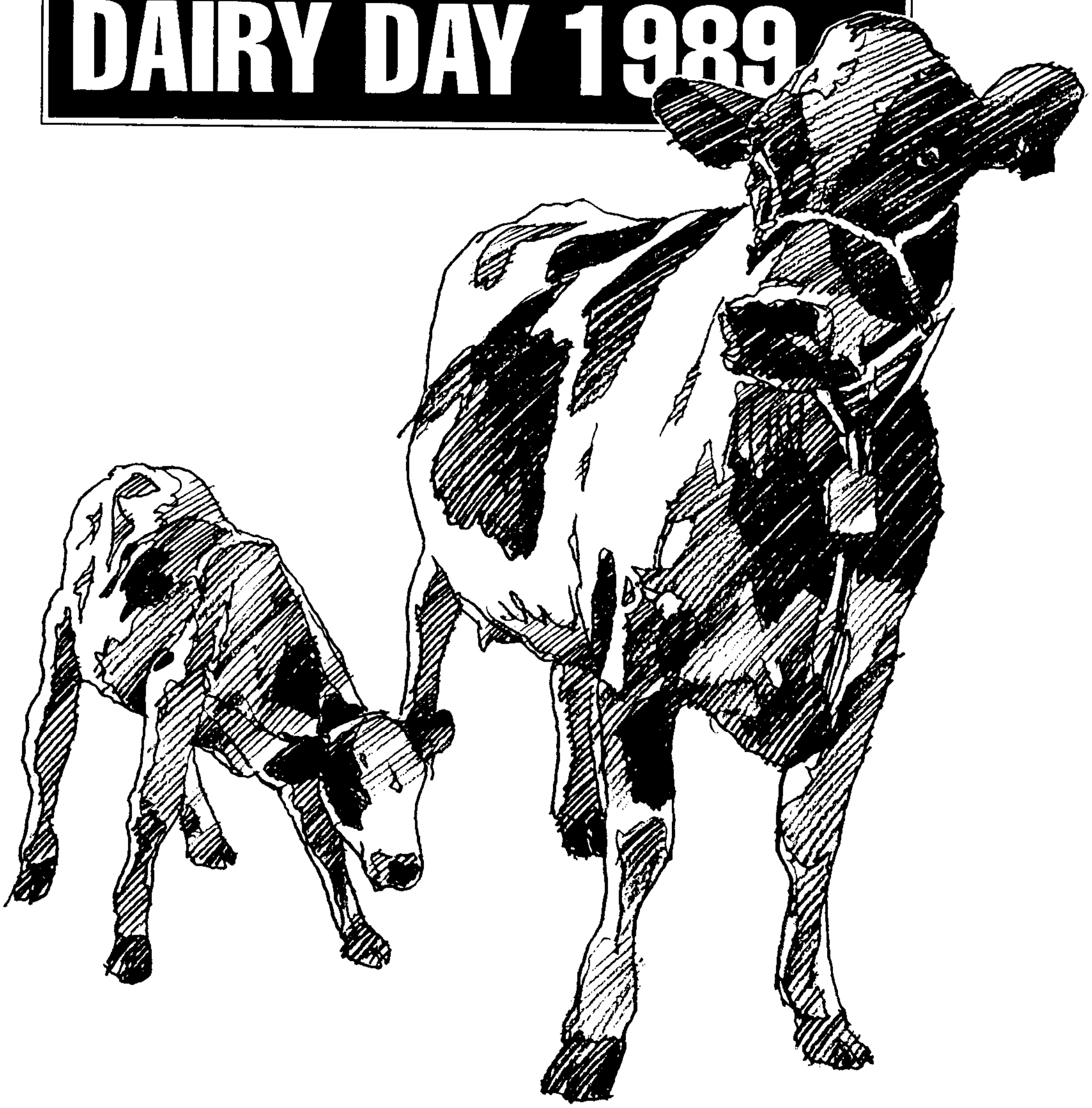
DAIRY DAY 1989



Report of Progress 580

Agricultural Experiment Station, Kansas State University, Manhattan
Walter R. Woods, Director

The 1989 Annual

KSU DAIRY DAY

Fourth in the series: *Reproductive Management and Health*

Pottorf Hall — CICO Park (Riley County Fairgrounds)

8:00 a.m.	Registration, VISIT EXHIBITS
10:00	WELCOME, Dr. Jack Riley, KSU
10:15	WHY WE ARE HERE! Dr. John Shirley, KSU
10:30	REPRODUCTIVE STATUS OF KANSAS HERDS, Dr. E. P. Call, KSU
10:45	REPRODUCTIVE RESEARCH AT KSU, Dr. J. S. Stevenson, KSU
11:00	WHY REPRODUCTIVE PROBLEMS? Dr. Jenks Britt, DVM, Russellville, Kentucky
11:45	RECOGNITION: NORMAN BARKER, Ivan Strickler, Myron Schmidt
NOON	LUNCH, Courtesy of Exhibitors
12:45	NATIONAL SCHOLARSHIP WINNERS, Ivan Strickler
1:00	QUALITY MILK AWARDS, Dr. J. R. Dunham, KSU
1:15	SOLVING REPRODUCTIVE PROBLEMS! Dr. Jenks Britt, DVM
2:00	QUESTIONS
2:30	ADJOURN

FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 1989. Dairying continues to be a viable business and contributes significantly to the total agricultural economy of Kansas. Wide variation exists in the productivity per cow, as indicated by the production testing program (DHIA) in Kansas. Nearly one-half of the dairy herds and dairy cows in Kansas are enrolled in DHIA. Our 1989 DHI program shows that tested cows average 16,463 lb milk compared with 10,302 lb for all nontested cows. Although profits are lower this year than they were in 1988, dairy herds enrolled in DHIA continue to average more income over feed cost ($1,007/cow) than nontested herds ($530/cow). Much 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 approximately 17,700 lb in August, despite many research projects that may not promote production efficiency.

