DAIRY DAY 1994

Report of Progress 716

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

The 1994 Annual

KSU DAIRY DAY

Ninth in the series—Managing High-Producing Herds: *Raising Dairy Heifers/Steers: A Business. Surviving GATT, NAFTA, and the 1995 Farm Bill*

Pottorf Hall — CICO Park (Riley County Fairgrounds)

9:00 A.M.	Registration - VISIT EXHIBITS
10:15	WELCOME - Dr. Jack Riley, Head, AS&I, KSU
10:30	RAISING DAIRY HEIFERS: A BUSINESS - Dr. Jim Morrill, KSU
11:00	GROWING AND FINISHING HOLSTEIN STEERS - Dr. Bob Brandt, KSU
11:30	DAIRY BEEF: WHAT THE PACKER WANTS - Marcine Moldenhauer, Excel Corp., Wichita
NOON	LUNCH (Courtesy of Exhibitors)
1:15 P.M.	QUALITY MILK AWARDS - Dr. J.R. (Dick) Dunham, KSU
1:30	SURVIVING GATT, NAFTA AND THE '95 FARM BILL - R.A. (Bob) Cropp, Professor, University of Wisconsin-Madison
2:15	QUESTIONS/ANSWERS
2:45	ADJOURN - Visit Exhibits
3:00	TOUR (Self-guided) - Dairy Teaching Research Center (DTRC)

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

FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 1994. Dairying continues to be a viable business and contributes significantly to the total agricultural economy of Kansas. Annual farm value of milk produced (1.22 billion lb) on Kansas dairy farms was $141 million in June, 1994, with an impact on the economy of Kansas amounting to $686 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-five percent of the dairy herds (n = 1,066) and dairy cows (n = 77,000) in Kansas are enrolled in DHIA. Our testing program shows that all DHI-tested cows average 17,361 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 ($1,093/cow) than all Kansas herds ($788/cow) in 1993. 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 to be +1,111 lb compared to non-AI bulls whose average PTA is only +317 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 18,886 lb in August, 1994, despite many research projects that do not promote production efficiency.

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 will give us the ability to expand our research efforts in various studies involving nutrition and feeding, reproduction, and herd management. The excellent functioning of the DTRC is due to the special dedication of our staff. Appreciation is expressed to Richard K. Scoby (Manager, DTRC), Donald L. Thiemann (Asst. Manager, DTRC), Michael V. Scheffel (Research Assistant), Daniel J. Umsheid, Mary J. Rogers, Charlotte Boger, Kathleen M. Cochran, Becky K. Pushee, Lesa Reves, Tamara K. Redding, and Lloyd F. Manthe. Special thanks are given to Neil Wallace, Natalie W. Brockish, Betty Hensley, and Cheryl K. Armendariz for their technical assistance in our laboratories.

As demonstrated, each dollar spent for research yields a 30 to 50 percent return in practical application. Research is not only tedious and painstakingly slow but expensive. Those interested in supporting dairy research are encouraged to consider participation in the Livestock and Meat Industry Council (LMIC), a philanthropic organization dedicated to furthering academic and research pursuits by the Department. More details about LMIC are provided 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
1994 Dairy Day Report of Progress

Dedication to Dr. E. P. (Ed) Call

On November 1, 1994, Dr. Ed Call, Professor of Animal Sciences and Industry, will retire as a Kansas dairy leader. For 42 years, Call has unselfishly served the Kansas Dairy industry and Kansas State University. During that period, he worked on the staff of the Kansas Artificial Breeding Service Unit, as a Dairy Specialist in the Cooperative Extension Service, and on the resident staff in teaching and research.

Born on a small dairy farm near Kent, Ohio, Call was active in 4-H youth programs, milked cows, tapped maple syrup, and helped around the farm. He served with distinction in the Pacific theater during World War II. Upon his return home, he enrolled at The Ohio State University. Following graduation, he was DHIA supervisor and A.I. technician in Ohio before coming to Kansas in 1952. He earned his Ph.D. from Kansas State University in 1967 and worked as a Dairy Specialist until 1970, before spending 8 years on the resident staff at K-State, teaching courses in reproduction, dairy science, and genetics as well as investigating methods to improve dairy cattle fertility. He spent a 1-year sabbatical leave at the University of Florida in 1976-1977, where he worked with Dr. Bill Thatcher.

Since 1979, Call has concentrated his efforts in the field of reproduction as part of a two-man dairy extension team along with Dr. Dick Dunham. He has been a strong proponent of A.I. to maximize genetic gain and the use of DHI records in dairy herd management. His A.I. Reprofresher Clinics, held throughout Kansas, have provided a unique teaching method by which both dairy and beef producers have reviewed the techniques of A.I. using frozen-thawed reproductive tract specimens. Along with Dunham, Call has been a strong supporter of production testing as a means of measuring and evaluating cow and herd profitability. Another effort has involved the Milking Management Clinics held around Kansas, in which on-farm demonstrations have illustrated vividly that milking cows properly will yield more milk. For many years, Kansas has been the Great Plains leader in participation in the DHI program. Call and Dunham played an important role in guiding the formulation of the new Heart of America DHIA Affiliate, which, beginning January 1, 1995, will consist of six states, Kansas, Arkansas, Oklahoma, Nebraska, North and South Dakota, with the DHI laboratory headquartered in Manhattan.

Call's leadership and talents have not gone unnoticed. He was named Kansas Dairy Leader in 1985 and Friend of Kansas County Agents in 1991 and was the 1993 recipient of the highest honor given by the American Dairy Science Association to someone in Extension, the Alfa Laval Agri Dairy Extension Award.

A personal note. Ed always credits his success to his colleagues; friends; and especially to his wife, Jo, their three children, and six grandchildren. Although Ed is quick to offer his thanks to others, everyone in the Department of Animal Sciences will miss his humor, kindness, and gentlemanly manner. In his often quiet ways, behind the scenes, Ed has always sought to help others. We all wish him well in his retirement.

CONTENTS

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J. E. Shirley

The primary focus of the dairy industry in Kansas has been the milking herd. However, dairy heifer replacements and dairy steers offer income opportunities that have been largely ignored by some Kansas dairy producers. The 1994 Dairy Day program highlights these programs as potential profit centers. An "opportunity cost" analysis comparing the economic returns from your present enterprises with the potential returns from a dairy heifer or steer enterprise might propel you into a new career or enhance the profitability of your total operation.

The dairy commodity group at Kansas State University strongly believes that there is a future in the dairy industry for the family farm - small and large. We also are convinced that production per cow, judicious allocation of resources, knowledge of the U.S. and world economic climates, effective marketing, and a willingness to adopt new technologies are keys to success in the dairy industry. The economic climate of the future will be affected significantly by GATT, NAFTA, and the 1995 Farm Bill. The challenge is to be aware of the positive and negative aspects and adjust business management decisions accordingly. Remember, in most cases, it is not the number of cows nor the government that determines success or failure but the ability of the manager to adapt to change.

RAISING DAIRY HEIFERS: A BUSINESS

J. L. Morrill

Summary

On many dairy farms, improvement is needed in raising replacement heifers, especially in providing proper nutrition and management to allow for freshening at 23 to 24 mo of age at a desirable size. With larger herds, there is a trend toward more specialization, which may (but may not) result in more attention to, or responsibility for, proper care and management of the heifer. In some cases, the heifers are raised by a person at a location away from the dairy farm on which they originated, and contract raising of dairy replacements has several potential advantages and disadvantages. These are discussed in this paper, along with the results that should be expected and some of the types of programs and typical charges when heifers are raised on contract.

(Key Words: Heifers, Contract Raising, Growth.)

Introduction

In the past, most dairy producers in the Midwestern section of the U.S. have raised their own replacement heifers, whereas in other parts of the U.S., especially in the west, heifers may be raised on contract by someone other than the original owner. Currently, interest is increasing in having heifers raised by a person who specializes in that kind of work. There are several reasons for this change. Having heifers raised by specialists offers advantages and disadvantages, and several types of programs are being used. The purpose of this paper is to discuss each of these items and to provide some guidelines for establishing contracts for raising heifers.

The trend for dairy herds to become larger is driven by the need to become more efficient, to allow for more specialization, and to provide income for more than one family so that one person does not care for the herd every day. One example of becoming more efficient is when the number of cows being milked in a milking parlor is increased, and the parlor cost per cow is decreased. That is also true of equipment costs (such as feed mixing equipment), cost of services (such as feed formulation costs), and other expenses. As the number of lactating cows increases, it becomes more likely that more of one person's time will be devoted to the cows, and another person, either on the farm or at a commercial heifer facility, will care for the replacement animals. This, in turn, increases the probability that a person can be working in a particular area where he or she has a special interest or expertise. In some cases, enlargement of a herd has made it necessary to build new facilities and, at that time, the decision may be made to contract the raising of heifers.

The producer may benefit from various advantages by having heifers raised by someone else:

1) Labor and management that would otherwise be devoted to the heifers can be used for lactating cows or other more productive purposes. This is especially true if this labor and/or management can be used to care for more cows without increasing capital investment.
2) An experienced specialist, who is concentrating on the heifers, might do a better job or might do it more economically, although this is not always the case.
3) Having the heifers raised by someone else might relieve problems associated with inadequate shelter, overcrowded lots, or land availability for distributing manure.

Possible disadvantages to the dairy producer of having heifers raised by someone else might include:

1) Possible conflicts or misunderstandings with the contractor.
2) Heifers might not do as well.
3) If producing his own feed, a producer might lose an outlet for feed best suited for heifers (more likely to be true for forages).
4) In some cases, a producer might lose use of facilities designed for heifers.
5) Disease organisms might be brought back into the herd when heifers return for calving.

Possible advantages also exist for the person who is raising dairy heifers as a business:

1) An opportunity for a satisfying full or part-time profession, with less capital investment than would be required for a dairy herd. Part-time employment with a limited number of heifers might be ideal for a semiretired person, a person with another full- or part-time job, or a person with some physical handicap.
2) An opportunity to use certain feed resources that are less suited for lactating cows. Examples might include a pasture located away from the milking barn or lower quality forage.
3) An opportunity to make use of buildings and other facilities not used for other enterprises. Several dairy heifer growers use facilities that were used for feedlots.

Characteristics of the business of raising heifers that might be considered undesirable include:

1) Possible conflicts or misunderstandings with the owner of the heifers.
2) The frequency of contact with the heifers that is necessary, especially for heifers that are due to be bred.

Types of Programs

Although some people buy and raise heifers for resale, most people who raise heifers as a business do not become their owners. Often, ownership is retained, and the heifers return to the herd of origin. In other cases, the heifers may be bought by investors and sold when a certain stage of maturity is reached.

A common procedure followed when the owner retains possession of the heifers is for the calves to be raised to a certain size (varying between 350 and 500 lb) on the home farm, then the contractor will raise the heifer until shortly before freshening. In some cases, heifer calves are picked up from the farm at a few days of age and either grown to a certain size and then shipped to another grower or kept until shortly before calving. A good opportunity exists for calf growers raising surplus dairy bull calves for shipment to feedlots also to raise newborn heifer calves, because the programs would be very similar for the first 3 mo of life. Raising young dairy calves successfully requires considerable knowledge and skill, and those who are successful probably should specialize in working with animals of that age in order to utilize their talents to the greatest degree.

Types of Contracts

Although several different methods are used to pay for raising heifers, the most common ways are to assess a daily yardage fee or to base the fee on a unit of feed or gain. When using any of these methods, further agreements must be reached concerning other costs, including:

1) Reproduction - Breeding service, semen cost, pregnancy checks, estrous synchronization, use of clean up bull for repeat breeders.
2) Health - Vaccinations, routine and emergency health care, external and internal parasite control, dehorning, and necropsies.
3) Transportation to and from grower's facilities and any other costs about which there might be a question. Also, clear understanding must exist about the expected growth and condition of the heifers, the accounting for heifers that die, and the procedure to be followed for heifers that do not do well or do not breed.

A custom heifer grower should provide a printed schedule of charges, a complete description of services provided, and the kind of results to expect.

Expected Performance

Dairy heifers should freshen at about 23 to 24 mo of age. To accomplish this, conception should take place at 14 to 15 mo of age and breeding should begin at about 13 mo of age. Because heifers first start coming into heat at a certain body weight (600 lb for Holsteins) rather than age, they must be fed adequately so they will reach puberty and experience several estrous cycles before they reach sufficient height and weight to be bred. However, if heifers get too fat, udder development will be affected adversely. The time when this is most critical is between about 4 mo of age and when the heifers achieve puberty (first heat).

After calving, Holstein heifers should weigh 1200 to 1250 lb, with heifers of other breeds weighing in proportion to their mature weight. If heifers are too small at freshening, their milk production will be reduced. Considering all of this, the importance of proper growth throughout the growing period should be apparent. A clear understanding should exist about the expected growth rate, because, as has been shown, either insufficient growth or excessive conditioning before puberty is undesirable. Probably more questions would arise about inadequate growth, if charges were assessed on a per day basis, whereas overconditioned heifers might be more of a problem, if charges were made per pound of gain. An accurate scale is an absolute necessity for the contract grower to document weight changes. Table 1 shows body weights and sizes (expressed as height at withers) that are desirable for Holstein and Jersey heifers at various ages.

Budgeting Costs of Raising Heifers

Every heifer-growing program will be different and have different costs. Therefore, each program must be designed for a specific location. Various publications and programs are available to help determine costs of raising heifers. These include simple worksheets, computer spreadsheets, and computer programs such as the Cornell Cattle Systems IV. The Cornell program also helps to evaluate rations and make predictions of potential profitability using various feeding and management systems.

Tables 2 and 3 show the types of expenses encountered in raising heifers and some typical charges to clients. These costs vary and should be adjusted according to specific location and time. The total cost does not include any charge for management or make allowances for death losses. When evaluating these costs, it is important to remember that this budget assumes that the heifer has grown at an acceptable rate throughout life, is of good size, and is ready to freshen. Most current market quotations for springing heifers in the Midwest and Far West range between $1000 and $1400 per head (The Dairyman, August 1994).

Many dairy producers lose money by failing to feed and manage their heifers to achieve freshening at 23 or 24 mo of age. Feeding and maintaining the heifer for an extra 4 mo would cost at least $144, excluding the value of the milk not produced during that time.

Establishing Prices Charged by Contract-Raisers

Each commercial calf grower will provide different services and will encounter different costs; therefore, it would be difficult to present a proposed cost schedule that would be appropriate for any specific location. As a starting point, the data in Table 2 could be used. The data in Table 4 can be used to estimate the cost of raising heifers, starting at different weights. For example, for heifers starting at 500 lb body weight, 75% of the cost of raising the heifer still remains. Thus, if raising a heifer from birth to freshening costs $900, then raising a 500 lb heifer to freshening would cost $675. If the 500 lb heifer was 8 mo of age, the cost per day would be $675/488=$1.38 per day. If the cost of raising a heifer is $1120.51, as shown in Table 2 (total cost less cost of calf), the cost per day of raising a 500 lb heifer would be $1.72. Recently published prices charged by contract growers were $1.35 per day for heifers from weaning to freshening in one case, or $1.15 per day for heifers that arrive weighing between 400 to 600 lb, $1.20 for heifers between 600 and 800 lb, and $1.25 for heifers over 800 lb in another.

Table 1. Desirable Body Weights and Heights of Holstein and Jersey Heifers at Various Ages

	Weight (lb)		Height at withers (inches)	
Months of age	Holstein	Jersey	Holstein	Jersey
3	220	166	35.5	33
4	273	220	37.2	35
5	328	255	39.4	36.5
6	381	290	41.4	37
7	436	332	42.7	39
8	488	373	43.9	40
9	543	404	45	40.5
10	596	437	46.3	41
11	651	463	47.5	42
12	704	510	48.7	43
13	759	535	49.1	43.5
14	812	568	49.7	44.5
15	867	603	50.3	45
16	920	622	50.9	45.5
17	972	653	51.4	45.8
18	1027	696	51.9	46.1
19	1080	710	52.4	46.5
20	1135	755	52.8	46.8
21	1188	773	53.2	47.2
22	1243	810	53.4	48
23	1296	819	53.7	48.4
24[1]	1350	842	54.1	48.8

[1]Weight before calving.

Source: Data for Holsteins were adapted from Daccarett et al. (1993) J. Dairy Sci. 76:606 and Bortone et al. (1994) J. Dairy Sci. 77:270. Data for Jerseys were adapted from Heinrichs and Hargrove, Hoard's Dairyman, June, 1994, p 464.

Table 2. Replacement Heifer Budget, October 1994

	Age of heifers, mo			
Item	0 to 3	3 to 12	12 to 24	0 to 24
Variable Costs	------- Dollars -------			
Feed	67.45	158.65	373.80	599.90
Bedding	5.00	17.00	22.00	44.00
Health	8.00	6.00	8.00	22.00
Breeding	--	--	25.00	25.00
Power and fuel	4.00	8.00	7.00	19.00
Supplies	2.35	1.55	15.50	19.40
Interest	1.08	7.17	22.56	30.81
Total	87.88	198.37	473.86	760.11
Fixed Costs				
Buildings	9.37	28.12	37.50	74.99
Equipment	6.75	20.25	27.00	54.00
Int., taxes, ins.	2.84	21.20	63.37	87.41
Total	18.96	69.57	127.87	216.40
Total except for labor, mgmt. and calf	106.84	267.94	601.73	976.51
Labor ($6/hr)	30.00	54.00	60.00	144.00
Calf	130.00			130.00
Total	266.84	321.94	661.73	1250.51

Source: Feed costs were based on data collected at Kansas State University and on formulated rations, using current feed costs, and are shown in more detail in Table 3. Other data were adapted from Luening, R.A., R.M. Klemme, and W.T. Howard. 1991. Wisconsin Farm Enterprise Budgets - Dairy Cows and Replacements. University of Wisconsin - Extension Publication A2731; and B.J. Conlin and J.G. Linn. 1993. Minnesota Extension Service Dairy Update Issue 116, University of Minnesota.

Table 3. Calculation of Feed Cost for Growing Heifer[1]

	Age, mo					
	0 to 3		3 to 12		12 to 24	
Feed	lb	$	lb	$	lb	$
Milk replacer	35	27.30				
Calf starter	180	28.80				
Calf grower	84	10.08				
Alfalfa hay - late veg.	30	1.27				
Alfalfa hay - early bloom			1330	53.19		
Alfalfa hay - mid bloom					1989	77.59
Grass hay					5883	176.50
Corn			1778	71.42	183	7.35
Soybean meal			2.35	20.01	934	79.38
Supplements				14.03		32.98
Total		67.45		158.65		373.80

[1]Prices used were: milk replacer, $78/cwt.; calf starter, $16/cwt; calf grower, $12/cwt; alfalfa hay - late veg., $85/ton; alfalfa hay - early bloom, $80/ton; alfalfa hay - mid bloom, $78/ton; grass hay, $60/ton; corn, $2.25/bushel; soybean meal, $170/ton.

Table 4. Effect of Starting Weight on Cost to Raise Heifers

Starting Weight (lb)	Age (mo)	% Total cost	Increment %[1]
100	0	100	8
200	2	92	5
300	4	87	6
400	6	81	6
500	8	75	7
600	10	68	8
700	12	60	8
800	14	52	8
900	16	44	9
1000	18	35	11
1100	20	24	12
1200	22	12	12
1300	24	0	--

[1]The proportion of total cost incurred at that weight range.

Source: P.C. Hoffman, Second Biennial Northeast Heifer Management Symposium, September 8-9, 1993. Cornell Animal Science Mimeograph Series.

