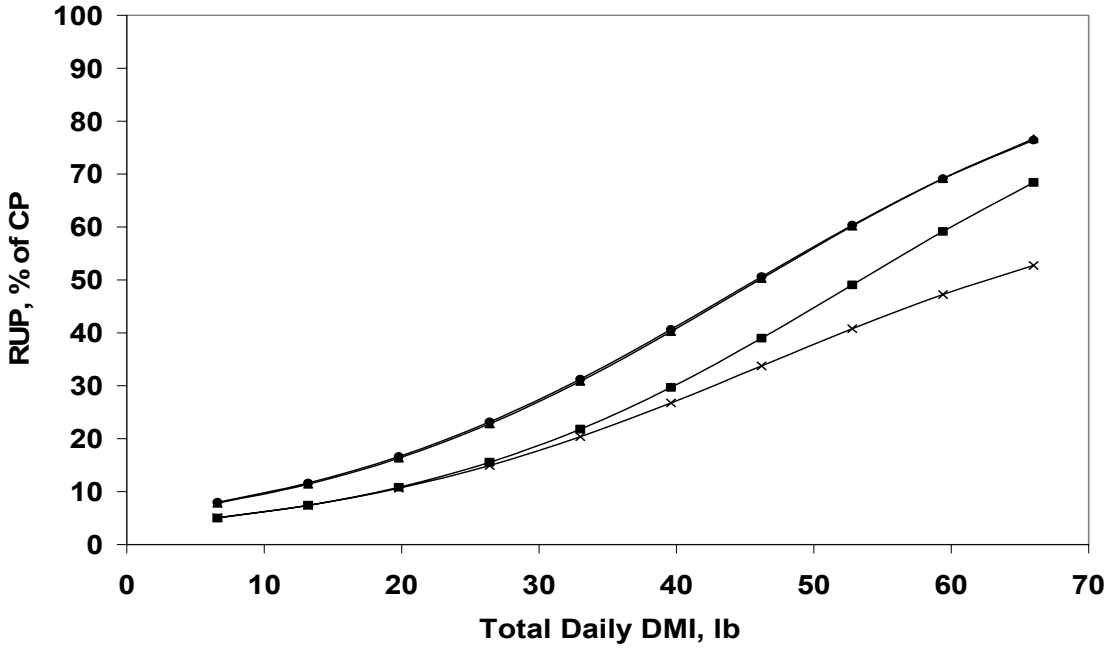

Figure 1. Apparent RUP content of barley grain (■), corn grain (▲), high moisture corn grain (×), and sorghum grain (●) at differing dry matter intake as determined using equation 4.