The excellent functioning of the DTRC is because of the special dedication of our staff. Appreciation is expressed to Richard K. Scoby (Manager, DTRC), Gregory Kropf (Asst. Manager, DTRC), Dan Umsheid, Mary Rogers, Charlotte Kobiskie, Bill Hanson, Robert Resser, Kathy Snyder, Becky Wolfe, and Lloyd Manthe. Special thanks are given to Neil Wallace, Natalie Brockish, Betty Hensley, Lois Morales, and Cheryl 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 later in this publication. Appreciation is expressed to Charles Michaels (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 enabled us to develop cooperative research and establish an exemplary herd health program.

J.S. Stevenson, Editor
1989 Report of Progress

Dedicated to...

NORMAN H. BARKER

Pratt County Milk Producers, Southwest Milk Producers, Wichita Milk Producers, Milk Producers Inc., Associated Milk Producers Inc., National Milk Producers Federation: these organizations represent the long-time leadership service of Norman H. Barker, Pratt. Born on the family farm, Norman has been in the dairy business, with brother Morton, all of his life. He soon learned the value of cooperative effort and was instrumental in the formation of the Pratt County Milk Producers. Mergers eventually saw the formation of the Associated Milk Producers, Inc. in 1969, and he was a charter member of the board. He has served that cooperative as secretary since 1972.

Norman was first elected to the National Milk Producers Federation in 1955. He served as president of that organization from 1980 to 1985 and was instrumental in the enactment of a nationwide, full participation dairy program. Norman also provided strong leadership in the implementation of the dairy diversion and dairy termination programs. He continues to serve on National Milk's Executive Committee.

In 1988, Norman was recognized as the Man of the Year at the World Dairy Expo. He has been lauded by industry and government leaders. Tom Camerlo, current president of National Milk Producers Federation noted, "Barker has dedicated virtually his entire life to advancing the interests of dairy farm families."

Active in 4-H as a youth, junior leader, and adult leader, Norman attended Kansas State University and University of New Mexico and did advanced graduate work at California Institute of Technology. He and wife, Beth, have two children and five grandchildren and are active in local church and community activities as time permits.

Kansas State University is pleased to recognize the many contributions of Norman H. Barker and to dedicate this Dairy Day Report of Progress to him.

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.

CONTENTS

MANAGING THE HIGH-PRODUCING HERD. IV. REPRODUCTIVE MANAGEMENT AND HEALTH

John E. Shirley

Kansas dairy producers on the DHI program reached the 17,000 lb level of milk production per cow in 1988-89. This production level was achieved through improved management, genetics, competitive grain and oilseed prices, and favorable weather conditions. We foresee continued improvement in breeding stock and management with grain and oilseed prices remaining steady to lower. Thus, with favorable weather, Kansas DHI producers may reach 18,000 lb per cow this coming year.

Production per cow remains the best predictor of profitability, but as we approach the 18,000 lb level and beyond, management must intensify. Increased attention to body condition, facility sanitation, milking practices, heat detection, sire selection, culling, feed selection, etc., will be required to realize continued increases in production per cow.

Dairy Day—1989 focuses on reproduction because this is an area that is often negatively affected by increased milk production per cow. Generally, days open increase as production increases if management remains constant. Thus, it is important to adjust your reproductive management program simultaneously with changes in nutrition, genetics, and other factors related to increased milk production.

REPRODUCTIVE STATUS OF KANSAS DAIRY HERDS

E.P. Call

Introduction

There has been no appreciable change in the reproduction status of Kansas dairy herds over the last 25 yr. For example, the average calving interval was 398 days in 1965 and 405 days in 1988. Analysis of other measures show similar results. Although the long-stated management goal for a dairy herd has been a calf-a-year or 365-day calving interval, few herds realize this efficiency. On the positive side, the stability of reproductive performance is noteworthy, since genetic antagonism exists between production and reproduction. From 1965 to 1988, average yearly milk production in production-tested herds (DHI) has increased 41%.

Measures of Reproductive Efficiency

Several measurements may be considered when evaluating reproductive performance, namely,

1. Calving interval (Days open)
2. Services per conception
3. Days dry
4. Age at calving (Lactation 1)
5. Heat detection efficiency
6. Days open-cows not bred
7. Day to first service
8. Percent culled-reproduction
9. Conception rate

No one measure is all conclusive. For example, average calving interval may be ideal, but if a significant part of the herd has not been bred and averages more than 70 days open, serious economic consequences result.

The KSU Dairy Herd Analyzer (KSU-DHA) provides an economic evaluation of four areas of herd management, as noted in Table 1. Any comparative analysis requires assumptions and/or goals. In the KSU-DHA, the stated goals (and economic consequences) are defined as follows:

1. Calving interval: 365 days
   365-395 d — $1 loss per day
   > 395 d — $3 loss per day
2. Days dry 45-60 days
   < 45 or > 60 d — $3 loss per day

3. Services per conception: 1.7
   $2 per each .1 > 1.7
4. Age at first calving: 24 mo
   $30 per mo > 24 mo

The value of the KSU-DHA is not the specific economic loss at any point in time but the comparison over time to evaluate management changes. For example, if a preventive herd health program (PHHP) were initiated, then the KSU-DHA would be an excellent way to evaluate the program after a year. Reproduction is the most difficult management area to evaluate in the dairy business and the easiest to overlook. Open cows (not pregnant but should be) are not sick or debilitated. Reproductive losses are insidious.