STRATEGIES FOR SMALL DAIRY FARMERS TO BE PROFITABLE AND COMPETITIVE IN THE FUTURE

B. Cropp[1]

Summary

Profitable dairying will not become any easier in the future. Farm level milk prices will continue to be volatile. The government will not provide additional price or income support to dairies. Long-run milk prices will be either flat or perhaps even trending slightly lower. Average annual milk prices will be in the range of $12.00 to $13.25 per hundredweight. Dairy producers must be able to generate adequate net income at these milk price levels. Smaller dairy operators need to find means of being cost competitive with the larger operators. Without question, smaller producers can be profitable in the decade ahead with proper changes. Not all profitable dairy operations will be those with at least 300 milk cows. There will be very profitable herds with 40, 50, 75, 100, and 150 cows. Even smaller herds will exist with substantial off-farm income or income from other farming enterprises.

(Key Words: Small Farms, Herd Size, Profitable, Costs, Milk Prices.)

Introduction

The question is frequently asked, will all dairy producers need to be large to be profitable and competitive in the future? In order to answer the question, we need to define what is a small or large dairy producer. The answer to this varies geographically. In the West and Southwest, small may mean anyone who is milking fewer than 250 cows. In the Upper Midwest, small probably is anyone who milks fewer than 75 cows.

The average herd size for the U.S. was 59.7 milk cows in 1993. Almost 38% of U.S. dairy herds had fewer than 30 milk cows, but they accounted for just 3.9% of total U.S. milk production. Another 21.9% had between 30 and 49 cows which produced 13.1% of the total milk production; 26.9% had 50 to 99 cows and produced 27.2% of total production; 9.2% had 100 to 199 cows and accounted for 19.6% of total production; and just 4.3% had 200 or more cows but accounted for 36.2% of total production.

Clearly, there are a lot of small dairy producers, but the number of producers is declining and the average herd size is increasing. In 1982, there were 278,000 farms with milk cows and the average herd size was 39.1 cows. By 1993, the number of farms with milk cows had declined 42% to 162,450. As previously mentioned, the average herd size was 59.7 cows. We could easily reduce the number of farms with milk cows by at least a fourth and perhaps as many as a third by the year 2000. The average herd size would increase to between 75 and 85 cows. A large percentage of the herds would still have fewer than 100 milk cows.

I will assume for this paper that small means those producers having herd sizes of less than 100 milk cows. For many of these herds to be profitable and competitive and to generate income for adequate family living, they will need to make some changes in how they operate. In this paper, I discuss the environment for dairying in the decade ahead and what strategies smaller producers will need to follow if

[1]Director of University of Wisconsin Center for Cooperatives and Dairy Marketing and Policy Specialist in the Department of Agricultural Economics, University of Wisconsin-Madison.

they wish to be a part of the dairy industry in the future.

The Environment in the Decade Ahead

Generating profits in dairying will not become any easier to generate profits in dairying. Profit margins per hundredweight of milk or per cow will remain tight or get even tighter. Thus, the challenge for all dairy farmers to generate adequate total net income to meet an acceptable family living standard will become greater. Even if the smaller dairy herds have equal net profit per cow to that of larger herds, they may not have a sufficient number of livestock units to generate adequate income. This may mean that producers with smaller dairy herds either have to lower production costs per hundredweight of milk, generate some income from off-farm activities, generate income from other farm enterprises, or simply accept a lower living standard.

On what basis do I make the above statements? Let me start with federal dairy policy. From 1950 to 1981, farm-level milk prices were supported at 75 to 90% of parity. In the 10-year period of 1970 to 1980, the support price more than doubled, going from $4.66 per hundredweight to $13.10. The average "all milk price" during this period increased from just $5.71 per hundredweight to $13.05 per hundredweight. Milk prices were increasing faster than increases in the costs of production. Parity milk prices are not the same as milk production costs. The result was huge milk surpluses by the late 1970's and early 1980's. By 1983, the Commodity Credit Corporation purchased almost 17 billion lb of surplus milk, milkfat equivalent basis, more than 12% of total farm marketings, at a cost of $2.5 billion. These levels of CCC purchases and associated costs became unacceptable to congress. In fact, in 1981, congress removed the dairy price support program off of parity. Since then, congress has set the support level based upon the level of CCC purchases of surplus dairy products and/or dollar expenditures. In addition, assessments were imposed against dairy producers to reduce government costs of the federal dairy price support program. And for the first time ever, voluntary supply management programs were implemented by congress, the Dairy Diversion Program in 1984-85 and the Dairy Termination Program in 1986-87.

The support price was reduced from its peak of $13.10 per hundredweight during 1980-81 to $10.10 per hundredweight by 1990. The 1990 Farm Bill essentially has kept the support level at $10.10 per hundredweight through 1995. This price is well below the full costs of production for most all dairy producers and below the cash costs of many. This means that farm-level milk prices will stay above support nearly all of the time. If prices fall near or to support, the higher-cost producers will exit the business, milk production levels will change, and farm-level prices will increase again above support. In fact, since 1988, farm-level milk prices have stayed above support. Clearly, market forces and not the federal dairy price support program determine farm-level milk prices today. The federal dairy price support program may be referred to as a market-oriented program.

Considerations for provisions of the 1995 Farm Bill will soon begin. Frankly, at this time, it does not appear that any major changes in the existing federal dairy price support program will occur. It is hard to believe that dairy policy would revert back to a relatively high support level from the existing market-oriented policy. Several factors limit any major changes in federal dairy policy. The federal budget deficit problem will not allow for an increase in federal dollars for the purpose of supporting dairy or any other farm commodity. In fact, it is quite clear that funding for price and income support programs will be reduced from existing levels in the 1995 Farm Bill. International trade policy also works against any higher support prices for dairy. U.S. policy is to become more competitive on the international market. With NAFTA and the likelihood of GATT being implemented, there is not much room for increasing support prices for milk. There is also a lack of consensus in the dairy industry as to what federal dairy policy ought to be. This lack of consensus has existed every since 1981 when the support program went off of parity and congress started setting support levels based upon CCC purchases and expenditures. Support levels were being reduced because purchases and expenditures were too high, and regionalism developed. Regions began pointing fingers as to who was causing the surplus. The 1985 Farm Bill further spurred regionalism by increasing Class I differentials in federal order markets distant from the Upper Midwest.

I question whether the dairy industry will do much better in developing a consensus behind one dairy policy option during the 1995 Farm Bill debate. Congress has made it clear that a consensus is essential in order to get any change in federal dairy policy. The best evidence of recent lack of consensus has been the attempt to pass a self-help program for dairy this year. Although more consensus may have existed than in the past for the idea of self-help, major differences remained in how self-help ought to be structured and how it should function.

Many people are pleased with existing federal dairy policy. They feel that the existing program is working. These individuals are dairy producers themselves, members of dairy industry trade associations and some farm organizations, and many in congress. After all, no milk surplus has existed since 1988. The only surplus is butterfat purchased by the CCC as butter. Cheese and nonfat dry milk prices have stayed above support for the most part. As a result, annual government costs for the dairy support program have been below $300 million for the past 4 years. Financial conditions of dairy farms have improved. In 1987, the debt/asset ratio for dairy farms was .24. In 1992, it was .19. The percent of dairy farms in favorable a financial position increased from 59% in 1987 to an estimated 66% in 1993. U.S. dairy products are now more competitive internationally. Butter prices, for example, are near world prices. Although cheese and nonfat dry milk prices are still well above world prices, they are closer. It is anticipated that full implementation of NAFTA and GATT will result in some increase in world market prices of dairy products. And finally, many dairy producers do not want any increase in support levels that will require supply control programs, restricting their ability to expand milk production.

Of course, a considerable number of people are of the opinion that the existing dairy support program is not working. The market-oriented dairy policy has made dairy product prices and, in turn, farm-level milk prices highly volatile. Considerable market and price risks now exist in dairy. This has impacted negatively upon dairy producers, dairy cooperatives, and other dairy manufacturers, as well as food ingredient companies that purchase dairy products. Others are concerned about the continual decline in dairy farm numbers. Profitability has been inadequate, especially for smaller commercial dairy farms. Regional shifts in milk production have occurred and continue to occur. Although milk production has declined in the more traditional regions of the Upper Midwest and Northeast, production has grown dramatically in the West, Southwest, and South. A problem of surplus butterfat remains. And finally, an excess milk production capacity exists. That is, the potential for increases in milk production exceeds the potential for increases in domestic plus international commercial dairy sales. Annual increases in milk per cow will be well above 2%, but the mature domestic market for dairy products will result in annual increases in commercial sales well below 2%. This means that the long-run outlook for farm-level milk prices is not upward, but rather fairly flat with yearly fluctuations. Average annual farm-level milk prices for the next few years will fall in the $12.00 to $13.25 per hundredweight range.

In summary, the economic environment over the next decade for dairy poses a real challenge for profitability. Federal dairy policy is likely to remain very market oriented. Although farm-level milk prices will remain volatile, the long-run trend in prices is either flat or perhaps slightly downward. History shows that milk production costs on a per hundredweight basis move in the direction of farm-level prices. This is because dairy producers strive to increase profitability by adopting innovative ways to reduce production costs. The modern technology and relatively low per-cow capital costs for milking and dairy facilities that are being applied to the large dairy herds in the West, South, Southwest, and elsewhere are resulting in lower costs of production per hundredweight than the smaller or traditional dairy operations. Some dairy producers are also reducing production costs by reducing input costs through rotational grazing systems.

Strategies for Profitability for Smaller Dairy Producers

With long-run average all-milk prices in the range on $12.00 to $13.25 per hundredweight, any individual dairy producer must decide whether or not he/she wishes to remain in dairy. If anyone is currently experiencing too low a profitability and is hanging on the hope that farm-level prices will improve on their own or with higher support levels from federal dairy policy, they need to face the reality that higher milk prices are not likely. If they are unable to reduce production costs, their best decision may be to exit from dairying.

Without question, the larger modern dairy facilities being constructed and well managed are experiencing full costs of production well under $12.00 per hundredweight and some below $10.00 per hundredweight. Not all of these are 1,000- to 3,000-milk cow operations. It appears that 300- to 600-cow operations can be nearly as cost competitive. This size can fully utilize the technology and experience labor efficiencies.

Without question, additional environmental regulations will be forthcoming. Animal waste management will be a part of these new regulations. Considerable attention will be given to environmental regulations in the 1995 Farm Bill discussions. The costs of compliance are likely to be less on a per cow or per hundredweight of milk basis for the larger herds than for the smaller herds. This is simply it does not cost 20 times more to build a waste management system for 1000 cows than for 50 cows.

All of this discussion comes down to the fact that smaller dairy herds need to consider means of reducing milk production costs per hundredweight of milk produced. Even then, some minimum herd size will be required to generate adequate net income for adequate family living. This will be extremely difficult with herds fewer than 40 or 50 milk cows. Herds smaller than this will not have a sufficient number of livestock units to generate adequate income, even if they have per hundredweight production costs near the most efficient producers. Either some off-farm income or additional income from other farm enterprises will be needed to supplement dairy income. There may be some niche markets for these smaller herds to consider, such as going organic and processing this milk into organic dairy products that command a higher value. In Wisconsin, a group of smaller dairy producers, most with 35 to 40 milk cows, formed a cooperative that is marketing organic cheeses, butter, yogurt, and beverage milk not only in the Upper Midwest, but in the Northeast and even in the West. These organic dairy products sell at higher prices than the comparable nonorganic products to the extent that these dairy producers are receiving about $16.00 per hundredweight for their milk.

More than one means is available for these smaller herds and, for that matter, all sizes of dairy herds, to reduce per cow and per hundredweight production costs. These means include the following:

1) Maintain a herd in which milk per cow exceeds the state average. Research on cost-of-production data shows that the highest-producing herds are not necessarily the most profitable. But at the same time, those herds with milk per cow near or below the state average usually are not highly profitable. For a Holstein herd, anything less than about 17,000 lb of milk per cow should be questioned.

Smaller herds should consider hiring nutrition and herd health consultants. Such expenditures could very well reduce milk production costs per hundredweight. More milk per cow could increase the lb of milk per labor hour as well as reduce fixed cost per hundredweight of milk.

2) Reduce the capital investment per cow. I don't believe it is any longer feasible for producers with smaller herds, perhaps even herds of 150 cows, to own a full line of modern equipment planting to harvesting. They simply do not have sufficient acres to spread the fixed cost of this investment. Besides, during planting and harvesting, management time is spread thinly and often suffers.

Owners of smaller herds need to consider such options as purchasing all or part of their forages and grain. My experience is that many smaller farmers should not raise any grain, but just concentrate on the forages. This eliminates the need for grain planting and harvesting equipment. Other options include the hiring of custom operators for planting and harvesting, leasing rather than owning the equipment, and the sharing of machinery (co-ownership or equipment trade) with other dairy producers in the area.

3) Contract for the raising of dairy replacements. This is beginning to be practiced by large size producers and may be a good alternative for small producers. It may free up labor and management time to be devoted to the milking herd.

4) Reduce input costs through rotational grazing systems. Such systems may reduce milk production costs per hundredweight and increase profitability. However, like anything else, a rotational grazing system requires proper management. Simply turning the cows out to grass is not the answer. Further, not all dairy producers have the land resources conducive to grazing systems.

5) Smaller producers can consider getting together and building a larger and more modern dairy facility. Several types of arrangements are possible. The facility could be owned under a cooperative structure, subchapter S corporation, a limited liability company (not legal in all states), or a partnership arrangement. Each individual producer could keep his/her farm and grow and harvest the forage and grains to supply the combined dairy herds that are housed and milked in the co-owned dairy facility. Or the dairy producers could own the dairy facility, cows, and cropland together as one farming unit. The purpose of this joint ownership is to share the costs of constructing a larger and more modern dairy operation and have the dairy herd managed by trained a herdsperson. The fixed costs per cow and per hundredweight of milk from combining individual herds would be lower than if each producer built his/her own more modern milking system.

6) Practice sound financial management. Regardless of size, sound financial and business management is absolutely essential for financial success. Decisions must be made on the basis of profitability. Business and production records must be accurate. Dairy producers need to have detailed records on the costs of production, not just a check book and minimum records for tax purposes.

This certainly is not a complete list. But it does illustrate that more than one way is available to be profitable in dairying.

MANAGEMENT ANALYSIS OF DAIRY COW HERD ENTERPRISES IN THE KANSAS FARM MANAGEMENT ASSOCIATION

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

Summary

Actual records of dairy cow herd enterprises from Kansas Farm Management Association farms over the past 4 years have shown an increase in returns over variable costs from $17,900 to $27,000 per farm for a 100-cow dairy herd in favor of herds with higher milk-producing cows. Cost per hundred weight of milk produced per cow decreased for the higher-producing herds compared with lower-producing herds, even though total cost per cow increased. In 1993, for every extra $1.00 spent on feed and other variable costs, the higher producing herds earned $2.34. This was a 234% return per dollar invested.

(Key Words: Economics, Dairy, Management.)

Introduction

Detailed dairy cow 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 is also useful to nonmembers for benchmark comparisons. Total dairy herd production expenses, along with production information, are expressed on the basis on per hundred weight (cwt) of milk sold and per cow. This complete dairy herd enterprise analysis, along with DHIA records, provide the information for dairy farmers to evaluate correctly their dairy herd program.

Procedures

Dairy cow herd producers keep monthly receipt and expense records in an account book or on a computerized accounting program. Detailed records of crop production, feed, and inventory are completed each year under the supervision of Extension Agricultural economists of 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 1993 dairy cow herd enterprise records from 89 dairy farms were analyzed by dividing the farms into herds with milk sales below and above 17,500 milk 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 1993, the higher-producing herds sold 3,834 lb more milk per cow (over 24% greater production), which resulted in $471 additional gross income per cow. For the higher-producing herds, total feed cost per cow

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increased by $82 and other variable costs (direct production costs) increased by $119. These herds returned $270 more per cow above variable costs than the lower-producing herds. For a 100-cow herd, higher production provided $27,000 more income for family living, debt repayment, replacement of machinery and equipment, and other capital investments. Costs and returns for dairy herds ranked by production are illustrated in Table 2. Income over feed cost and return to labor and management per cow increased significantly as milk production increased. Feed cost per cwt of milk production decreased significantly, whereas nonfeed costs remained fairly constant with increased milk production.

Table 3 provides information on all dairy herds for the past 4 years.

Table 1. Kansas Farm Management Association Analysis of Milk Production by Dairy Cow Enterprise (1993)

Factor	Milk sold per cow: Under 17,500 lb		Milk sold per cow: 17,500 lb and over	
Production Data				
No. farms	33		56	
No. cows/farm	75		97	
Milk sold/cow, lb	15,452		19,286	
	Per cow	Per cwt milk sold	Per cow	Per cwt milk sold
Production Returns				
Milk sold	$1,990	$12.88	$2,445	$12.68
Livestock sales and other	311	2.01	327	1.70
Gross income	$2,301	$14.89	$2,772	$14.38
Production Costs				
Feed fed	$1,341	$8.68	$1,423	$7.38
Hired labor	138	.89	174	.90
Vet, supplies, marketing	301	1.95	324	1.68
Repairs, fuel, utilities	196	1.27	239	1.24
Interest & miscellaneous	99	.64	116	.60
Total variable costs	$2,075	$13.43	$2,276	$11.80
Return over variable cost	$226	$1.46	$496	$2.58

Table 2. Costs and Returns of Farm Management Association Dairy Herds Ranked by Production for 1993

No. of cows	Milk sold, lb per cow	Feed cost per cwt	Other costs per cwt	Income over feed cost per cow	Labor and management return per cow
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

Table 3. Kansas Farm Management Association Dairy Cow Enterprise Analysis, 1990-1993

Factor	1990	1991	1992	1993
Production Data				
No. farms	87	113	108	89
No. cows/farm	92	85	86	89
Milk sold/cow, lb	17,969	17,518	18,135	18,054
Production Returns	Per cow			
Milk sold	$2,471	$2,094	$2,360	$2,299
Livestock and other	374	310	322	322
Gross income	$2,845	$2,404	$2,682	$2,621
Production Costs				
Feed fed	$1,321	$1,311	$1,367	$1,396
Hired labor	154	164	153	162
Vet, supplies, marketing	293	272	304	316
Repairs, fuel, utilities	211	209	218	234
Interest & miscellaneous	111	114	96	102
Total variable costs	$2,090	$2,070	$2,138	$2,210
Return over variable cost	$755	$334	$544	$411

EFFECT OF YEARLY MILK PER COW ON VARIOUS REPRODUCTION TRAITS

E. P. Call

Summary

An analysis of 4,334 Holstein dairies confirms the negative genetic correlation that exists between milk production and reproduction. The most obvious traits affected are services per conception and conception rate. When subjected to analysis by the KSU Dairy Herd Analyzer (DHA) program, higher-producing herds have less economic loss because their managers do a better job of controlling factors not under genetic control, such as average days dry and age at calving of first-calf heifers (L-1). Higher-producing herds also have fewer cows that are open and should be bred.

Key Words: Milk Production, Genetics, Production, Reproductive Losses.)

Introduction

Although a negative genetic relationship exists between milk production and reproduction, it is difficult to determine the economics of reduced reproductive efficiency as production increases. The KSU Dairy Herd Analyzer (KSU-DHA) (1989 Dairy Day, KAES Rep. Prog. 580:46-48) provides a means to evaluate a herd's reproductive performance and assess the economic impact of less than optimal efficiency. Inputs into the evaluation include calving interval, days dry, services per conception, and age at calving of first-calf heifers (L-1).

Average days dry and age at calving for L-1 are dictated mostly by management decisions. Genetic antagonism between milk production and reproduction should be expressed by services per conception. Calving interval is affected by services per conception but may be masked by the voluntary waiting period (VWP), as measured by average days to first service. The data for entry into the KSU-DHA are obtained from herd summary reports (DHIA 202 A-B) from herds enrolled in Dairy Herd Improvement Associations (DHIA).

Procedures

Holstein herds (n = 4,334) processed by Midstates Dairy Records Processing Center, Iowa State University, Ames, as of June, 1994, were categorized into 2,000 lb milk incremental production groups. Production was expressed by the rolling herd average (RHA) that represents the average cow's production during the last 365 days. Average data from each group of herds were subjected to the KSU-DHA program that compares actual performance with stated goals. The values generated can be related to improvement in cash flow if the goals are attained.