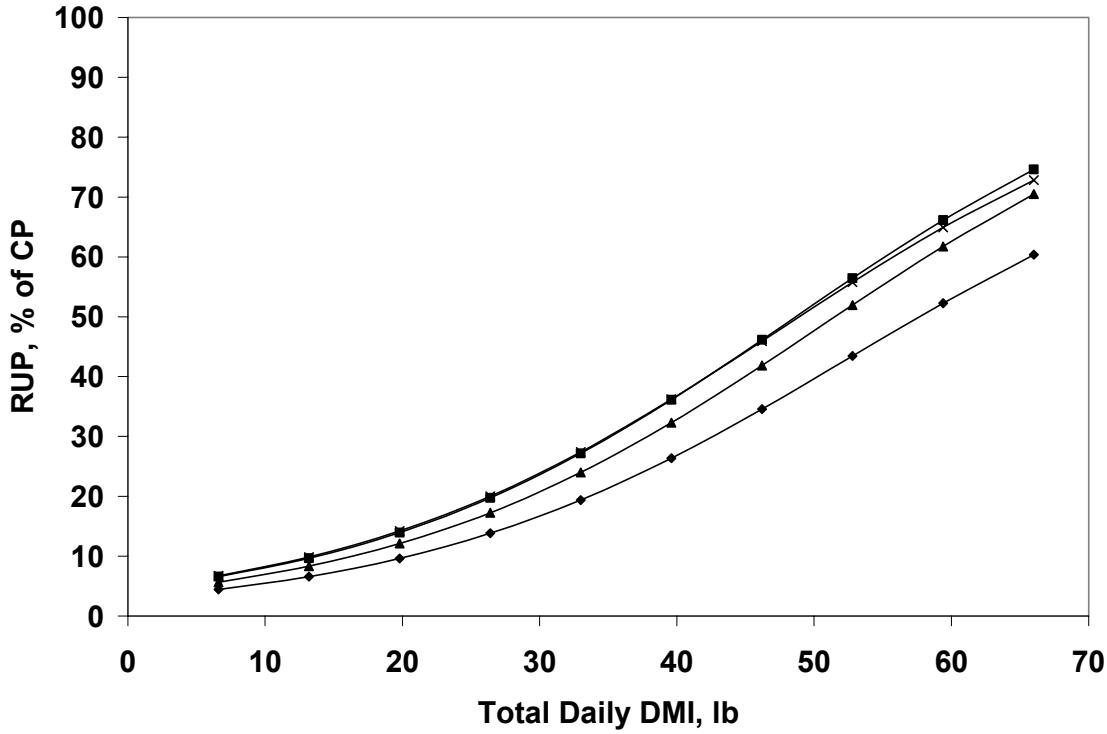

Figure 2. Apparent RUP content of canola seed meal (♦), solvent extracted soybean meal (▲), expeller extracted soybean meal (×), and cottonseed meal (■) at differing dry matter intake as determined using equation 4.

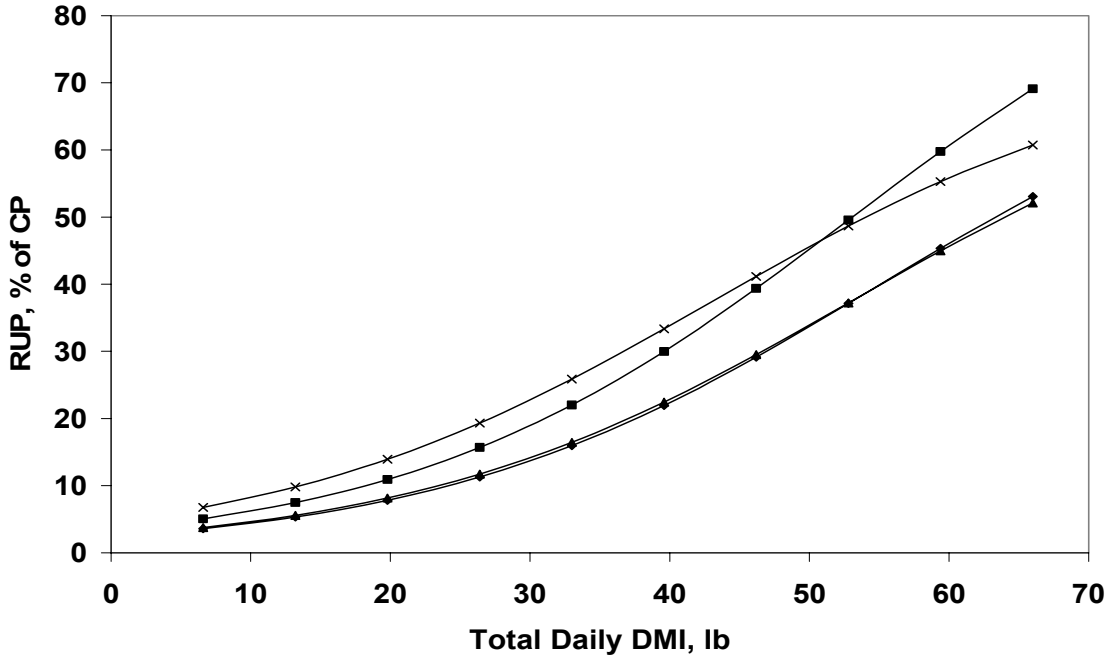

Figure 3. Apparent RUP content of canola seed (♦), raw soybeans (▲), roasted soybeans (×), and whole cottonseed (■) at differing dry matter intake as determined using equation 4.

