DAIRY DAY
1995

Report of Progress 742

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

Dairy Day 1995

FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 1995. Dairying continues to be a viable business and contributes significantly to the total agricultural economy of Kansas. Annual farm value of milk produced (1.08 billion lb) on Kansas dairy farms was $151 million in June, 1995, with an impact on the economy of Kansas amounting to $735 million. Wide variation exists in the productivity per cow, as indicated by the production testing program (Dairy Herd Improvement Association or DHIA) in Kansas. Fifty percent of the dairy herds (n = 1,018) and 51% of the dairy cows (n = 81,000) in Kansas are enrolled in DHIA. Our testing program shows that all DHI-tested cows average 18,366 lb milk compared with approximately 13,333 lb for all Kansas dairy cows. Dairy herds enrolled in DHIA continue to average more income over feed cost ($1,2ll/cow) than all Kansas herds ($838/cow) in 1994. Most of this success occurs because of better management of what is measured in monthly DHI records. In addition, use of superior, proven sires in artificial insemination (AI) programs shows average predicted transmitting ability (PTA) of AI bulls in service (January, 1995) to be +1,066 lb compared to non-AI bulls whose average PTA is only -7 lb milk. More emphasis should be placed on furthering the DHIA program and encouraging use of its records in making management decisions.

With our herd expansion program, which was begun in 1978 after we moved to the new Dairy Teaching and Research Center (DTRC), we peaked at about 210 cows. The herd expansion was made possible by the generous donation of 72 heifers and some monetary donations by Kansas dairy producers and friends. Herd expansion has enabled our research efforts to increase, while making the herd more efficient. Our rolling herd average was 21,829 lb in August, 1995, nearly a 3000-lb increase since August, 1994.

Progress has been statewide as illustrated in the next column.

Progress of DHIA Herds in Kansas from 1984 to 1994

Item	Year 1984	Year 1994	± Change (%)
Milk per cow, lb	14,366	18,366	+28
Price per cwt*	$12.13	$12.15	0
Feed cost	$820	$1,021	+25
Income over feed cost	$922	$1,211	+31
Cows per herd	65	79	+22

Source: Kansas Dairy Extension News, May, 1995.
*After deducting hauling charge.

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

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

J. S. Stevenson, Editor
1995 Dairy Day Report of Progress

DEDICATION TO DR. JAMES L. MORRILL

James L. Morrill is Professor of Animal Sciences at Kansas State University. He was born and reared on a dairy farm in Graves County, Kentucky. He attended Murray State University, Murray, Kentucky, until leaving to enter military service during the Korean war. After serving as a pilot in the U.S. Air Force, he returned to Murray State, completing the B.S. degree in 1958. He received his M.S. degree in 1959 from the University of Kentucky and the Ph.D. degree in dairy cattle nutrition in 1963 from Iowa State University.

Since 1962, Morrill has been a faculty member at Kansas State University, where he has taught undergraduate and graduate courses in dairy cattle nutrition, animal nutrition, and dairy science and has assisted in other courses in the College of Agriculture and the College of Veterinary Medicine. He was selected as Outstanding Academic Advisor in Agriculture and College of Agriculture Faculty of Semester. He has served on the University Faculty Senate, the Graduate Faculty Council, and numerous college and university committees.

Morrill's research interests have been in the area of dairy cattle nutrition with emphasis on calf nutrition and management. He is author of numerous scientific journal articles, book chapters, popular press articles, and other publications. He has presented seminars or invited presentations or has worked with dairy producers in several locations in the United Sates, Canada, Central and South America, Japan, England, Spain, and Russia.

He has been a member of the American Dairy Science Association (ADSA) since 1959 and served as Director from 1988 to 1991, on the Journal Management Committee, the Internal Affairs Committee, the Editorial board of *Journal of Dairy Science* for 6 years, on the Production Division Resolutions Committee, and the Membership Committee and was a member and Chairperson of the Feeding and Management Committee. He was Chairperson of the ADSA Subcommittee on Animal Care and a member of the Intersociety Animal Care Committee. He represented ADSA as Trustee of the American Association for Accreditation of Laboratory Animal Care and was a member of the coordinating committee and of the writing committee that prepared the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching.* He served as Secretary-Treasurer, President and Past President of the Midwest Branch of ADSA. He is also a member of the American Society of Animal Science, Phi Kappa Phi, Sigma Xi, Phi Zeta, Dairy Shrine, and Gamma Sigma Delta, serving as President of the Kansas Chapter in 1980.

Morrill and his wife, Nelda, have been married since 1952 and have 5 children and 8 grandchildren. He is active in church and community programs.

A personal note. Jim will retire from the Department of Animal Sciences in December (1995) after 33 years of devoted service. Jim is always modest about his accomplishments, of which many are cited above. His gentlemanly and kind ways will be missed by those he taught and with whom he associated in the dairy industry. We wish him well in his retirement (Editor).

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MANAGEMENT STRATEGIES: THE NUTRITION PROGRAM

J. R. Dunham

Summary

Reduced milk prices and greater feed costs dictate that dairy farmers carefully manage their nutrition program in order to maintain profitable milk production. Reducing feed cost by feeding less will result in lower milk production and less income over feed cost. Some by-product feeds are less expensive than traditional grain mixes and can be fed to reduce feed cost and maintain greater income over feed cost. Poorer quality hay is less expensive than better quality hay, but income over feed cost will be reduced when low quality hay is purchased and fed.

(Key Words: Nutrition Management, Income Over Feed Cost, By-Products, Dry Matter Intake.)

Introduction

When the economics of dairying get tighter because of reduced milk prices and(or) greater feed costs, dairy farmers need to evaluate carefully their nutritional management to avoid making decisions that might result in less income over feed cost.

Too often, the decision is made to feed less grain mix as feed ingredient prices increase. This action almost always results in less milk production and reduced income over feed cost, because cows produce more milk per pound of dry matter intake as production increases. Because the same amount of feed is required for maintenance in all cows with the same body weight, reducing the amount of grain mix fed will proportionally decrease milk production.

Poorer quality hay usually costs less than better quality hay. Selecting a poorer quality hay will reduce income over feed cost, because milk production declines as dry matter intake decreases when poorer quality hay and forages are fed.

Dairy farmers in Kansas can reduce feed cost by replacing some of the traditional ingredients in the grain mix with some by-product feeds. The decision to use these feeds requires proper management.

This report will illustrate the basis for making nutritional management decisions when trying to maintain profitable milk production in a tight dairy economy.

Production Level vs Income Over Feed Cost

All things being equal, there is a better opportunity for higher producing herds to be profitable than lower producing herds. Body size, not production level, determines the maintenance requirement. Therefore, the maintenance requirement is a smaller portion of the total nutrient requirement for high-producing than for lower-producing cows.

Table 1 shows that the maintenance cost for all levels of milk production is $1.11 per cow per day, assuming that the cows are the same size and using the feed prices indicated. This cost has to be paid regardless of how much milk is produced.

Table 1 also illustrates that income over feed cost is increased from $715 for the lowest to $1531 (214% increase) for the highest production group, even though the daily feed cost increased from $2.23 to $3.73 (167% increase) for the high production level.

Obviously, the decision to feed less in order to save on feed cost is not a good management decision.

Culling

When dairy profitability is marginal, culling becomes an even more important management decision. Because higher-yielding cows produce milk more efficiently than lower-yielding cows, culling low producers and feeding the remaining cows for higher production can result in more income over feed cost. But culling 17% of the lowest producers and feeding the remaining cows for higher production results in the same income over feed cost as before culling. Example: a herd with a 17,000-lb average would have the same income over feed cost after culling 17% of the cows for production and feeding the remaining cows for 20,100 lb of milk.

Dry Matter Intake

Because today's dairy cows have a tremendous ability to produce milk, maximizing dry matter intake should be the goal of every nutrition program. Dry matter intake is increased by feeding grain mixes, but the maximum amount of grain mix that can be fed is about 60% of the total ration dry matter. Higher levels can cause digestive upsets.

Relative Feed Value (RFV) of forages, in most cases, is the most limiting factor for dry matter intake. Table 2 illustrates the influence of RFV of alfalfa hay on dry matter intake, milk production, and income over feed cost. Income over feed cost increased as the RFV of hay increased, because dry matter intake and milk production was higher. Lower prices were assigned to the lower RFV hay, which resulted in lower daily feed costs, yet income over feed cost was higher with the higher RFV hay.

Dry cow feeding is also an important consideration in nutritional management of a dairy herd. Dry cows should be fed enough nutrients to obtain a body condition score of 3.5 to 4.0 by calving time. Because it is more efficient to increase body condition of cows during lactation, providing more dry matter for thinner cows during the last 2 to 3 months of lactation is warranted before they are dried off. Adjusting the rumen microbes to the lactating cows' ration 2 to 3 weeks before calving also will improve productivity.

Other factors affecting dry matter intake include: total mixed ration (TMR), number of daily feedings, and moisture content of the ration. Total mixed rations tend to increase dry matter intake because fewer digestive upsets are apparent when cows consume grain mixed with forage. Feeding more than once per day will increase dry matter intake, because the feed remains fresher and more palatable.

During hot weather, adjusting the moisture content of a TMR can increase DMI, because cows can consume the ration at a faster rate. Many dairy farmers are adding water to the TMR mix before feeding to adjust the moisture content to 45 to 50%.

By-Products

Selecting by-products can be an important nutritional management decision. These feeds can lower feed costs and/or provide critical nutrients. Most are readily available and competitively priced in Kansas.

Table 3 lists some by-product feeds. Table 4 shows the break-even price of by-product feeds when compared to current prices of traditional feeds.

When a by-product is priced lower than the break-even price, feed costs will be reduced. Example: if wheat mids are priced lower than $6.28/cwt, feed cost will be reduced.

Tallow is a by-product that usually costs more than the break-even value. However, tallow is selected for many rations to increase energy density.

Conclusions

When milk price is suppressed and feed cost increases, the management strategy for the nutrition program should be to maximize production.

Table 1. Comparison of Rolling Herd Average to Income Over Feed Cost

Rolling herd average	Maintenance cost per day	Daily feed cost[1]	Income over feed cost per year
-- lb --		$	
13,900	1.11	2.23	715
17,000	1.11	2.58	928
20,100	1.11	3.00	1,116
23,200	1.11	3.37	1,322
26,300	1.11	3.73	1,531

[1]Feed prices per ton: Alfalfa $110.00, corn silage $25.00, cottonseeds $140.00, soybean meal $200.00, corn $115.00, vitamin-minerals $270.00.

Table 2. Effects of Alfalfa Quality on Dry Matter Intake

Alfalfa RFV[1]	Alfalfa dry matter intake	Estimated milk	Feed cost (cwt milk)	Income over feed cost/cow
	- lb -	- lb -	- $ -	- $ -
160	32.6	68.0	5.73	3.58
149	31.0	64.6	5.78	3.37
138	29.5	61.4	5.84	3.17
129	28.2	58.6	5.90	2.99
107	27.0	56.1	5.96	2.83

[1]Alfalfa prices: RFV 160 = $120.00, RFV 149 = $115.00, RFV 138 = $110.00, RFV 129 = $105.00, RFV 107 = $100.00.

Table 3. By-Product Feeds Available in Kansas

By-Product	Purpose	Comments
Cottonseeds	Increases energy and fiber density	Limit to 6 lb
Distiller grain	Increases UIP[1]	May be an inexpensive source of protein
Hominy	Substitutes for grain	Does not flow well
Meat-bone meal	Increases UIP; good source of phosphorus	Limit to 2 lb
Tallow	Increases energy density	Limit to 1.25 lb
Soy hulls	Increases fiber density	Limit to 5 lb
Wheat mids	Substitutes for grain and protein supplement	Limit to 12 lb

[1]UIP = undegradable intake protein

Table 4. Estimated Value of By-Products

By-product	Estimated value (cwt)
	---- $ ----
Cottonseeds	8.08
Distillers grain	7.86
Hominy	6.84
Meat-bone meal	16.75
Tallow	14.64
Soy hulls	5.44
Wheat mids	6.28

[1]Prices of other feeds used in the comparison: Alfalfa hay = $5.75, corn = $5.75, soybean meal = $10.00.

MANAGEMENT STRATEGIES: REPRODUCTION

J. F. Smith and J. S. Stevenson

Summary

Despite the negative effects of milk production on some reproductive traits, calving intervals between high- and low-producing groups varied by only 9 days (414 vs 423). First-service conception rates were 8 percentage points greater in the low-producing group than in the high-producing group. However, the percentage of cows not yet inseminated that were more than 120 days in milk was 18 percentage points greater in the low- than high-producing herds. When Kansas dairy herds in the DHIA program are evaluated, the higher producing herds seem to have lower first-service conception rates and more services per conception. However, managers of high-producing herds are doing a better job of servicing cows inseminated earlier in lactation and putting replacements into the milk string at a younger age. This occurs because managers of high-producing herds have reproductive records and heat detection programs that allow them to detect a higher percentage of the cows in heat before 120 days in milk. Fine tuning the reproductive management program also can improve the profitability of a dairy operation. The reproductive losses in high-producing herds are considerably less than those in low-producing herds ($139 vs $203). There are no magic formulas in establishing a good reproductive program. Combining good records, diligent heat detection, and sound artificial insemination technique can increase the profitability of a dairy.

(Key Words: Management, Reproduction.)

Introduction

Dairy producers often lose significant income because of poor reproductive performance in their herds. The costs associated with substandard reproductive performance can be significant and often go undetected. In this report, 402 Kansas Holstein dairy herds participating in the Heart of America DHIA were divided into three production groups based on 365-day rolling herd averages. The reproductive performance of the three production groups was evaluated using the Kansas State University Dairy Herd Analyzer.

Effect of Milk Production Level on Reproductive Performance

The rolling herd averages of three production groups evaluated were 14,580 (low), 19,167 (medium), and 23,426 (high) lb. Rolling herd averages of the individual herds ranged from 12,000 to 30,000 lb. Measures of milk production and reproductive performance of the three groups are presented in Table 1. As the rolling herd average increased, days dry, age at first calving, and calving interval decreased. Average number of services per conception and days in milk increased as milk production increased. Days open were greatest in the low production group. When we look at the information in Table 1, it is also apparent that cows in higher producing herds tend to breed earlier in lactation. Thirty-five percent of the cows in the low group had not yet been inseminated by 120 days in milk compared to 17% in the high-producing group.

Most studies monitoring genetic trends for reproductive traits report negative relationships between milk yield and some reproductive traits. In contrast, the superior management in most high-producing herds seems to maintain good reproductive performance.

Economics of Reproductive Performance

The Dairy Herd Analyzer calculates the amount of reproductive loss per cow based on the average performance of the herd. The reproductive loss per cow is calculated using the following criteria: 1) $1 per day when the calving interval is between 365 and 395 days and $3 per day when the calving interval is over 395 days; 2) $3 per day when average days dry are <45 days or >60 days; 3) $2 per 0.1 service per conception over 1.7; and 4) $30 per month for each month of age at first calving >24 months. When calving interval, age at first calving, or days dry are extended, reproductive loss is associated with additional feed cost, lost milk production, and loss in future replacements. The costs associated with services per conception over 1.7 cover additional semen and labor costs.