In addition, comparisons were made among the groups for days open and percentage of days open above 60 and 120 days. Conception rate to first service and cumulative rate to first plus second service also were evaluated.

Results and Discussion

Table 1 summarizes the effects of yearly milk production (rolling herd average - RHA) on the four increases associated with reproduction. Improvement in average days dry and age at calving of L-1 reflect positive responses to intensified management. Average services per conception suggest that higher-producing cows are more difficult to settle. Even though a negative trend occurs for services per conception, calving intervals are similar because the VWP (average days to first service) for higher-producing herds is shorter.

The economic effects of lowered reproductive efficiency are shown in Table 2. The dollar values obtained from the KSU-DHA reflect improvement in cash flow if the goals of the program are attained. The economic effect of more services per conception is relatively insignificant when compared to increasing cash flow by improving the factors that are mostly management oriented.

Table 3 illustrates the relationship of yearly milk per cow (RHA) on conception rate, percentage cows open, and days to first service (VWP). The negative relationship between production and reproduction is evident by declining conception rates at first service with a similar effect after two services. The positive effect of a shorter interval to first service resulted in comparable calving intervals among groups (Table 1). The results of more intensive management in the reproduction program are seen in the lower percentage of cows not yet bred > 60 and 120 days. Managers of higher-producing herds (RHA) not only breed cows sooner after calving (shorter VWP) but have fewer cows that are not yet bred but should be.

Table 1. Effect of Rolling Herd Average on Various Reproductive Traits in 4,334 Holstein Herds

Rolling herd average	Calving interval	Days dry	Services/ conception	Age at calving (L-1)
- milk, lb -	- days -	- days -	- no. -	- mo. -
13,152	420	73	1.7	28
15,071	414	68	1.8	28
17,012	412	66	1.9	27
18,960	412	64	2.0	27
20,846	413	63	2.0	26
22,840	411	61	2.0	26

Table 2. Economic Effect of Rolling Herd Average on Various Reproductive Traits as Measured by the KSU-DHA in 4,334 Holstein Herds

Rolling herd average	Calving interval	Days dry	Services/ conception	Age at calving (L-1)	Total loss
- milk, lb -	- $ -	- $ -	- $ -	- $ -	- $ -
13,152	105	39	0	39	183
15,071	87	24	2	39	152
17,012	81	18	4	33	136
18,960	81	12	6	33	132
20,846	84	9	6	24	123
22,840	78	3	6	24	111

Table 3. Effect of Rolling Herd Average on Days to First Service, Conception Rate, and Percentage Cows Not Yet Bred

Rolling herd average	Days to 1st service	Conception rate		% Cows not yet bred	
		1st service	1st +2nd	>60	>120
- milk, lb -	- days -	- % -	- % -	- % -	- % -
13,152	99	57	78	61	35
15,071	95	58	81	59	32
17,012	91	53	77	52	24
18,960	89	50	76	52	22
20,846	90	51	76	52	21
22,840	88	50	75	50	18

STAGE OF LACTATION PROFILE REFLECTS NUTRITION AND MANAGEMENT

J. R. Dunham

Summary

The Stage of Lactation Profile (SOLP) is a good estimate of the shape of the lactation curve for dairy herds. The SOLPs for herds with various milk production levels are somewhat similar. The rates of decline of all SOLPs are about the same. Therefore, the differences in production levels are about the same in late stages of lactation and in early lactation, regardless of production Rolling Herd Average (RHA). In addition, higher-producing herds have their highest level of production in the second stage of lactation (51 to 100 days in milk), whereas this occurs in the first stage of lactation (<50 days in milk) in lower-producing herds. Nutrition and management programs have a large impact on the early stages of lactation that affects the total lactation milk yield.

(Key Words: Stage of Lactation Profile, Summit Milk Yield, Rolling Herd Average.)

Introduction

Nutrition and management programs account for 75 to 80% of the difference in RHA among dairy herds. These programs are extremely important at the beginning of lactation, because the peak of the lactation curve is affected at this time. After the peak of the lactation curve is established, milk production level declines at a rather constant rate, and the curve cannot be changed to any great extent.

Dairy Herd Improvement (DHI) records show a SOLP, which is a good estimate of the lactation curve for dairy herds. The Summit Milk Yield (SMY), which is a good estimate of the peak of the lactation curve, also is reported in DHI records. A comparison of SMY and SOLP for herds with various RHAs indicates a vast difference in nutrition and management in Kansas dairy herds.

Procedures

Data were collected from 391 Kansas Holstein herds with DHI records. Herds were divided into four groups (quartiles) based on RHAs for milk production to evaluate SMYs and SOLPs.

Results and Discussion

Figure 1 depicts SOLPs of Kansas Holstein herds grouped according to RHA. SMYs, SOLPs, and Predicted Transmitting Ability (PTA) of sires of cows are shown in Table 1.

The RHA for the first through fourth quartiles were 20,648, 18,276, 16,269, and 13,142 lb milk, respectively. The shapes of the SOLPs are somewhat similar. The production differences were of similar magnitudes through all stages of lactation among all production groups. Hence, cows must start the lactation at a high level in order to be milking at a higher level late in lactation.

The first and second quartiles had the highest production levels in the second stage (50 to 100 days in milk) of lactation, whereas production was highest in the first stage for the third and fourth quartiles. This illustrates the important role nutrition plays during early lactation.

Dairy cows have two sources of nutrients, those that are provided by the ration and energy stored in the form of body fat. Both sources have a positive effect on production during early stages of lactation. Assuming adequate genetic ability, milk production will be determined by nutrient intake and removal of energy from stored body fat. Therefore, the first two quartiles were not as limited by nutrient intake as the lower two quartiles. Because production was declining by the second stage of lactation in the two lower quartiles, body weight loss appears to have occurred earlier in lactation. An average of 16% more concentrate was fed during the two higher quartiles than the two lower quartiles.

The SMYs shown in Table 1 are the best estimates of the peak of the lactation curves. The fact that SMY was higher for each higher milk-producing group illustrates the role of nutrition and management. Comparing the highest to lowest production groups, these data show that RHA is increased by 289 lb milk for each 1 lb increase in SMY.

The following nutrition and management programs affect early lactation production levels and SOLP:

1. Feed nutrient levels to obtain body condition scores between 3.5 and 4.0 during the dry period.

2. Lead feed dry cows 2 to 3 wk prior to calving with rations similar to those fed to early lactation cows.

3. Feed highest quality forages to early lactation cows.

4. Challenge early lactation cows nutritionally with energy and protein.

Table 1. Comparisons of Summit Milk Yield (SMY), State of Lactation Profiles and Predicted Transmitting Ability for Milk (PTAM) of Sires of Kansas Holstein Herds Ranked by Quartile

			Stage of Lactation Profile (SOLP)					
			Days in milk					
Quartile	Average RHA[1]	Average SMY	<50	50-100	101-200	201-300	>300	PTAM
1st	20648	79.7	77.3	77.3	67.7	56.2	44.7	1455
2nd	18276	71.3	68.9	69.1	58.8	50.4	40	1446
3rd	16269	66.6	66.2	64.1	54.7	46.2	34.7	1423
4th	13142	53.8	54.7	53.4	43.5	37.5	29.3	1221

[1]Average rolling herd average.

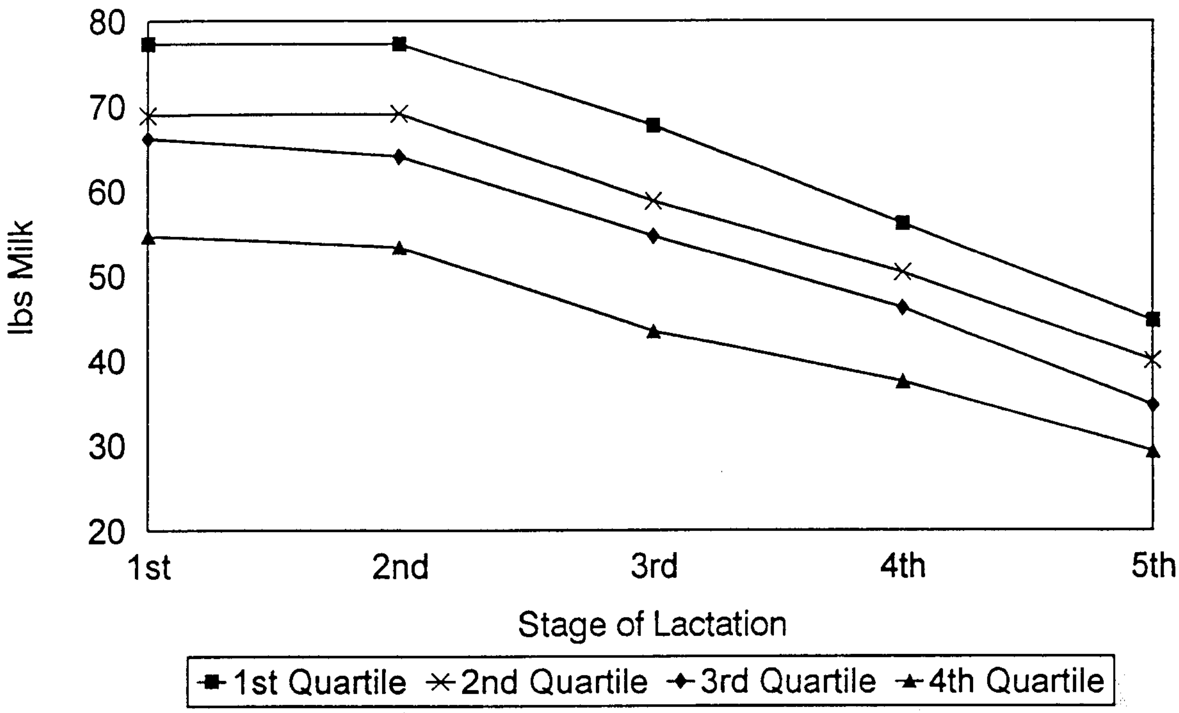

Figure 1. State of Lactation Profiles of Kansas Holstein Herds Ranked by Quartiles

EFFECTS OF SUNSHADES ON TEMPERATURE AND COW COMFORT

J. E. Shirley

Summary

Sunshades provide an effective method of reducing ultraviolet sunrays and increasing cow comfort.

(Key Words: Sunshades, Environmental Temperature, Cow Comfort.)

Introduction

Dairy cows have a zone of thermal neutrality within which they are comfortable based on measures of feed intake and milk production. Warm-season temperatures in Kansas average above 80 degrees F during the day, with incidences of 100 degrees + F. The upper critical temperature of dairy cows is defined as the temperature at which they must utilize energy to reduce body temperature. As the ambient temperature rises above critical temperature, feed intake is decreased, leading to a subsequent decrease in milk production.

The upper critical temperature is related to the level of milk production. Cows producing 100 lb of milk per day will be affected negatively at a lower temperature than cows producing 50 lb of milk per day. This occurs because higher-producing cows have an elevated metabolic rate and generate more heat during the digestive process at higher levels of feed intake. A decrease in milk production in the 100-lb producer might be observed at an ambient temperature of 80 degrees F, whereas the 50-lb producer might not show a decrease until the ambient temperature reaches 95 degrees F.

Sunshades are relatively inexpensive and easy to install in a dry lot or other loafing area. This study was conducted to determine the temperature differential existing between sites located under a sunshade and in direct sunlight.

Procedures

Ambient temperature in degrees Fahrenheit was measured with black bulb and bare bulb thermometers at 0730, 0900, 1030, 1200, 1330, 1500, 1630, 1800, and 1930 hr for 7 consecutive days at the Kansas State University Dairy Teaching and Research Center. Temperatures were measured in direct sunlight and under a sunshade. Thermometers were located 2 ft. above cow height at all sites. Cows were housed at all observation sites during the study. Black bulbs were used to provide a measure of ultraviolet sunrays that have been associated more with cow comfort than ambient temperature measured by bare bulbs.

Results

Black bulb readings averaged 4.9 degrees F lower during the day and peaked 8.0 degrees F lower under the sunshade relative to direct sunlight. Peak black bulb temperatures during the 7-day period were 106.3 degrees F in direct sunlight compared to 97 degrees F under the sunshade.

Black bulb temperature under the sunshade remained above 96 degrees F for approximately 1.5 hr during the day, whereas temperature in direct sunlight remained above 96 degrees F for approximately 6.25 hr.

Bare bulb temperatures were similar in direct sunlight and under the sunshade and were consistently lower than black bulb temperatures except at 730 and 1930 hr (Figure 1).

Conclusions

Sunshades reduce the exposure of cows to ultraviolet sunrays as measured with a black bulb thermometer but have little effect on temperature measured with a bare bulb thermometer.

Table 1. Effect of Sunshades on Temperature

	Bare bulb		Black bulb	
Measurement	Direct sun	Sunshade	Direct sun	Sunshade
Average temperature, °F	83.5	83.1	89.7	84.8
Average peak temperature, °F	91.4	90.0	104.0	94.1
Average hr of peak temperature	15:08	15:34	14:56	15:22

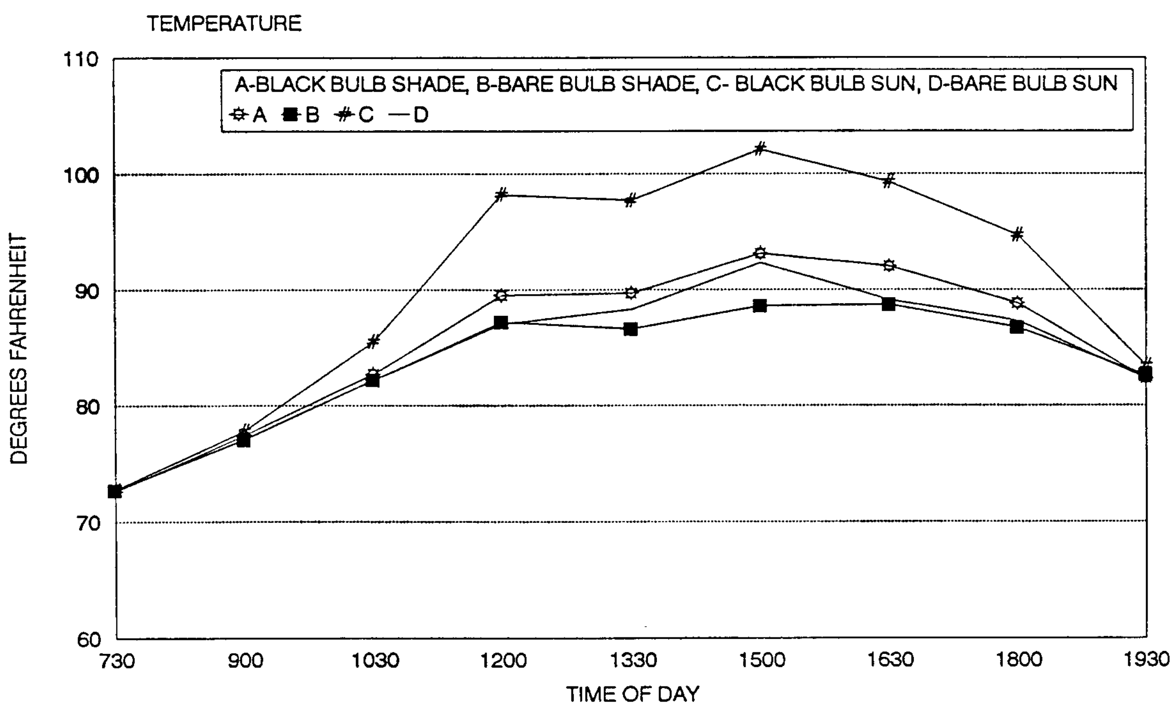

Figure 1. Effect of Sunshade and Time of Day on Temperature Readings with Black and Bare Bulb Thermometers

INFLUENCE OF SOURCE OF CALORIES ON COMPOSITION AND PRODUCTION OF MILK

J. E. Shirley and A. J. Gallegos

Summary

Wheat and tallow increased milk production in a complementary fashion when added to a milo-based grain mix.

(Key Words: Concentrate Mixes, Tallow, Wheat, Milo, Milk Yield.)

Introduction

Feeding to achieve near maximum function of the rumen microbial population is the first criterion that must be met to achieve maximum production from the dairy cow. Diets should contain sufficient rumen-soluble carbohydrates and protein to fulfill requirements of the rumen microbes.

In an earlier study (KAES Report of Progress 608:19), cows fed a low rumen-soluble carbohydrate (milo) produced 71.3 kg of milk daily containing 3.49% fat and 3.0% protein and exhibited a plasma urea nitrogen (PUN) level of 6.98 mM. When dietary rumen-soluble carbohydrate was increased by substituting wheat for 30% of the milo, and calorie and protein intake were held constant by the amount fed, milk output increased by 3%, milk fat percentage decreased (3.49 vs 3.36%), and milk protein and PUN percentage remained constant. When dietary rumen soluble carbohydrate was decreased by substituting fat (fancy white tallow) for a portion of the milo (equal caloric basis), milk output increased by 14%, milk fat and protein percentage remained constant, and PUN tended to increase (6.98 vs 6.68 mM).

These data suggest that a deficit of rumen-soluble carbohydrate in the milo diet reduced rumen microbial activity because PUN was decreased when wheat was substituted into the diet. However, this did not have a major effect on milk output.

The increase in milk output realized from the substitution of fat calories for carbohydrate calories suggests that dietary fat is utilized more efficiently or has a positive impact on nutrient supply to the mammary gland apart from its caloric contribution. The combined data indicate that an increase in soluble carbohydrate simultaneously with the addition of fat might have an additive effect on milk output if, in fact, soluble carbohydrates stimulate rumen microbial activity and dietary fat enhances metabolic activity in favor of the mammary gland.

Procedures

Thirty-two Holstein cows averaging 90 days in milk were assigned randomly to four treatments. Treatments were balanced by pretrial milk yield, days in milk, and parity. A four by four Latin Square with 28-day periods was utilized to evaluate treatment effects. Treatments were: sorghum-milo base grain mix (S); 2) 70% sorghum-milo + 30% wheat base mix (SW); 3) sorghum-milo mix + tallow (ST); and 4) 70% sorghum-milo + 30% wheat base mix + tallow (SWT). One lb of tallow per head per day was substituted in diets on an equal caloric basis. Chopped alfalfa hay was the only forage in all diets. Diets were formulated in accordance with NRC recommendations to support a 1400 lb cow producing 80 lb of 4.0% fat, 3.2% protein milk. All cows were fed a total mixed ration twice daily (40% in A.M., 60% in P.M.).

Results

Results of this study are presented in Tables 1 and 2. In essence, the effects of increasing rumen-soluble carbohydrate and dietary fat simultaneously equals the single effect of increasing rumen soluble carbohydrate plus the single effect of increasing dietary fat relative to milk output. This complementary effect can be illustrated by utilizing the formula [(SW-S) + (ST-S)] = SWT - S, where S, SW, ST, and SWT represent milk yields (lb/cow/day) from the experimental diets:

[(SW – S) + (ST – S)] = SWT – S
[(66.44 – 64.24) + (68.64 – 64.24)]
= 70.62 – 64.24
2.2 + 4.4 = 6.38
6.6 = 6.4

The substitution of fat into the milo diet (ST) depressed (P<.05) milk protein relative to the milo:wheat diet. Average daily lb of milk protein was lowest for cows fed the S diet (2.07 lb), similar for cows fed the SW (2.16 lb) and ST (2.17 lb) diets, and highest for cows fed the SWT diet (2.25 lb). Average daily lb of milk fat was lowest for the S (2.4 lb) and SW (2.4 lb) diets, slightly higher for cows fed the ST (2.51 lb) diet, and highest for cows fed the SWT diet (2.58 lb). Increasing rumen-soluble carbohydrate reduced (P<.05) PUN in the cows fed the SW diet, whereas the substitution of fat increased PUN relative to the basal milo diet. Simultaneous inclusion of fat and increase in rumen-soluble carbohydrate resulted in a PUN value similar to that of the basal diet of milo.