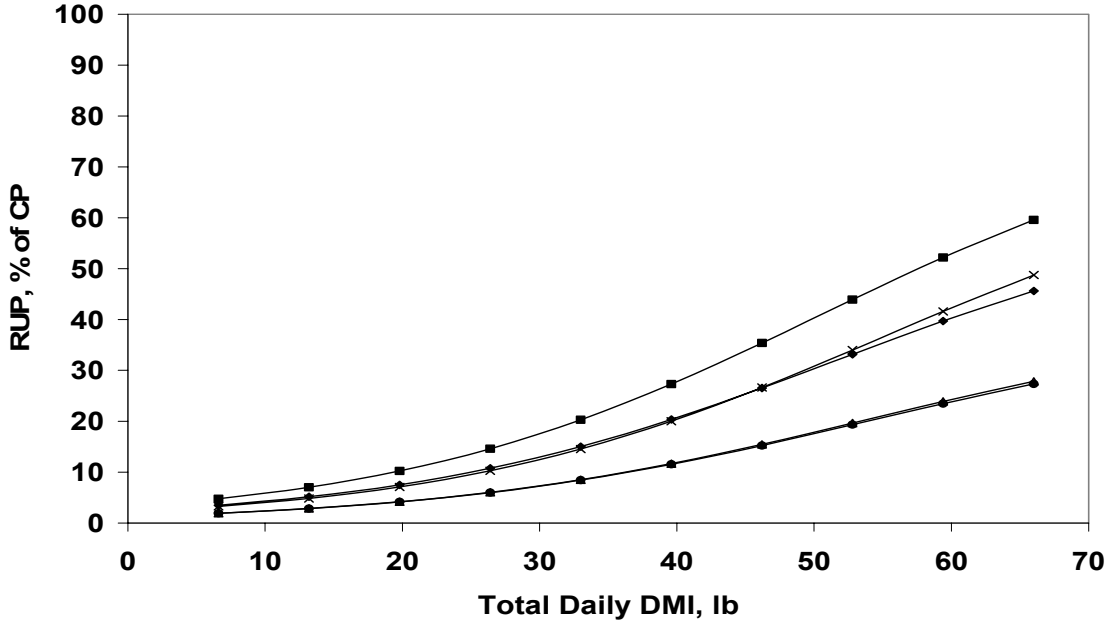

Figure 4. Apparent RUP content of corn silage (♦), grass silage (▲), legume hay (×), grass hay (■), and legume silage (●) at differing dry matter intake as determined using equation 4.

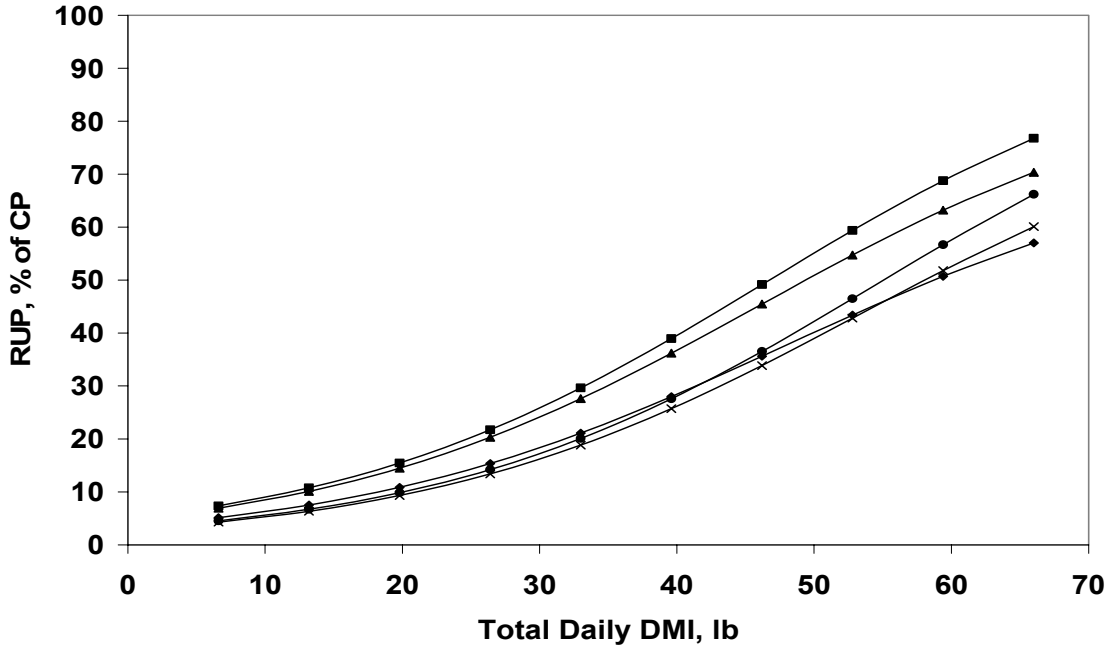

Figure 5. Apparent RUP content of beet pulp (♦), corn distillers grains with solubles (▲), soybean hulls (×), dried brewers grains (■), and wheat middlings (●) at differing dry matter intake as determined using equation 4.