Table 1. Economic Benefits to the Average Kansas Holstein Herd by Meeting Goals of the KSU Dairy Herd Analyzer

	Economic benefit, $	
Management area	per cow	per herd
Reproduction	$116	$ 8,572
Nutrition	132	9,787
Milk quality	18	1,303
Genetics	34	2,501
Total	$300	$22,163

Production vs Reproduction

Genetic antagonism exists between production and reproduction. Simply stated, higher producing cows are more difficult to settle. This relationship between production and reproduction is confounded by a management tendency to delay breeding back the higher producers, which also tend to be more difficult to detect in heat. The physiological basis for lowered efficiency in higher producing cows is difficult to determine.

Table 2 examines some reproductive measurements in herds at various levels of yearly production. The negative effect of production on reproduction is not apparent from the data under farm conditions. Apparently, managers of higher producing herds "over manage" the antagonism by getting more cows bred earlier in lactation. This fact is especially evident when comparing cows open, not-yet-bred, and the percent of cows open more than 120 days in Table 2. Although conception to first breeding is higher at lower production levels, there is little difference in percent of cows pregnant among herds after two breedings.

Identifying Reproductive Problems

Every open cow is a potential problem, because only 90% will conceive and deliver a calf under the management goals set by most producers. The basic problem in most herds is one of infertility—not sterility. The most common mistake in most herds is the failure to get cows bred back soon after calving. As noted in Table 2, the average number of days to first breeding is 82. Since conception to service is 50% and about one-half of heat periods are missed, the calving interval is dictated to be 400+ days.

Studies confirm that the fundamental difference between herds with high and low reproductive efficiency is awareness—awareness that cows need to be serviced before they can possibly become pregnant. Adequate records are necessary to identify those cows not bred—but should be. Such records also should identify those cows serviced that are open at pregnancy exam. These two conditions contribute the majority of reproductive losses in Kansas dairy herds. The proper use of synchronizing agents (prostaglandins) can contribute markedly in reducing reproductive losses.

Tools are Available

Adequate record systems are available to "keep on top" of reproductive problems in dairy herds and minimize losses. The basic Dairy Herd Improvement (DHI) provides both a cow and herd evaluation on a monthly basis. The Flexible Management Report (FMR) will provide even more detailed information. Herds enrolled in the Electronic Barn Sheet option (EBS) can further fine tune reproductive management. As with any record system—simple or complex—there is little value to be gained unless it is used.

Table 2. Reproduction Characteristics of 498 Kansas Holstein Herds Ranked by Yearly Production per Cow

	Rolling herd average, lb			
Item	13,587	15,988	17,938	20,227
Calving interval, days	401	409	407	406
Services per conception	1.8	2.0	2.1	2.1
Days dry	71	67	63	61
> 70 days, %	39	29	21	16
Age at first calving, mo	30	29	27	27
Estimated reproductive loss per cow, $	133	151	116	106
Conception rate, %				
First service	53.7	49.0	45.4	46.4
First + second	77.6	74.6	72.7	72.9
Days to first breeding	83	83	80	80
Heats detected				
18-24 days, %	38	38	38	39
> 24 days, %	50	54	56	56
Cows not bred				
Days open	128	98	83	67
% open	34	27	27	22
> 120 days, %	33	26	20	12

REPRODUCTIVE RESEARCH IN DAIRY CATTLE AT KSU

Jeffrey S. Stevenson[1]

Summary

Research in reproductive physiology and breeding management of dairy cattle at Kansas State University has the following objectives: 1) to better understand those factors that influence the reestablishment of ovarian function, estrous cycles, and fertility after calving and 2) to apply that knowledge to areas of management in which pregnancy rates and calving intervals can be improved in dairy herds. Our past efforts have included 1) pioneering research into the applications of gonadotropin-releasing hormone (GnRH) at the time of insemination and early postpartum as a prophylactic treatment for inducing estrous cyclicity; 2) application of treatments utilizing prostaglandin F_{2a} (PGF_{2a}) for breeding management of open cows, estrous induction for first services, and postpartum therapy for cows with periparturient problems; 3) utilization of progesterone-releasing intravaginal devices (PRIDs) to induce estrus and enhance fertility; 4) studies aimed at understanding estrous behavior, including the influence of the thyroid gland; 5) efforts to understand the influence of progestogens on the function of the corpus luteum; and 6) estrous synchronization of heifers and cows utilizing PGF_{2a}.

Introduction

Reproductive performance affects average milk produced per day of herdlife, the number of potential herd replacements, and the longevity of the cow in the herd. All of these factors determine efficiency and profit. Because reproductive events culminate in an "all or none" endpoint, a cow or heifer is either pregnant or open. Therefore, reproductive failure causes frustration for dairy managers.

Our reproductive research is aimed at gaining better understanding of the factors involved in preventing reproductive failures. This involves studies that help us understand the physiology of reproduction, as well as manipulating and managing these factors to minimize reproductive loss. In practice, this must translate into the discovery of new principles and the integration of those principles into well-designed programs for breeding, preventive herd health, and reproductive management. Ultimately, this leads to minimal involuntary culling of problem breeders by maintaining healthy, profitable cows in the herd. Despite our best efforts, some culling will inevitably occur because of the complex nature of reproductive physiology.

