EXTENSION UPDATE

Ellen Jordan and Sandra Stokes
Texas Agricultural Extension Service
The Texas A & M University System

REDUCING NITROGEN AND PHOSPHOROUS LOADING FROM DAIRY CATTLE PRODUCTION SYSTEMS

Introduction

The Texas dairy industry has been undergoing significant changes since the 1980's. First there was a significant expansion in the industry and more recently there has been a decrease in the number of herds in the state, but an increase in the size of the remaining herds. With this change in average herd size, the industry has come under increased scrutiny for its impact on the state's water quality, particularly in relation to nitrogen and phosphorus.

Traditionally animal waste management problems have been addressed by agricultural engineering and agronomic programs, however, there is a potential to increase the efficiency of nitrogen and phosphorus usage by today's dairy cow. Increasing the efficiency of nutrient utilization can be a cost effective management tool as well as an environmentally friendly practice. Frequently Best Management Practices (**BMP**) have focused on managing animal waste after it exits the cow.

In 1997, we began a demonstration project to evaluate currently available technology which could be used as BMP to alter the composition of the excreta of dairy cows. Excess nitrogen and phosphorus are excreted whenever there is excess intake or inefficient utilization of the nutrients. When these nutrients are balanced relative to the animal's requirements the efficiency of nutrient utilization improves and the quantity excreted decreases (Fox et al., 1994; Fox and Barry, 1995).

Historically, crude protein (**CP**) has been used to characterize protein nutrition of ruminants. Advances in protein research in the areas of rumen degradable and undegradable intake protein as well as amino acid balancing have set the stage for increasing nitrogen utilization in ruminants, thereby reducing nitrogen excretion. As dietary intake protein increases in the ruminant diet, blood NH_3 and its metabolite (urea) increases. Excess nitrogen is then excreted in the urine as urea. In addition, it has been shown that the urea content of milk is correlated to blood urea nitrogen and might be used as an indicator of efficiency of nitrogen utilization.

The primary route of phosphorus excretion is in the feces. Fecal analysis has been implemented by other livestock enterprises (range cow/calf production) as an indicator of the phosphorus composition of diets (Stuth, 1995). As phosphorus intake increases, the amount of unused phosphorus excreted in the feces increases. Recent reports indicate that phosphorus may be included in rations at 150% of the cow's requirement. Balancing intake phosphorus with the cow's requirement will increase the efficiency of phosphorus use.

Objectives

The overall objective of this project is to balance nitrogen and phosphorus utilization in dairy cattle production systems to aid in the prevention of water pollution in concentrated dairy production areas by:

- Implementing a milk urea nitrogen monitoring system to evaluate protein utilization and nitrogen excretion from dairy cows.
- Monitor fecal phosphorus to predict the inefficient use of phosphorus.
- Implement nutritional BMP through reformulating rations to optimize phosphorus and nitrogen utilization.

- Develop decision support systems for nutritional BMP which producers might adopt to minimize potential environmental nitrogen and phosphorus contamination.

Progress to Date

In May, 1997, nine herds were contacted and agreed to participate in this project. Since that time, one of the herds has sold out. These herds are located in Comanche, Hopkins, Erath, Hamilton, Johnson, Wise and Archer Counties. During the first year of the trial, baseline data for the cooperator herds is being collected to assess the current ration for nitrogen and phosphorus efficiency by tracking bulk tank milk urea nitrogen and fecal phosphorus. Ration ingredients, as well as the entire ration, are being analyzed for nutrient composition. At the conclusion of the establishment of baseline data, rations will be evaluated and ration changes made in cooperation with herd owners and their nutritionists.

Preliminary Data

Table 1 summarizes the data ration and fecal composition through February. Means and ranges for each herd are presented to illustrate the variability found to date. This preliminary data indicates variation occurs in fecal output of nitrogen and phosphorus. The next phase of the project will be to demonstrate how ration changes can impact the concentration.