When these criteria were used to evaluate the low-, medium-, and high-production groups, the reproductive losses per cow were $203, $158, and $139, respectively. These costs that are assessed by the Dairy Herd Analyzer for reproductive failure are not "true" costs, because they do not represent out-of-pocket expenses but losses in potential income. These losses in income can have a significant effect on the profitability of a dairy operation.

Techniques for Successful Reproductive Management

✓ Use an estrus-synchronization program for replacement heifers to begin inseminations by 13 months of age. This practice ensures that replacements calve by 24 months of age.

✓ Establish an elective waiting period consistent with herd goals. Generally, for each 1-day decrease in days to first service in cows, a 0.8-day decrease in days open or calving interval occurs.

✓ Use some estrus-synchronization protocol for programming first services in cows. These protocols ensure timely first inseminations by a given target day in milk.

✓ Manage repeat services by effective and diligent heat detection, which reduces intervals between repeated services by eliminating more missed heats.

✓ Use prostaglandins effectively to induce estrus for efficient rebreeding of cows identified open at pregnancy diagnosis.

✓ Establish and adhere to a herd-specific preventive herd health program including disease prevention by vaccination, cleanliness, and routine veterinary consultation and care.

✓ Make routine observations of suspect cows for various health disorders while watching cows for estrus.

Table 1. Reproductive Profiles of Low-, Medium-, and High-Producing Kansas Dairy Holstein Herds Enrolled in the Heart of America Dairy Herd Improvement Association

Rolling herd average	No. of herds	No. of cows per herd	Age at 1st calving	Days in milk	Days open	Days dry	Calving interval	Services per conception
milk, lb	no.	no.	months	days	days	days	days	no.
14,580	84	76	29	191	143	74	423	1.93
19,167	270	88	28	193	136	65	416	2.17
23,426	48	91	26	206	134	63	414	2.51

Rolling herd average	Conception rate		% of cows not inseminated			Low income per cow associated with reproduction
	First	1 + 2	<60 days	60-120 days	>120 days	
milk, lb	%	%	%	%	%	$/cow
14,580	51	78	41	24	35	203
19,167	45	72	51	24	25	158
23,426	39	66	51	27	17	139

DAIRY HERD PROFITABILITY: EFFECTS OF MILK YIELD AND COST OF PRODUCTION ON NET RETURNS

F. D. DeLano[1] and L. N. Langemeier[1]

Summary

Dairy cow herd enterprise records from Kansas Farm Management Association farms over the past 4 years have shown an increase in returns to labor and management from $252 to $355 per cow. Returns for higher milk-producing cows were over $400 each. Cost per hundred weight of milk produced per cow for the higher-producing herds compared with lower-producing herds was about the same. In 1994, for every extra $1.00 spent on feed and other variable costs, the higher-producing herds earned $1.28.

(Key Words: Profitability, Production Costs, Production Returns.)

Introduction

Detailed dairy herd records from farms enrolled in the Kansas Farm Management Association program are analyzed each year using the K-MAR-105 mainframe computer as the basis for providing valuable information to each participating dairy farm. This detailed information also is useful to nonmembers for benchmark comparisons. Total dairy herd production expenses, along with production information, are made available on a per hundred weight (cwt) of milk sold basis and a per cow basis. This complete dairy herd enterprise analysis, along with DHIA records, provide information for dairy farmers to evaluate correctly their dairy herd program.

Procedures

Dairy herd producers keep monthly receipt and expense records in an account book or on a computerized accounting program. Detailed crop production, feed, and inventory records are completed each year under the supervision of Extension agricultural economists in the Farm Management Association Program.

Milk production is based totally on sales and, thus, does not include home use or milk fed to calves. The total feed expense includes all feed consumed by the dairy cow herd including pasture, value of stock fields, etc. Values are based on average farm market price for the current production year, inventory value, or actual purchase cost.

Results and Discussion

The 1994 dairy herd enterprise records from 92 dairy farms were analyzed after dividing the herds with milk sales below and above 18,500 lb per cow. High production per cow is very important to obtain acceptable returns to the operator for management, labor, and equity capital.

Table 1 compares these two milk production groups. In 1994, the higher-producing herds sold 3,960 lb more milk per cow (over 23% greater production), which resulted in $495 additional gross income per cow. For the higher-producing herds, total feed cost per cow increased by $231 and other variable costs (direct production costs) increased by $155. These herds returned $109 more per cow above variable costs than the lower-producing herds. For a 100-cow herd, higher production provided $10,900 more income for family living, debt

[1]Department of Agricultural Economics.

repayment, replacement of machinery and equipment, and other capital investments. Table 2 provides information on all dairy herds in the Kansas Farm Management Association Program for the 1991-94 period.

Table 3 compares the difference in milk production, gross income, variable cost, and net returns by level of production.

Table 1. Kansas Farm Management Association Dairy Herd Enterprise Analysis, 1994

Factor	Milk sold per cow: <18,500 lb		Milk sold per cow: >18,500 lb	
Production Data				
No. of farms	48		44	
No. of cows/farm	87		100	
Milk sold/cow, lb	17,001		20,961	
	Per cow	Per cwt milk sold	Per cow	Per cwt milk sold
Production Returns				
Milk sold	$2,188	$12.87	$2,680	$12.79
Livestock sales and other	312	1.84	315	1.50
Gross income	$2,500	$14.71	$2,995	$14.29
Production Costs				
Feed fed	$1,343	$7.90	$1,574	$7.51
Hired labor	145	.85	197	.94
Vet, supplies, marketing	279	1.64	365	1.74
Repairs, fuel, utilities	258	1.52	260	1.24
Interest and miscellaneous	85	.50	100	.48
Total variable costs	$2,110	$12.41	$2,496	$11.91
Return over variable cost	$390	$2.30	$499	$2.38

Table 2. Kansas Farm Management Association Dairy Herd Enterprise Analysis, 1991-1994

Factor	1991	1992	1993	1994
Production Data				
No. of farms	113	108	89	92
No. of cows/farm	85	86	89	93
Milk sold/cow, lb	17,518	18,135	18,054	19,077
Production Returns	Per cow			
Milk sold	$2,094	$2,360	$2,299	2,446
Livestock sales and other	310	322	322	315
Gross income	$2,404	$2,682	$2,621	2,761
Production Costs				
Feed fed	$1,311	$1,367	$1,396	1,465
Hired labor	164	153	162	171
Vet, supplies, marketing	225	304	316	325
Repairs, fuel, utilities	209	218	234	260
Interest and miscellaneous	114	96	102	92
Total variable costs	$2,070	$2,138	$2,210	$2,313
Return over variable cost	$334	$544	$411	448

Table 3. Cost and Returns of Kansas Farm Management Association Dairy Herds Ranked by Production*

No. of cows	Milk sold per cow	Feed cost per cwt	Other costs per cwt	Income/feed per cow	Labor and management return, per cow
	-lb-	$			
74	14,156	8.69	8.27	567	43
68	16,110	8.21	7.30	702	77
98	18,024	7.57	7.26	920	236
111	19,958	7.74	7.23	991	374
120	21,855	6.18	7.55	1,395	673

Source: Dairy Cow Enterprise Data Bank 1994, Department of Agricultural Economics, Kansas State University, Manhattan, Kansas.

CASH OPERATING INCOME AND LIQUIDITY MANAGEMENT FOR DAIRY FARMS

***B. D. Elliott*[1], *M. R. Langemeier*[1], *and A. M. Featherstone*[1]**

Summary

Net cash flow measures the amount of cash remaining after all cash expense obligations are satisfied. This cash is available for additional farm investment, off-farm investment, family living, and additional debt repayment. A 5-year average monthly cash flow statement was used to determine net cash flow for 19 Kansas dairy farms. Results indicated that excess cash and debt were used primarily to invest in machinery, vehicles, and nonfarm assets and increase the allocation for family living. Investments in land and buildings increased moderately during the study period.

(Key Words: Investment, Liquidity, Cash Flow.)

Introduction

Liquidity and cash-flow management tools are essential components used in the implementation of financial control. Liquidity refers to the ability of the farm business to meet financial obligations as they come due and typically is measured using a cash-flow statement. Monthly cash-flow statements provide information necessary to assess seasonal credit requirements. Long-term cash-flow projections also can provide information pertaining to a firm's ability to repay intermediate and long-term loans.

The objective of this study was to determine how excess cash profits (if present) were used on several Kansas dairy farms. Monthly sources and uses of funds are presented and discussed.

Procedures

Cash transactions, inventories, and production information for 19 dairy farms were available from the Financial Plus program of the Kansas Farm Management Association. To be included in the analysis, a farm had to be enrolled for 1988, 1989, 1990, 1991, and 1992.

A monthly cash-flow statement was utilized to determine the amount of excess cash available for investment and debt repayment. This statement summarizes all cash transactions concerning the business or enterprise during a given period of time. The net cash-flow measure included on-farm sources and uses of cash as well as nonfarm cash flows. Cash operating income, defined as the amount of cash income from the farm business, was used to measure both profitability and liquidity. This cash is used for discretionary purposes, such as meeting scheduled principal payments, on and off farm investment, and family living. Net loans are calculated as loans received minus loans repaid and reflect the level of debt repayment or lack thereof. A negative value for net loans indicates that producers were paying down their debt. Financial and production variables were analyzed to ascertain where excess cash was invested.

[1]Department of Agricultural Economics.

Results and Discussion

Table 1 presents a 5-year average monthly cash flow statement for the 19 dairy farms. The dairy farms were relatively profitable during the period, averaging $57,479 of net farm income (accrual basis) per year and $53,985 of cash operating income (cash basis) per year. Using Table 1, we can analyze the seasonality of the various revenue and expense items as well as the summary variables in the lower portion of the table. Farm expenses increased proportionally more than farm sources during December, resulting in a negative cash operating income. The largest monthly net cash flow occurred in January. The largest monthly principal payments occurred in May and October. Dairy producers took out the most loans in April and December. April and December were the months when net loans were most positive, indicating the accumulation of debt. However, dairy farms paid down loans by average of $1,894 per year, over the 5-year period.

The data indicate that excess cash was used primarily to finance intermediate assets (Table 2). Table 2 is not a complete balance sheet but lists end-of-year balances for dairy farm assets. Dairy producers in this study increased their cash outlays for vehicles and equipment, whereas cash expenditures on buildings decreased. Breeding stock and nonfarm asset inventories increased appreciably during the period. Nonfarm asset inventory increased from $8,369 in 1988 to $17,204 in 1992 or 105.5%. The value of owned land increased by 14.4% during this period. The producers in this study also increased their allocation for family living by 62% during the period.

Fluctuations in the values of current livestock and crop inventories can be misleading and may not indicate a change of production. These fluctuations can be caused by changes in the individual commodity prices. Production numbers such as average cows per year indicate that milk production was steady during the period.

Cash-flow management is an essential component of effective financial control. Anticipating cash requirements alleviates last minute decisions that are potentially costly. In addition, understanding the seasonal need of cash generation will allow producers to make better investment decisions.

Table 1. Monthly Cash-Flow Statement for Dairy Farms (1988-1992)[1]

Item	Jan	Feb	Mar	Apr	May	June
Sources			$			
Livestock	22,249	20,061	19,994	19,917	19,362	19,227
Breeding stock	3,341	2,094	2,157	1,413	1,656	1,385
Crops	2,895	2,255	3,287	3,175	2,340	3,722
Miscellaneous	512	614	294	912	425	427
Asset sales	39	87	425	603	518	771
Total farm sources	29,036	25,111	26,157	26,020	24,301	25,532
Nonfarm	2,773	1,809	1,758	2,706	1,560	1,313
Total sources	31,809	26,920	27,915	28,727	25,861	26,845
Uses						
Livestock purchases	948	1,770	2,561	1,358	359	470
Feed	4,192	4,606	5,132	5,574	5,333	5,673
Veterinary	361	412	425	434	595	384
Fert., seed, and chem.	938	1,165	1,880	2,621	3,735	3,271
Machine hire/labor	2,656	2,191	2,555	2,604	2,572	3,432
Fuel and repairs	2,066	2,522	2,829	2,804	2,780	2,779
Asset purchases	1,381	2,639	3,158	5,713	1,745	2,271
Interest paid	1,220	1,264	1,026	819	898	657
Miscellaneous	4,817	3,677	4,422	4,354	2,899	4,970
Total farm uses	18,579	20,246	23,988	26,281	20,916	23,907
Total nonfarm uses	7,987	6,727	4,560	5,717	2,666	3,204
Total uses	26,566	26,972	28,548	31,998	23,583	27,111
Loans received	4,979	4,898	6,367	9,978	6,725	3,880
Loan payments	6,158	5,875	5,958	6,892	8,398	4,126
Net loans	(1,179)	(977)	409	3,086	(1,672)	(246)
Operating income	11,801	7,418	4,903	4,848	4,612	3,126
Net cash flow	4,064	(1,029)	(224)	(185)	606	(511)
Debt servicing ratio, %	23.2	26.5	25.0	26.8	35.9	17.8

[1]Numbers in parentheses represent negative values.

Table 1. Monthly Cash-Flow Statement for Dairy Farms - Continued (1988-1992)[1]

Item	July	Aug	Sept	Oct	Nov	Dec	Total
Sources				$			
Livestock	18,338	21,084	18,989	21,000	19,515	21,825	241,562
Breeding stock	1,428	1,918	2,154	2,060	2,481	1,238	23,325
Crops	5,817	1,957	2,239	10,135	4,084	5,872	47,778
Miscellaneous	632	555	1,319	525	1,091	1,810	9,118
Asset sales	395	867	102	60	146	147	4,160
Total farm sources	26,610	26,381	24,803	33,780	27,317	30,892	325,941
Nonfarm	1,814	2,037	950	1,152	1,709	6,495	26,076
Total sources	28,424	28,419	25,754	34,932	29,026	37,387	352,017
Uses							
Livestock purchases	660	1,107	1,903	1,986	1,856	843	15,822
Feed	5,647	6,073	5,827	7,642	6,868	12,198	74,765
Veterinary	453	435	491	526	556	641	5,715
Fert., seed, and chem.	2,501	1,140	782	1,877	1,368	5,022	26,299
Machine hire/labor	3,497	3,038	2,962	3,214	2,814	3,894	35,427
Fuel and repairs	3,237	3,171	3,441	2,979	3,375	4,009	35,992
Asset purchases	814	4,049	594	1,766	929	1,234	26,293
Interest paid	1,294	1,620	1,267	1,241	1,131	9,431	21,868
Miscellaneous	3,376	3,227	3,469	4,146	5,400	7,153	51,910
Total farm uses	21,479	23,860	20,736	25,377	24,297	44,425	294,089
Total nonfarm uses	3,569	3,810	3,179	4,558	4,793	4,986	55,754
Total uses	25,048	27,669	23,915	29,935	29,089	49,412	349,845
Loans received	2,125	5,308	3,418	3,596	3,690	9,201	64,165
Loan payments	5,800	5,134	4,898	7,592	5,351	(123)	66,059
Net loans	(3,675)	173	(1,480)	(3,996)	(1,662)	9,324	(1,894)
Operating income	5,550	5,702	4,560	10,109	3,804	(12,447)	53,985
Net cash flow	(300)	923	359	1,001	(1,725)	(2,701)	278
Debt servicing ratio, %	25.0	23.8	23.9	25.3	22.3	24.9	25.0

[1]Numbers in parentheses represent negative values.