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[1]The author wishes to acknowledge the following who have contributed substantially to this research effort: E. P. Call, R. E. Stewart, M. O. Mee, I. Rettmer, B. S. Masilo, M. C. Lucy, S. F. Plunkett, M. BenMrad, R. K. Scoby, M. K. Schmidt, J. F. Smith, K. D. Frantz, S. Durham, E. Carpenter, and T. DelCurto.

Estrous Behavior

We have investigated recently the role of the thyroid gland in reproductive behavior. According to the literature in the 1950's, removal of the thyroid gland from the cow resulted in continued normal development of the egg and follicle (i.e., normal oogenesis and folliculogenesis) during the estrous cycle, resulting in fertile ovulations. However, cows without a thyroid gland did not express heat (no estrous behavior). One of the biggest problems we face today on the dairy farm is catching cows in heat. We hypothesized that high-producing dairy cows today might be difficult to catch in heat because of physiological reasons such as hypothyroidism, metabolic imbalances, and negative energy balance (inability to consume sufficient feed to meet the requirements of milk produced), in addition to simply not observing cows often enough to catch more heats. Our experiments thus far lead us to conclude that cows without intact thyroid glands can express estrus in response to estrogen. This suggests that the thyroid gland is not essential for the cow to show heat.

Programmed Weekly Inseminations

Over the last 9 yr, we have tested many systems to determine the benefit of utilizing the prostaglandins (prostaglandin F_{2a}: Lutalyse® and Estrumate®) to control the onset of estrus (synchronized heats) for the convenience of management goals and use of labor. We reported earlier the benefit of utilizing prostaglandin for dairy cows with silent heats (1984 Dairy Day, KAES Rep. Prog. 460, pp 28-30). These are cows that are cycling normally but are not caught in heat to receive their first service or, once bred, are not observed in heat when pregnancy fails to occur. These cows should be palpated by the veterinarian during his regular PHHP herd visit to determine if they have a functional corpus luteum (CL). This also can be accomplished by testing a sample of their milk to determine if the progesterone concentration is high (indicating a functional CL). Administering one of the prostaglandins resulted in these cows being bred and becoming pregnant 2 to 3 wk sooner than untreated cows. The success of this treatment, depended on our breeding cows at 72 and 96 hr after prostaglandin treatment when we failed to catch them in heat. These cows either show weak heats or we had difficulty catching them in heat when they truly were estrual. Therefore, insemination at 72 hr and re-insemination at 96 hr achieved a pregnancy rate of 45%.

We further demonstrated that using prostaglandin on Monday mornings allows us to breed cows during the 5-d work week, with most cows showing heats on Thursdays and Fridays. We are doing further work to test this management system utilizing milk progesterone evaluations on cows eligible to be injected with prostaglandins on Mondays and inseminated during that week.

Fertility Applications

We have shown that cows with periparturient problems will have improved fertility when injections of gonadotropin-releasing hormone (GnRH or Cystorelin®) are given around 2 wk after calving or when a prostaglandin is given about 4 wk after calving (1985 Dairy Day, KAES Rep. Prog. 484, pp 40-42). Both hormone injections appear to increase early cycling activity and promote better uterine involution.

Administering GnRH to repeat-breeder cows increased pregnancy rates in several of our studies (1987 Dairy Day, KAES Rep. Prog. 527, pp 24-25 and 1988 Dairy Day, KAES Rep. Prog. 554, pp 16-18). We continue to recommend its use for cows at third and fourth services. Injections of GnRH given at the time of those services increased pregnancy rates by 8 to 12 percentage points (15 to 20% improvement). We are currently doing more work with GnRH in repeat breeders to determine its minimum effective dose, as well as its influence on the secretion of various important reproductive hormones that are essential for normal fertility.

We are pursuing new studies utilizing very potent analogs of GnRH that seem to be effective in increasing pregnancy rates of heifers when the analog is administered about 2 wk after breeding. We have observed a dose response in over 400 heifers tested and will continue these studies in lactating dairy cows in the future.

We have done some work with the hormone progesterone. We found that it effectively synchronizes estrus, improves estrous expression and reduces conception intervals (1987 Dairy Day, KAES Rep. Prog. 527, pp 26-28). We have used a vaginal device that releases progesterone, which then is absorbed by the vaginal wall. We are now testing its effects on pregnancy rates of cows when it is administered after insemination during the first 2 to 3 wk after estrus.

Corpus Luteum Function

We are conducting experiments to understand better the factors controlling the onset of estrous cycles after calving and the function of the first corpus luteum that forms after ovulation. We have observed that administering progestogens early after calving will normalize the estrous cycle (1988 Dairy Day, KAES Rep. Prog. 554, pp 19-21). We are doing more work to understand the effect of progestogen treatment on ovarian follicular development, ovulation, and formation and function of the corpus luteum.

WHY DO DAIRY COWS HAVE REPRODUCTIVE PROBLEMS? HOW CAN WE SOLVE THOSE REPRODUCTIVE PROBLEMS?

Jenks S. Britt, DVM[1]

Why Manage Reproduction?

The following table gives reproductive information from the DHIA records of 4,566 herds involving 502,260 cows sent to the Dairy Records Processing Center at Raleigh, NC.