Investigators

Wayne Greene, Ellen Jordan, Sandy Stokes, Max Sudweeks, Michael Tomaszewski, Christy Rippel, Gary Goodall, and Joe Price.

Table 1: Actual Analysis of TMR and Fecal Samples on DM basis.

Herd	Average CP,% (Range)	Average P,% (Range)
TMR		
A	20.3 (18.3 - 23.3)	0.72 (0.61 - 0.8)
B	17.9 (14.9 - 19.9)	0.56 (0.44 - 0.73)
C	18.6 (17.9 - 19.2)	0.61 (0.52 - 0.75)
D	17.3 (15.3 - 19.1)	0.49 (0.43 - 0.58)
E	17.9 (14.2 - 20.5)	0.54 (0.34 - 0.69)
FECAL		
A	2.97 (2.55 - 3.17)	1.40 (1.17 - 1.79)
B	2.79 (2.64 - 3.04)	1.15 (0.97 - 1.47)
C	2.89 (2.72 - 3.14)	1.13 (1.04 - 1.21)
D	2.65 (2.43 - 2.87)	1.19 (1.07 - 1.32)
E	2.92 (2.81 - 3.12)	1.02 (1.05 - 1.20)

COW COOLING

Summer heat stress places a tremendous strain on dairy cows. Immediate milk production losses and lingering effects on body condition and reproduction also lower total lactation performance. Various cooling systems have been installed with a wide range in expense. However, animal response and the economics of such systems have not been well documented in Central Texas.

Experimental Methods

Cooling system. The cooling system evaluated was from Korral Kool®, Inc, of Mesa, AZ. This system is unique in that the amount of water injected through the system is computerized, based on environmental temperature and humidity. This system includes side shades that lower to maintain cooled air under the shades for optimum effects.

Demonstration site and experimental set-up. This demonstration was done on a commercial dairy in Central Texas. All pens contained misters over the feed lanes, but no additional cooling under the shades. Two pens (side by side) were chosen for the demonstration and one of the pens was fitted with the Korral Kool® system under the shade structure. Cows were grouped by similar age (first calf heifers vs. mature cows), days in milk, and production level. They were then assigned to either the control pen or the pen with the Korral Kool® system. Cows were fed and milked twice daily. Ongoing 24-hour temperature and humidity cycles were recorded.

Weekly measurements included feed intake, milk production, and respiration rates. Body condition scores were measured at the beginning of the trial and then monthly throughout.

Also 30 cows expected to calve in August were assigned to each of the treatments (30 in the control pen and 30 cows in the cooled pen). Milk production and reproduction data was collected on these cows through the remainder of the trial (calving date to October 1) as well as through their entire lactation to evaluate the effects of cooling in the fresh period on total lactation performance.

Results

Animal response. Figure 1 illustrates how milk production responded to additional shade cooling. Cooled cows averaged 6.7 lbs. more milk (Table 2) than did control cows, with weekly differences being as great as 12 lbs. per cow (Figure 1). Table 3 lists environmental conditions associated with weekly milk weights (average daily high with corresponding humidity levels and nightly lows). Fresh cows that were cooled had 7.1 lbs. higher peaks than cows kept in the control pen (Table 2). Cooled fresh cows also appeared to peak one week earlier and were able to sustain continuous higher levels of milk production than control cows (Figure 2).

Figure 1: Effect of cooling on milk production of test groups.

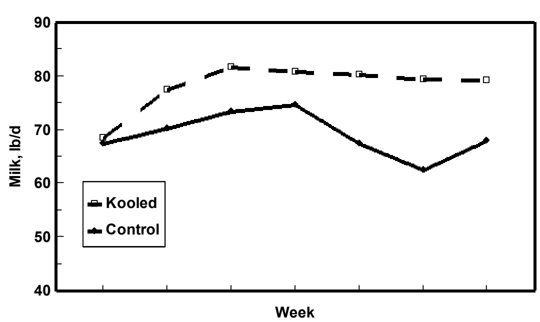

Table 2: Effect of cooling on milk production.