Conclusions

These data tend to support the concept that rumen-soluble carbohydrates have a direct positive effect on rumen microbial activity, whereas dietary fat alters metabolic activity in favor of milk synthesis. It has been hypothesized that the substitution of fat calories for carbohydrate calories negatively alters insulin secretion rate via a reduction in propionate production, and thus avoiding an insulin-directed diversion of nutrients from milk synthesis to synthesis of body tissue.

Table 1. Diet Composition (% As Fed)

	Dietary treatments[1]			
Ingredient	S	SW	ST	SWT
Alfalfa hay	44.11	44.72	45.95	46.51
Sorghum grain	43.45	31.03	38.59	27.53
Wheat		13.15		11.66
Tallow			1.62	1.64
Soybean meal	5.21	3.78	6.63	5.39
Distillers grains	3.11	3.15	3.24	3.28
Molasses	1.55	1.59	1.38	1.41
Dicalcium phosphate	.64	.61	.73	.72
Limestone	.43	.47	.42	.44
Bicarbonate	.76	.76	.73	.72
Magnesium oxide	.37	.38	.37	.36
TM salt	.25	.24	.23	.23
Vit ADE	.12	.13	.11	.11

[1]S = sorghum-milo base grain mix; SW = 70% S + 30% wheat; ST = S = 1 lb of tallow; and SWT = S + 30% wheat + 1 lb of tallow.

Table 2. Treatment Effects on Production and Metabolic Traits

	Dietary treatments				
Item	S	SW	ST	SWT	SE
Milk, lb	64.2[a]	66.4[ab]	68.6[bc]	70.6[c]	1.0
4% FCM, lb	61.8[a]	62.0[a]	64.9[ab]	66.9[b]	1.21
Fat, %	3.73	3.61	3.65	3.65	0.08
Protein, %	3.23[ab]	3.25[a]	3.16[b]	3.19[ab]	0.02
Lactose, %	4.79	4.74	4.79	4.81	0.03
SNF, %	8.74	8.72	8.65	8.71	0.05
SCC (×1000)	175.3	139.8	126.3	110.5	27.8
Body wt. (BW), lb	1431	1445	1432	1436	
Change in BW, lb/day	.90	.75	.97	1.19	1.41
Dry matter intake, lb/day	61	60	62	61	
Dry matter intake, % of BW	4.27	4.17	4.36	4.24	
Body condition score	3.07	3.03	3.05	3.04	0.01
Plasma glucose, mM	3.08	3.09	3.03	3.04	0.04
Plasma urea nitrogen (mM)	7.42[ab]	6.99[b]	7.85[a]	7.58[a]	0.15

[1]S = sorghum-milo base grain mix; SW = 70% S + 30% wheat; ST = S = 1 lb of tallow; and SWT = S + 30% wheat + 1 lb of tallow.

[abv]Means within row without a common superscript letter differ (P<.05).

RUMINAL DEGRADATION OF DIETARY PROTEIN IN STEERS FED LASALOCID

R. H. Wessels, E. C. Titgemeyer, and G. St. Jean[1]

Summary

A trial was conducted to investigate the effect of lasalocid (Bovatec®) on ruminal degradation of dietary protein in Holstein steers. Five ruminally and duodenally cannulated steers (305 kg) were fed a corn-alfalfa-soybean meal diet (17% CP), with or without lasalocid, in a three period, switch-back experiment. Ruminal pH, ammonia, volatile fatty acids, and amino acid and peptide concentrations were unaffected by lasalocid. Lasalocid reduced (P<.05) ruminal protease activity by 15%, but did not change deaminase activity. Digestibilities of dry matter, organic matter, fiber, and crude protein were similar between treatments. Intestinal flows of microbial and feed crude protein fractions, as well as amino acids, remained unchanged when lasalocid was fed. Thus, in this experiment, lasalocid failed to decrease feed protein degradation in the rumen and, therefore, was unable to increase the supply of crude protein or amino acids to the small intestine.

(Key Words: Ionophore, Lasalocid, Protein Degradation, Microbial Protein, Amino Acids, Ruminants, Dairy Cattle.)

Introduction

Much of the feed protein ingested by cattle is degraded by the microbial population of the rumen to peptides, amino acids, and ammonia. Ammonia not utilized by the microbes is absorbed into the blood, converted to urea, and largely excreted in the urine. This constitutes a loss to the animal, and, therefore, it is of interest to investigate ways to decrease ruminal protein degradation and increase feed protein reaching the small intestine where it can be digested and absorbed by the animal. Especially in high milk-producing dairy cows, postruminal amino acid supply may limit performance. Ionophores, like lasalocid (Bovatec®), potentially can decrease ruminal protein breakdown because of their antimicrobial properties. Therefore, our objective was to evaluate the effect of lasalocid on ruminal protein degradation and on supply of amino acids to the small intestine of cattle, with the experiment serving as a model for the dairy cow.

Procedures

Five ruminally and duodenally cannulated Holstein steers (305 kg) were used in a switch-back experiment with three periods, to evaluate two experimental treatments, a basal diet with or without lasalocid. Three steers received the control diet in periods 1 and 3 and lasalocid in period 2, whereas the reverse order of treatments was applied to the other two steers. One observation was missing for the control treatment in period 1 because of excessive feed refusals by one steer.

The basal diet was high in protein and moderate in roughage (Table 1). Chromic oxide was included to serve as a digesta flow marker. Steers were fed twice daily at levels just below ad libitum intake. Each period consisted of a 10-day adaptation phase followed by a 4-day sample-collection phase. On the last day of adaptation, ruminal fluid samples were collected for measurements of deaminase and protease activity. Collections of ruminal fluid, duodenal digesta, and feces were made three times daily at 4-hr intervals with times moved forward 1 hr daily such that each hour between feedings was represented. Ruminal fluid samples were analyzed for pH, ammonia, volatile fatty acids, and free amino

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Table 1. Diets Fed to Steers

	Treatment	
Ingredient	Control	Lasalocid
	---- % as fed ----	
Dry rolled corn	44.4	44.4
Alfalfa hay	43.9	43.9
48% Soybean meal	10.0	10.0
Dicalcium phosphate	.6	.6
Trace-mineral salt	.5	.5
Molasses	.5	.5
Vitamin ADE	.1	.1
Lasalocid (45 ppm)		.03
Cellulose	.03	
Nutrient	--- % of DM ----	
Organic matter	92.4	92.5
NDF	29.6	29.9
Crude protein	16.6	16.8

acid and peptide concentrations. Duodenal and fecal samples were used to measure ruminal and total tract digestion of organic matter, fiber, and protein. Whole ruminal content samples were taken once a day, mixed in a blender, and strained through cheesecloth, with the subsequent ruminal fluid being pooled to obtain a representative sample of rumen bacteria.

Results and Discussion

Ruminal pH, ammonia, volatile fatty acids, and amino acid and peptide concentrations were unaffected by the presence of lasalocid in the diet; the values in Table 2 represent the averages across all of the collection times. Ruminal protease activity, a measure of the rumen's microbial capacity to degrade feed proteins, was reduced ($P<.05$) by 15% when lasalocid was fed, but deaminase activity, a measure of the rumen's microbial capacity to degrade free amino acids, did not change (Table 2). The decreased protease activity, however, did not appear to be large enough to affect intestinal crude protein (Table 4) or amino acid supply (Table 5).

Intake and digestion of dry matter, organic matter, and fiber remained unchanged when lasalocid was fed (Table 3), although ruminal digestibilities were numerically higher for lasalocid. The apparent ruminal digestibilities of organic matter appear somewhat low, but this may relate to a relatively rapid passage of corn particles that is often observed when mixed diets are fed.

Data for crude protein intake and digestion are presented in Table 4. If lasalocid, in fact, had decreased protein degradation in the rumen, we would have expected to see an increase in duodenal crude protein and amino acid supplies. However, these measures were not different between treatments. Partitioning intestinal crude protein supply between microbial and nonmicrobial fractions also showed no differences. Thus, lasalocid apparently affected neither the escape of dietary protein from ruminal degradation nor the quantity of bacterial protein that reached the small intestine. Although total tract digestion of crude protein is often less than ideal for assessing small intestinal digestion, the similarities between treatments for duodenal crude protein supply and fecal crude protein output would lead to the assumption that small intestinal digestion of crude protein was probably similar between treatments.

Flow of amino acids to the small intestine is shown in Table 5. Given the general lack of effect of lasalocid on total crude protein supply to the intestine, it is not surprising that intestinal amino acid supplies also were unaffected by lasalocid.

In conclusion, lasalocid decreased ($P<.05$) ruminal protease activity, but the decrease was of insufficient magnitude to alter either feed or bacterial crude protein supply to the small intestine. Thus, in this experiment, decreasing feed crude protein degradation in the rumen and increasing feed crude protein supply to the small intestine were not among the potentially beneficial effects of feeding lasalocid.

Table 2. Ruminal Measurements

	Treatment		
Parameter	Control	Lasalocid	SEM
pH	6.59	6.53	.05
Ammonia, mM	11.8	12.3	.77
Total VFA, mM	90.4	91.3	3.2
Acetate, mM	59.9	61.9	1.6
Propionate, mM	17.2	15.7	1.0
Butyrate, mM	9.0	9.0	.6
Isobutyrate, mM	1.4	1.4	.03
Valerate, mM	1.2	1.2	.04
Isovalerate, mM	1.9	1.8	.05
Amino acids, mg N/liter	1.88	1.83	.11
Peptides, mg N/liter	1.92	1.99	.09
Protease activity[1]	.477	.405[a]	.017
Deaminase activity[2]	.070	.066	.004

[a]Different (P<.05) from control.
[1]mg nonprotein-N produced per mL of rumen fluid per hr.
[2]mg ammonia-N produced per mL of rumen fluid per hr.

Table 3. Intake and Digestion of Dry Matter, Organic Matter, and Fiber

	Treatment		
Intake	Control	Lasalocid	SEM
	------------------- g/day -------------------		
Dry matter	5924	6138	216
Organic matter	5474	5680	201
NDF	1755	1838	65
Ruminal digestibility	--------------------- % ---------------------		
Dry matter, apparent	14.4	22.2	3.1
Organic matter, apparent	19.9	29.1	2.6
NDF	31.3	38.5	3.3
Total tract digestibility	--------------------- % ---------------------		
Dry matter	66.3	64.2	1.5
Organic matter	67.6	66.1	1.4
NDF	50.0	50.7	1.3

Table 4. Crude Protein Intake and Digestion

Crude protein	Treatment: Control	Treatment: Lasalocid	SEM
	g/day		
Intake	985.6	1034.4	39.4
Duodenal flow	877.5	868.8	51.3
Microbial	469.4	450.0	51.3
Nonmicrobial	408.1	418.8	21.3
Total tract digestibility, %	67.2	67.1	1.0
MOEFF[1]	193.1	187.5	49.4

[1]Microbial efficiency, g microbial CP/kg organic matter truly fermented in the rumen.

Table 5. Duodenal Amino Acid Flows

Amino acid	Treatment: Control	Treatment: Lasalocid	SEM
	g/day		
Aspartate	69.3	68.0	4.2
Threonine	40.8	39.1	2.4
Serine	44.6	43.0	2.6
Glutamate	118.1	112.4	6.8
Glycine	49.2	47.0	2.6
Alanine	59.6	56.4	3.7
Valine	45.6	42.7	2.9
Methionine	15.2	14.7	.9
Isoleucine	42.9	40.9	2.9
Leucine	79.1	75.8	5.2
Tyrosine	31.9	32.7	2.3
Phenylalanine	42.7	40.8	2.7
Lysine	48.5	49.4	3.1
Histidine	20.7	19.0	1.1
Arginine	42.1	40.8	2.2
Total amino acids	750.3	722.7	44.3

EFFECT OF PROCESSING SORGHUM GRAIN ON DAIRY CALF PERFORMANCE

I.E.O. Abdelgadir and J. L. Morrill

Summary

Two trials evaluated the effect of processing sorghum grain on performance of young dairy calves. In trial 1, newborn Holstein calves (49 heifers and 27 bulls) were blocked by age and sex and assigned randomly to each of three calf starters containing either raw, roasted (Jet-Pro®) at 280 degrees F, or conglomerated (Jet-Pro®) sorghum grain. The conglomeration process consisted of grinding the grain, adding water, and pelleting the mixture, then roasting it. Raw and roasted sorghum grains were ground through a .125-inch screen and included in complete pellet starters, whereas conglomerated sorghum grain pellets were mixed with the other ingredients of the starter, which were pelleted. Starters were offered ad libitum from birth to 8 wk of age. The raw sorghum grain starter was palatable and supported acceptable growth rates, but processing did not further enhance calf performance. In trial 2, roasted and conglomerated sorghum grains were ground through a .125-inch screen and included in pelleted starters fed ad libitum to Holstein calves (21 heifers and 28 bulls) from birth to 8 wk of age. Feed consumption and body weight gain were not affected by method of grain processing. However, 22% of calves on the conglomerated sorghum grain starter bloated sometime during the post-weaning period, which may have resulted in reducing feed intake. Measures to ensure maintenance of the rumen environment may be necessary, if a potential benefit of conglomerating sorghum grain for young dairy calves is to be realized.

(Key Words: Sorghum Grain, Processing, Calf Starters.)

Introduction

Extensive research had investigated methods for processing sorghum grain to improve its utilization by ruminants. The feeding value of sorghum grain is improved by steam flaking, reconstitution, micronizing, and popping. Processing disrupts the organization of starch and the association between protein and starch in the grain endosperm. In general, these methods have the potential for improving the utilization of the grain by 12 to 15%. Although these benefits were recognized widely for feedlot cattle, less information is available on the value of raw and processed sorghum grain for dairy calves.

The objective of this study was to evaluate the effects of feeding calf starters containing either raw, roasted, or conglomerated sorghum grain on the performance of dairy calves from birth to 8 wk of age.

Procedures

The study consisted of two feeding trials. In trial 1, newborn Holstein calves (49 heifers and 27 bulls) were moved to 4×4 ft wood hutches bedded with straw. They were blocked by sex and age, and calves within each sex block were assigned randomly to each of three isonitrogenous starters (Table 1) that contained either raw, roasted (Jet-Pro Co., Atchison, KS) at 280 degrees F, or conglomerated (Jet-Pro Co., Atchison, KS) sorghum grain. For the conglomeration process, the grain was ground, water was added, and the mixture was formed into pellets using a unique pellet-forming process, then roasted. The degrees of gelatinization (mg maltose equivalents/g sample) of raw, roasted, and conglomerated grain were 28.5, 66.9, and 198.6, respectively. Raw and roasted sorghum grains were ground through a

.125-inch screen and each included in a complete pellet starter, whereas conglomerated sorghum pellets were mixed with the complementary ingredients of the starter, which were pelleted. Starters were offered ad libitum from birth to 8 wk of age. Calves were fed milk at 4% of birth weight twice daily and weaned when they consumed 1.5 lb of starter per day for 3 consecutive days, provided that they were not less than 3 wk of age and had gained greater than or equal to 10 lb of body weight since birth.

In trial 2, roasted and conglomerated sorghum grains were compared in two isonitrogenous calf starters (Table 2) fed to Holstein calves (21 heifers and 28 bulls) from birth to 8 wk of age. Both grains were ground through a .125-inch screen and each included in a complete pellet starter.

In both trials, calves were observed daily for general appearance and consistency of their feces. Starter consumption and body weight gain were determined weekly. Heart girth and wither height were measured at the beginning and end of the experiments.

Results and Discussion

Trial 1

Weekly feed intake (Figure 1), weekly body weight gain (Figure 2), and overall performance (Table 3) were not improved by sorghum grain processing. The raw sorghum grain starter was palatable and supported acceptable growth rates. Calves on the conglomerated sorghum grain starter consumed less feed and tended to gain less weight. The hardness of pellets as measured by the pellet durability index method was similar across diets (93-94%), indicating that palatability rather than the hardness of the conglomerated sorghum grain pellets might be the reason for reduced starter consumption. Rumen fluid pH, which may serve as an indicator of rumen fermentation activity, was unexpectedly high (Table 3) for calves on the conglomerated grain starter, despite the high degree of gelatinization of the conglomerated sorghum grain starch. This may have been due to either low feed intake, the pellets being less available for the rumen microorganisms, or both.

Trial 2

Weekly feed intake (Figure 3), body weight gain (Figure 4), and overall performance (Table 4) were not affected by method of sorghum grain processing. However, 22% of calves on the conglomerated sorghum grain starter bloated sometime during the postweaning period. Bloat was more severe when calves were consuming more than 6 lb of starter per day, mostly when they were more than 6 wk of age. Bloat was relieved easily by passage of a stomach tube, and, in all cases no special medication was required. However, bloat, which tended to recur in the same calves (the good eaters), may have resulted in depressed starter consumption and consequently may have prevented a potential enhancement of weight gain by the conglomeration process.

Results from this study indicate that raw sorghum grain can support acceptable growth rates when used in calf starters. Roasting the grain did not improve its feeding value under the conditions of this experiment. If a potential benefit from feeding conglomerated sorghum grain is to be realized in young calves up to 8 wk of age, proper measures to prevent bloat may be necessary.