Table 1. Reproductive Traits of 502,260 DHIA Cows

Rolling herd average, lb	Minimum calving interval, mo	Services per conception	Average days open	First service conception rate, %	Average days to first service
<10,999	14.8	1.7	169	63	94
11,000-11,999	14.8	1.8	146	59	90
12,000-13,999	13.9	1.9	142	57	89
14,000-15,999	13.6	2.2	134	50	87
16,000-17,999	13.4	2.3	128	47	86
18,000-19,999	13.3	2.2	126	46	87
20,000-21,999	13.4	2.3	128	44	88
>22,000	13.5	2.3	129	46	91

Except for very low producing herds, management of reproduction does not seem to have much effect on the herd's level of production. To counter this statement, we must ask the question: "If they did not manage reproduction, what would their production level be?"

[1]Animal Health Management Service, Bov-Eq Embryo Transfer, P. O. Box 787, Russellville, KY 42276-0787.

Causes of Reproductive Failure

Dairy cows develop reproductive problems from three major categories of causes: man-made, biological, and environmental.

Man-made Causes

1. Poor cow ID (identification) — We know she is in heat but she doesn't have a tag, brand, or an identification that we can read.
2. Inadequate record system — When did we breed her last? How many services has she had? Did she have problems at calving? How did we treat her last vet check? Does she have a lifetime health card? Is she on the computer? Is correct information supplied to the DHIA supervisor?
3. Heat detection — Who is responsible? Do we have a heat prediction system? Was she marked with a heat detection aid? Was her heat date recorded?
4. Nutrition — Is her ration balanced for health and reproductive needs? Is this ration being fed? Is the cow eating this ration?
5. AI — is proper AI technique being used? Are the people doing the breeding retrained on a regular basis? Are we using quality semen that is stored properly?
6. Reproductive evaluations — Is the herd on a regular reproductive health management program with a veterinarian?
7. Records — Do we ever look at the DHIA or reproductive record summary and see if goals are being met?
8. Education — Is an effort made to educate all herd workers in the importance of getting cows pregnant?

Biological Causes

1. Calving time problems — Did the cow have difficulty calving? Did she clean up? Mastitis, D.A., feet, ketosis? Other problems?
2. Infectious or toxic abortions — Did the cow have vaccinations against known bacterial and viral diseases? Was she exposed to molds?
3. Semen quality, bull power — Was semen of known quality used on the cow? Was the bull evaluated for breeding soundness?
4. Genetic — Is the cow a DUMPS carrier? Are there inherited breeding problems?
5. Nutrition — Are the feeds we utilize in our ration used by the cow's digestive system?

Environmental Causes

1. Heat stress — Do we stop breeding when the environmental temperature goes above 80 degrees?
2. Weather stress — Do we watch heats when snow covers the cow lots? Do we "cold shock" semen in the winter?
3. Footing — Are cows on slick concrete or do they have access to dirt lots?

Reproductive Management

Management of reproduction requires effort in the following areas: 1) Cow ID (identification), 2) individual cow records, 3) disease prevention, 4) heat detection, 5) nutrition, 6) AI, 7) reproductive status evaluation of the cow, 8) treatment of reproductive problems, 9) record analysis, and 10) client and labor education.

Cow ID

All cows should be identified with large readable numbers. Brands or double ear tags work best. All employees should be able to identify the cow. Some type of permanent ID is needed for cows that lose tags.

Individual Cow Records

A sample record card is enclosed (Figure 1). This lifetime card can be used for all records related to health. Large herds must use computers to keep adequate information on all cows.

Disease Prevention

Vaccination to prevent disease can be a major expense on many farms. Before a vaccination program is started, one should consider a rationale for vaccination, including: 1) threat of disease, 2) effectiveness of the vaccine, 3) duration of immunity, 4) ease of administration, 5) shelf life, 6) multivalent, and 7) cost $$ vs risks.

An attempt should be made to diagnose abortions, even though success may be limited.

Heat Detection

Heat activity increases 50% or more when cows are off concrete and on dirt. Heat activity increases more than 100% when more than one cow is in heat at a time. Single cows that try to mount other cows from the front are usually in heat. About 80% of the cows doing the riding are in heat or will be in heat in 48 hr. Many cows exhibit heat 6 hr or less. Observe for heat 4× daily when cows ARE NOT being fed. Moving cows through a lane often increases heat activity. ONE PERSON on each farm should be responsible for heat detection. Heat detection aids should be used, such as crayon marking, heat detector patches, heat prediction charts, and teaser animals.

Nutrition

Rations should be balanced for energy, protein (degradable, soluble, and by-pass), fiber (including effective fiber), minerals, and vitamins. Clean water, free of organisms and toxins, is important for the cow. Effective fiber is a "scratch factor" and should be at least 5 lb daily of dry matter that is longer than 1". Lack of effective fiber causes the 3 L's, (low fat test, lack of fetuses, lame feet). Milking cows should receive 400 units of vitamin E and 6 mg of selenium daily.

AI

The most accurate time to inseminate a cow is 12 to 16 hr after LH peaks in her blood. This LH peak is very closely associated with the first signs of standing heat. Ovulation occurs 25 hr after the LH peak. Breeding should occur 12 hr before anticipated ovulation. The AM/PM rule is still best for an AI program. The best thawing temperature for both straws and ampules is 95^0F. Don't thaw more semen than will be used in 15 min. Retraining of AI personnel on the farm is important; compare conception rates among technicians on each farm. Horn breeding probably only assures proper placement of semen by the technician. About 94% of the semen deposited in the uterus is no longer there 12 hr later. Most is lost through the cervix. Conception rates of cows will drop below 20% in the three summer months, but heifer rates will stay at 50% or better. Use young sire semen in the summer and use the most expensive semen on heifers. Solar stress reduces reproductive performance, and a 60-d lag period is associated with heat stress.