Milk production, lb/d	Control	Korral Kool®
Test group	66.1	72.8
Fresh cows, peak	74.7	81.8
Fresh cows, average	69.1	78.2

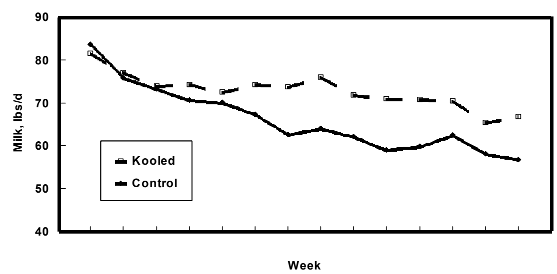

Figure 2: Effect of cooling on milk production of fresh cows.

Cooled cows averaged higher feed intakes than did the control cows (5.7 lbs per day; Table 4). Furthermore, respiration rates averaged 86.9 and 48.2 breaths per minutes for the control and cooled cows, respectively. Using 70 breaths per minutes as a measure or sign of heat stress, the cooled cows had dramatically lower respiration rates. Figure 3 illustrates the differences in shade temperatures of the control versus cooled pen, supporting the differences in respiration counts between the groups. Although intakes were increased and respiration counts were lowered with cooling, there was no significant difference in body condition scores between the two groups.

Costs. One obvious question concerns the economics of summer cooling -- the cost of operation of the system versus expected returns. Electricity use during this study averaged $0.41 per cow per day (Table 4), with ranges from $0.32 to $0.45 per cow per day over the entire trial.

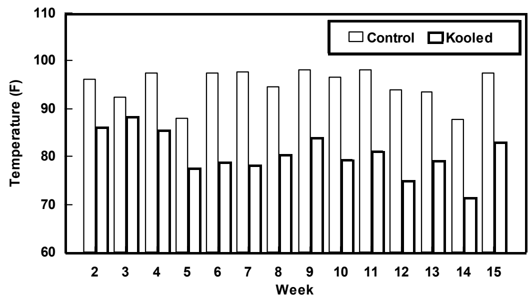

Figure 3: Effect of cooling on shade temperatures.

Additional information. As with any cooling system, there was an increase in maintenance under the shade. The system itself put out an average of 30 gallons of water per cow per day (Table 4). Furthermore, the cooled cows remained under the shade for a greater part of the day, thus accumulating more manure and urine in a concentrated area. Maintenance of the shaded surface area was increased to a daily or every other day routine.

Conclusions

Economic evaluation of a cooling system must weigh the additional income from the system against expenses of purchasing and operating the system. In this study, the additional milk production from the cows housed with the cooling system was attractive (6.7 lbs. over that of the control). Furthermore, the fresh cows' performance

Table 3. Average temperature and humidity by test period[1].

Test Week	Average daily high temperature, ^oF	Corresponding relative humidity[2],%	Average nightly low temperature, ^oF
2	91	47	71
3	90	46	71
4	91	46	69
5	88	46	71
6	94	36	69
7	97	37	73
8	95	44	73
9	90	77	68
10	95	39	76
11	93	46	73
12	93	33	67
13	82	67	69
14	92	33	69
15	97	36	74

[1] Listed as three day average prior to testing (including test day). Measurements were recorded for 24-hour cycles of temperature and humidity on-site.

[2] Relative humidity reading corresponds with the daytime high temperature

Table 4. Environment, animal respiration rates, body condition scores, and electricity costs of various shade cooling systems.

	Control	Korral Kool®
Dry matter intake, lbs/day	50.1	55.8
Respiration rate*	86.9	48.2
Shade temperature, °F	95.4	80.6
Electricity charge, $/cow/day ($0.07 kWh)		$0.41
Water use, gallons/cow/day		30

*Respiration rates were measured as the number of breaths per minute and were recorded on a subset of animals within each group.