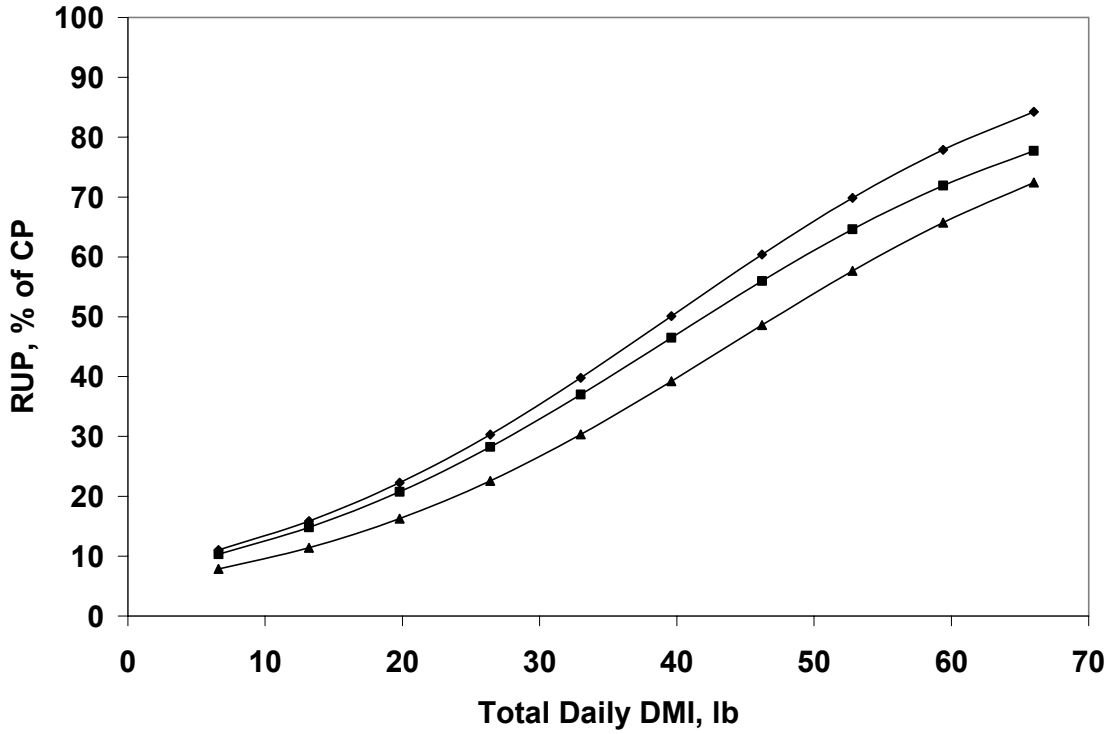

Figure 6. Apparent RUP content of blood meal (♦), fish meal (▲), and feather meal (■) at differing dry matter intake as determined using equation 4

Undergraduate Programs in Dairy Science

UNDERGRADUATE CONCENTRATIONS IN DAIRY SCIENCE AT LSU

Bruce F. Jenny, Professor and Head, Department of Dairy Science

The dairy industry of today is science, technology and business oriented, and the Department of Dairy Science at LSU is in a unique position to prepare students for career opportunities. The Department of Dairy Science is one of three departments nationally that offers comprehensive programs in both dairy production and dairy foods technology.

Dairy production involves all aspects of milk production including dairy cattle nutrition, genetics, reproductive physiology, heard health and farm management. Dairy foods technology includes quality assurance, dairy product manufacturing, packaging, marketing and distribution of final product to the consumer. Both programs offer a solid educational background by requiring basic and applied courses in the major along with general education courses. The general education requirements include courses in communication skills, social sciences, humanities, mathematics, chemistry and biological sciences.

Through selection of approved and free electives, the dairy science program has the flexibility and breadth that allow students to gain a strong knowledge of dairy science while developing skills in related areas. Many students select courses related to animal and food biotechnology, food processing or communication. If management, marketing or sales careers interest a student, he or she can select courses in agricultural economics and business, management, finance, marketing, etc. Nearly 40 hours of approved and free electives allow students to develop programs to meet their career goals.