Table 2. Dairy Farm Assets, Liabilities, and Family Living Expenses (1988-1992)

Item	1988	1989	1990	1991	1992	% change 1988-1992
Current assets			$			
Cash and accounts receivable	44,728	50,831	52,979	55,017	59,642	33.3%
Feeder livestock	17,059	22,868	25,936	24,554	22,653	32.8%
Stored grains	48,429	51,476	57,481	45,324	61,221	26.4%
Supplies	1,365	2,408	3,467	1,772	4,134	202.9%
Intermediate assets						
Dairy breeding stock	132,317	131,419	146,436	139,845	150,162	13.5%
Other breeding stock	8,221	7,854	8,861	11,111	12,347	50.2%
Vehicles and equipment[a]	16,534	18,885	22,806	12,970	22,305	34.9%
Long-term assets						
Buildings[a]	1,430	3,615	1,704	475	691	-51.7%
Land	189,443	203,954	205,794	213,710	216,752	14.4%
Current loans	63,663	76,205	83,246	94,299	85,521	34.3%
Intermediate loans	59,848	53,347	55,890	54,438	62,071	3.7%
Long-term loans	102,037	101,981	90,910	97,406	112,343	10.1%
Family living expense[b]	16,341	28,683	23,988	26,786	26,478	62.0%
Nonfarm assets	8,369	10,243	10,320	12,333	17,204	105.6%
Nonfarm loans	100	696	24	500	93	-6.8%

[a]Cash expenditure.
[b]Data were not available for all farms.

ECONOMICS OF USING rbST

J. F. Smith

Summary

As new technologies such as rbST become available to dairy producers, evaluating the profitability of those technologies on individual farms is essential. Costs associated with rbST include purchase of product, feed, and labor. The costs of product and labor are independent of milk response. However, feed cost will increase as the milk production response to rbST increases. If the mailbox milk price is $10, approximately 7 lb more milk per day will be required to break even. It is essential that dairy producers have the management in place to achieve a profitable milk response to rbST.

(Key Words: Recombinant Bovine, Somatotropin, Economics.)

Introduction

Recombinant bovine somatotropin (rbST) first became available to U.S. dairy producers in February, 1994, after approval by the Food and Drug Administration. The product approved, Posilac®, is manufactured and marketed by the Monsanto Company. As new technologies such as Posilac® become available, it is essential that dairy producers understand how to use them profitably. A number of factors affect the profitability of cows supplemented with rbST. Some of these costs include: feed, labor, price of the product, milk price, and achieved milk production response. The objective of this report is to consider the financial implications of rbST on a per cow basis.

Feed Costs

Dry matter intake of dairy cows treated with rbST will increase 2 to 7 wk after the initiation of treatment. Rations should be balanced to meet the requirements for body condition and milk production.

The amount of energy required to produce an additional pound of milk is .31 Mcal. This assumes that the maintenance requirements of the cow have been satisfied. If a ration contains .78 Mcal per lb of dry matter, a dairy cow would have to consume an additional .4 lb of dry matter per lb of milk response, or 4 lb of dry matter per 10 lb of milk.

Table 1 lists the feed costs required to produce an additional pound of milk at different costs per lb of dry matter (5¢ to 12¢).

Table 1. Feed Cost Associated with Cows Treated with rbST as Related to the Cost of Dry Matter per Pound

Cost per pound of dry matter	Feed cost per pound of milk response to rbST [1]
--cents--	--cents--
5	2.0
6	2.4
7	2.8
8	3.2
9	3.6
10	4.0
11	4.4
12	4.8

[1] Calculations are based on .31 Mcal per pound of milk above maintenance and a ration providing .78 Mcal per pound.

In Table 2, the daily feed costs associated with treating cows with rbST at different milk response levels (4 to 15 lb) have been calculated. Using a combination of the information in Tables 1 and 2, a producer can determine the additional feed cost associated with treating cows with rbST at different levels of milk production achieved.

Labor

Dairy producers will need to reallocate existing labor and/or hire more labor in order to implement effectively an rbST program. Additional labor should be used to keep injection records, inject cows, and score cows for body condition. The rbST program can be as simple or complex as desired. The labor cost of an rbST program likely will vary significantly from farm to farm. For example, some dairy producers keep injection records and body condition scores for individual cows. Other producers assign cows to pens in which all cows are treated with rbST every 14 days. An additional labor cost was assumed to be $.02 per treated cow.

Price of rbST

In this paper, it was assumed that the cost of a 14-day dose of Posilac® is $5.80. Therefore, the daily cost of Posilac is $.41.

Achieved Milk Response and Milk Price

Milk response to rbST and the market price of milk have dramatic effects on the profitability of using rbST. The profitability of using rbST is evaluated on a per cow basis in Table 3. Nine milk response levels (7 to 15 lb) and three mailbox milk prices were used. The costs of Posilac® and labor remained constant in the analysis. However, feed cost increased with the level of milk response.

The mailbox milk price will have a significant effect on profitability at a given level of milk response to rbST. For example, a $10 milk price with a 10-lb milk response generates a profit of 29¢ per treated cow. That compares to a 49¢ profit per treated cow at a $12 milk price at the same milk response level.

On the other hand, the level of milk response to rbST is also extremely important in effectively using this new technology. If we assume a constant milk price of $10 per cwt, an 8-lb response to rbST will generate a profit of 14¢ per treated cow compared to 43¢ per treated cow with a 12-lb response.

Table 2. Daily Feed Cost Associated with Treatment with rbST at Different Daily Milk Responses

	Feed cost per pound of response			
Milk response	2.0¢	2.5¢	3.0¢	3.5¢
--lb/day--	--------------------------cents per cow per day-----------------------------			
4	8.0	10.0	12.0	14.0
5	10.0	12.5	15.0	17.5
6	12.0	15.0	18.0	21.0
7	14.0	17.5	21.0	24.5
8	16.0	20.0	24.0	28.0
9	18.0	22.5	27.0	31.5
10	20.0	25.0	30.0	35.0
11	22.0	27.5	33.0	38.5
12	24.0	30.0	36.0	42.0
13	26.0	32.5	39.0	45.5
14	28.0	35.0	42.0	49.0
15	30.0	37.5	45.0	52.5

Table 3. Predicted Profitability of Using rbST Based on Variable Milk Price and Milk Response[1]

	Expenses				Mailbox milk price					
					$10 per cwt		$11 per cwt		$12 per cwt	
Milk response	rbST	Feed	Labor	Total cost	Gross income	Net income	Gross income	Net income	Gross income	Net income
--lb/day--	cents per day									
7	.41	.20	.02	.63	.70	.07	.77	.14	.84	.21
8	.41	.22	.02	.66	.80	.14	.88	.22	.96	.30
9	.41	.25	.02	.69	.90	.21	.99	.30	1.08	.39
10	.41	.28	.02	.71	1.00	.29	1.10	.39	1.20	.49
11	.41	.31	.02	.74	1.10	.36	1.21	.47	1.32	.58
12	.41	.34	.02	.77	1.20	.43	1.32	.55	1.44	.67
13	.41	.36	.02	.80	1.30	.50	1.43	.63	1.56	.76
14	.41	.39	.02	.83	1.40	.57	1.54	.71	1.68	.85
15	.41	.42	.02	.85	1.50	.65	1.65	.80	1.80	.95

[1] Assumptions: Cost of rbST ($5.80) per 14-day dose, feed cost of 7¢ per lb of dry matter, labor cost of 2¢ per treated cow per day.

PERFORMANCE OF COWS IN THE LACTATION FOLLOWING rbST TREATMENT

J. R. Dunham

Summary

The first 305-2×-ME lactation record (after 45 days in milk) projected by the DHI program in 28 cows was not different from their first projected lactation record in a previous lactation in which recombinant bovine somatotropin (rbST) injections were begun by the 90th day of lactation. These results suggest when rbST-treated cows are fed and managed properly during lactation and the dry period, no negative effect of rbST or so-called "burn out" occurs.

(Key Words: Recombinant Bovine Somatotropin, Burn Out, Sophomore Slump.)

Introduction

Recombinant bovine somatotropin (rbST)-treated cows usually produce daily from 8 to 15 more lb of milk than non-rbST-treated cows. Two concerns often are expressed by dairy farmers when the topic of rbST is discussed. The first concern is that rbST-treated cows will not produce as well in the next lactation when rbST is not used. Does the stress of producing the additional milk when treated with rbST result in less milk production in the subsequent lactation? A second concern is that second-lactation milk yields will be affected adversely when first-lactation cows are treated with rbST. This phenomenon often is referred to as "burn out" or "sophomore slump". The objective of this study was to compare milk production of cows in one lactation with rbST treatment and in the next lactation when rbST was not injected.

Procedures

The first 305-2×-ME lactation records projected by the DHI program in 28 cows (14 in first lactation and 14 in second and third lactation), which were included in a rbST experiment (The Upjohn Co.) during 1991, were compared with their first projected 305-2×-ME records in the next lactation in which rbST was not used.

The first injection of rbST was given on the 90th day of lactation, and the last injection was given 7 days before dry off. Cows were dried off to allow for a 60-day dry period. During the dry period, prairie hay and 9 lb of a grain mix balanced for energy, protein, vitamins, and minerals were fed daily. This program was designed to obtain a body condition score of 3.5 to 4.0 during the dry period.

The first projected 305-2×-ME records were compared between the two lactations because the first projection is made by the DHI program at the first test after 45 days in milk. Therefore, the first 305-2×-ME record during the experimental lactation was made before injections of rbST began.

Results and Discussion

Average projected 305-2×-ME records of cows used in the rbST experiment during 1991 and their subsequent record in 1992, when rbST was not used, are shown in Table 1. The average 305-2×-ME record in all cows during the rbST lactation was 104 lb of milk greater than the average for the next untreated lactation. The difference was only 28 lb greater when the lactation record was converted to fat-corrected milk (FCM). The differences were not significant.

Comparing the average 305-2×-ME records for first and second lactations showed that the second lactation was greater by 279 lb of milk or 408 lb of FCM. These differences also were not significant.

Apparently, cows treated with rbST can be fed and managed properly during lactation and the dry period to overcome any possible negative effects of increased milk production in response to treatment with rbST. These data also suggest that first-lactation cows do not experience "burn out" during the first lactation or exhibit the so-called "sophomore slump" when fed and managed adequately during their first lactation and dry period.

Table 1. Comparison of First Projected Lactation Records of Cows Used in an rbST Experiment with Their Records in the Next Lactation

Cows	First projected 305-2×-ME		Fat-corrected milk (FCM)
	Milk	Fat	
All 28 cows (1991)[1]	20,014	713	18,695
All 28 cows (1992)[2]	19,910	714	18,667
14 cows in first lactation (1991)[1]	20,206	720	18,887
14 cows in second lactation (1992)[2]	20,485	740	19,295

[1]Projected DHI lactation record (305-2×-ME) after 45 days in milk before cows were injected with rbST during the remaining lactation beginning on the 90th day in milk.

[2]Projected DHI lactation record (305-2×-ME) after 45 days in milk in a subsequent lactation in which cows were not injected with rbST.

INCLUSION OF FAT IN DIETS FOR EARLY LACTATING HOLSTEIN COWS

J. E. Shirley and M. E. Scheffel

Summary

Twenty-four Holstein cows were used to study the effect of dietary fat on milk production and metabolic traits. Whole cottonseed and tallow were used as fat sources and substituted into the control diet on an isocaloric basis. Chopped alfalfa hay and grain sorghum silage constituted the forage in all diets. Treatments were balanced for parity, body weight, and previous lactation milk production or genetic potential (primiparous cows). Cows were housed in a tie-stall barn beginning 4 weeks prepartum, fed similar diets, and assigned to treatment on the day of calving. Diets were formulated to provide 3.3, 4.8 and 6.5% fat. Diets actually measured 2.1, 3.8, and 5.3% fat. Serum urea nitrogen and cholesterol increased with increased dry matter intake and with increasing dietary fat. Serum triglycerides decreased at parturition and were similar among diets through 20 days postpartum. Thereafter, cows fed the 2.1% fat diet had fewer serum triglycerides than cows receiving 3.8% and 5.3% fat diets. Similar differences were observed with regard to mammary uptake of triglycerides. Serum glucose peaked at calving in all cows and tended to be similar among diets. Glucose uptake by the mammary gland increased with milk production. Cows fed the 5.3% fat diet had less urine ketones by 3 weeks postpartum. Weeks to positive energy balance were 8, 7, and 5 for cows fed 2.1, 3.8, and 5.3% fat diets, respectively. Dry matter intake in kg/day and as a percentage of body weight tended to be greater in the high fat group after 3 weeks of lactation. Milk yield (total and 3.5% FCM) was similar among diets through 10 weeks of lactation. Thereafter, lactation curves in cows fed the 5.3% fat diet were more persistent. Similar trends were observed for milk fat and protein. Milk protein percentage was slightly depressed on the 5.3% fat diet, but protein yield increased.

(Key Words: Cows, High-Fat Diets, Milk, Cholesterol.)

Introduction

Use of fat sources such as whole cottonseed, roasted soybeans, tallow, or rumen-protected fats to increase the energy density of diets for high-producing dairy cows is a general practice in today's dairy industry. Questions concerning the amount to include, when to include it, and the source or sources to use have not been fully answered. Furthermore, questions relating to the metabolic effects of increasing amounts of dietary fat remain unanswered.

Previous studies showed a 14% increase in milk production when tallow was added to the diet at 25 days in milk (KAES Report of Progress 608:19) and 6.8% when added to the diet at 90 days in milk (KAES Report of Progress 716:24). Tallow inclusion in both studies was sufficient to increase total dietary fat to approximately 5%. Field observations suggest that the combined use of whole cottonseed and tallow in total mixed rations permits the feeding of dietary fat in excess of 5% without resorting to the use of rumen-protected fat to prevent depressed feed intake and milk protein percentage.