Table 1. Composition and Analysis of Calf Starters in Trial 1

	Starter		
Ingredient	Raw sorghum grain	Roasted sorghum grain	Conglomerated sorghum grain
	---% as fed---		
Sorghum grain	40.05	38.95	38.5
Soybean meal	16.01	16.31	16.45
Oats	14.76	15.03	15.11
Alfalfa hay, ground	19.46	19.82	19.97
Molasses	7	7.13	7.19
Coccidiostat	1.31	1.33	1.33
Vit-mineral premix	1.41	1.43	1.45
Analysis			
DM, %	88.3	88.8	90
	---% of dry matter---		
CP	19.5	19.8	20.2
NDF	23.3	22.8	20.7
ADF	11.2	11.5	11.3
Ether extract	2.8	2.6	2.4
Ash	7.1	6.8	6.6

Table 2. Composition and Analysis of Calf Starters in Trial 2

	Starter	
Ingredient	Roasted sorghum grain	Conglomerated sorghum grain
	---% as fed---	
Sorghum grain	39.33	39.01
Soybean meal	16.18	16.5
Oats	15	15
Alfalfa hay, ground	20	20
Molasses	7	7
Coccidiostat	1.32	1.32
Vit-mineral premix	1.17	1.17
Analysis		
DM, %	89.1	88.5
	---% of dry matter---	
CP	19	19.6
NDF	20.2	20.1
ADF	11.4	11.3
Ether extract	2.6	2.4
Ash	7.1	6.6

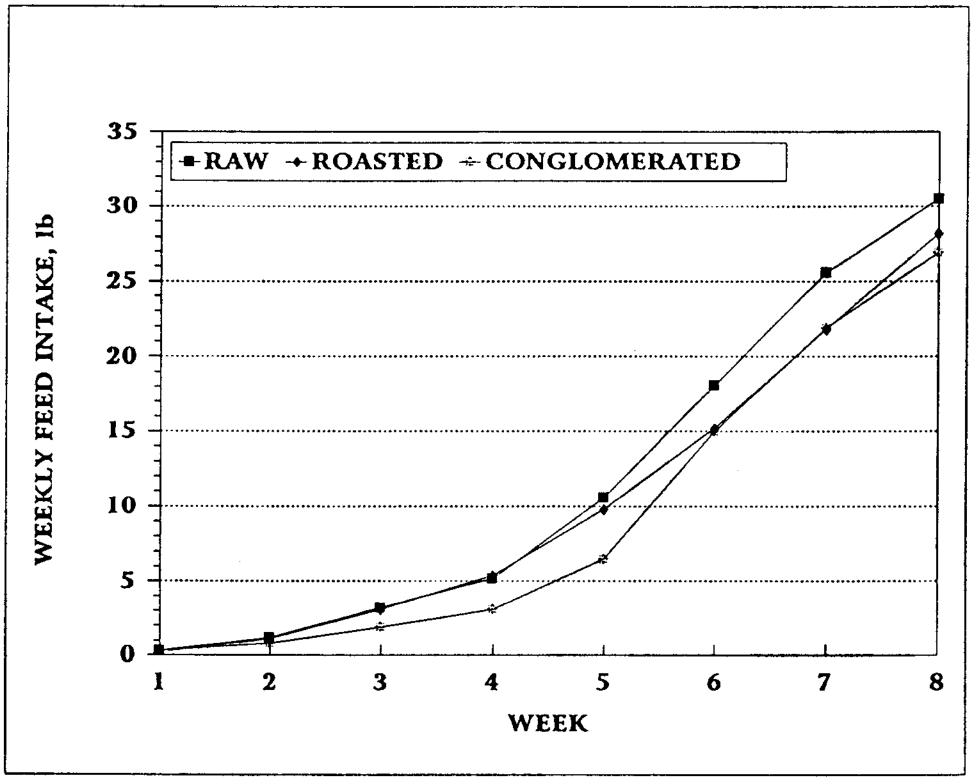

Figure 1. Weekly Feed Intake of Calves in Trial 1

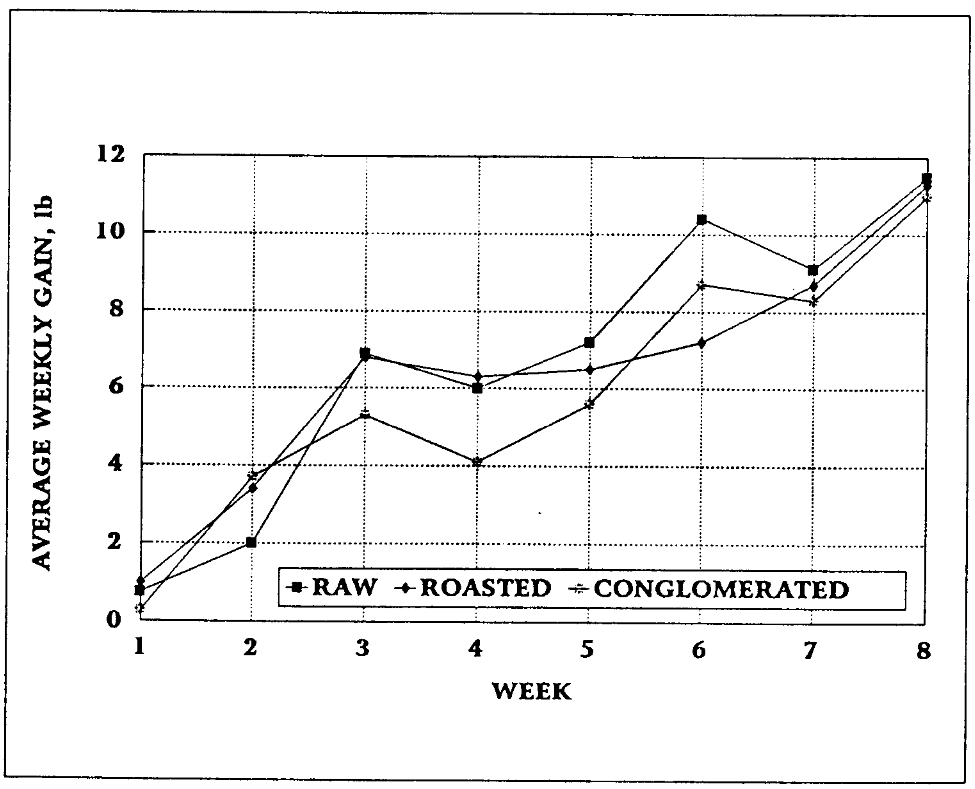

Figure 2. Weekly Body Weight Gain of Calves in Trial 1

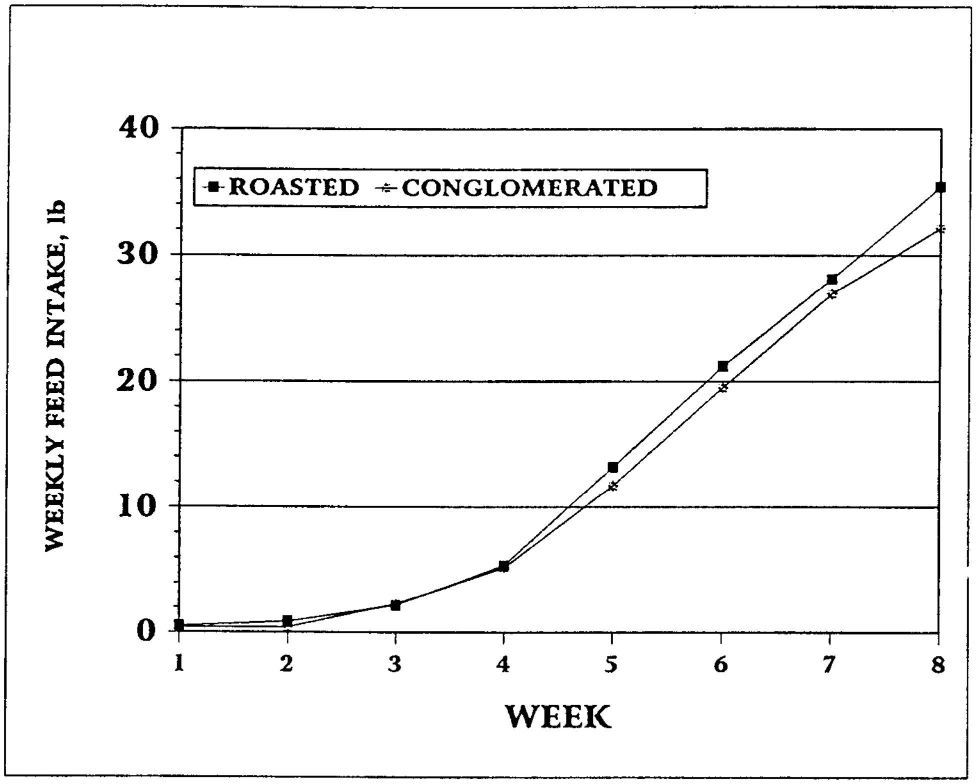

Figure 3. Weekly Feed Intake of Calves in Trial 2 (22% of Calves on the Conglomerated Sorghum Starter Bloated during Wk 6 to 8.)

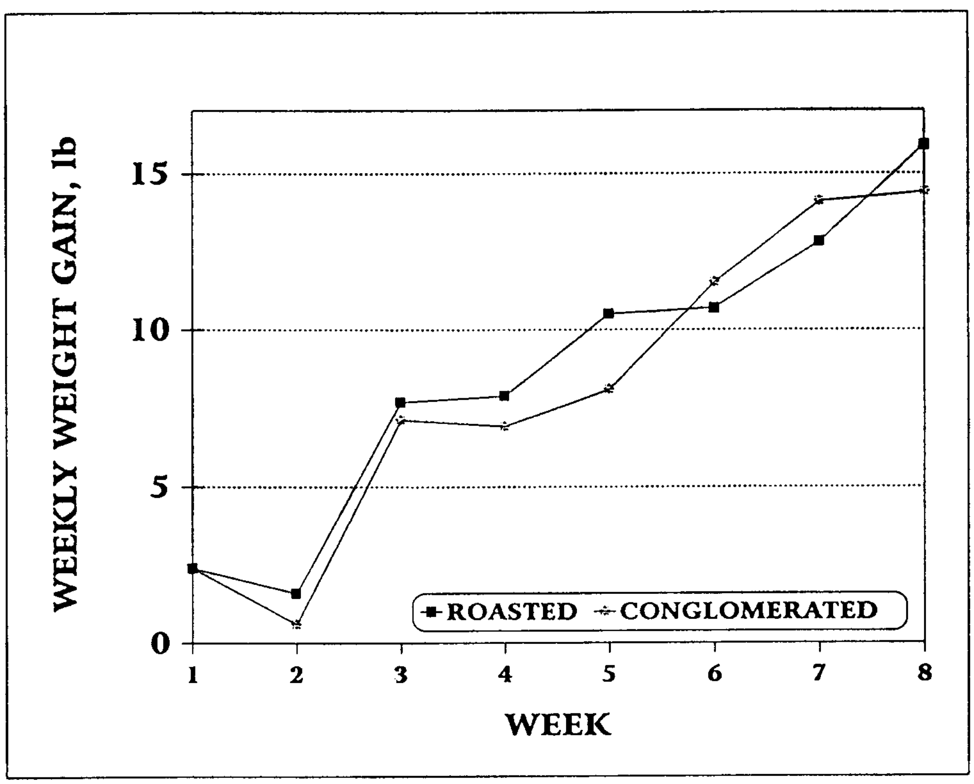

Figure 4. Weekly Body Weight Gain of Calves in Trial 2 (22% of Calves on the Conglomerated Sorghum Grain Starter Bloated during Wk 6 to 8.)

Table 3. Overall Calf Performance in Trial 1

	Starter diet			
Item	Raw	Roasted	Conglomerated	SEM
Weight gain, lb	52.3	51.2	46.5	3.5
Feed intake, lb	94.7[a]	84.9[a]	76.4[b]	8.4
Gain:feed, (lb/lb)[1]	.37	.39	.41	.03
Girth gain, in	5.2	5.1	4.6	.33
Height gain, in	2.7	2.7	2.7	.22
Average age at weaning, days	32.2	34.7	33.6	1.3
Rumen fluid pH[2]	5.79[b]	5.36[b]	6.11[a]	.22

[a,b]Means within a row lacking a common superscript letter differ (P<.10).
[1]Determined for the postweaning period (wk 6 to wk 8).
[2]Measured at wk 8.

Table 4. Overall Calf Performance in Trial 2

	Starter diet		
Item	Roasted	Conglomerated	SEM
Weight gain, lb	68.9	65.6	3.3
Feed intake, lb	106.8	98.7	6.1
Gain:feed, (lb/lb)[1]	.46	.48	.11
Girth gain, in	5.6	5.1	.3
Height gain, in	3	2.99	.2
Average age at weaning, days	31.8	31.8	.9
Rumen fluid pH[2]	5.87	5.7	.14

[1]Determined for the postweaning period (wk 6 to wk 8).
[2]Measured at wk 8.

EVALUATION OF ENZYME-MODIFIED WHEAT GLUTEN AS A COMPONENT OF MILK REPLACERS FOR CALVES

H. Terui, J. L. Morrill, and J. J. Higgins[1]

Summary

Holstein bull calves (n=120) were assigned randomly to be fed either of five milk replacers (MR) that contained different amounts of crude protein (CP) and protein from wheat gluten (WG) for 6 weeks. Weight gains of calves fed MR containing 20% CP, with either 0, 30, or 50% of the protein coming from WG, were similar, as were gains of calves fed MR containing 18% CP with either none or 33% of the protein from WG. When WG supplied 33% of the protein, calves fed 18% CP gained as much as calves fed MR containing 20% CP. Calves fed MR containing 20% CP consumed more dry feed than those fed MR containing 18% CP, when both used only milk sources for protein. Calf feces were more solid when calves were fed MR containing 20% CP if 30% of the protein was supplied by WG, compared to when 50% was supplied by WG. Enzyme-modified WG was an effective substitute for milk protein in a calf milk replacer.

(Key Words: Wheat Gluten, Milk Replacers, Calves, Crude Protein.)

Introduction

Calves need milk or a high energy, high protein MR in very early stages of life. Good performance can be attained by using all-milk protein MR; however, more economical sources for part or all of the protein for MR are needed. In a recent study conducted at Kansas State University, nursery pigs showed a significant improvement in performance when WG was included at 6 to 8% of their diet. The objective of this study was to evaluate soluble (enzyme modified) WG as a protein source in MR for calves.

Procedures

Holstein bull calves (n=120) were purchased in Oklahoma and transported to Cottonwood Farm in McLouth, KS, within 3 d after birth. Those calves were blocked randomly and assigned to be fed either of five MR (Table 1). All MR contained 20% fat. The contents of CP for those MR were: 20% CP (100% of protein from milk [MP]) (20WG0); 20% CP (30% of protein from wheat gluten [WG]) (20WG30); 20% CP (50% WG) (20WG50); 18% CP (100% MP) (18WG0); and 18% CP (33% WG) (18WG33). Calf starter (Calf Choice 16 B68, Farmland Industries Inc., Table 2) was available ad libitum during wk 4 to 6 for all calves and fed daily in amounts necessary to ensure freshness. Weekly starter consumption was determined. Fecal scores were recorded (1 = firm to 4 = liquid) during wk 1 to 3.

Results and Discussion

Five calves died during the 6 wk of the experiment: one each on 20WG0, 20WG30, and 20WG50, and two on 18WG0.

Table 3 summarizes averages of body weights. At wk 6, calves fed 20WG50 were heavier (P<.10) than calves on 18WG0. No other differences in body weights occurred among other treatments during the 6-wk study.

Table 4 presents body weight gain. From wk 2 to wk 4, the calves on 18WG0 gained less (P<.10) than calves on 20WG30 and 18WG33. From wk 4 to 6, weight gains of calves on 20WG0 and 20WG50 were greater (P<.05) than gains of calves on 18WG0. Calves fed

[1]Department of Statistics.

18WG33 gained more (P<.10) than calves on 18WG0. Overall, calves on 20WG50 gained more (P<.05) than calves on 18WG0. In addition, calves fed 20WG0 and 18WG33 gained more weight than calves on 18WG (P<.10). No other difference in body weight gain was observed.

Table 5 illustrates dry feed consumption. Wk 6 and overall amounts of dry feed consumed were greater (P<.05) for calves on 20WG0 than calves on 18WG0.

The average fecal scores (Table 6) were lower (P<.05; less diarrhea likely) for the calves on 20WG30 than for the calves on 20WG0 in wk 1. In wk 2, calves on 20WG30 had lower (P<.05) fecal scores than calves on 20WG50, 18WG33, and 18WG0. Calves on 20WG0 had lower (P<.05) fecal scores than calves on 20WG50 and 18WG0. According to overall fecal scores, more (P<.05) diarrhea was likely for calves on 20WG50 than for calves on 20WG30.

In conclusion, enzyme-modified WG was a good source of protein for calf milk replacers. Growth of calves fed MR containing 20% CP did not differ when WG furnished 0, 30, or 50% of the CP. Between 18% CP milk replacers, calves gained more weight (P<.10) when 33% of CP was supplied by wheat gluten. In wk 1 to 3, replacing 50% of CP with WG caused more diarrhea than replacing 30% of CP with wheat gluten in 20% CP milk replacers.

Table 1. Compositions of the Milk Replacers (Dry Matter Basis)

Item	20WG0	20WG30	20WG50	18WG0	18WG33
			%		
Lactose	47.0	45.0	45.0	48.5	47.3
Crude protein	19.9	20.1	20.1	18.0	18.0
Milk protein (% of CP)	100.0	70.0	50.0	100.0	67.0
Wheat protein (% of CP)	--	30.0	50.0	--	33.0
Crude fat	19.9	19.8	19.8	19.9	20.0
Energy (ME Mcal/kg)	4.3	4.2	4.2	4.3	4.2
Ash	5.7	6.0	6.2	6.0	6.3
Ca	0.76	0.78	0.79	0.79	0.81
P	0.68	0.71	0.73	0.70	0.73
Na	0.55	0.68	0.76	0.58	0.70
K	1.37	1.29	1.23	1.40	1.31
Mg	0.10	0.10	0.11	0.11	0.11
			mg/kg		
Fe	105.11	108.43	110.71	105.01	108.28
Co	1.24	1.23	1.22	1.24	1.23
Cu	11.40	11.72	11.94	11.34	11.65
Mn	41.54	42.35	42.93	41.86	42.66
Zn	105.39	107.19	108.50	105.49	107.33
Se	0.31	0.31	0.31	0.31	0.31
I	8.40	6.90	5.79	7.88	6.37
			IU/lb		
Vitamin A(x 10^3)	31.0	31.0	31.0	31.0	31.0
Vitamin D_3(x 10^3)	11.0	11.0	11.0	11.0	11.0
Vitamin E	110.1	110.1	110.1	110.1	110.1

Table 2. Nutrient Content of Dry Feed[1] (Calf Choice 16 B68)

Nutrient		Percent
CP	(minimum)	16.0
C-Fat	(minimum)	2.0
C-Fiber	(maximum)	12.5
Lasalocid		68 g/ton

[1]Percentage guaranteed by Farmland Industries, Inc.

Table 3. Mean Body Weight of Calves Fed Milk Replacers

	Week			
Milk replacer	0	2	4	6
	lb			
20WG0	85.7	91.9	101.8	109.7[cd]
20WG30	85.0	89.6	101.3	107.3[cd]
20WG50	86.3	91.9	102.0	110.8[c]
18WG0	87.7	93.4	102.0	104.6[d]
18WG33	85.7	91.2	102.6	109.0[cd]
SE	1.8	1.8	2.0	1.2

[c,d]Means within column without a common superscript letter differ (P<.10).

Table 4. Average Body Weight Gain of Calves Fed Milk Replacers

	Week			
Milk replacer	0 to 2	2 to 4	4 to 6	Total (0 to 6)
	lb			
20WG0	5.9	9.9[cd]	7.7[a]	23.8[ab]
20WG30	4.8	11.7[c]	5.7[ab]	22.2[ab]
20WG50	5.1	9.5[cd]	8.8[a]	24.7[a]
18WG0	5.7	8.6[d]	2.6[b]	17.2[b]
18WG33	5.5	11.5[c]	6.4[ab]	23.3[ab]
SE	1.5	1.1	1.5	2.4

[a,b]Means within column without a common superscript letter differ (P<.05).
[c,d]Means within column without a common superscript letter differ (P<.10).

Table 5. Mean Weekly Feed Consumption of Calves Fed Milk Replacers

	Week			
Milk replacer	4	5	6	Total (0 to 6)
	lb			
20WG0	.29	2.60	7.44[a]	10.35[a]
20WG30	.31	2.58	6.70[ab]	9.58[ab]
20WG50	.26	2.49	6.87[ab]	9.74[ab]
18WG0	.24	2.09	5.13[b]	7.47[b]
18WG33	.37	2.44	7.05[ab]	9.87[ab]
SE	.07	.29	.75	1.01

[a,b]Means within column without a common superscript letter differ (P<.05).

Table 6. Mean Fecal Scores of Calves Fed Milk Replacers

	Week			
Milk replacers	1	2	3	Total (1 to 3)
20WG0	3.35[a]	2.26[bc]	2.28	2.61[ab]
20WG30	2.99[b]	2.21[c]	2.38	2.52[b]
20WG50	3.22[ab]	2.47[b]	2.42	2.69[a]
18WG0	3.14[ab]	2.58[a]	2.21	2.63[ab]
18WG33	3.17[ab]	2.40[ab]	2.36	2.63[ab]
SE	0.13	0.07	0.10	0.06

[a,b,c,d] Means within column without a common superscript letter differ (P<.05).

TOTAL MIXED RATIONS FOR FEEDING DAIRY HEIFERS FROM 3 TO 6 MONTHS OF AGE

H. Terui, J. L. Morrill, and J. J. Higgins[1]

Summary

Total mixed rations (TMR) with different forage (F):concentrate (C) ratios were fed to Holstein heifers (n = 135) 12 to 24 wk of age. In four trials, the heifers were divided into different age groups and fed three different F:C ratios. Based on the results, the following recommendations are made.

First, if facilities are available for only two groups from 12 to 24 wk of age and heifers are at the desired body weight (BW) at 12 wk of age, they should fed a diet similar to the experimental TMR 50:50 with a F:C ratio of 50:50 from 12 to 18 wk of age. For the next 6 wk, the heifers should be kept on the same diet or changed to a higher or lower concentration of energy, depending on their condition at the time, which will be a function of the quality of ingredients (primarily, the roughage) used in the diet. Feed consumption will be about 9 lb/head/day for heifers 12 to 18 wk of age, and 12 to 13 lb/head/day for heifers 18 to 24 wk of age.