Students interested in veterinary or graduate school have ample opportunity to take the additional required courses in chemistry, physics and other sciences. A number of our students have entered the LSU School of Veterinary Medicine or Graduate School after completing a concentration in dairy science. Students may also participate in the Pre-Veterinary Medicine concentration through dairy science. This concentration allows students entering the School of Veterinary Medicine after three years (102 hours) to receive a B.S. degree following completion of the first year of the professional curriculum in veterinary medicine.

All students are assigned to faculty members who will serve as their academic advisors while in the dairy science program. The academic advisor helps the students to develop an individual career-oriented program. As graduation approaches, the academic advisor also works with the student and helps with job placement.

In addition to a strong educational program and personal advising, the Department of Dairy Science has one of the strongest scholarship programs in the College of Agriculture. Eight to ten $1800 scholarships are available yearly to new freshmen and transfer students. These scholarships can be renewed for an additional three years, giving a total of $7200. More than $45,000 in scholarships was awarded to Dairy Science students for the 2004-05 academic year. Part-time jobs in the department offer students another opportunity to help meet college expenses. Academic success of

students is our primary objective; work schedules are set so they will not interfere with a student's classes and study time.

Student jobs are also a valuable part of the student's overall education and training. The practical, hands-on training gained while working on the dairy farm, in the LSU Creamery or in our research laboratories can be a tremendous advantage when students begin the job search as graduation approaches. Practical experience is a valuable part of a student's education, and we have developed an internship course to help meet this need. Students can receive college credit by participating in a controlled learning experience associated with a summer job. A college degree will open many doors, but experience along with the degree will help students obtain the jobs they desire.

Students have the opportunity to participate in the Dairy Science Club, which provides educational and social activities that complement their college educations. Students also can become members of the LSU Intercollegiate Dairy Products Evaluation Team or the Dairy Cattle Judging Team. Participation in extracurricular activities helps students develop organizational and leadership skills along with teaching poise, good judgment and self-confidence. These activities afford students the opportunities to travel and to meet other students and established industry leaders from throughout the state, region and nation.

There are good career opportunities and demand for well-qualified dairy science graduates. If you or someone you know is interested in taking advantage of these opportunities, please contact us for more information. We would be more than happy to answer any questions you may have or arrange a campus visit for you. Please contact:

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DAIRY SCIENCE CLUB RECOGNIZED AT NATIONAL MEETING

Dairy Science Club members Tony Bridges, Melissa Brown, Mindy Chaisson, Tim Duckless, Mark Konzelman, Bridget Lyons, Justin Roberts and Laura Ward, along with club advisor Dr. Cathy Williams, attended the American Dairy Science Association-American Society for Animal Science-Poultry Science Association Joint Annual Meeting in St. Louis, Missouri. The meetings were held July 25-29, 2004, and attracted more than 3000 students and professional members from the United States and 56 countries.

During the meetings, the students participated in a tour of the Monsanto Company research facilities, a dairy quiz bowl, business meetings, undergraduate paper competitions, a careers symposium and an awards luncheon. They also had the opportunity to attend a St. Louis Cardinals' baseball game and see some of the local attractions in St. Louis.

The students attended the meetings as members of the Student Affiliate Division, American Dairy Science Association (SAD-ADSA). The SAD-ADSA is a division of the parent organization that works to develop leadership and promote scholarship among students interested in the dairy industry and to encourage students toward careers in dairy science.

Bridget Lyons and Justin Roberts competed in the paper presentation contests. Bridget placed second in the dairy foods paper presentation contest with her presentation "An Industry Approach to Increasing the Consumption of Dairy Products," and Justin presented a dairy production paper titled "Managing an Ovulation Synchronization Program with PCDART." Laura Ward participated in the activities symposium with a presentation about a club service project where the club held a work day to clean and groom the yard of a departmental staff member who was not able to do the yard work. Justin Roberts was elected as 1st Vice President of the SAD-ADSA, and Dr. Cathy Williams was elected 1st Year Advisor. During the awards luncheon, the Dairy Science Club was recognized with 2nd place in the scrapbook contest and was honored as the 3rd place overall chapter in the nation.

ADSA was established in 1906 as a scientific and educational association to serve the dairy and dairy-related industries. It facilitates the discovery, application and dissemination of dairy science knowledge and information.