Use of supplemental fat in the diet of cows during the first 30 to 60 days postpartum is thought to be counterproductive, because the cow is rapidly mobilizing body fat at this time. Increased dietary fat in the early postpartum period might aggravate the normal fatty liver condition, or at best, not be utilized efficiently. Furthermore, high fat diets might result in depressed intake and contribute to increased clinical ketosis. Conversely, if dry matter intake is not depressed and the additional dietary fat is shunted directly to the mammary gland without interfering with liver function, then the cow would return to positive energy balance sooner, resulting in higher peak milk yield and a more persistent lactation curve. The purpose of this study was to investigate the impact of increased dietary fat during the immediate postpartum period on production and metabolic traits of Holstein cows.

Procedures

Diets were control grain mix (diet C; 2.1% fat); control plus 6 lb of whole cottonseed (diet D; 3.8% fat); and control plus 6 lb of whole cottonseed with 1 lb of tallow (diet E; 5.3%). Whole cottonseed and tallow were substituted into the control diet on an isocaloric and isonitrogenous basis. The forage component of all diets included chopped alfalfa hay and grain sorghum silage. Diets were fed twice daily as a total mixed ration (TMR) (50% in the A.M. and 50% in the P.M.) and daily weight backs obtained prior to the A.M. feeding. The 24 cows were housed in a tie-stall barn beginning 4 weeks before calving, fed similar diets, and assigned to treatments on the day of calving. Treatments were balanced for parity, body weight, and previous lactation milk production or genetic potential in the case of first-lactation cows.

Beginning 4 weeks before calving, weekly body weights and condition scores were obtained on the same day of the week and at the same time of the day (± 30 min). Additional weights and condition scores were obtained within 24 hr after parturition. Milk weights were recorded daily. A.M. and P.M. samples were collected weekly and pooled for composition analysis. Milk fat, protein, lactose, solids-not-fat, and somatic cells were determined by the DHI Laboratory, Manhattan, KS.

Urine samples were checked for concentration of ketones on days 5 and 1 prepartum, at calving, and daily for the first 21 days postpartum. Blood samples were obtained from tail and subcutaneous abdominal veins. Serum was analyzed for urea nitrogen, triglycerides, glucose, cholesterol, and bovine somatotropin (bST). Blood samples were collected between 2 and 3 hr after the A.M. feeding. Sampling dates were days 5 and 1 before calving and days 1, 3, 5, 7, 9, 12, 15, 20, 25, 30, 45, 60, 90, 120, and 180 postpartum.

Individual feed ingredients were sampled weekly and composited monthly for analyses. Total mixed rations and weigh backs were sampled weekly for dry matter determination. Feed analyses included dry matter, crude protein, crude fat, crude fiber, ADF, NDF, NE_L, calcium, phosphorus, potassium, chloride, and sulphur.

Cows were observed daily and observations recorded relative to health problems, with particular emphasis on milk fever, ketosis, displaced abomasum, mastitis, feet and legs, off-feed, reproductive abnormalities, and other occurrences that would impact the interpretation of data. Outside daily ambient temperature, humidity, and barn temperature were recorded.

Results and Discussion

The experimental diets (Tables 1 and 2) were formulated to be isocaloric and isonitrogenous. The major difference between diets was the source of calories (i.e., fat substituted for carbohydrates). This substitution created some differences in dietary specifications (Table 3), particularly in nonstructural carbohydrates (NSC), calcium, and neutral detergent fiber (NDF). Increasing the amount of fat increases the energy density of the diet and reduces the amount of dry matter cows must consume to meet their nutrient requirements for a specified level of milk production. This can be particularly important to the fresh cow, because her dry matter intake (Figure 1) is relatively low. Thus, one of the objectives of substituting fat for carbohydrates in diets for lactating cows is to increase nutrient intake as rapidly as possible and reduce the duration of negative energy balance. Results of this study show that weeks to reach positive energy balance after parturition were 8, 7, and 5 for cows fed low-, medium-, and high-fat diets, respectively (Figure 2). These results were achieved from both the higher nutrient density of the diet and the fact that appetite (Figure 1) was not depressed with increasing amounts of supplemental dietary fat. However, the reduction in weeks to reach positive energy balance did not translate into increased production at peak lactation or increase in body condition score (Figures 3 and 4, respectively). Milk production was similar among diets through 10 weeks of lactation. Thereafter, cows fed the high-fat diet were more persistent than cows fed the medium- or low-fat diets. Thus, the practice of adding fat immediately after calving may be convenient in herds with only one group of cows, but it may be economically advantageous to wait until 30 to 60 days postpartum in cases where herd size permits grouping (Table 4).

Body weight and condition scores were similar throughout the study. Cows fed the high-fat diet began the study with an average body score of 2.68 versus 3.02 and 3.08 for cows fed the medium- and low-fat diets, respectively. Consequently, cows fed the high fat diet lost .64 units of body condition, whereas cows receiving the medium- and low-fat diets lost .83 and .84 units, respectively. The difference in initial body condition is probably the reason for the elevated feed intake by the high-fat group. Dry matter intake in lb/day and as a percentage of body weight tended to be higher in the high-fat group after 3 weeks postpartum.

The addition of ruminally unprotected fat to diets in amounts sufficient to increase total dietary fat above 5% may result in a depression in percentage milk protein. We observed a nonsignificant decrease in milk protein percentage, but protein yield (lb/day) tended to follow milk production (Figure 5). The combination of fat sources used in this study, whole cottonseed and tallow, may have an advantage over other sources when fed in a TMR. The whole cottonseed tends to associate with the forage fraction. It is consumed over an extended period and provides a slow release of fat in the rumen, because it becomes a part of the ruminal fibrous layer. Tallow is a saturated fat that requires essentially no energy expenditure by rumen microorganisms during its passage through the digestive system. In essence, the combination of whole cottonseed and tallow might mimic ruminally inert fat sufficient to have no negative impact on rumen microbial activity. Evidence contrary to this conclusion is the concentrations of blood urea nitrogen (BUN). Cows fed the high-fat diet had elevated BUN relative to the other groups. Concentrations of BUN in the high-fat group may have resulted from the low nonstructural carbohydrate (NSC) content of the diet (33.3% vs. 39.8 and 35.7, low- and medium-fat diets, respectively). Earlier studies (KAES Report of Progress 716:24) demonstrated that increasing the dietary NSC in diets containing tallow tended to reduce BUN. The generally recommended level of NSC diets for lactation cows is 35 to 40%.

Supplementing diets for cows in early lactation may reduce the incidence of ketosis. Urine ketone data, expressed as a percentage of cow days exhibiting levels in the moderate or greater range, indicated that cows fed the high-fat diet had less subclinical ketosis by 3 weeks than the other groups. Further studies using more cows and quantitative blood ketone levels are needed to verify this concept.

It has been reported that supplemental dietary fat might reduce the effects of heat stress on milk production. Our data, although inconclusive, show that milk yield from cows receiving the low-fat diet exhibited a sharp drop during weeks 13 and 16 following 3 days of 90 degrees F temperature each time. No response to elevated temperature was noted in the high-fat group.

Serum cholesterol and triglycerides were increased ($P<.01$) by supplemental dietary fat, as expected. No differences were observed in serum glucose and bST concentrations among treatments.

In conclusion, whole cottonseed and tallow can be used safely to increase the energy density of diets for cows during early lactation. However, such diets will notimprove peak lactation performance but will improve persistency of lactation. When herd size is sufficient to permit grouping cows according to stage of lactation, it may be economically advantageous to initiate supplemental fat feeding at 50 to 60 days in milk. Further work is needed to ascertain the ability of dietary fat to reduce heat stress and the incidence of ketosis in high-producing cows.

Table 1. Experimental Diets

Ingredients	Diet C (2.1% fat)	Diet D (3.8% fat)	Diet E (5.3% fat)
	------------------ as fed lb/day	---------------------	
Alfalfa hay	18.0	18.0	18.0
Corn silage	24.0	24.0	24.0
Wheat	2.0	2.0	2.0
Molasses	.9	.9	.9
Whole cottonseed	—	6.0	6.0
Grain mix C	37.5		
Grain mix D		30.5	
Grain mix E			28.5

Table 2. Experimental Grain Mixes

Ingredient	Grain Mix C	Grain Mix D	Grain Mix E
	----------------------------- % fed	------------------------------	
Soybean meal	25.15	26.18	31.0256
Distillers grains	6.22	6.48	7.67
Shelled corn	51.21	48.69	40.67
Soy hulls	12.52	11.91	10.0
Fat	—	—	3.53
Dical	1.31	1.41	1.62
Ground limestone	1.15	2.94	3.14
Bicarb	1.522	1.50	1.41
Mag. oxide	.16	.098	.14
Trace mineral salt	.53	.524	.495
Vitamin premix (ADE)	.187	.227	.245
Vitamin E	.0205	.025	.0275
Selenium	.0205	.025	.0272
Total	100.00	100.00	100.00

Table 3. Ration Specifications for a 1400 Pound Cow Producing 90 Pounds of 4.0% Butter Fat, 3.2% Protein Milk

Item	Diet C (2.1% fat)	Diet D (3.8% fat)	Diet E (5.3% fat)
Est. dry matter (DM) intake, lb/day	59.7	58.6	56.7
Est. DM intake, % BW	4.3	4.2	4.1
Neutral detergent fiber, % DM	31.1	33.4	33.5
Acid detergent fiber, % DM	20.1	22.3	22.4
Protein, % DM	18.1	18.4	19.0
Undigested intake protein, % protein	36.8	36.2	35.8
NE_L, mcal/lb	.77	.78	.81
Calcium, % DM	.78	1.05	1.08
Phosphorus, % DM	.49	.50	.51
Potassium, % DM	1.41	1.44	1.47
Magnesium, % DM	.24	.25	.26
Fat, % DM	3.32	4.84	6.51
Nonstructural carbohydrate, % DM	39.8	35.7	33.3

Table 4. Effects of Dietary Fat on Various Production Traits in Lactating Holsteins

Item	Diet C (2.1% fat)	Diet D (3.8% fat)	Diet E (5.3% fat)	SE
Milk, kg/day	33.4	34.8	35.5	1.88
Milk fat, %	3.52	3.44	3.54	.08
Milk protein, %	3.16	3.00	3.07	.07
Energy corrected milk, kg/day	23.3	23.8	24.8	1.34
Dry matter intake, kg/day	21.4	22.5	23.0	.8
Milk, kg/day				
Weeks 1 to 9	36.6	37.2	37.2	2.36
Weeks 10 to 24	31.4	33.2	34.5	1.67
Milk protein, %				
Weeks 1 to 9	3.15	3.04	3.14	.06
Weeks 10 to 24	3.1	3.0	3.0	.08
Somatic cells ($\times 10^3$)	132	84	85	35

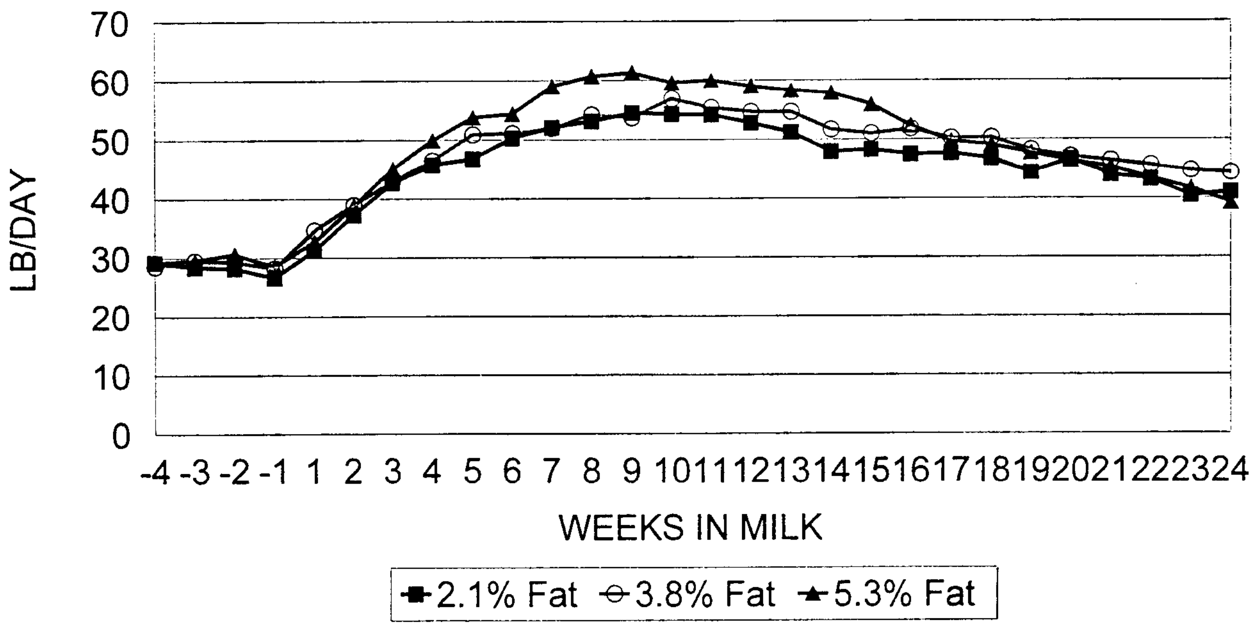

Figure 1. Dry matter intake of cows fed three levels of fat.

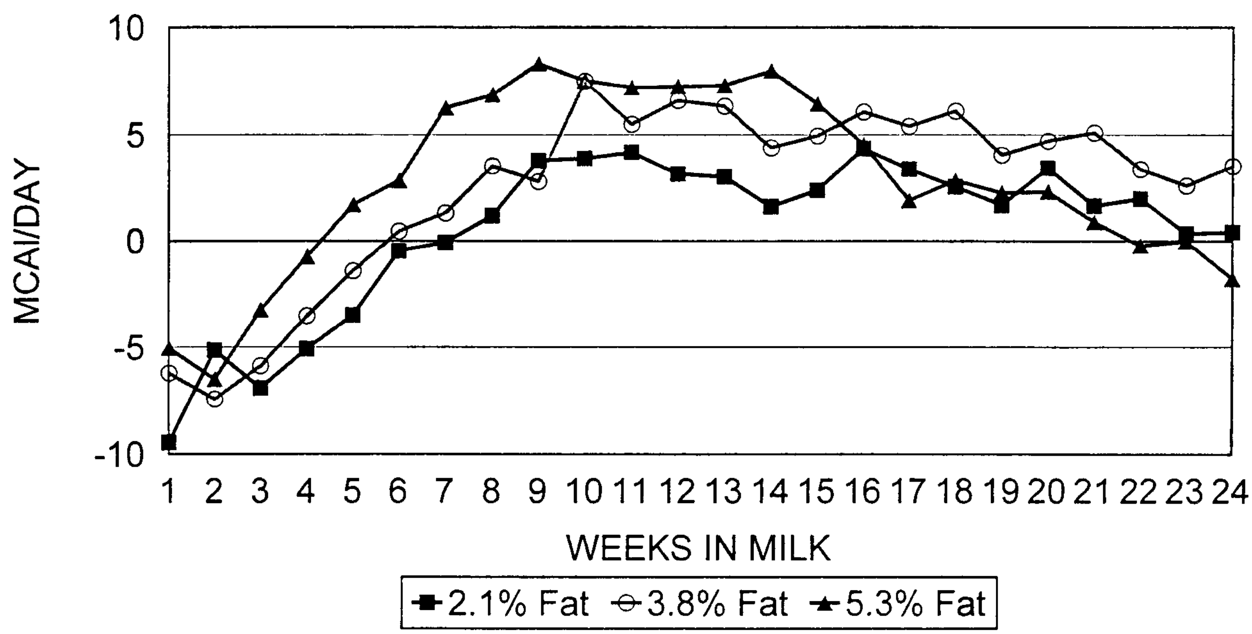

Figure 2. Energy balance of cows fed three levels of fat.