Reproductive Exams

An examination of all postpartum cows that have not been previously approved for breeding is recommended. In large herds, this may be limited to cows fresh more than 3 wk plus any cow fresh less than 3 wk that had a difficult birth or retained placenta. Cows bred more than 30-35 days can be examined for pregnancy. The practitioner should establish his or her own cutoff date for early pregnancy checks. This date may be different in heifers or young cows than in older cows. Anestrous cows, cows that have cystic-like conditions, or problem breeders should be examined. REMEMBER: MOST PROBLEM BREEDERS PROBABLY HAD A PROBLEM 100 TO 180 DAYS AGO WHEN THEY CALVED, AND THIS IS THE BASIS OF THEIR LOW CONCEPTION RATE. A milk progesterone test should be run on cows that have a cyst-like condition. The use of rump marking with crayons to designate "estrus watch", "pregnancy", and "treatments" helps the herdsman to observe these cows in the next few days.

Treatments

Very few reproductive problems require treatments. The failure of most cows to settle is a result of poor timing of insemination, poor AI technique, not being in estrus, or having a uterine-oviduct-ovarian problem that cannot be palpated. The major treatments that we use in practice are listed below.

1. Prostaglandin is used for cows having palpatable luteal tissue that will respond to prostaglandin and cause estrus.
2. GnRH is used on third service or later cows to increase conception rates. It is used with restraints on semen cost, time of year, and cost of the GnRH. It is also used on cystic cows.
3. HCG is used when cows fail to respond to GnRH.
4. Syncro-Mate-B implants are used for some cystic conditions or to induce estrus in static young cows that have limited ovarian activity.
5. Progesterone in sesame oil is used at 75 mg daily for 12 days to get a response similar to that from Syncro-Mate-B.
6. Infusions. Uterine infusions of cows infected with pathogenic bacteria may be effective in returning the uterus to a condition that will maintain pregnancy. Our choice of products

in the early postpartum cow is oxytetracycline. After 30 days postpartum, we use penicillin. "Exotic" infusion mixtures may cost more, but they are not any more effective. RESIDUE AVOIDANCE MUST BE ADDRESSED BY THE INDIVIDUAL HERD AND PRACTITIONER. We recommend use of the DELVO - P test.

Record Analysis

Too many reproductive management programs fail because managers do not spend enough time looking at performance of the program. Records are only as good as the information that goes into them. DHIA summary information is a good source of data to evaluate herd breeding successes. EXTRA effort must be made by the herdsman to report ALL data on the DHIA system. We look at the following factors:

1. Average days to first service — a goal is 70 days. Many herds on a base milk system may have cycles in this trait.
2. Average days open — a goal is 110 days. However, many high-producing herds are only reaching 130 days.
3. First service conception rate — a goal is 50% for milking cows and 70% for virgin heifers. Herds that continue to breed during the three summer months will have poorer conception rates.
4. Services per conception — a goal is 2.0 or less. However, early breeding and good heat detection may raise this figure. Summer breeding will also raise this figure.
5. Technician % pregnant — if more than one technician is breeding on the farm, data on each technician will evaluate "who" should be the primary breeder. EACH FARM SHOULD HAVE ONE PRIMARY TECHNICIAN.
6. Summer Breeding — a decision to breed or not to breed during the summer months must be made. If cows are bred, use young sire semen, and save the most costly semen for heifers. When summer conception rates reach 15% or below, it takes about 17 units of semen to get one female replacement that will live to enter the milking string.

Client and Labor Education

This is a continual process and goes on as the work is being done on each farm visit. Repeated instructions must be used to convey the message to the farm workers. Visual aids, hands-on training, incentives, and client education seminars are all necessary for an effective program.

Tips from our Reproductive Seminar

1. 85% of the cows doing the riding in a herd are in heat or will be in heat in 1 to 3 days.

2. Cows trying to ride several other cows are probably in heat, even though no cows try to ride them.

3. A cow trying to mount other cows from the front is almost always in heat.

4. Cows on dirt show a 50% increase in riding activity and a 4-hr increase in time they stay in heat.

5. The best time to breed cows is 12 hr after the FIRST STANDING HEAT. It makes no difference how long a cow stays in heat; the important thing is when she came in heat and first stood.

6. The best thaw temperature for semen is 95^{0}F, and semen should be in the cow within 15 minutes of the time it leaves the tank.

7. Horn breeding may improve conception by making the technician more aware of proper placement of the semen.

8. LOW EFFECTIVE FIBER in the diet causes low fat test, lame feet, and lack of fetuses (open cows).

9. Clean calving areas are the most critical part of a good reproductive health program.

10. Most cows that don't settle had a problem 60 to 120 days earlier near the time of calving.

11. The size of the cervix 2 wk after calving is a good indicator of uterine health and rebreeding potential.

12. Cows with feet problems won't show good heats or breed back.

13. ONE PERSON should be responsible for the heat detection on each farm. Each farm should have ONE primary AI technician.

14. Conception rates in June, July, and August will be below 20% on milking cows. Conception rates on heifers will be much better and may be near 50% or higher.

15. Avoid summer breeding. If you do breed cows during the three summer months, use young sire semen. Use your best semen on heifers.