Second, if facilities allow for three groups from 12 to 24 wk of age and the heifers are at the desired BW at 12 wk of age, the diet should contain approximately 33, 50, and 70% hay for heifers 12 to 16, 16 to 20, and 20 to 24 wk of age, respectively. If heifers are not at the desired BW at 12 wk of age, they should stay on the 33:67 diet until they reach desirable weight. Feed consumptions will be about 8 to 9 lb/head/day for heifers 12 to 16 wk of age, 10 to 12 lb/head/day from 16 to 20 wk of age, and 12 to 14 lb/head/day from 20 to 24 wk of age.

(Key Words: Total Mixed Ration, Heifer, Forage:Concentrate Ratio.)

Introduction

Use of TMR for feeding lactating cows has become common in most parts of the United States and some other parts of the world. However, feeding TMR to dairy heifers 12 to 24 wk of age has not been evaluated adequately. To formulate TMR for heifers, dry matter (DM) consumption at the different ages with different ratios of F and C must be known. Dairy heifers should gain approximately 1.7 lb per day from 12 to 24 wk of age and weigh approximately 380 lb by 24 wk of age. Desirable F to C ratios should be determined to achieve that daily gain.

The objective of this experiment was to determine the proper F:C ratio for dairy heifers from 12 to 24 wk of age as measured by BW, body condition score (BSC), average daily gain (ADG), and DM intake.

Procedures

Holstein heifers (n = 135) at the Kansas State University Dairy Research Center were used. In four trials, different F to C ratios used were 33:67, 50:50, and 70:30 (Table 1). In each trial, fresh TMR was always available in the feed bunk. Water was available ad libitum. Feed refusals, BW, and BCS, were measured weekly.

Four pens were available for use; thus, in each trial the heifers were divided into four groups that differed in ages and/or feed consumed.

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Trial 1. Data were collected on 61 heifers during the time they were in one of four groups: 12 to 18 wk of age fed 33:67; 12 to 18 wk of age fed 50:50; 18 to 24 wk of age fed 33:67; or 18 to 24 wk of age fed 50:50. Heifers started on 33:67 stayed on that ratio when they reached 18 wk of age but were moved to the pen with heifers 18 to 24 wk of age, and heifers started on 50:50 stayed on that ratio, but were moved to another pen, when they reached 18 wk of age.

Trial 2. Heifers (n = 21) were assigned to one of four groups: 12 to 18 wk of age, fed F:C ratio of 33:67; 12 to 18 wk of age, fed 50:50; 18 to 24 wk of age, fed 70:30; and 18 to 24 wk of age, fed 50:50. Heifers on 33:67 from 12 to 18 wk of age were assigned to 70:30 from 18 to 24 wk of age and moved to another pen with heifers 18 to 24 wk of age, and heifers started on 50:50 stayed on that ratio, in another pen, from 18 to 24 wk of age.

Trial 3. The heifers (n = 26) were assigned randomly to four groups. All heifers were fed 33:67 from 12 to 20 wk of age, but were in different groups from 12 to 16 wk and from 16 to 20 wk of age. At 20 wk of age, the heifers were assigned either to be fed a 50:50 or 70:30 TMR according to their BW. If the heifer was lighter than the desirable BW (328 lb), she was assigned to 50:50 and moved to the pen with heifers 20 to 24 wk of age. If heavier, she was assigned to 70:30 and moved to another pen.

Trial 4. Heifers (n = 27) were grouped following the same procedure as trial 3, except they were assigned randomly either to be fed a 50:50 or 70:30 TMR when they were 20 wk of age.

Results and Discussion

Trial 1. Figure 1 shows weekly BW. Average wt of heifers was less than desirable at 12 wk of age. From 12 to 16 wk of age, gain of the heifers was similar and acceptable for heifers of that age (Table 3) but was not sufficient to bring heifers to desirable BW at 16 wk of age. From 16 wk of age until 24 wk of age, growth of heifers fed 33:67 was above normal for that age and allowed the heifers to reach desirable BW by 24 wk of age. The gain of heifers fed 50:50 was adequate but was less ($P<.05$) than that of heifers fed 33:67 from 16 to 24 wk of age and did not allow them to reach desirable BW by 24 wk of age. Heifers fed 33:67 consumed more ($P<.05$) feed between 18 and 24 wk of age than those fed 50:50 (Table 2). No significant difference was observed in BCS during the trial (Table 3).

Trial 2. Figure 2 shows weekly BW. Average BW of heifers assigned to 33:67 was below normal at the start of the trial but close to the desired BW by 18 wk of age. Heifers assigned to 50:50 were close to desirable BW at 12 wk of age and remained close to desirable BW during the entire 12 wk. The heifers changed from 33:67 to 70:30 reached desirable BW by 20 wk of age and were close to desirable BW by 24 wk of age.

Trial 3. Figure 3 shows weekly BW. The average BW of the heifers was close to, but slightly below, desirable BW at the beginning of the trial and stayed slightly below desirable BW throughout the 6 wk that they were fed 33:67. From 20 to 24 wk of age, BW of heifers fed 70:30 was more ($P<.01$) than that of heifers fed 50:50. This difference was expected at the beginning, because the heifers were separated according to size; however, we expected that the difference in BW between groups would decrease, because the lighter wt heifers were fed a ration with higher energy concentration. Why the difference did not decrease could not be explained by feed consumption, because both groups consumed the same (Table 2). The heifers fed 70:30 consumed less protein than the other group; therefore, protein intake could not explain their better performance. They may have used feed more efficiently, and this may have been why they were larger than heifers assigned to the 50:50 TMR.

Trial 4. Heifers used in Trial 4 were at the desired BW at 12 wk of age (Figure 4) and wt gains from 12 to 20 wk of age were above the desired rate of gain (Table 3), resulting in heifers that were, on the average, slightly above desired BW at 20 wk of age. From 20 to 24 wk of age, heifers fed 50:50 consumed more ($P<.01$) feed (Table 2). Weight gains of both groups were above 1.7 lb per day (Table 3), and heifers fed the 50:50 seemed to gain more.

Intake of nutrients depends on diet formulation and amount of that diet consumed. Intake of diet will depend on quality of ingredients, as well as management and environmental factors; thus, intake of a given formulation will not be a constant. Therefore, there are limitations in adapting these results to a specific location. With these qualifications in mind, these data should be useful in formulating TMR for heifers of this age, and the following recommendations are presented.

First, if facilities are available for only two groups from 12 to 24 wk of age and heifers are at the desired body weight (B W) at 12 wk of age, they should be fed a diet similar to the experimental TMR 50:50 from 12 to 18 wk of age. For the next 6 wk, the heifers should be kept on the same diet or changed to a higher or lower concentration of energy, depending on the condition of their at the time, which will be a function of the quality of ingredients (primarily, the roughage) used in the diet. Feed consumption will be about 9 lb/head/day for heifers 12 to 18 wk of age and 12 to 13 lb/head/day for heifers 18 to 24 wk of age.

Second, if facilities allow for three groups from 12 to 24 wk of age and the heifers are at the desired BW at 12 wk of age, the diet should contain approximately 33, 50, and 70% hay for heifers 12 to 16, 16 to 20, and 20 to 24 wk of age, respectively. If heifers are not at the desired BW at 12 wk of age, they should stay on the 33:67 diet until they reach desirable weight. Feed consumption will be about 8 to 9 lb/head/day for heifers 12 to 16 wk of age, 10 to 12 lb/head/day from 16 to 20 wk of age, and 12 to 14 lb/head/day from 20 to 24 wk of age.

At all times, the individual heifers should be observed and should be changed to a different diet if condition is above or below that desired.

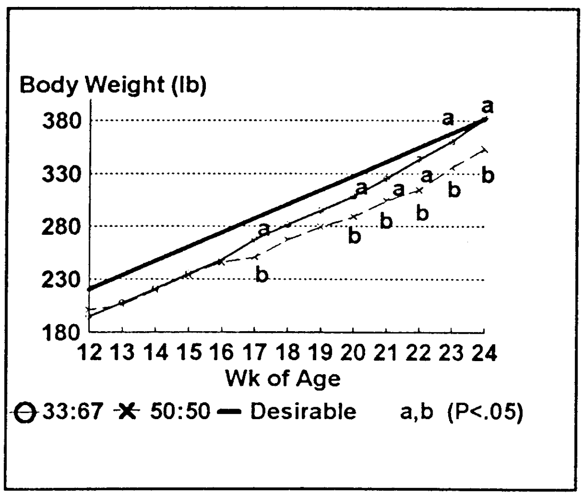

Figure 1. Weekly Body Weight from 12 to 24 Wk of Age (Trial 1)

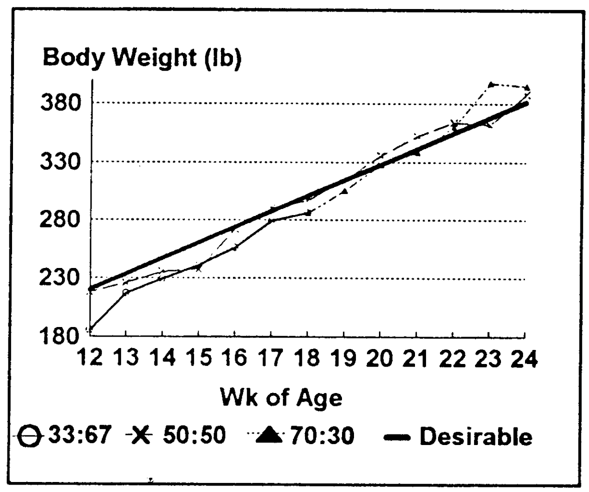

Figure 2. Weekly body Weight from 12 to 24 Wk of Age (Trial 2)

Table 1. Composition of Total Mixed Rations (TMR) on a Dry Matter (DM) Basis

	Forage:concentrate ratio		
Item	33:67	50:50	70:30
Ingredients	----------	%	----------
Alfalfa hay	32.1	47.1	69.0
Molasses	1.2	1.1	2.2
Corn	55.6	46.6	28.0
SBM 44	10.8	4.7	-
Ca-P supplement (18% Ca 22% P)	.14	.25	.06
Se supplement 600 ppm	.01	.10	.01
TM Salt	.14	.13	.10
Lasalocid 68 g/lb	.02	.02	.01
Vitamin E 2000 IU/lb	—	—	.05
Chemical Composition			
	----------	%	----------
DM	88.2	89.0	89.3
NDF	21.2	24.3	36.4
ADF	11.5	17.1	28.4
CP	17.6	15.8	15.5

Table 2. Average Feed Consumption in Four Trials

	Forage:concentrate ratio			
Week of age	33:67	50:50	70:30	SE
Trial 1	----------	lb/head/day	----------	
12 to 18	8.7	7.9	—	.3
18 to 24	12.2[c]	11.4[d]	—	.3
Trial 2				
12 to 18	9.0	8.5	—	.4
18 to 24	—	13.1	11.7	.4
Trial 3				
12 to 16	8.4	—	—	.5
16 to 20	10.7	—	—	.5
20 to 24	—	12.2	12.2	.5
Trial 4				
12 to 16	9.6	—	—	.4
16 to 20	12.1	—	—	.4
20 to 24	—	14.6[a]	12.5[b]	.4

[a,b]Means within a row without a common superscript letter differ (P<.01).
[c,d]Means within a row without a common superscript letter differ (P<.05).

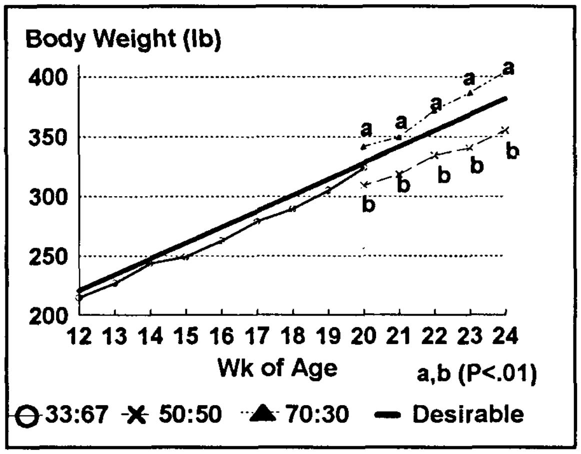

Figure 3. Weekly Body Weight from 12 to 24 Wk of Age (Trial 3)

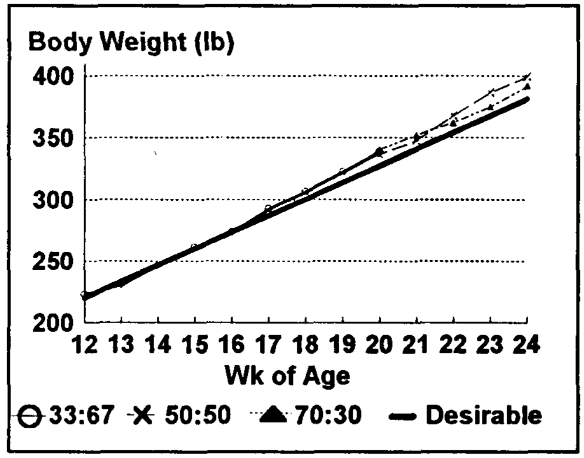

Figure 4. Weekly Body Weight from 12 to 24 Wk of Age (Trial 4)

Table 3. Body Condition Score and Average Daily Gain of Heifers in Four Trials

	Forage:concentrate ratio			
Week of age	33:67	50:50	70:30	SE
	Body condition scores			
Trial 1				
12 to 18	3.1	3.0	—	.1
18 to 24	2.8	2.8	—	.1
Trial 2				
12 to 18	2.8	2.8	—	.1
18 to 24	—	3.2	3.0	.2
Trial 3				
12 to 16	2.9	—		.1
16 to 20	2.9	—		.1
20 to 24	—	3.0	3.1	.1.
Trial 4				
12 to 16	2.9	—	—	.3
16 to 20	3.0	—	—	.3
20 to 24	—	3.3	3.1	.1
	Average daily gain (lb/day)			
Trial 1				
12 to 18	2.0	1.9	—	.1
18 to 24	2.6[a]	2.1[b]	—	.1
Trial 2				
12 to 18	1.9	1.7	—	.4
18 to 24	—	2.3	1.8	.5
Trial 3				
12 to 16	2.0	—		.2
16 to 20	2.7	—		.1
20 to 24	—	1.9	2.2	.3
Trial 4				
12 to 16	2.0	—	—	.1
16 to 20	2.3	—	—	.1
20 to 24	—	2.5	2.0	.4

[a,b]Means within a row without a common superscript letter differ (P < .01).

RATE AND EXTENT OF LOSSES FROM TOP SPOILAGE IN ALFALFA SILAGES STORED IN BUNKER SILOS

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Summary

Alfalfa silages were made in pilot- and farm-scale silos, and five sealing treatments were compared. After 90 days, sealing dramatically reduced dry matter (DM) losses at the 5 and 10 inch depths in the farm silos and at the 0 to 12, 12 to 24, and 24 to 36 inch depths in the pilot silos. Extending the storage period to 180 days in pilot silos had no effect on DM losses for sealed or delay-sealed silages, but DM losses for unsealed silages continued to increase at all three depths. Placing a roof over the unsealed, farm-scale silo increased the silage DM content at all three depths, increased storage temperatures at the 10 and 20 inch depths, and reduced DM loss at the 10 inch depth compared to the unsealed silo without a roof. Rainfall was much above normal (16.8 inches during the first 90 days of storage; 11.2 inches the second 90 days) and contributed to huge increases in the moisture content of silage at the lower depths in the unsealed, no roof, pilot- and farm-scale silos. Sealing also increased the nutritive value of the silages at the 5 and 10 inch depths.

(Key Words: Silage, Alfalfa, Top Spoilage, Bunker Silos.)

Introduction

Large horizontal silos (i.e., bunkers, trenches, and stacks) are economical for storing large quantities of ensiled feeds, but by design, much of the silage is exposed to the environment. In a silo with about 1,000 tons capacity (100 ft long × 40 ft wide × 12 ft deep), up to 25% of the original silage mass is within the top 3 feet. In an earlier study with alfalfa, we found that DM losses in an unsealed bunker exceeded 72 and 32% in the top 0 to 12 and 12 to 24 inches, respectively, after 12 wk of storage (KAES Report of Progress 623, page 74). However, sealing with polyethylene sheeting reduced the DM losses to less than 8% at each depth.

Our objectives were: 1) to measure the rate and extent of top spoilage losses in unsealed and sealed alfalfa silages and 2) to determine the effects of delaying sealing and of placing a roof over the silage mass on preservation efficiency and nutritive value. To our knowledge, the feasibility of using a roof to protect an unsealed silage mass from rain and snowfall has not been studied in controlled experiments.

Procedures

Farm-scale silos. On June 25 and 26, 1992, second cutting alfalfa was chopped and packed into four, 16 ft long × 13.5 ft wide × 4 ft deep, bunker silos. Alternate loads were used to fill the bottom half of each silo on the first day and the top half of each silo on the second day. All alfalfa was cut with a mower-conditioner and allowed to wilt for 24 hr before chopping. While the silos were being filled, nylon net bags, each containing 4.4 lb of fresh material, were placed at depths of 5, 10, and 20 inches from the surface of the initial ensiled mass (3 bags/ depth/silo). Thermocouples were placed at each bag location, and temperatures were recorded daily for the first 30 days, then twice weekly thereafter. The silos contained similar amounts of fresh material and were packed with tractors to densities that were similar to farm-scale conditions.

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Treatments were: 1) silo left unsealed, without a roof; 2) sealed, without a roof; 3) left unsealed, with a roof; and 4) sealed, with a roof. Both sealed silos were covered with a single sheet of .4 mm polyethylene, weighted with tires. A galvanized, tin roof was used for treatments 3 and 4. Bunkers were emptied at 90 days postfilling. The nylon net bags were recovered after the settling depths had been recorded, and the silage was weighed; mixed; sampled; and analyzed for dry matter (DM), pH, and in-situ DM digestibility. Depth settled was not recorded at the 10 inch depth.

Pilot-scale silos. The same chopped alfalfa that was used to fill the farm-scale silos was packed to equal densities into 33, polyethylene-lined, 55-gal drum, pilot-scale silos. Each drum was divided horizontally into thirds with nylon netting to partition the fresh material at 12 and 24 inches below the initial surface. A perforated, 1-inch, PVC pipe was placed at the bottom of the drums and connected through an air lock to drain percolated water. The first four treatments were the same as those described for the farm-scale silos, plus a fifth treatment in which sealing was delayed 7 days. All sealed silos were covered with a single .4 mm sheet of polyethylene; silos designated as "unroofed" were stored outside; silos designated as "roofed" were stored in an open-sided, metal building.

The "unroofed" pilot-scale silos were opened at 7, 90, and 180 days postfilling; the "roofed" silos were opened at 90 and 180 days; and delay-sealed silos were opened at 180 days. Three silos per treatment were opened at each time; the silage at each depth was weighed, mixed, and sampled; and the samples were analyzed for DM and pH.

Data collected from the pilot-scale silos were analyzed by analysis of variance of a split-plot design with sealing treatments and time after filling being whole-plot factors and location (depth from the initial surface) within drums denoting the subplot units. When significant sealing treatment by storage time by depth interactions occurred, the depths were analyzed separately. Comparisons were then made within days postfilling across sealing treatment.

Results and Discussion

The effects of sealing treatment, depth from the initial surface, and days postfilling on the preservation efficiency and nutritive value traits measured are shown in Table 1 (farm-scale silos) and Table 2 (pilot-scale silos).