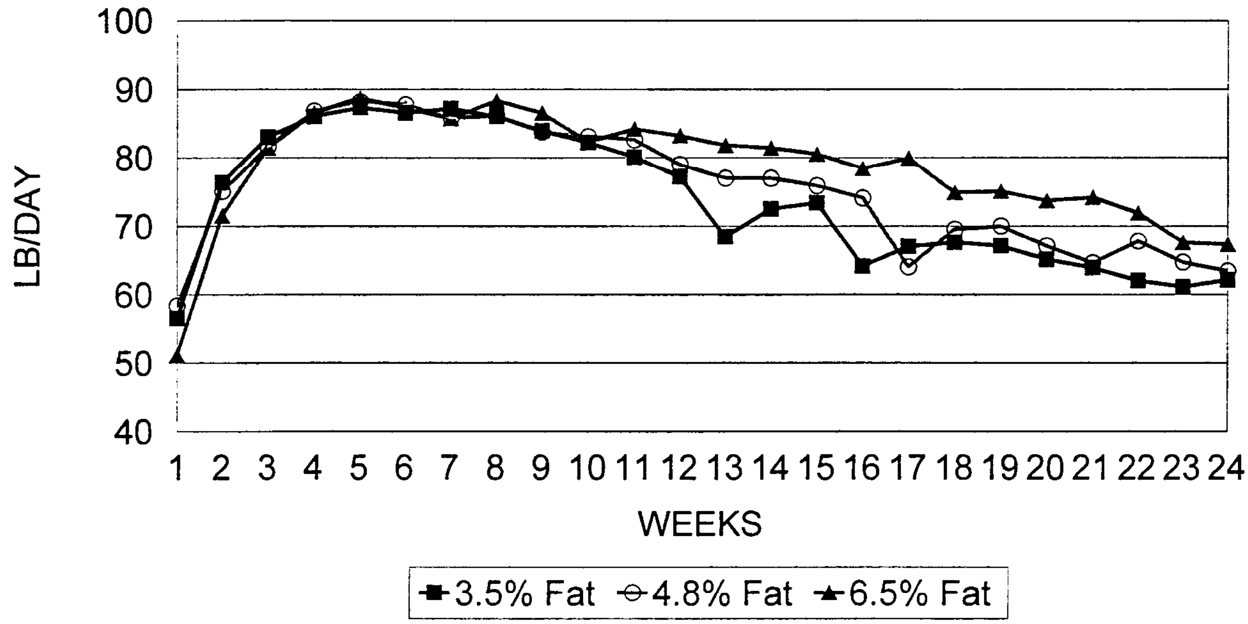

Figure 3. Milk production of cows fed three levels of fat.

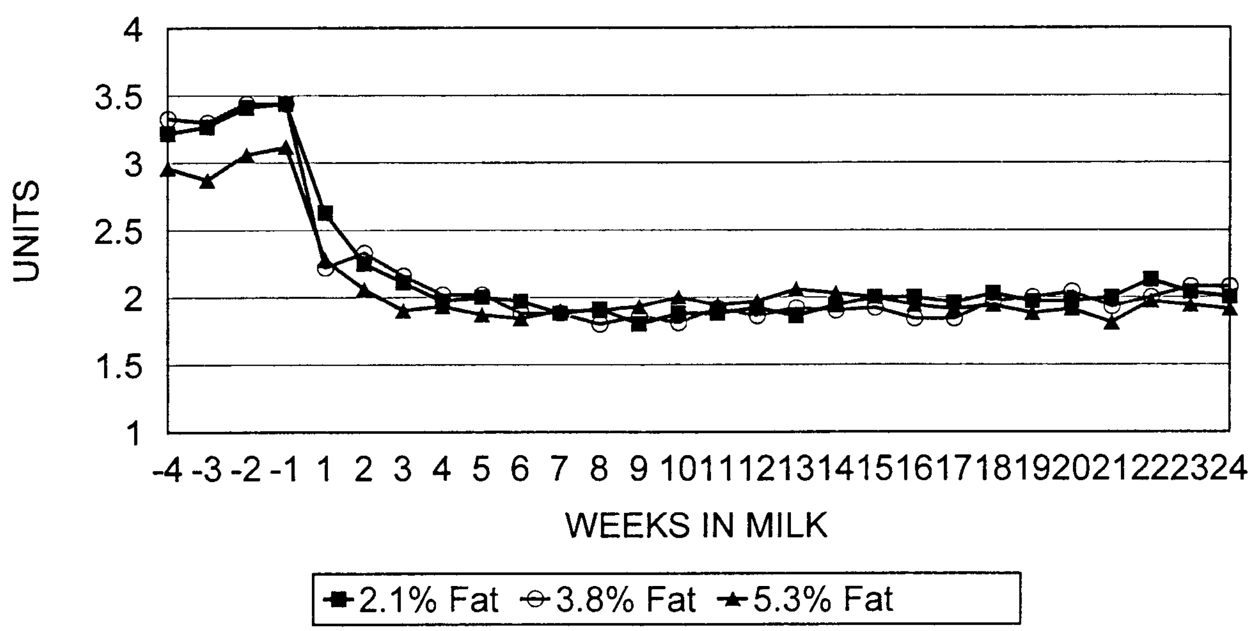

Figure 4. Body condition scores of cows fed three levels of fat.

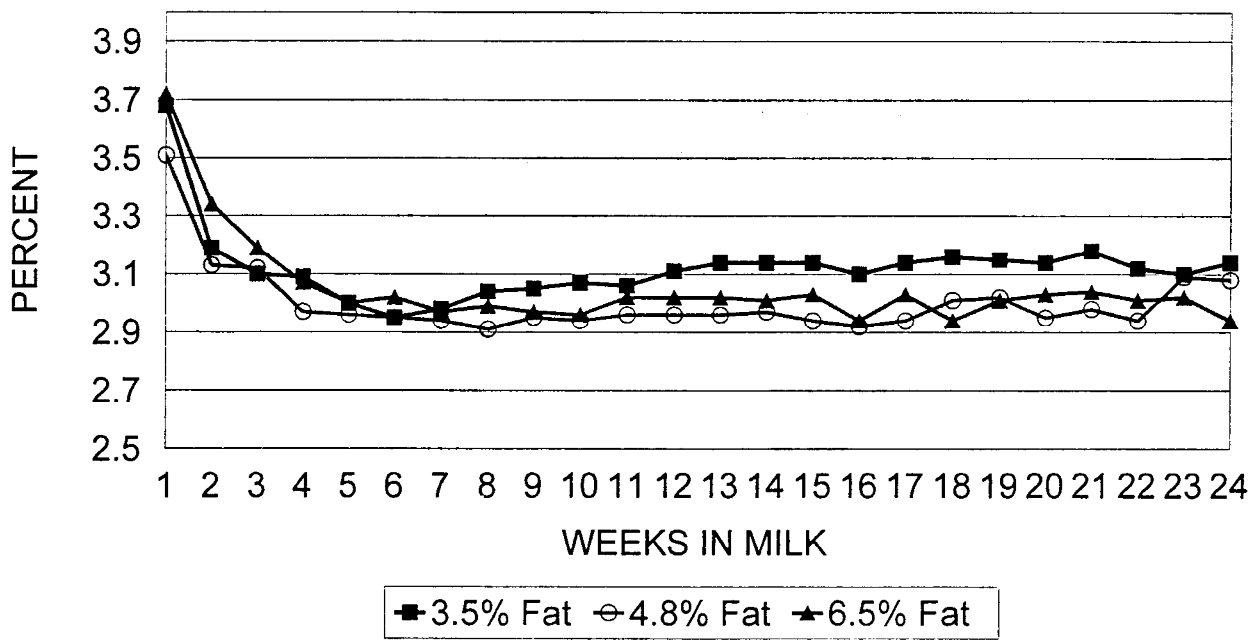

Figure 5. Milk protein for cows fed three levels of fat.

IMPROVING SILAGE QUALITY

K. K. Bolsen, M. A. Young,
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Summary

Results at Kansas State University from over 200 laboratory-scale trials and 28 farm-scale trials showed that bacterial inoculants consistently improved preservation efficiency and nutritive value of the ensiled material. In contrast, anhydrous ammonia or urea adversely affected dry matter recovery and production per ton of crop ensiled. Economic analysis also favored the use of bacterial inoculants over nonprotein-nitrogen additives. Research conducted using corn, sorghum, and alfalfa silages showed that sealing the exposed surface dramatically reduced top spoilage losses in bunker, trench, or stack silos.

(Key Words: Silage, Inoculant, Nonprotein Nitrogen, Top Spoilage.)

Introduction

Advances in silage technology, which include high-capacity precision chop harvesters, improved silos, polyethylene sheeting, shear-cutting silage unloaders, and total mixed rations, have made silage the principal method of forage preservation for dairy and beef cattle producers in North America in the 1990's. Silage quality and nutritional value are influenced by numerous biological and technological factors, including: the crop, stage of maturity and dry matter (DM) content at harvest, chop length, type of silo, rate of filling, forage density after packing, sealing technique, feedout rate, weather conditions at harvest and feedout, use of an effective additive, timeliness of the silage-making activities, and training of personnel. Because many of these are interrelated, it is difficult to discuss their significance individually. However, there are two dominant features of every silage: 1) the crop, its stage of maturity, and its "ensileability" and 2) the management and know-how imposed by the silage maker.

Silage Additives

Additives have been used throughout the 20th century to improve silage preservation by ensuring that lactic acid bacteria (LAB) dominate the fermentation phase. However, the silage additive industry did not play a significant role in silage production in the U.S. until the past two or three decades. Additives can be divided into three general categories: 1) fermentation stimulants, such as bacterial inoculants and enzymes; 2) fermentation inhibitors, such as propionic, formic, and sulfuric acids; and 3) substrate or nutrient sources, such as molasses, urea, and anhydrous ammonia.

Perhaps no other area of silage management has received as much attention among both researchers and livestock producers in recent years as bacterial inoculants. Effective bacterial inoculants promote a faster and more efficient fermentation of the ensiled crop, which increases both the quantity and quality of the silage. The bacteria in the commercial products include one or more of the following species: *Lactobacillus plantarum* or other *Lactobacillus* species, various *Pediococcus* species, and *Enterococcus faecium*. These strains of LAB have been isolated from silage crops or silages and were selected because: 1) they are homofermentative (i.e., ferment sugars predominantly to lactic acid) and 2) they grow rapidly under a wide range of temperature and moisture conditions. Bacterial inoculants have inherent advantages over other additives, including low cost, safety in handling, a low application rate per ton of chopped forage, and no residues or environmental problems.

Enzymes are capable of degrading the plant cell wall and starch, which could provide additional sugars for fermentation to lactic acid and increase the nutritive value of the ensiled material. Although enzymes offer potential to improve silage quality, considerable work needs to be done before they will become commonly used additives.

The justifications for using nonprotein nitrogen (NPN) have been prolonged aerobic stability during the feedout phase and the addition of an economical nitrogen source to low-protein crops, such as corn and sorghum. However, major drawbacks to ammoniation are the potentially dangerous volatile and caustic properties of anhydrous ammonia, with the need for specialized application and safety equipment.

Silage Additive Research at Kansas State University. Evaluation of silage additives began in 1975 in the Department of Animal Sciences and Industry and continues today. These 20 years have lead to the following general conclusions about inoculant and NPN additives.

Question: When should a bacterial inoculant be used?
Answer: Inoculants should be applied to every load of forage ensiled!!
Question: When should NPN, such as urea and anhydrous ammonia, be used?
Answer: Never!! Unless this is the only means of preventing aerobic deterioration during the feedout phase.

Results from over 200 laboratory-scale studies, which involved nearly 1,500 silages and 25,000 silos, indicated that bacterial inoculants were beneficial in over 90% of the comparisons. Inoculated silages had faster and more efficient fermentations -- pH was lower, particularly during the first 2 to 4 days of the ensiling process, and lactic acid content and lactic to acetic acid ratio were higher than in control silages. Inoculated silages also had lower ethanol and ammonia-nitrogen values compared to untreated silages.

Results from 28 farm-scale trials, which evaluated 71 silages, showed that bacterial inoculants consistently improved fermentation efficiency, DM recovery, feed to gain ratio, and gain per ton of crop ensiled in both corn and forage sorghum silages. Applying urea or anhydrous ammonia adversely affected fermentation efficiency, DM recovery, average daily gain, feed to gain ratio, and gain per ton of crop ensiled, particularly for the higher moisture forage sorghums. An additive with a urea-molasses blend had less of a negative influence on silage preservation and cattle performance than urea or anhydrous ammonia.

Economics of Bacterial Inoculant and NPN Silage Additives. An effective bacterial inoculant is a sound investment for every dairy and beef cattle producer who makes and feeds silage. Based upon the results at Kansas State University, a 3 to 4 lb increase in gain per ton of crop ensiled produces $2 to $4 increases in net return per ton of corn or sorghum ensiled. If producers use NPN, they actually lose $4 to $6 per ton of crop ensiled because of the decreased DM recovery, increased feed to gain ratio, and added cost of replacing the loss of volatile nitrogen. These results apply to beef producers who background cattle or grow replacement heifers and to dairy producers who raise heifers.

The use of a bacterial inoculant by dairy producers who make and feed whole-plant corn or sorghum silages and alfalfa silage or haylage in their lactation rations is also a good management decision. The additional "cow days" per ton of crop ensiled, because of the increased DM recovery, and the increased milk per cow per day from the inoculated silage or haylage (.25 to 1.25 lbs) produce $4 to $8 increases in net return per ton of corn or sorghum ensiled and $6 to $10 increases in net return per ton of alfalfa ensiled.

Recommendations. Why leave the critical fermentation phase to chance by assuming that the indigenous microorganisms (those occurring naturally on the forage) are going to be effective in preserving the silage crop? Even if a dairy or beef cattle producer's silage has been acceptable in the past--because silage-making conditions in Kansas are generally good--there are always opportunities for improvement.