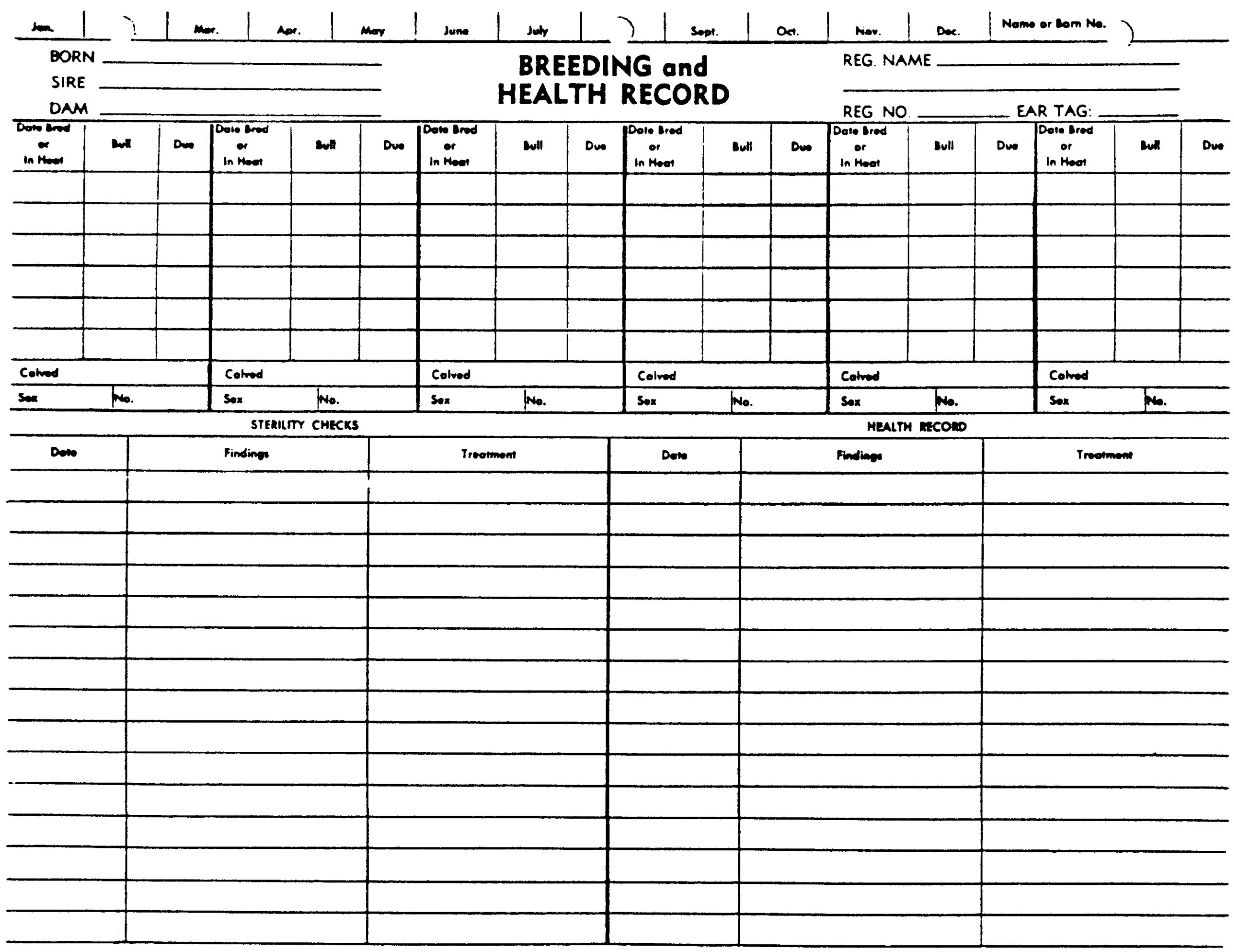
16. Three simple goals for a breeding program:

    a. Calve all heifers by 25 mo of age.
    b. Maintain a 12- to 13-month calving interval.
    c. 90% of the cows in the herd should breed back.

17. If you infuse over 5% of the cows in your herd, look at sanitation in your calving and fresh cow pens.

18. SOLAR STRESS (sunlight) can reduce the reproductive performance of dry cows; SHADE should be provided.

19. HEAT STRESS lasts for 30 to 60 days after the weather begins to cool. This is why conception rates may be low in September.


Jan. | Mar. | Apr. | May | June | July | Sept. | Oct. | Nov. | Dec. | Name or Barn No.

BORN
SIRE
DAM

BREEDING and HEALTH RECORD

REG. NAME
REG NO. EAR TAG:

Date Bred or In Heat	Bull	Due	Date Bred or In Heat	Bull	Due	Date Bred or In Heat	Bull	Due	Date Bred or In Heat	Bull	Due	Date Bred or In Heat	Bull	Due	Date Bred or In Heat	Bull	Due
Calved			Calved			Calved			Calved			Calved			Calved		
Sex	No.		Sex	No.		Sex	No.		Sex	No.		Sex	No.		Sex	No.	

STERILITY CHECKS

Date	Findings	Treatment

HEALTH RECORD

Date	Findings	Treatment

Figure 1. Breeding and Health Record.

THE EFFECT OF NUTRIENT INTAKE AND PROTEIN DEGRADABILITY ON THE GROWTH AND DEVELOPMENT OF HOLSTEIN HEIFERS

D. E. Isbell and J. L. Morrill

Summary

One hundred and twelve Holstein heifers were used from 10 wk until 26 wk of age. They were assigned to receive either 100% or 115% of NRC (1978) recommended nutrients and to be fed either control or extruded SBM. There were no interaction effects between the nutrient amount and type of SBM. Heifers on the higher nutrient amounts gained 205 lb vs 168 lb for the heifers on the lower nutrient amounts. Those on the higher nutrient amounts also had greater increases in height (8.7 vs 7.5 in), length (10.2 vs 8.7 in), and heart girth (12.6 vs 10.6 in). There were no differences in body scores. There were no statistical differences or apparent trends between the extruded and control SBM-fed heifers.