(peaking 7.1 lbs higher and one week earlier) is even more appealing because of the potential complete lactation effects. For every additional pound of milk at peak production, research suggests an additional 225 pounds of milk over the complete lactation. Using this figure, we can project that the fresh cows will average 1598 pounds more milk throughout that lactation than cows that were not cooled. There may be further benefits possible in health and reproductive performance of cooled cows. Reduced health complications support higher levels of milk production, as well as a possible earlier return to breeding. Potential returns in reproduction may include shorter time to first breeding and higher first service conception rates. Offsetting increased returns in milk (actual) and reproduction and health (projected) are the cost of the system, add electric bills and labor and equipment charges for corral surface maintenance.

The performance of the fresh cows on this trial support the use of this system for that group. The increase in milk production and feed intake may support calving performance throughout the summer in Central Texas. Data on the reproductive performance and complete lactation of the cows freshening in August has not been different. It is possible that the control cows may have been able to recover from the heat stress once cooler fall weather arrived.

Investigators

Sandy Stokes and Joe Pope,
Texas Agricultural Extension Service

TESTING A NEW APPROACH TO BREEDING DAIRY COWS

Background

The targeted breeding program using prostaglandins has become the industry standard for breeding dairy cattle to increase pregnancy rate. Many dairies are using the program as designed with excellent results. Other dairies say they are using a targeted breeding program, but when the program is detailed, they are only using parts and most are not using appointment breeding.

Targeted breeding was designed to improve pregnancy rates. Pregnancy rate is most important in the first 21 days after the start of breeding. It's value decreases with each potential heat opportunity. To maximize our breeding opportunities, success at first service is the key.

Recent programs to remove heat detection were designed to change pregnancy rates (Pursley et al., 1997a,b; Thatcher et al., 1997). Ovsynch or Timed Al (TAI) uses GNRH and prostaglandin. The expected pregnancy rates are in the 25-35% range. The value of the GNRH in these programs is to start a new wave of follicles which will respond better when the prostaglandin is given. A second shot of GNRH is given 48 hours later in an attempt to more accurately time the ovulation and make appointment breeding more successful.

It is possible that combining the concept of targeted breeding with the ability of GNRH to stimulate new follicular development could significantly improve pregnancy rates over either program alone. By using this approach, the synchronized heats will be in a short window of 24-36 hours instead of 5 days or more. They will also be stronger because of higher levels of estrogen.

Pilot Trial:

This new concept was tested in three Erath Co. herds, by alternating control and treatment programs for four weeks. Data from one herd could not be used as a result of an unrelated problem which arose on one of the dairies. All cows calving in a single week were identified and in the "Kick Start" group, the first Lutalyse injection (A) was given from day 24 ± 3 days prior to the end of the herds voluntary waiting period. The control cows were treated with prostaglandin using the herd's standard procedures. The voluntary waiting period within a herd was identical for both the control and treatment cows.

Three locations, with over 1000 cows each, were initially selected. The initial week for the first Lutalyse injection (A) was during April 1997 for each group of cows. Thus all first breedings occurred prior to the onset of severe heat stress. All pregnancy exams were performed by the herd veterinarian. Final pregnancy data was collected after all cows had surpassed 250 days in milk, so that the number of cows pregnant by 150 days in milk could be determined by group.

Cow examinations or treatments that would normally be done prior to the start of the breeding were continued at the herds discretion (e.g. postpartum exams).

Final reproductive information was collected in January, 1998 and cows were assigned their actual days open or services up to that time.