Although whole-plant corn and sorghum ensile easily, research data clearly show that the quality of the fermentation and subsequent preservation and utilization efficiencies are improved with bacterial inoculants. Alfalfa (and other legumes) are usually difficult to ensile because of a low sugar content and high buffering capacity. However, adding an inoculant helps ensure that as much of the available substrate as possible is converted to lactic acid, which removes some of the risk of having a poorly preserved, low-quality silage.

Finally, if producers already are doing a good job but using a bacterial inoculant for the first time, they probably will not see a dramatic difference in their silage. But the benefit will be there -- additional silage DM recovery and significantly more milk or beef production per ton of crop ensiled!

Selecting a Bacterial Inoculant. The inoculant should provide at least 100,000 colony-forming units of viable LAB per gram of forage. These LAB should dominate the fermentation; produce lactic acid as the sole end product; be able to grow over a wide range of pH, temperature, and moisture conditions; and ferment a wide range of plant sugars. Purchase an inoculant from a reputable company that can provide quality control assurances along with independent research supporting the product's effectiveness.

Protect Silage from Air and Water

Everyone in the silage business acknowledges that sealing (covering) a horizontal silo (i.e., bunker, trench, or stack) ranks high on the troublesome list, but high on the quality reward list, too. Because so much of the surface of the ensiled material is exposed to air, great potential exists for excessive DM and nutrient losses. The extent of these losses in the top 2 to 4 ft if there is no protection is far greater than most people realize. A barrier must be built against air and water after the filling operation is completed.

Although future technology might bring a more user and environmentally friendly product, polyethylene is the most effective sealing (covering) material today. After it is put over ensiled forage, the sheet must be weighted down. Tires are the most commonly used weights, and they should be placed close enough together that they touch (about 20 to 25 tires per 100 sq ft). In a 1,000-ton bunker silo, an effective seal to protect the top 3 ft of silage can prevent the loss of $500 to $2,500 worth of silage, depending on the value of the crop. The bottom line is that sealing the exposed surface is one of the most important management decisions in any silage program.

PERFORMANCE OF LACTATING COWS FED PROCESSED GRAIN SORGHUM AND EXPELLER SOYBEAN MEAL

E. C. Titgemeyer and J. E. Shirley

Summary

Forty-four Holstein cows were used to measure milk production responses to dry-rolled vs processed grain sorghum and expeller vs solvent soybean meal (SBM) in a 2×2 factorial arrangement of four treatments. Processing of grain sorghum decreased feed intake 5%, but increased milk by 3%, protein by 4%, and efficiency by 7%, with fat being unaffected. Replacement of solvent SBM with expeller SBM had little effect on intake, but increased milk by 3%, fat by 5%, and efficiency by 4%, with protein being unaffected. The processing of grain sorghum seems to be a valuable method to improve its nutritive value for lactating cows. Total milk and fat yield, but not protein yield, were increased in response to feeding expeller SBM in the place of solvent SBM.

(Key Words: Expeller Soybean Meal, Grain Sorghum, Cows.)

Introduction

Grain sorghum is a feed resource available to many dairy producers in the midwest and is often less expensive than other grains such as corn. Minimally processed grain sorghum (ground or dry-rolled) has a lower energy value than competing grains such as corn and barley, whereas steam-flaked grain sorghum is similar to corn in supporting lactation in dairy cows. Although steam-flaking improves the nutritive value of grain sorghum, the necessary equipment requires a large initial investment. Steam-flaking increases solubility in the rumen and total tract digestibility of the starch component of grain sorghum by gelatinization. An alternative method of starch gelatinization involves heating grain sorghum in a moist environment to at least 156 degrees F then drying to a low moisture suitable for long-term storage. This process can be accomplished with an extruder and a drying oven. Little is known about the effectiveness of this processing method, but the lower initial investment required for its operation may justify its use by dairy production units with access to grain sorghum.

Protein supplementation of dairy cows is becoming increasingly sophisticated. Yet, in many cases, the relationship between protein intake and performance is poorly defined. Processing of soybeans under conditions where heat is generated (i.e., expeller soybean meal) will increase amino acid supply to the dairy animal by making the protein more resistant to degradation in the rumen.

This experiment was conducted to evaluate a new processing method for grain sorghum and to determine if protein needs of dairy cows would be better met by replacing solvent soybean meal (SBM) with expeller SBM.

Procedures

Grain sorghum, purchased from a commercial elevator, was finely ground at the Kansas State University feed mill and transported to the JET-PRO processing facility in Atchison, KS for final processing. Water was added to the ground grain sorghum to achieve a final moisture content of 31%. The wet material was processed through an extruder, then dried at 200 degrees F to a final moisture content of 5%. The resultant product was a pellet with moderate stability during handling.

The expeller SBM was obtained from Delavan Processing, Delavan, KS. The content of undegradable intake protein was increased by exposing the soybeans to heat prior to mechanical extraction of the oil. The undegradable intake protein value for the resulting SBM approximated 50% compared to 35% for solvent-extracted SBM.

Forty-eight Holstein cows (half primiparous) were allotted by age, milk production, and days in milk to four dietary treatments. Four cows were removed from the experiment because of health problems. Treatments of ground vs pelleted grain sorghum and solvent vs expeller SBM (Table 1) were arranged in a 2×2 factorial. Diets were formulated so the pelleted grain sorghum was substituted directly into diets in place of dry-rolled grain sorghum. Expeller SBM was used as a replacement for solvent SBM. Because the expeller SBM contained a greater amount of residual fat than the solvent SBM (8.5% vs 1.5% of dry matter), diets were balanced to maintain equal levels of lipid by decreasing the amount of supplemental tallow in diets containing expeller SBM. Cows were maintained in tie stalls with ad libitum access to feed that was supplied twice daily as a total mixed ration. Daily weigh backs were obtained immediately prior to the morning feeding. Milk production was measured daily, and weekly milk samples were collected to measure milk composition.

Results and Discussion

Production characteristics of dairy cows fed diets containing either ground or pelleted grain sorghum are shown in Table 2. Dry matter intake was reduced substantially when the pelleted grain sorghum was fed. This was most likely due to the higher energy content and more rapid fermentation of the pelleted product. Milk production tended ($P<.10$) to be increased by the pelleted grain sorghum. However, the fat content of milk was reduced ($P<.05$) by the pelleted grain sorghum and, thus, 3.5% fat-corrected milk (FCM) production was not affected by pelleting. Because pelleting of grain sorghum reduced feed intake without depressing FCM, feed efficiency was improved by 7% when pelleted grain sorghum diets were fed. Total protein yield was increased by pelleting.

Research from the University of Arizona compared steam-flaked grain sorghum to dry-rolled grain sorghum when included in diets for lactating cows. Across their studies, feed intake decreased by 1%, FCM increased by 5%, and efficiency improved by 6% when the grain sorghum was steam-flaked vs dry-rolled. The improvement in efficiency (7%) that we observed after pelleting of grain sorghum was similar to that observed for steam-flaking. This indicates that our processing method may be similar to steam-flaking for improving the nutritive value of grain sorghum.

Production data for cows fed diets containing either solvent or expeller SBM are shown in Table 3. Cows fed diets containing expeller SBM tended ($P<.15$) to produce more total milk and FCM than those fed solvent SBM. Feed intake was not affected by protein source, so the feeding of expeller SBM improved efficiency by slightly more than 4%. Total milk fat yields tended ($P<.15$) to be increased by expeller SBM. This resulted from greater milk yields rather than from a change in fat percentage. Surprisingly, replacing solvent SBM with expeller SBM decreased the percentage protein in milk. However, total milk protein production was not affected by protein source.

In conclusion, processing of grain sorghum improves its nutritive value for lactating cows. The pelleted grain sorghum product that we evaluated caused a 7% improvement in lactation efficiency when added to diets in place of ground grain sorghum. Under our experimental conditions, the replacement of solvent SBM with expeller SBM increased production of milk and fat, but not of protein.

Table 1. Composition of Experimental Diets

	Solvent SBM		Expeller SBM	
Ingredient	Ground GS	Pelleted GS	Ground GS	Pelleted GS
	---------------------% of dry matter	---------------------		
Alfalfa	29.6	29.6	29.6	29.6
Grain sorghum, ground	27.2	-	27.2	-
Grain sorghum, pelleted	-	27.2	-	27.2
Soybean meal, solvent	11.4	11.4	-	-
Soybean meal, expeller	-	-	12.1	12.1
Corn silage	10.3	10.3	10.3	10.3
Whole cottonseed	8.8	8.8	8.8	8.8
Soy hulls	6.7	6.7	6.7	6.7
Tallow	1.5	1.5	.8	.8
Molasses	1.0	1.0	1.0	1.0
Minerals/vitamins	3.5	3.5	3.5	3.5

Table 2. Production of Dairy Cows Fed either Ground or Pelleted Grain Sorghum

	Grain sorghum		
Item	Ground	Pelleted	SEM
Dry matter intake, lb/day	57.3	54.7[a]	.5
Milk, lb/day	68.2	70.5[b]	.9
3.5% FCM[1], lb/day	70.6	71.4	1.1
Efficiency, FCM/intake	1.23	1.32[a]	.02
Fat, %	3.73	3.58[a]	.05
Fat, lb/day	2.53	2.52	.05
Protein, %	3.10	3.13	.02
Protein, lb/day	2.11	2.20[a]	.03

[1]Fat-corrected milk.
[a]Different (P<.05) from ground grain sorghum.
[b]Tended (P<.10) to differ from ground grain sorghum.

Table 3. Production of Dairy Cows Fed either Solvent or Expeller Soybean Meal

	Soybean meal		
Item	Solvent	Expeller	SEM
Dry matter intake, lb/day	56.2	55.7	.5
Milk, lb/day	68.4	70.3[a]	.9
3.5% FCM[1], lb/day	69.6	72.4[a]	1.1
Efficiency, FCM/Intake	1.25	1.30[b]	.02
Fat, %	3.62	3.69	.05
Fat, lb/day	2.46	2.58[a]	.05
Protein, %	3.14	3.08[b]	.02
Protein, lb/day	2.16	2.16	.03

[1]Fat-corrected milk.
[a]Tended (P<.15) to differ from solvent soybean meal.
[b]Different (P<.05) from solvent soybean meal.

Dairy Day 1995

SYNCHRONIZED OVULATION WITH GONADOTROPIN-RELEASING HORMONE, PROSTAGLANDIN $F_{2\alpha}$, AND FIXED-TIME INSEMINATION

J. S. Stevenson and Y. Kobayashi

Summary

Lactating Holstein cows and replacement heifers were treated with a novel synchronized ovulation protocol, which involves one fixed-time insemination without heat detection. One injection of GnRH (Cystorelin®) was given, followed in 7 days with an injection of $PGF_{2\alpha}$ (Lutalyse®). Approximately 32 to 36 hr later, ovulation was induced with a second injection of GnRH, and one fixed-time insemination was given 18 hr later. Control cattle were given one injection of $PGF_{2\alpha}$ and inseminated at observed estrus. Pregnancy rates measured by palpation between 38 and 52 days after insemination in controls (47.1%) were slightly, but not significantly, greater than those in the synchronized ovulation treatment (35.3%). The treatment worked much better in lactating cows than in virgin heifers. This treatment may be particularly well suited to cows in which estrus is rarely observed, as well as for synchronizing first or repeat services.

(Key Words: Prostaglandin, Gonadotropin-Releasing Hormone, Synchronized Ovulation, Pregnancy Rates.)

Introduction

Since the discovery of the luteolytic properties of prostaglandin $F_{2\alpha}$ and the introduction of Lutalyse® in 1979, programs to synchronize estrus for fixed-time inseminations have been tested. Many early attempts to use $PGF_{2\alpha}$ in lactating dairy cows demonstrated its effectiveness in controlling the estrous cycle. Pregnancy rates after $PGF_{2\alpha}$ usually were best when inseminations were performed based on observed signs of heat. Our early attempts to use fixed-time inseminations at first services in lactating dairy cows demonstrated that pregnancy rates were less than desirable. Using two injections of $PGF_{2\alpha}$ given 11 days apart, we found that pregnancy rates averaged 23% when one fixed-time insemination was administered at 80 hr after the second of two injections of $PGF_{2\alpha}$, whereas pregnancy rates improved slightly to about 30% when the 80-hr insemination was preceded 8 hr earlier by 100 μg of GnRH (Cystorelin®) or when two fixed-time inseminations were given at 72 and 96 hr after the second injection of $PGF_{2\alpha}$. Pregnancy rates in control cows inseminated at estrus were 51% in that study.

Recent work has demonstrated that controlling follicular growth relative to the programmed termination of the corpus luteum with $PGF_{2\alpha}$ may improve pregnancy rates associated with one fixed-time insemination. An injection of GnRH during the estrous cycle in lactating cows induced either luteinization or ovulation of a large (dominant) follicle via the release of luteinizing hormone (LH). As a result of such treatment, a new group of follicles began to grow and one follicle became dominant and capable of ovulation within 6 or 7 days after the injection of GnRH. When an injection of $PGF_{2\alpha}$ was administered 6 or 7 days after GnRH, this freshly developed dominant follicle was induced to ovulate with a second injection of GnRH before one fixed-time insemination was given. The objective of our study was to determine pregnancy rates in heifers and lactating cows following the use of this synchronized ovulation protocol.

Procedures

A novel synchronized ovulation treatment was compared to a treatment using one injection of $PGF_{2\alpha}$. Treatments were applied to virgin heifers (minimum body weight of 800 lb and 12 mo of age) and to lactating cows (minimum of 60 days in milk) before first and repeat services.

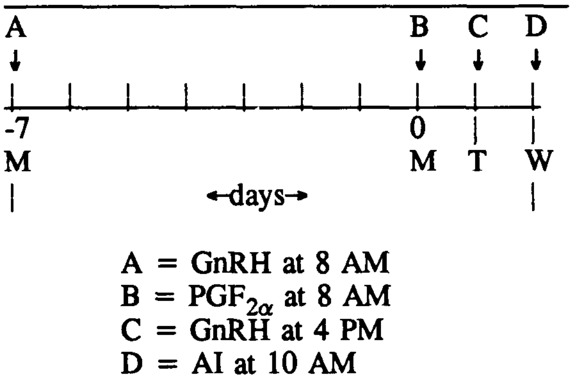

Figure 1. Synchronized ovulation protocol

The synchronized ovulation treatment (Figure 1) consisted of a l00-pg injection of GnRH (Cystorelin®) on a Monday morning, followed 7 days later with one 25-mg injection of $PGF_{2\alpha}$ (Lutalyse®). Then, 32 to 36 hr after $PGF_{2\alpha}$, a second l00-pg injection of GnRH was given to induce the preovulatory release of LH, which induced ovulation 24 to 32 hr later. Cows were given one fixed-time insemination 18 hr after the second injection of GnRH. The specific hours of injections are listed in Figure 1. Controls received 25 mg of $PGF_{2\alpha}$ and were inseminated when detected in estrus. Pregnancy diagnoses were made by palpation of the uterus and its contents between days 38 and 52 after insemination.