In the farm-scale silos, sealing (with or without a roof) dramatically reduced silage DM losses and storage temperatures at the 5 and 10 inch depths. The silages in the two sealed silos were well preserved at all three depths, but only the silage at the 20 inch depth in the two unsealed silos was of acceptable quality. Silage DM losses at the 20 inch depth ranged from 6.3 to 12.8% in the four silos. Temperatures in the two sealed silos peaked within the first 3 days postfilling; temperatures in the unsealed, no-roof silo peaked within the first 3 to 4 wk; but temperatures in the unsealed, roof silo remained high for the longest time, particularly at the 20 inch depth. The unusually high rainfall during the 90-day storage (16.8 inches) produced a large amount of percolated water through the unsealed, no-roof silage; and the silages at the 10 and 20 inch depths were 10.1 and 15.3 percentage units wetter than the pre-ensiled forage. In contrast, the silages at the 10 and 20 inch depths in the unsealed, roof silo were actually 22.3 and 2.3 percentage units drier than the pre-ensiled forage, because considerable dehydration/evaporation took place in the absence of a seal. Placing a roof over the unsealed silage did not affect DM losses at the 5 and 20 inch depths compared to the unsealed, no-roof silage, but it reduced DM loss from 52.4 to 23.4% at the 10 inch depth. In-situ DM digestibilities of the unsealed silages at the 5 and 10 inch depths were 10 to 15 percentage units lower than those of the sealed silages.

In the pilot-scale silos, sealing (with or without a roof) produced similar preservation traits (i.e., DM content, DM recovery, and pH) as the farm-scale silos after 90 days of storage; and little, if any, additional deterioration occurred after 180 days. In general, the pilot-scale, unsealed, roofed silos had similar silage preservation traits to the farm-scale silo; however, silages in the pilot-scale, unsealed, no-roof silos at 90 days were much more deteriorated than their farm-scale counterpart. This is explained, in part, by a greater influence of the side wall in the 2.1 ft diameter pilot silos vs. the 13.5 ft wide farm silos. Delayed sealing (7 days) resulted in a dramatic improvement in preservation efficiency in the top 36 inches of silage compared to no seal, which is consistent with our previous studies with corn and forage sorghum silages (KAES Report of Progress 651:135).

These data document that sealing alfalfa silage in bunker silos greatly increases preservation efficiency and nutritive value in the initial top 2 to 3 ft of ensiled material.

Table 1. Effects of Sealing Treatment and Depth from the Initial Surface on the Settling Distance, Dry Matter (DM) Content, DM Recovery (Rec.), pH, In-situ Digestibility (Dig.), and Maximum Temperature (Temp.) of the Alfalfa Silages Stored in Farm-scale Bunker Silos

Sealing treatment	Initial depth	Distance settled[1]	Initial DM	90-day silage DM	90-day silage DM rec.[2]	90-day silage pH	In-situ DM dig.	Maximum temp.[3]
	--- inches ---		%	%	%	units	%	
Unsealed/ No roof	5	3.0	55.3	65.4	66.4	8.21	64.3	148.3 (16)
	10		55.3	45.2	47.6	8.68	64.9	147.3 (17)
	20	4.6	50.8	35.5	90.6	4.85	74.9	125.9 (24)
Sealed/ No roof	5	1.5	54.9	52.9	90.7	5.23	74.7	107.1 (1)
	10		54.9	52.7	91.1	5.28	76.8	110.0 (1)
	20	2.2	50.4	47.2	89.5	5.20	75.4	113.6 (1)
Unsealed/ Roof	5	<1.0	53.4	72.0	64.2	8.10	59.4	142.5 (17)
	10		53.4	75.7	76.6	7.57	59.4	148.8 (35)
	20	<1.0	47.2	49.5	87.2	4.63	71.4	134.7 (82)
Sealed/ Roof	5	<1.0	56.8	57.8	91.5	5.41	74.5	111.0 (2)
	10		56.8	57.7	89.9	5.41	74.7	112.7 (3)
	20	<1.0	50.3	53.8	93.7	5.20	68.7	108.9 (1)

[1]Distance settled during the 90-day storage period was not recorded for the 10 inch depth.
[2]Expressed as a % of the DM ensiled.
[3]The day postfilling when the maximum temperature occurred is shown in parentheses.

Table 2. Effects of Days Postfilling, Depth from the Initial Surface, and Sealing Treatment on the Dry Matter (DM) Content, DM Recovery, and pH of the Alfalfa Silages Stored in the Pilot-scale Silos

Days after filling	Initial depth	Sealing treatment[1]	DM	DM recovery[2]	pH
	inches		%	%	units
7	0 to 12	1	54.3	96.9	6.72
		2	52.9	94.5	5.80
		SE[3]	2.71	2.11	.15
	12 to 24	1	52.8	96.8	5.53
		2	53.5	97.0	5.58
		SE	3.53	2.79	.49
	24 to 36	1	54.5	98.1	5.56
		2	53.9	97.3	5.62
		SE	3.00	1.54	.15
90	0 to 12	1	23.6[a]	37.7[a]	7.71[b]
		2	49.1[b]	92.0[c]	5.08[a]
		3	48.3[b]	73.9[b]	8.94[c]
		5	49.4[b]	87.3[c]	5.53[a]
		SE	3.51	2.00	.09
	12 to 24	1	22.6[a]	66.8[a]	5.03[a]
		2	50.3[c]	94.4[c]	5.16[a]
		3	42.5[b]	84.1b	6.81[b]
		5	51.4[c]	93.4[c]	5.16[a]
		SE	2.46	2.17	.38
	24 to 36	1	23.5[a]	77.9[a]	4.90
		2	54.5[b]	97.0[b]	5.10
		3	54.5[b]	97.0[b]	5.26
		5	49.9[b]	94.7[b]	5.12
		SE	2.79	1.87	.11
180	0 to 12	1	26.8[a]	34.4[a]	8.28[b]
		2	46.8[b]	98.4[cd]	5.00[a]
		3	47.9[b]	57.4[b]	8.96[c]
		4	50.4[b]	92.5[d]	5.50[a]
		5	52.8[b]	84.3[c]	5.36[a]
		SE	2.71	2.11	.15
	12 to 24	1	21.3[a]	59.3[a]	5.74[b]
		2	47.8[b]	94.5[c]	5.07[a]
		3	45.1[b]	82.5[b]	6.62[b]
		4	51.3[b]	93.0[c]	5.06[a]
		5	54.2[b]	92.4[c]	5.13[a]
		SE	3.48	3.07	.55
	24 to 36	1	18.3[a]	65.9[a]	5.11
		2	48.9[b]	93.1[b]	5.07
		3	49.9[b]	90.4[b]	5.10
		4	50.9[b]	91.5[b]	5.02
		5	51.9[b]	90.5[b]	5.10
		SE	2.63	1.68	.16

[1]Treatment (TRT) 1 = unsealed, no roof; TRT 2 = sealed, no roof; TRT 3 = unsealed, roof; TRT 4 = sealed, roof; and TRT 5 = delay sealed, no roof.

[2]Expressed as a % of the DM ensiled.

[3]SE = standard error.

[a,b,c,d]Means across sealing treatment at each day postfilling and depth in the same column with different superscripts differ (P<.05).

DIAMETER OF OVARIAN FOLLICLES, ESTRADIOL AND PROGESTERONE CONCENTRATIONS, AND PREGNANCY RATES IN CATTLE TREATED WITH PROGESTINS AND $PGF_{2\alpha}$

M. W. Smith and J. S. Stevenson

Summary

Holstein cows and virgin heifers were treated with progestins and $PGF_{2\alpha}$ before first service to determine their influence on reproductive traits. Control cows were given two injections of $PGF_{2\alpha}$ 14 days apart and inseminated at estrus after the second injection. Two groups received a norgestomet ear implant (N1) or a progesterone-releasing intravaginal device (PRID; P1) 8 days after one injection of $PGF_{2\alpha}$, followed the next day by $PGF_{2\alpha}$ to regress the corpus luteum, and the progestin source was removed 7 days later. The last two treatments were similar except the second injection of $PGF_{2\alpha}$ was given 14 days after the first and norgestomet (N6) or PRID (P6) sources were removed 1 day later. Inseminations were performed at estrus in the latter four treatments. Pregnancy rates and serum progesterone were higher and serum estradiol and follicular diameters were lower in controls, P6, and N6 treatments, where the corpus luteum was functional during progestin treatments, than in those treatments where the corpus luteum was absent (P1 and N1). Follicle turnover occurred more consistently in control, P6, and N6 treatments, whereas when follicular diameter and serum estradiol were greater (N1 treatment), turnover did not occur as often and pregnancy rates at first service were reduced markedly. Treatments with progestins must control follicular growth, or fertility will be reduced.

(Key Words: $PGF_{2\alpha}$, Progestins, Follicles, Fertility.)

Introduction

During the past 8 years, much has been learned about the dynamics and control of follicular growth in cattle because of our ability to visualize and monitor the development of individual follicles by transrectal ultrasonography. It is now recognized that either two, three, or four waves of follicles develop during the course of the estrous cycle. These waves develop at various stages of the cycle, with the first wave always beginning shortly after estrus. Follicles (2 to 4 mm in diameter) are recruited by identifiable increases in follicle-stimulating hormone in blood serum. These follicles begin to increase in diameter until one grows more quickly and dominates or suppresses the growth of the remaining emerging follicles. Longer estrous cycles (>21 days) are associated with three or four waves of follicular growth. The first large follicle, which dominates the remaining follicles in both ovaries, reaches its maximal diameter around day 6 to 8 of the cycle and is capable of ovulating, if the corpus luteum is regressed by administering $PGF_{2\alpha}$ (Lutalyse® or Estrumate®). If a dominant follicle is exposed to various sources of progestin before and after natural or induced regression of the corpus luteum, the follicle continues to increase in diameter and, when it ovulates, subsequent fertility seems to be impaired. Our study was designed to determine the effect of two sources of progestin on changes in ovarian follicular growth, concentrations of progesterone and estradiol, and fertility in virgin heifers and lactating Holstein cattle exposed to five different treatments designed to increase or decrease fertility.

Procedures

Five treatments were employed to test our hypothesis that holding a follicle after regression of the corpus luteum would reduce pregnancy rates in association with increased concentrations of estradiol and larger-diameter follicles. Treatments were applied to virgin heifers (minimum body weight of 800 lb and 13 months of age) and to lactating cows (minimum of 50 days in milk) before first service. All cattle received 25 mg of $PGF_{2\alpha}$ (Lutalyse®) on day O of the experiment, and controls were given a second injection of $PGF_{2\alpha}$ 14 days later. Two groups were given norgestomet (6-mg ear implants) for 7 days, beginning on day 8, with $PGF_{2\alpha}$ being injected either 1 (Nl) or 6 days (N6) after implant insertion. The remaining two treatments consisted of two groups receiving a progesterone-releasing intravaginal device (PRID) containing 1.5 mg of progesterone for 7 days, beginning on day 8, with $PGF_{2\alpha}$ being given either 1 (Pl) or 6 days (P6) after PRID insertion.

Blood samples were collected on days O, 1, and 8 to 16 of the experiment in all cattle, and follicles in both ovaries were monitored daily by ultrasonography from day 8 of the experiment until ovulation was detected. All cattle were inseminated when detected in estrus following the second injection of $PGF_{2\alpha}$ or after removal of the norgestomet ear implants or PRID. Pregnancy diagnoses were made by transrectal ultrasonography at day 28 and were confirmed later by palpation of the uterus per rectum between days 40 and 54.

Results and Discussion

Resulting pregnancy rates are summarized in Table 1. Pregnancy rates at ultrasound determination or by palpation were greater ($P < .05$) in the control, N6, and P6 treatments than in the N1 treatment. Fertility in the P1 treatment was intermediate between that in N1 and the other three treatments. Embryonic survival rates ranged from 81 to 93%, with 16 embryos (7.6910) failing to survive between day 28 and days 40 to 54 of pregnancy. This late embryonic loss probably was associated with failure of the placenta to attach to the uterine wall.

Concentrations of progesterone for the five treatments are illustrated in Figure 1.

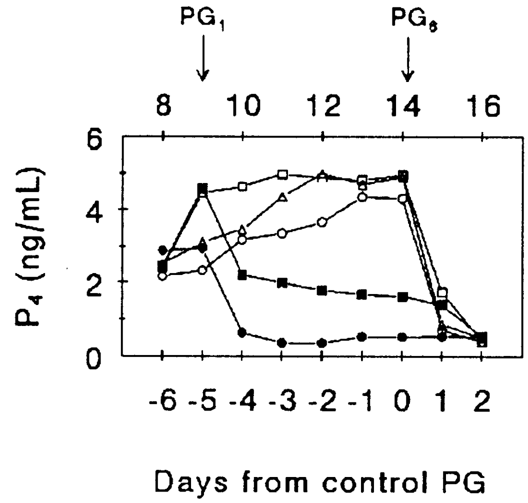

Figure 1. Progesterone in Serum in Control (△), P6 (□), N6 (○), P1 (■), and N1 (●) Treatments from Day of $PGF_{2\alpha}$ (PG) Injection (day 14)

Progesterone between days 8 and 16 was greater ($P < .01$) in control, N6, and P6 treatments because of the continued presence of a functional corpus luteum compared to concentrations of progesterone in the N 1 treatment in which the corpus luteum was regressed by administering $PGF_{2\alpha}$ on day 9. Concentrations of progesterone were intermediate in the P1 treatment. The PRID in the P1 treatment maintained low (~2 ng/mL) concentrations of progesterone, whereas the progestin activity of the N1 or N6 treatments was not assessed and is not reflected by the concentrations of progesterone shown in Figure 1.

Table 2 illustrates concentrations of estradiol and maximal diameter of the dominant follicle on day 14 of the experiment (time of $PGF_{2\alpha}$ in the controls, N6, and P6 and 1 day before removal of the progestin sources). Diameter of the follicles was greater ($P < .05$) in the N 1 and P1 treatments (corpus luteum regressed 5 days earlier) than in the control, N6, or P6 treatments. These differences in diameters among treatments are reflected mostly by concentrations of estradiol in blood serum. The N1 treatment had greater ($P < .05$) concentrations of estradiol than any of the other treatments, which was associated with its significantly lower fertility (Table 1).

In the absence of adequate concentrations of progesterone or a functional corpus luteum, the dominant follicle fails to turn over and normal patterns of follicular growth (waves) are not maintained during the estrous cycle. Our study demonstrates that in the absence of the corpus luteum (N1 and P1 treatments) or adequate concentrations of progesterone (N1), follicles continue to grow to larger diameters and secrete more estradiol. These characteristics of follicular development were related to reduced pregnancy rates (Table 1). High concentrations of estradiol and(or) increased retention time of the dominant follicle had adverse effects on the subsequent pregnancy rates. The lower fertility may be associated with aging of the follicle or the egg cell found within it. Either aging of the egg cell that eventually ovulated and(or) the effects of high concentrations of estradiol adversely altered factors related to normal fertility. These negative effects might include alterations in the oviductal and uterine environment as they prepare to nourish the fertilized egg and developing conceptus. Other recent studies have suggested that improved fertility, or prevention of lowered fertility in some cases, is achieved by manipulating the presence of the dominant follicle while estrus is synchronized. Treatments with progestins and $PGF_{2\alpha}$ must synchronize follicular growth, or reduced fertility will occur.

Table 1. Pregnancy Rates and Embryo Survival in Cattle Treated with Progestins and $PGF_{2\alpha}$ at First Services

Treatment	No. of cows	Pregnancy rates: Ultrasound[1]	Pregnancy rates: Palpation[2]	Embryo survival[3]
		---------- % ----------		
Control	43	66^{x}	53^{x}	81
P6	41	58^{x}	56^{x}	93
N6	41	58^{x}	51^{x}	89
P1	41	48^{xy}	41^{xy}	83
N1	45	26^{z}	27^{y}	91

[1]Day 28 after insemination.
[2]Between days 40 and 54 after insemination.
[3]Survival of viable embryos between day 28 and days 40 to 54 after insemination.
[x,y,z]Means within a column without a common superscript letter differ ($P < .05$).

Table 2. Concentrations of Estradiol and Diameter of Ovulatory Follicle

Treatment	No. of cows	Estradiol[1]	Diameter of follicle[1]
		---- pg/mL ----	---- mm ----
Control	12	7.3 ± 0.9^{x}	16.4^{x}
P6	9	7.7 ± 1.0^{x}	16.4^{x}
N6	8	7.6 ± 1.1^{x}	15.8^{x}
P1	9	8.4 ± 1.0^{x}	18.4^{y}
N1	9	11.5 ± 1.0^{y}	18.2^{y}

[1]Determined on day 14 of the experiment when the second injection of $PGF_{2\alpha}$ was administered to the control, P6, and N6 treatments.
[x,y]Means within a column without a common superscript letter differ ($P < .05$).

USE OF GnRH AND $PGF_{2\alpha}$ FOR SYNCHRONIZED OVULATION AND FIXED-TIME INSEMINATIONS

J. S. Stevenson and Y. Kobayashi

Summary

Holstein cows and virgin heifers were treated with GnRH and $PGF_{2\alpha}$ in a novel ovulation synchronization protocol, which involves one fixed-time insemination. One injection of GnRH is given on a Monday morning, followed in 7 days with an injection of $PGF_{2\alpha}$. Approximately 32 hr later, ovulation is induced with a second injection of GnRH, and one insemination is made 18 hr later. Control cattle were given one injection of $PGF_{2\alpha}$ and inseminated at estrus. Pregnancy rates measured between 28 and 35 days after insemination by ultrasonography were slightly, but not significantly, higher in controls (52.9%) than in the ovulation synchronization treatment (44.3%). 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: $PGF_{2\alpha}$, GnRH, Ovulation Synchronization, 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 insemination have evolved. Many of the early attempts to use $PGF_{2\alpha}$ in lactating dairy cows demonstrated its effectiveness in controlling the estrous cycle for programmed breeding. Pregnancy rates following $PGF_{2\alpha}$ usually produced the best results 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 injection, whereas pregnancy rates improved slightly to about 30% when the 80-hr insemination was preceded 8 hr earlier by 100 µg of GnRH 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 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 will either induce luteinization or ovulation of a large (dominant) follicle via GnRH-induced release of luteinizing hormone (LH). As a result of such treatment, a new group of antral follicles begins to grow, and one becomes dominant and then is fully capable of ovulation within 6 or 7 days after the injection of GnRH. When an injection of $PGF_{2\alpha}$ is administered 6 or 7 days after GnRH, this freshly developed dominant follicle can be induced to ovulate with a second injection of GnRH before one fixed-time insemination is 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 ovulation synchronization 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 13 months of age) and to lactating cows (minimum of 60 days in milk) before first and repeat services. The two treatments utilized are illustrated in Figure 1.

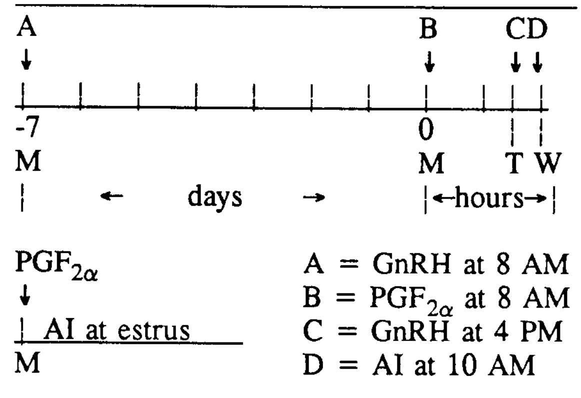

Figure 1. Ovulation Protocol

The ovulation synchronization treatment (top of figure) consisted of one 100 μg injection of GnRH (Cystorelin®) on a Monday morning followed 7 days later with one 25 mg injection of $PGF_{2\alpha}$ (Lutalyse®). Then, 32 h after $PGF_{2\alpha}$, a second 100-μg injection of GnRH was given to induce the preovulatory release of LH, which induced ovulation in about 24 to 32 h. 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. The control cattle (bottom of figure) received 25 mg of $PGF_{2\alpha}$ and were inseminated when detected in estrus. Pregnancy diagnoses were made by transrectal ultrasonography between days 28 and 35 after insemination.