Table 5: Reproductive parameters of cows in the trial

Group		DFS[1], days		SPC[2], No.		DO[3], days	
	n	Mean	SE	Mean	SE	Mean	S
45 day VWP[4]							
Control	44	61.8	2.7	3.75	.36	142.2	11.3
Treatment	40	52.3	.95	3.4	.39	135.8	12.9
60 day VWP							
Control	53	67.1	3.3	3.11	.28	141.8	10.3
Treatment	45	61.9	1.8	3.16	.26	133.4	9.67

[1]DFS, Days to First Service
[2]SPC, Services per Conception, all cows
[3]DO, Days Open
[4]VWP, Voluntary Waiting Period

Table 6: Percent of the herd bred by either 120 or 150 days postpartum depending upon the voluntary waiting period (VWP) of the herd.

Group	n	% Pregnant First Service	Bred by 120 days PP[1], %	Bred by 150 days PP, %
45 day VWP				
Control	44	29.5	40.9	61.3
Treatment	40	17.5	62.5	75.0
60 day VWP				
Control	53	28.3	49.0	62.3
Treatment	45	15.5	60.0	71.1

[1] PP, Postpartum

An example program for a voluntary waiting period of 60 days:

Day 33-40		Lutalyse "A"
	wait 14 days	
Day 47-53		GNRH
	wait 7 days	
Day 54-61		Lutalyse "B"
	next 2-4 days	Heat detection (24-36 hour window)
Day 57-63		Breed on Heat
	wait 7 days (for cows not observed in heat and bred)	
Day 61-68		GNRH
	wait 7 days	
Day 68-75		Lutalyse "C"
	next 2-4 days	Heat detection
Day 71-78		Breed (Heat detect day 2 and day 3)
	If not observed by 72-80 hours appointment breed – %	

Control Program

Consisted of normal reproductive management of the herd. In the two herds which completed the trial, an aggressive prostaglandin program was in use. Cows which had not exhibited heat by the conclusion of the voluntary waiting period were injected at the next regularly scheduled veterinary visit and reinjected as needed until bred.

Results

The results of the Kick Start Program are presented in Tables 5 and 6. Since different voluntary waiting periods (**VWP**) were used in the herds, data are presented based on the VWP. Days to first service (**DFS**), services per conception (**SPC**), days open (**DO**), percent bred by 120 days, percent bred by 150 days and percent pregnant at first service were the parameters evaluated.

Although it appeared that this protocol decreased the number of cows conceiving at first service, the percent bred by either 120 or 150 days was improved on the treatment group.

Investigators
Ellen Jordan[1], Joe Pope[1], Austin Belschner[2]
[1]Texas Agricultural Extension Service and
[2]Pharmacia & Upjohn

REFERENCES

Fox, D.G., S.D. Klausner, T.P. Tylutki, and J.J. Hancher. 1994. Cows, crops and cash: Making dairy farms sustainable. *In*: Cornell Nutrition Conference Proceedings, p. 47.

Fox, D.G., and M.C. Barry. 1995. Application of the Cornell net carbohydrate and protein system for feeding dairy cattle. *In*: Mid-South Ruminant Nutrition Conference Proceedings, p.1.

Stuth, J.W. 1995. NIRS-NUTBAL Nutritional Management System for Cattle. *In*: Mid-South Ruminant Nutrition Conference Proceedings, p. 89.

Pursley, J.R., M.C. Wiltbank, J.S. Stevenson, J.S. Ottobre, H.A. Garverick, and L.L. Anderson. 1997a. Pregnancy rates per artificial insemination at a synchronized ovulation or synchronized estrus. J.Dairy Sci. 80:295.

Pursley, J.R., M.R. Kosorok, and M.C. Wiltbank. 1997b. Reproductive management of lactating dairy cows using synchronization of ovulation. J.Dairy Sci. 80:301.

Thatcher, W.E., F. Moreira, J.D. Ambrose, C.A. Risco, and R.L. de la Sota. 1997. Manejo reproductive de hatos lecheros bajo estrés calórico. *In:* III Ciclo de Conferencias Internacionales sobre Nutrición y Manejo, p. 29.

.