Results and Discussion

Overall pregnancy rates for the two treatments are illustrated in Table 1. Pregnancy rates at first services were 47.1% (40/85) in the control and 35.3% (30/85) in the synchronized ovulation treatment. Although the control showed a slight advantage in pregnancy rates, the difference was not significant. Pregnancy rates tended to be reduced more by the synchronized ovulation treatment in replacement heifers and first-lactation cows than in older cows.

The synchronized ovulation treatment reduced pregnancy rate in lactating cows regardless of whether body condition was < 2.5 or >2.5 at approximately 60 days in milk (Table 1). Furthermore, cumulative pregnancy and culling rates were unaffected by treatment (Table 1).

These results suggest that ovulation can be synchronized sufficiently to achieve acceptable pregnancy rates with ***one*** fixed-time insemination. This treatment may be particularly well suited to cows in which estrus is rarely observed, as well as for synchronizing first or repeat services (for cows found open at pregnancy checks). However, this treatment is not recommended for use in replacement heifers because of the reduced pregnancy rate. Research at other locations is finding similar successes.

Table 1. Pregnancy Rates after Synchronized Ovulation with GnRH and $PGF_{2\alpha}$

	Synchronized ovulation[1]		Control[1]	
Item	No./no.	%	No./no.	%
Pregnancy rate at service	30/85	35.3	40/85	47.1
Lactation number				
Heifers	7/13	53.8	10/14	71.4
Primiparous	7/16	43.7	12/24	50.0
Multiparous	16/56	28.6	18/47	38.3
Body condition[2]				
<2.5	14/42	33.3	16/38	42.1
>2.5	9/30	30.0	14/33	42.4
Cumulative pregnancy rate[3]	51/85	60.0	62/85	72.9
Culling rate[3]	25/85	29.4	18/85	21.2

[1]Synchronized ovulation protocol consisted of cattle receiving GnRH followed in 7 days by $PGF_{2\alpha}$. Thirty-two to 36 hr after $PGF_{2\alpha}$, a second dose of GnRH was given to induce ovulation of the dominant follicle, and one fixed-time insemination was given 18 hr later. Controls were given $PGF_{2\alpha}$ and inseminated at estrus.

[2]Body condition of cows was assigned at the time of the first injection of $PGF_{2\alpha}$ (1 = thin and 5 = obese) at an average of 56.7 ± 1.3 days in milk.

[3]Sums of pregnancy and culling rates do not equal 100% because some pregnant cows were culled for various reasons.

COMPARISON OF SYNCHRONIZED-OVULATION PROTOCOLS AND TRADITIONAL SYNCHRONIZED-ESTRUS PROGRAMS USING PROSTAGLANDIN $F_{2\alpha}$

J. S. Stevenson and Y. Kobayashi

Summary

Five treatments were developed to compare a new synchronized ovulation protocol, which programs follicular development with the regression of the corpus luteum, and traditional prostaglandin protocols that only control the regression of the corpus luteum. The synchronized ovulation treatment, which requires no heat detection before a fixed-time insemination, tended to decrease pregnancy rates compared to a similar synchronized ovulation treatment in which inseminations occurred at a detected estrus (30 vs 50%). The traditional two-injection prostaglandin protocol that synchronized estrus by regression of the corpus luteum had a greater pregnancy rate (57%) than similar two-injection prostaglandin protocols in which gonadotropin-releasing hormone (GnRH or Cystorelin®) was used to induce ovulation of the follicle before one fixed-time insemination (21%) or one fixed-time insemination was given in the absence of estrus (18%). The synchronized ovulation protocol improved pregnancy rates compared to prostaglandin protocols with fixed-time inseminations, but in either protocol, in which ovulation or estrus was synchronized, pregnancy rates were always greater when inseminations were performed after detected estrus.

(Key Words: Prostaglandin, Gonadotropin-Releasing Hormone, Synchronized Ovulation, Synchronized Estrus, Pregnancy Rates.)

Introduction

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

Follicular development must be controlled and synchronized with the regression of the corpus luteum after $PGF_{2\alpha}$ in order to reduce variation in the intervals to estrus. Precise control of follicular development with the regression of the corpus luteum should allow improved pregnancy rates associated with one fixed-time insemination. Such a synchronized ovulation protocol was described in the accompanying article that uses GnRH to induce ovulation of the dominant follicle via release of luteinizing hormone (LH). The objective of this study was to compare pregnancy rates achieved in heifers and lactating cows using this new synchronized ovulation protocol to those achieved with a standard, two-injection, prostaglandin protocol commonly used on dairy farms.

Procedures

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

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

Treatments were applied randomly to replacement heifers (minimum body weight of 800 lb and 12 months of age) and to lactating cows (minimum of 60 days in milk) before first services. Cow and heifers were grouped in 3-week breeding clusters beginning in July, 1994, and the experiment continued until July, 1995. Pregnancy rates were determined by palpation of the uterus and its contents between 38 and 52 days after insemination.

Results and Discussion

Pregnancy rates achieved in each of five treatments are summarized in Table 1. Pregnancy rate after synchronized ovulation tended ($P = .12$) to be greater when inseminations were performed at estrus than after one fixed-time insemination (treatments A vs B). Pregnancy rate after synchronized estrus with $PGF_{2\alpha}$ was greater ($P < .01$) when inseminations were performed at estrus (treatment E) than after one fixed-time insemination in which ovulation was induced by GnRH after the second $PGF_{2\alpha}$ injection (treatment C) or after one fixed-time insemination at 72 or 80 hr in the absence of detected estrus (treatment D).

These results indicate that the synchronixed ovulation protocol seems to improve pregnancy rates compared to prostaglandin protocols with fixed-time inseminations, but in either protocol, in which ovulation or estrus is synchronized, pregnancy rates are always greater when inseminations are performed after a detected estrus.

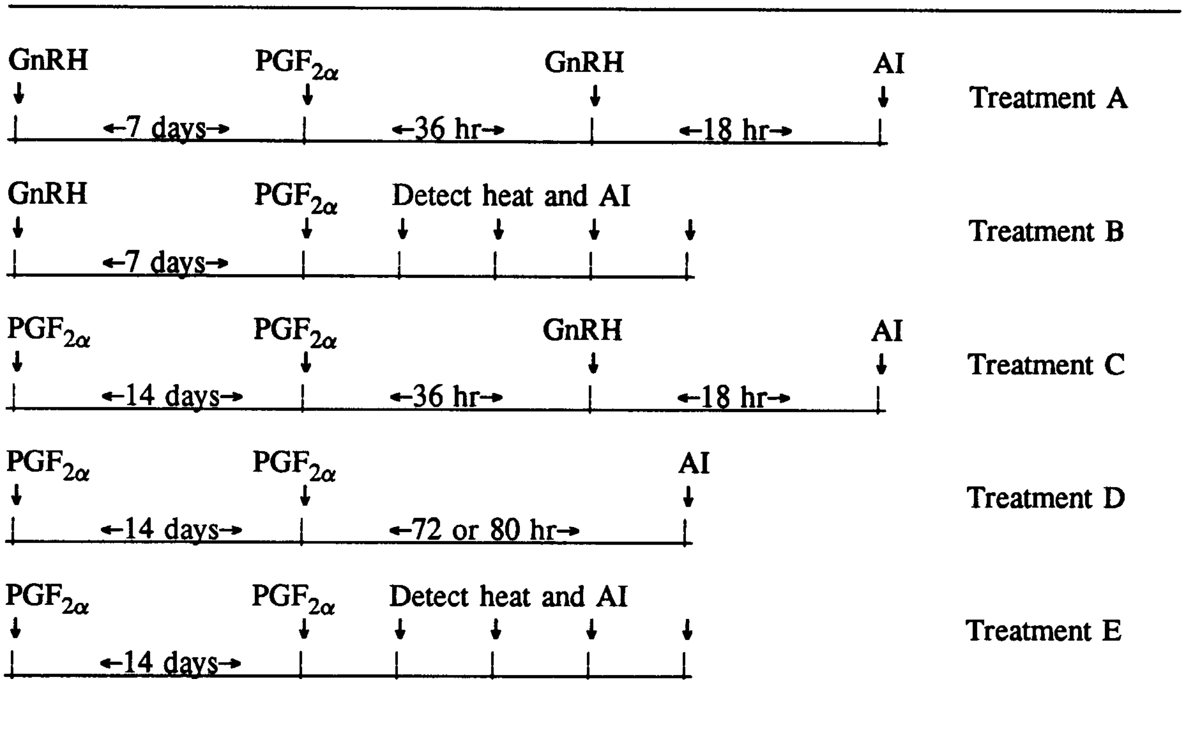

Figure 1. Treatment Protocols A, B, C, D, and E

Table 1. Pregnancy Rates after Synchronized Ovulation Compared with Synchronized Estrus

	Pregnancy rates	
Treatment	No./no.	%
A: Synchronized ovulation + A.I. at a fixed time	19/63	30.2[a]
B: Synchronized ovulation + A.I. at estrus	9/18	50.0
C: Synchronized estrus + GnRH + A.I. at fixed time	12/54	20.8[b]
D: Synchronized estrus + A.I. at 72 or 80 hr	8/44	18.2[b]
E: Synchronized estrus + A.I. at estrus	47/83	56.6

[a]Tended (P = .12) to differ from treatment B.
[b]Different (P<.01) from treatment E.

OBSERVATIONS WITH HEATWATCH® TO DETECT ESTRUS BY RADIOTELEMETRY IN CATTLE

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

Summary

In Experiment 1, the effectiveness of two estrus-detection methods (visual observation vs radiotelemetric, pressure-sensitive, rump-mounted devices [HeatWatch®]) were compared in heifers. A pressure sensitive device containing a battery-operated radio transmitter was affixed to the tailhead rump area of each of 41 heifers. Activation of the sensor sent a radiotelemetric signal to a microcomputer via a fixed radio antenna. Heifer identification, date, time of day, and duration of standing events were recorded. Estrus was synchronized, and heifers were observed visually for signs of estrus. Number of standing events during estrus, determined by the radiotelemetric device, averaged 50.1 ± 6.4 per heifer, with the duration of estrus ranging from 2.6 to 26.2 hr (average = 14 ± .8 hr). Number of standing events and duration of estrus were greater, but duration of standing events was similar, for heifers identified in estrus by both methods compared to those identified by the radiotelemetric device alone, indicating that heifers with a limited number of standing events and estrus of shorter duration were missed by visual observation. In Experiment 2, the average number of standing events during estrus was greater when estrus was induced early (days 6 to 9) in the cycle by $PGF_{2\alpha}$ compared to those induced later (after day 10) in the cycle. Regardless of when injections of $PGF_{2\alpha}$ occurred during the cycle, duration of standing events and duration of estrus were unaffected. Radiotelemetric devices are useful in identifying a greater proportion of heifers in estrus (increased efficiency) compared to visual observation with similar accuracy.

(Key Words: Radiotelemetry, Pressure Sensors, Estrus, Heifers, Heat Detection.)

Introduction

Failure to detect estrus or misdiagnosis of estrus accounts for an estimated annual loss of over $300 million to the U.S. dairy industry. Insufficient time allocation for detection of estrus contributes to lower efficiency and missed periods of estrus, particularly in cattle in which estrus is of lesser intensity and shorter duration. Many aids, including tail paint or chalk, chin-ball markers fitted to androgenized females or sterile bulls, heat-mount patches, video cameras, dogs trained to detect estrus-related odors, and pedometers have been developed for detection of estrus. Some methods improve detection efficiency when used simultaneously with visual observation; however, when used alone, their overall benefit is sometimes less effective. Systems that use a radiotelemetric, pressure-sensitive device, which attaches to the rump of the female and interfaces with a microcomputer, are available. Studies have demonstrated some promise for this technology to resolve estrus-detection problems in dairy cattle. The objectives of our study were to: 1) compare the efficiency and accuracy of a radiotelemetric system and the traditional visual method of detecting estrus; 2) characterize sexual behaviors in estrus-synchronized heifers; 3) and determine whether stage of the estrous cycle when estrus is induced by $PGF_{2\alpha}$ would alter various characteristics of estrus measured by the radiotelemetric system.

Procedures

Experiment 1. This experiment was conducted at the Kansas State University Agricultural Research Center-Hays in November, 1991. Forty-one crossbred (Angus × Hereford × Brahman) yearling beef heifers were maintained in a pasture of dormant native grass. Heifers were given ad libitum access to forage sorghum hay, and diets were supplemented with additional sorghum grain, soybean meal, vitamins, and minerals.

Estrus was synchronized by feeding melengestrol acetate (MGA; .5 mg per head/d) for 14 d, followed by injecting (i.m.) 25 mg of $PGF_{2\alpha}$ (Lutalyse®) 17 days after the last daily dose of MGA. Heifers were fitted with a radiotelemetric, pressure-sensitive device (DDX, Inc., Boulder, CO) 5 days before the injection of $PGF_{2\alpha}$ for a total of 17 days. Each single-unit device was held in a saddle-type patch that was glued to rump hair anterior to the tail head. The radiotelemetric device was connected to a battery-operated radio transmitter. The pressure-sensitive sensor was activated by the weight of a mounting female, which sent a radiotelemetric signal to a microcomputer via a fixed radio antenna adjacent to the dry lot pen holding the heifers. The signal transmitted heifer identification, date, time of day, and duration of sensor activation, which were recorded and stored in individual files for each heifer. This system was an earlier generation model of what now is marketed as the HeatWatch® (American Breeders Service, DeForest, WI).

Following the injection of $PGF_{2\alpha}$, heifers were observed visually for estrus twice daily (minimum of 45 min) at 0730 and 1630 and inseminated according to the AM-PM rule (12 to 16 hr after the first visually detected standing event) by the same individual using semen from two Angus sires. Timing of inseminations was based on visual observations made by the herdsman without knowledge of the radiotelemetric determinations to prevent potential bias in the comparison of two methods. If estrus was not detected by 72 hr after $PGF_{2\alpha}$, all remaining heifers were given one fixed-time insemination at 72 hr. If estrus was detected by the herdsman after the fixed-time insemination, a second insemination was not given. Pregnancy status was determined by palpation of the uterus and its contents 60 days after insemination.

Experiment 2. This experiment was conducted at the KSU Dairy Teaching and Research Center in the summer of 1995, using the HeatWatch® heat detection system marketed by American Breeders Service (ABS, DeForest, WI). Twenty-two Holstein dairy heifers were treated with $PGF_{2\alpha}$ on three occasions to induce estrus. The first two injections were given 14 days apart and then one-half of the heifers were injected on days 6 to 9 or the remaining half were injected on days 11 to 16 of the estrous cycle to determine if the various characteristics of estrus differed according to the stage of cycle in which $PGF_{2\alpha}$ was administered.

In both experiments, the following measurements were made: interval from the injection of $PGF_{2\alpha}$ to estrus, number and duration of standing events per period of estrus, and duration of estrus.