Results and Discussion

Pregnancy rates at first services were 51.1% (24/47) in the control and 44.7% (21/47) in the synchronized ovulation treatment. Those for cows at repeat services, previously diagnosed open, were 60% (6/10) and 42.9 % (6/14), respectively. Overall pregnancy rates for the two treatments are illustrated in Table 1. Although the control showed a slight advantage in pregnancy rates, the difference was not significant. These results are preliminary, but suggest that it is possible to synchronize ovulation 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). Research at other locations is finding similar successes. Other studies are ongoing in our KSU dairy herd to test further this new treatment in both heifers and lactating cows.

Table 1. Pregnancy Rates after Synchronized Ovulation at First and Repeat Services

Treatment	Pregnancy rates 28 to 35 days after AI	
	- No.-	- % -
Monday morning $PGF_{2\alpha}$	30/57	52.6
Synchronized ovulation	27/61	44.3

MANURE STORAGE STRUCTURES FOR SMALL DAIRIES

J. P. Harner [1] and J. P. Murphy [1]

Summary

Kansas environmental regulations require dairy producers with more than 300 animal units (215 mature cows at 1,400 lb, or equivalent weight) to be able to store the manure scraped from freestalls, lots, alleys, and holding pens for 120 days. Many dairies are smaller than the size requiring mandatory registration. However, some are considered a potential environmental problem because of their location near streams or waterways and/or their management and application of manure and may require registration. The intent of the regulations is that manure be stored from December to March to avoid applying it onto frozen ground. Most dairies consider these prime months for manure application, but these are the least desirable from an environmental perspective. Manure applied to frozen ground is not absorbed, and, therefore, the nutrient value of the manure drains from the fields when snow melts or early spring rains are heavy. Three types of storage structures are described.

(Key Words: Manure, Storage, Structures, Concrete.)

Introduction

Most dairies are able to store manure less than a week. In many cases, the manure manages the dairy producer rather than the dairy producer managing the manure. Storage structures enable the dairy producer to manage the manure and apply it immediately prior to working tillable land. Thus, maximum benefit from the nutrients in the manure is obtained. Data in Midwest Plan Service handbooks shows little decrease in nutrient value when manure is stored in nonanaerobic conditions. Storage structures also allow dairy producers more time for managing their dairy herd, because the manure is stored for extended periods. Manure is hauled and applied in several concentrated time periods during the year, rather than daily or weekly.

A dairy cow produces 80 lb of manure per 1,000 lb of live weight per day. The density of the manure is approximately 60 lb/cf. Therefore, the storage space required for a 1,000 lb cow is equal to 1.33 cf/day or 160 cf per 120 days of storage. A 1,400 lb cow produces 225 cf of manure during 120 days.

Fresh manure is about 87% moisture. Only a portion of it is actually scraped into the storage basin. The manure in the basin will be about 80% moisture, which reduces the total storage space required. For design purposes, the storage basin should be sized based on a minimum of 1 cf/1,000 lb/day.

Types of Storage Structures

Producers using straw, newspaper, or shavings may find the moisture content to be lower than 80%, but additional storage is required for the bedding. Straw bedding can be stacked on a flat slab with a 24 to 48 in high retaining wall on two or three sides.

Many options are available for storing manure and are being considered and used by Kansas dairies. Some include mechanical separators, concrete structures and slabs, or storage lagoons and ponds. Other dairies are considering rotational grazing as an option to

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reduce the manure storage requirements. These are not all of the possible methods for handling the manure, and additional structures are needed to handle the milk house or parlor effluent and runoff from confinement lots during rainfall.

The manure can be handled as a solid or a slurry. Most small dairies seem to favor the solid manure handling systems, because they already have the necessary equipment. Slurry systems required a manure tank wagon and agitator and often utilize aboveground storage structures. Dairy farms located in areas of high water table may have no alternative but to use aboveground storage structures to avoid ground water pollution problems.

Belowground concrete structures are common for handling the manure as a solid. These include a concrete sloped ramp and concrete wall structure (CSRCW), a concrete level bottom with concrete wall structure (CLBCW), and a concrete bottom with earthen side wall structure (CBES). Attached are drawings showing three examples of different storage structures. For design purposes, the assumptions for these drawings are as follows: 50 cow milking herd, average weight of 1,400 lbs or total live weight of 70,000 lbs, replacement and dry cows housed in another location, storage depth limited to 4 ft, 6 in of freeboard maintained, a full 120-day storage provided, and manure handled as a solid at 80% moisture content.

Option 1. Concrete Sloped Ramp and Concrete Wall Structure (CSRCW)

Figure 1 shows a schematic of a CSRCW storage structure. It is 32 ft wide, 106 ft long, and 4 ft deep. (Note: width and length can be adjusted to fit the site.) The slope of the entrance ramp may range from 5 to 10% (the one in Figure 1 is 8%. The length of the ramp is 50 ft, with the remaining 56 ft being a level bottom. A perforated drain pipe allows the liquid portion, or rain water, to drain from the CSRCW and to discharge into a holding pond, lagoon, sediment basin, or designed grass filter. A minimum of 20 in is allowed around the pipe to provide access for cleaning debris away from it. The pipe should be protected by a 3/4 in wire mesh screen or plastic-coated screen. The minimum area of the screen is 36 sq ft, or sized at 4 ft by 9 ft. The screen keeps the solids away from the pipe and prevents plugging. The screen should be mounted on a steel tubing frame. The frame should be removable to allow access to the pipe. Some producers are opting to place a wall through the middle, such that two, 16-ft wide tanks are created. This allows the manure to be scraped into one side, while the other side is drying or being cleaned. With this system, two perforated pipes are required, but they can drain into a common pipe upon exiting the basin. For a 50-cow dairy, a 6 in perforated pipe is adequate. The openings in the pipe should provide a minimum of 6 sq in of opening per vertical foot of pipe.

Option 2. Concrete Level Bottom with Concrete Wall Structure (CLBCW)

Figure 2 is an example of a CLBCW storage structure. This structure is 32 ft wide, 80 ft long, and 4 ft deep. Access into the CLBCW is through a 12 ft (minimum) width opening or gate on one end of the structure. The opening should be wide enough to allow a manure spreader and tractor to back into the CLBCW during unloading. A modification of the CLBCW uses the perforated drain pipe as shown in Figure 1 to drain away the liquid. In some cases, the wire screen is attached to the gate to allow the liquid to drain through the gate into a sediment basin. Another modification to this design is the use of timber planks, which slide into the notches on each side of the opening. A 1-in gap between the planks or perforated pipe is used to drain away the liquids. The disadvantage of planks is that their removal is necessary in order to empty the structure. Once the top plank is removed, manure can overflow onto the others before they are removed, and the structure is completely emptied.

Option 3. Concrete Bottom with Earthen Side Wall Structure (CBES)

A more economical structure for some dairies, the CBES, is shown in Figure 3. The top dimensions of the CBES are 52 ft by 116 ft, which do not include the top berm. The structure's depth is 4 ft, with end wall slopes of 12:1

and sidewall slopes of 4:1. This structure provides 12 to 16 ft wide concrete ramps on each end of the structure and a concrete bottom. The side walls are earthen with a slope of 3:1 to 5:1. End walls are 10:1 to 20:1. Concrete is placed on the side walls where manure is scraped into the CBES. A perforated pipe is used to drain the liquid from the structure. The pipe should be protected by a 4 ft by 4 ft wire mesh screen.

All of the structures should have a minimum of a 20 ft apron at the entrance. This provides a hard surface for equipment to park on while emptying the structure. The structures in Figures 1 and 2 can be expanded in 30- to 45-day storage increments, but that in Figure 3 is not readily expandable. Producers should use a consultant when seeking a permit from KDHE and consult with their milk inspector prior to initiating construction. Inspectors may wish to see other drainage problems corrected.

Conclusion

Kansas dairies that are below the required animal units for registration should be able to store their manure for a minimum of 30 days and preferably 60 or more. This would enable them to better manage the manure by less frequent application to land, thus avoiding environmentally sensitive times of the year. Properly managing the manure produced on a dairy farm and being concerned about the environment are ways to avoid additional regulations. Insensitivity to the environment, or the potential of nutrients leaving a field, could result in more stringent regulations and monitoring in the future.

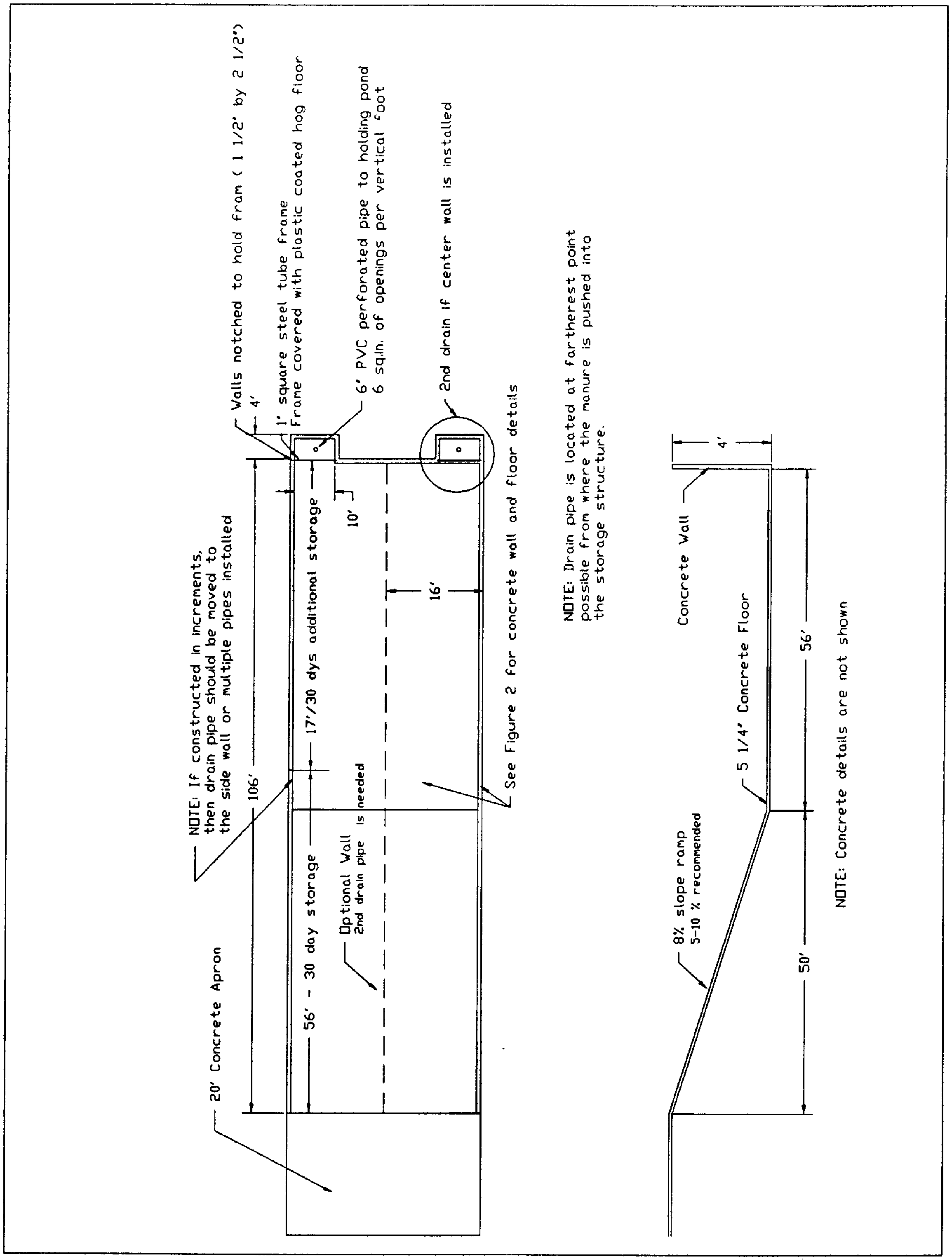

Figure 1. Concrete Sloping Ramp and Concrete Bottom Storage Structure

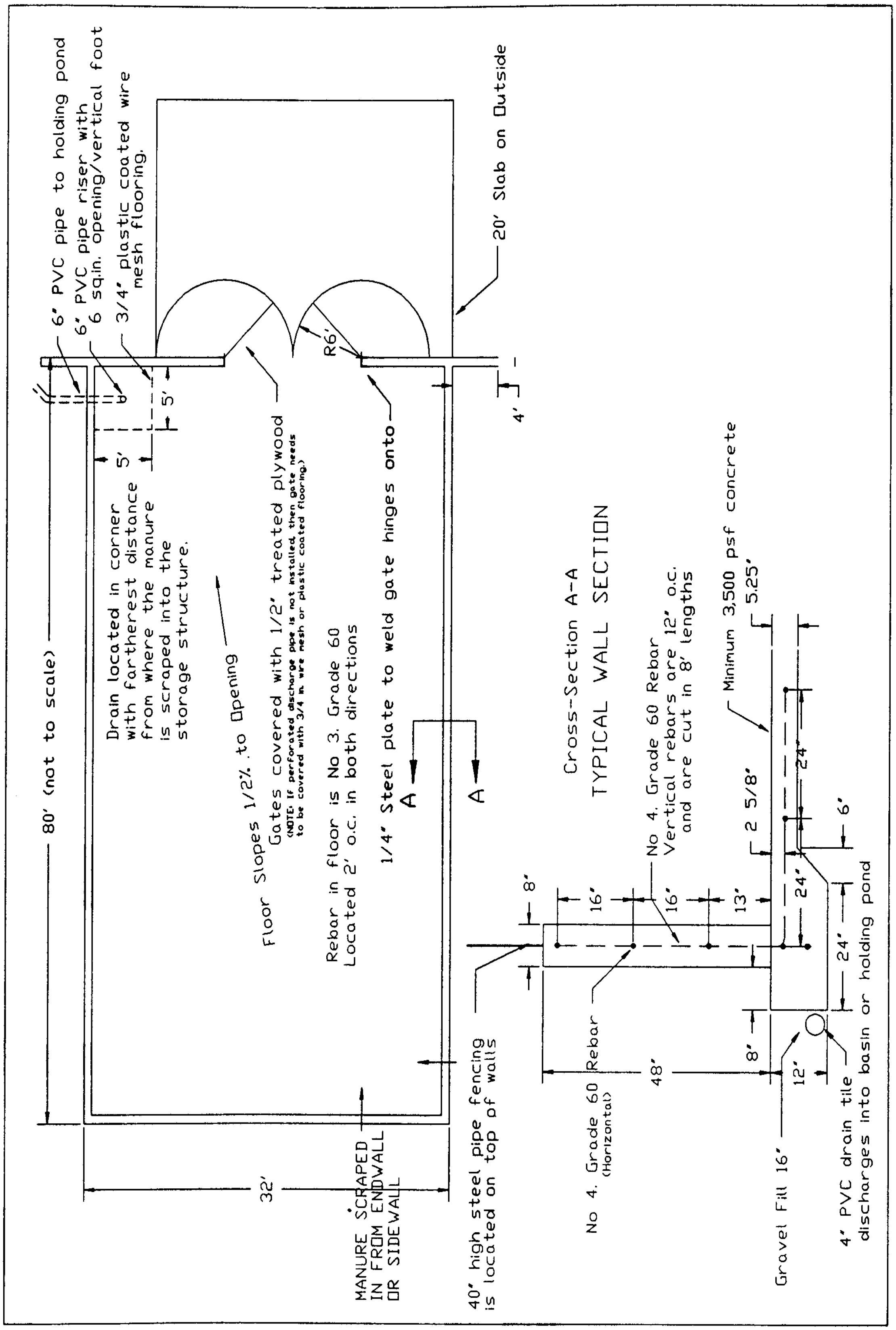

Figure 2. Concrete Level Bottom and Concrete Sidewall Structure

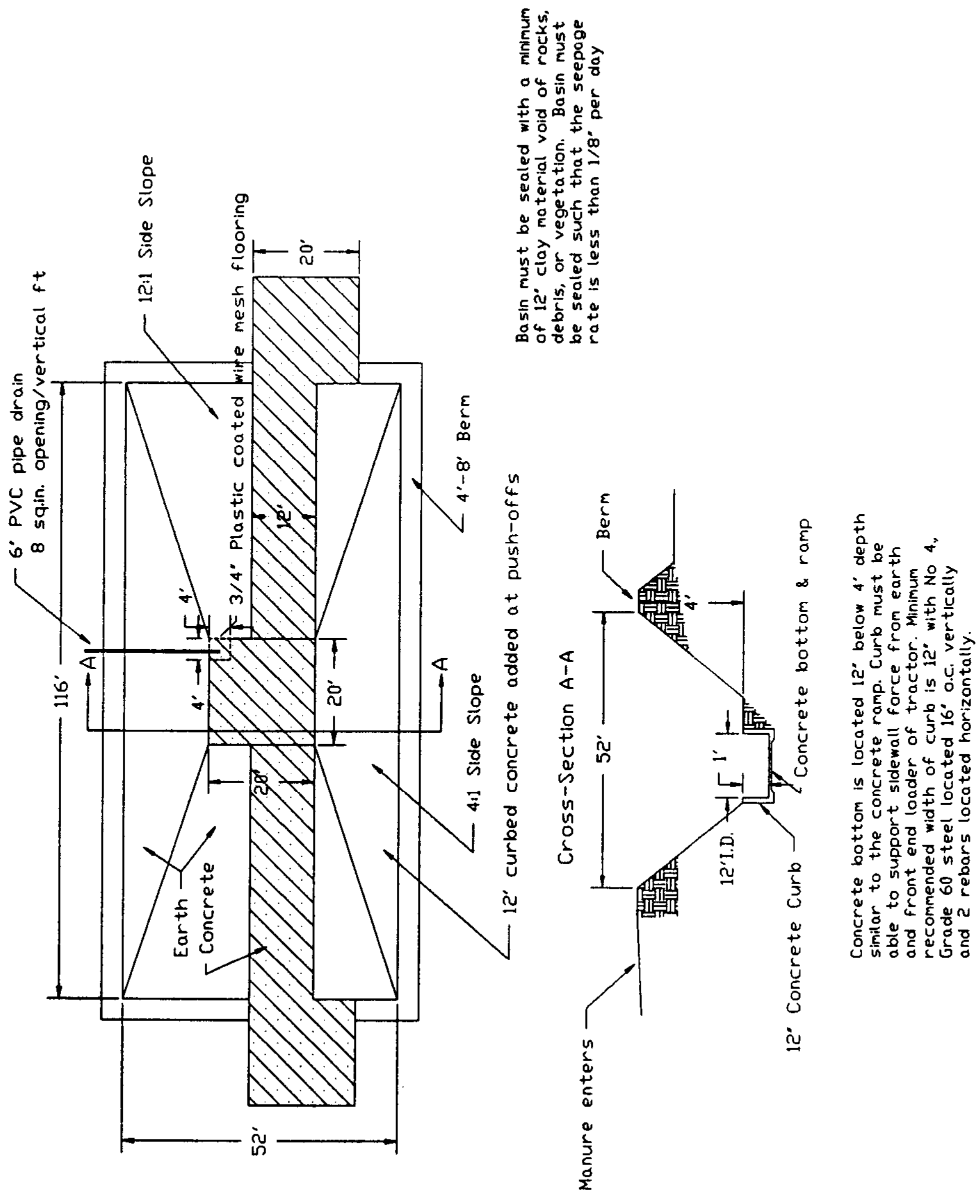

Figure 3. Concrete Bottom and Earthened Sidewalls with Concrete Entrance Ramps

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Delavan Processing, Inc., Delavan, 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
Kansas Value Added Center, Manhattan, KS
Kemin Industries, Inc., Des Moines, IA
Midwest Grain Prod., Inc., Atchinson, KS
Milk Specialities, Inc., Dundee, IL
Monsanto Company, St. Louis, MO
Porter Farms, Reading, KS
Sanofi Animal Health Inc., Overland Park, KS
The Upjohn Company, Kalamazoo, MI

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Agricultural Economics
Biological and Agricultural Engineering
Clinical Sciences
Statistics

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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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