Results and Discussion

Experiment 1. Interval to estrus after $PGF_{2\alpha}$ for both heat-detection methods is summarized in Table 1. Interval to estrus, determined by the radiotelemetric devices, was not different between methods (Table 1). Mean interval to estrus after $PGF_{2\alpha}$ for heifers detected by the herdsman tended to be greater ($P = .16$) than that detected by the radiotelemetric devices (58.2 ± 9.3 hr vs 51.5 ± 3.3 hr). This difference of 6.7 hr is to be expected because of the lower frequency of visual observation compared to a potential 24-h surveillance offered by the device. Heifers identified by both methods had more ($P < .001$) standing events (60.5 ± 10.3) than heifers identified in estrus by the radiotelemetric device alone (19.3 ± 10.3). With such high activity, it was not surprising that these 30 heifers were identified in estrus by visual observation.

Among the 11 heifers detected in estrus by the radiotelemetric devices alone, first standing events were distributed unequally throughout the 24-h day: one first stood between midnight and 0600; two between 0601 and noon; three between noon and 1800; and five between 1801 and midnight. Five heifers had five or fewer standing events during estrus.

Fewer ($P < .01$) total heifers were detected in estrus by visual observation (30 of 41) than by the radiotelemetric devices (41 of 41). Accuracy of detected estrus in 30 heifers was 100% by both methods, whereas the radiotelemetric devices detected 11 additional heifers in estrus that were not observed by the herdsman. Therefore, the efficiency of visual observation (detection of all periods of estrus; 73%) was less ($P < .01$) than that achieved by the radiotelemetric devices (100%). Although timing of detection and detection accuracy might be advantages of using the radiotelemetric devices, only an increased efficiency of identifying more periods of estrus was achieved in our study.

Duration of standing events was not different between groups, averaging 8 ± .6 sec. Based on the radiotelemetric data, duration of estrus in our study ranged from 2.6 to 26.2 hr and averaged 14 ± .8 hr in 39 heifers for which it could be determined. Duration of estrus was longer ($P < .01$) in heifers identified by both methods than in heifers identified in estrus by radiotelemetric devices alone (Table 3). Eight of 39 (20.5%) heifers had periods of estrus <10 hr in duration, with four of those being <6 hr in duration. Five of those eight heifers were detected only by the radiotelemetric devices.

Pregnancy rate at first service for heifers inseminated after estrus was detected by visual observation and the HeatWatch® system was 15 of 22 (68%). Eight additional heifers were detected in estrus by visual observation after the fixed-time insemination at 72 hr (also detected in heat by the devices), with conception occurring in three of them. Of the 11 heifers detected in estrus by the radiotelemetric device alone, only three conceived.

Experiment 2. Characteristics of estrus in heifers after $PGF_{2\alpha}$ on various days of the estrous cycle are summarized in Table 2. The interval to estrus was greater ($P<.05$) in heifers that were given $PGF_{2\alpha}$ after day 10 of the estrous cycle than in heifers that were injected between days 6 and 9 of the cycle. Shorter intervals to estrus after $PGF_{2\alpha}$ injections early in the cycle are consistent with our earlier observations. The first dominant follicle is capable of ovulating when the corpus luteum is regressed by $PGF_{2\alpha}$ at this early stage of the cycle. Average number of standing events during estrus was greater in the heifers injected early in the cycle compared to those injected later. In contrast, the duration of standing events and duration of estrus were similar regardless of the stage of the cycle in which $PGF_{2\alpha}$ was administered to induce estrus.

Summary

Use of radiotelemetric devices increased the efficiency of detecting estrus in estrus-synchronized heifers. This was especially true for heifers that had fewer standing events and(or) shorter duration of standing activity, in which estrus was missed by visual observation at specific observation periods. A radiotelemetric system provides around-the-clock monitoring of standing activity and also might increase accuracy of detected estrus, depending on the skill of those making visual observations. Such a system would be useful and reliable in various applications where behavioral estrus is an important end point, as well as potentially increasing the occurrence of pregnancy per unit of time.

Table 1. Profile of Standing Events in Heifers Classified by Method of Detected Estrus after Synchronization of Estrus with Melegenstrol Acetate (MGA) and $PGF_{2\alpha}$[1]

Item	Method[2]: Visual observation + HeatWatch®	Method[2]: HeatWatch®	SE
No. of heifers	30	11	–
Hours from $PGF_{2\alpha}$ to estrus	58.1	66.5	5.7
No. of standing events	60.5[a]	19.3	10.3
Average duration of event, sec	8.0	8.0	1.0
Duration of estrus, hr	15.6[a]	8.4	1.3

[1]Information was derived from a radiotelemetric device attached to each heifer.
[2]Estrus was detected by visual observation and/or by a radiotelemetric device (HeatWatch®) attached to the tailhead of each heifer.
[a]Different (P < .001) from radiotelemetric method alone.

Table 2. Characteristics of Estrus in Dairy Heifers after Injection of $PGF_{2\alpha}$ at Various Stages of the Estrous Cycle[1]

Item	Stage of cycle when $PGF_{2\alpha}$ was injected: Days 6 to 9	Stage of cycle when $PGF_{2\alpha}$ was injected: Days 11 to 16
No. of heifers	8	32
$PGF_{2\alpha}$ to onset of estrus, hr	39.3 ± 4.5[a]	60.7 ± 2.3
No. of standing events	28.2 ± 4.5[b]	16.3 ± 2.2
Duration of standing events, sec	3.3 ± .2	3.1 ± .1
Duration of estrus, hr	11.3 ± 1.8	13.1 ± 0.9

[1]Information was derived from a radiotelemetric device attached to each heifer.
[a]Different (P<.01) from later stage (days 11 to 16).
[b]Different (P<.05) from later stage (days 11 to 16).

COMPARISONS OF COMMERCIAL FROZEN YOGURT WITH KSU FORMULATION

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

Summary

Ten samples of vanilla frozen yogurt were purchased in Kansas and compared to a high-protein, KSU formulation. The KSU formulation had similar solids, fat, and sugar contents as the commercial samples. All commercial samples had lower protein (almost less than half) content and more lactose, and almost all samples had fewer lactic acid bacteria than the KSU formulation. All but one commercial sample had lower β-galactosidase activity than the KSU formulation. This may reflect the differing lactic acid bacterial populations in the frozen yogurts.

(Key Words: Frozen Yogurt, Lactic Acid Bacteria, Microbial Quality.)

Introduction

Frozen yogurt is a popular food item that has experienced a 45% increase in rate of growth since 1990. Because there is no adopted standard for frozen yogurt, composition varies considerably. Reasons why consumers choose to eat a frozen yogurt product vary, but the word "yogurt" implies a health benefit to many consumers. One of the health benefits of yogurt is its acceptability by lactose-intolerant individuals. Lactic acid bacteria (LAB), used to manufacture yogurt, produce the β-galactosidase enzyme that degrades lactose to glucose and galactose (preventing the problem of lactose intolerance). People also may elect to consume frozen yogurt for other health reasons such as reduced calorie, fat, or sugar contents. KSU researchers have developed a method to produce a high protein, low lactose, frozen yogurt. This product was compared against 10 commercial brands for overall quality and composition.

Procedures

Ten vanilla frozen yogurt products were purchased from several stores throughout Kansas. Samples were stored at -20 degrees F until analysis. A sample of the KSU product was selected randomly for comparison. The frozen yogurt samples were analyzed for protein, ash, fat, and total solids; titratable acidity (expressed as % lactic acid); and pH according acceptable standards for frozen dairy desserts. Total carbohydrate content was calculated by difference. Total aerobic, coliform, and LAB counts were enumerated using standard procedures. Carbohydrates were separated from the remaining ingredients and prepared for HPLC analysis. The extracts were analyzed for selected carbohydrates: fructose, glucose, lactose, and sucrose. Samples were analyzed for potential amount of β-galactosidase activity.

Results and Discussion

Table 1 shows the composition of the KSU product (KSU) and 10 purchased frozen yogurt samples. Great variability was observed in fat (.9-8.9%), protein (2.7-9.1%) and total solids (25.7-38.8%) contents. The KSU sample had the highest protein content (9.1%). For other components, the KSU sample was in the range of the commercial samples. Several samples selected were labeled as nonfat (Samples C = 2.8, E = 3.0, and I = .9). Samples C and I were low fat, instead of nonfat products, as defined by the federal Nutrition Labeling and Education Act.

Table 2 summarizes the microbial analyses. According to the National Yogurt Association guidelines, yogurt should contain a sufficient quantity of LAB. However, there are no standards for LAB content in frozen yogurt.

LAB are considered to have a positive effect on health. These 11 samples showed variable numbers of LAB, but all contained significant quantities. Total aerobic counts are reasonable considering that these samples may be made from cultured products. There is concern for those products with coliform counts greater than or equal to 1 cfu/ml. Coliforms are used as an indication of unsanitary practices or contamination. The samples with greater than or equal to 1 cfu/ml were purchased at freeze-on-premise operations. These operations should review and change their sanitation practices.

Table 3 shows the physical characteristics of all samples. Yogurt is a fermented product and has a low pH (4.0-4.3). There is no established standard for pH of frozen yogurt, but consumers prefer a product that is not too acidic. The pH and titratable acidity values reflect these preferences. The β-galactosidase enzyme was detected in all samples. Those samples with high β-galactosidase activity had higher LAB counts (Table 2).

Table 4 illustrates the selected sweetener composition of all samples. For people who are lactose maldigesters, the KSU sample had the lowest concentration of lactose. Sample C was labeled as nonsugar and did not contain any sucrose. All other samples contained a variety of sweeteners at various concentrations.

Conclusions

The overall composition and microbial quality varied greatly among frozen yogurt samples, reinforcing the lack of a national guideline or standard for this product. The presence of LAB and β-galactosidase activity indicated that most manufacturers are utilizing a "yogurt" base in their product. The production of a high protein, frozen yogurt seems to fit within the consumer's expectations of a frozen yogurt.

Table 1. Composition of Frozen Yogurt Samples

Sample	Protein	Fat	Selected sugars[1]	Ash	Other carbohydrates[2]	Total solids
	-------------------------	%	-------------------------			
A	3.5	2.6	11.3	1.2	15.4	37.0
B	4.4	6.1	13.6	0.9	11.8	38.2
C	4.4	2.8	5.6	0.9	9.5	25.7
D	4.8	9.0	15.8	1.1	6.3	36.9
E	4.4	3.0	15.6	1.0	7.3	31.3
F	3.6	3.8	17.7	0.8	12.9	38.8
G	3.8	7.8	16.4	0.8	6.3	35.1
H	2.9	3.4	15.0	0.8	9.3	31.4
I	2.8	0.9	15.3	0.8	6.0	25.8
J	3.7	5.5	13.6	0.8	7.6	31.1
KSU	9.1	4.2	12.9	1.0	7.2	34.4

[1]Represents fructose, galactose, glucose, lactose, and sucrose. [2]Carbohydrates excluding fructose, galactose, glucose, lactose, and sucrose.

Table 2. Microbial Quality of Frozen Yogurt Samples

Sample	LAB[1]	Coliform[2]	Aerobic Counts[3]
A	1.3×10^6	<1	2.6×10^5
B	2.6×10^8	<1	3.6×10^7
C	5.5×10^6	100	3.3×10^6
D	1.1×10^8	<1	5.0×10^7
E	1.9×10^8	<1	3.1×10^7
F	3.2×10^8	<1	7.5×10^7
G	2.1×10^9	<1	5.5×10^6
H	6.3×10^6	523	1.4×10^6
I	8.9×10^6	107	1.3×10^7
J	3.4×10^6	1	3.0×10^6
KSU	4.4×10^8	<1	4.0×10^8

[1]Lactic acid bacteria in cfu/ml. [2]Coliform count in cfu/ml. [3]Total aerobic counts in cfu/ml.

Table 3. pH, Titratable Acidity and β-Galactosidase Activity Values of Frozen Yogurt Samples

Sample	pH	Titratable acidity[1]	β-Galactosidase activity
A	6.40	0.29	2.48
B	6.56	0.26	10.60
C	6.71	0.23	1.12
D	6.53	0.32	9.42
E	6.42	0.24	21.94
F	5.76	0.38	43.12
G	5.93	0.38	21.47
H	6.58	0.21	3.42
I	6.65	0.23	1.14
J	6.72	0.20	1.12
KSU	6.11	0.43	27.28

[1]Expressed as % lactic acid.

Table 4. Selected Sweetener Composition of Frozen Yogurt Samples

Sample	Fructose	Glucose[1]	Sucrose	Lactose
	----------	---------- %	----------	----------
A	0.0	0.7	7.2	3.8
B	0.0	1.3	8.4	3.4
C	0.0	2.2	0.0	3.4
D	0.0	1.3	10.3	4.3
E	1.5	2.5	7.5	4.2
F	0.0	1.9	12.7	3.1
G	0.0	1.2	11.8	3.5
H	0.0	1	10.0	4.0
I	1.6	1.4	8.2	4.0
J	0.0	1.1	8.7	3.9
KSU	0.0	1.1	9.6	2.3

[1]May include galactose.

ACKNOWLEDGMENTS

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

21st Century Genetics, Shawano, WI
American Breeders Service, De Forest, WI
Associated Milk Producers, Inc., Wichita, KS
Eli Lilly and Co., Greefield, IN
Delavan Processing, Inc., Delavan, KS
Heart of American Dairy Herd Improvement Association (DHIA), Manhattan, KS
Hoffmann-LaRoche, Nutley, NJ
International By-Products, Des Moines, IA
Jet-Pro Co., Atchison, KS
Kansas Agricultural Experiment Station, Manhattan, KS
Kansas Artificial Breeding Service Unit (KABSU), Manhattan, KS
Kansas Dairy Herd Improvement Association (DHIA), Manhattan, KS
Kansas Grain Sorghum Commission, Topeka, KS
Kansas Soybean Commission, Topeka, KS
Kemin Industries, Inc., Des Moines, IA
Midwest Grain Prod., Inc., Atchinson, KS
Monsanto Company, St. Louis, MO
National By-Products, Omaha, NE
Pioneer Hi-bred International, Inc., Des Moines, IA
Sanofi Animal Health Inc., Overland Park, KS
The Upjohn Company, Kalamazoo, MI

Appreciation is expressed to Eileen Schofield, Associate Editor of the Kansas Agricultural Experiment Station for editing; to Valerie Stillwell, Brandy Nowakowski, and Diana Loomis for typing the contents of this publication; and to Fred Anderson for the cover design.

The following department at Kansas State University is recognized for its cooperation and contribution to our dairy research program:

Agricultural Economics

Contribution No. 96-106-S, from the Kansas Agricultural Experiment Station, Kansas State University, Manhattan 66506. Trade names are used to identify products. No endorsement is intended, nor is any criticism implied of similar products not named.

BIOLOGICAL VARIABILITY AND CHANCES OF ERROR

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

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

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

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

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

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SRP 742 October 1995

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