Introduction

Dairy heifers should calve at 24 mo of age, which means they will need to be bred at 15 mo of age. Increasing the energy concentration of their ration will increase the heifers' rate of gain and allow puberty to be reached at an earlier age. Unfortunately, this often leads to excessive fattening of the heifers, which impairs their future milk production. However, if all of the major nutrients were simultaneously increased, it might be possible for heifers to reach breeding and freshening size at an earlier age and/or reach larger mature weights without getting too fat.

Increasing the amount of protein that escapes ruminal degradation could result in improved protein nutrition or allow decrease of total dietary protein. Information is needed concerning the effect of increasing ruminal protein bypass at different dietary protein concentrations for growing replacement heifers.

This study was designed to provide information concerning these points.

Procedure

One hundred and twelve Holstein heifers were used from 10 to 26 wk of age. Heifers were assigned to a block of four by age, then heifers within a block were assigned randomly to each of four treatments. Brome hay was fed free choice. Amount of grain and hay, at estimated intake, was formulated to provide either 100% or 115% of NRC (1978) recommendations for protein, energy, Ca, P, and vitamins A, D, and E. The supplemental protein source was either control or extruded SBM.

Each week, individual body weights were taken, and average daily hay consumption was determined. At 18 and 26 wk of age, body measurements (wither height, length, heart girth) were taken. At 26 wk of age, body scores (1.0, thin to 5.0, fat) were recorded.

Results and Discussion

Because the heifers ate more hay than was estimated, they consumed more nutrients than was originally planned. Heifers on the higher nutrient amount receiving control SBM (HC) or extruded SBM (HE) actually consumed 127% and 125%, respectively, of NRC recommended nutrients. Heifers on the lower nutrient amount receiving control SBM (LC) or extruded SBM (LE) actually consumed 108% and 107%, respectively, of NRC recommendations.

The growth measurements of the heifers are shown in Table 1. Heifers on HC and HE gained more weight than heifers on LC and LE. The weights of HC and HE heifers were higher than current recommendations for replacement heifers. Suggested rates of gain are lower than those previously recommended because of the belief that high rates of gain in the prepubertal period will have a negative effect on mammary development. However, it may be possible to increase rates of gain without fattening the heifers. HC and HE heifers also had a greater increase in height, length, and heart girth. Ending body scores were 3.0 for HC and HE heifers and 2.95 for heifers on LC and LE. It remains to be seen what effect increasing the rate of gain along with increasing skeletal growth, and thereby not overconditioning the heifers, has on mammary development.

There were no statistical differences or any definite pattern between the control and extruded SBM-fed heifers.

Table 1. Growth Measurements of Heifers

Item	Treatment[1]			
	LC	LE	HC	HE
Weight, lb				
10 wk	168	172	173	170
18 wk	253[a]	260[a]	275[b]	275[b]
26 wk	338[a]	342[a]	374[b]	375[b]
ADG[2]	1.52[a]	1.52[a]	1.80[b]	1.83[b]
Wither height, in				
10 wk	32.5	32.8	32.6	32.4
18 wk	35.7[a]	36.1[a]	36.3[ab]	36.8[b]
26 wk	40.1[a]	40.4[a]	41.1[b]	41.3[b]
Increase	7.6[a]	7.6[a]	8.5[b]	8.9[b]
Length, in				
10 wk	33.2	33.4	32.6	33.2
18 wk	37.7[a]	38.4[ab]	38.7[b]	38.4[ab]
26 wk	41.6[a]	42.7[b]	43.5[b]	43.1[b]
Increase	8.4[a]	9.3[a]	10.9[b]	9.9[b]
Hearth girth, in				
10 wk	38.0	38.7	38.2	37.8
18 wk	44.7[a]	45.3[ab]	46.1[b]	45.8[ab]
26 wk	48.9[a]	49.8[ab]	50.9[b]	50.5[b]
Increase	10.9[a]	11.1[a]	12.7[b]	12.7[b]

[1]For description of treatments see text.
[2]Average daily gain, lb.
[ab]Means in the same row with different superscripts differ (P<.05).

EFFECT OF LASALOCID IN RATIONS FOR GROWING HEIFERS

D. E. Isbell and J. L. Morrill

Summary

Sixty-four Holstein heifer calves were used from 10 to 26 wk of age to study the effects of lasalocid on growth and feed consumption. Calves were evaluated weekly for weight gain and feed consumption. Lasalocid-fed heifers gained slightly, but not significantly, more than those that did not receive lasalocid. Their hay consumption was not significantly different than that of the control heifers.

Introduction

Lasalocid (Bovatec®) is a feed additive ionophore that is cleared for use in rations of growing heifers. The potential benefit of lasalocid is to produce heavier heifers through greater efficiency in protein and energy utilization in the rumen. The beneficial effect of lasalocid in rations for very young calves and in animals weighing over 400 lb has been demonstrated in recent research. However, there are few data showing the effect on animals weighing between 200 and 400 lb. The purpose of this experiment was to study the effects of lasalocid on heifers from 10 to 26 wk of age.

Procedure

At 10 wk of age, 64 Holstein heifers were assigned randomly to each of two groups. Each heifer in both groups was fed prairie hay ad libitum and 5.7 lb of concentrate per day. The concentrate mixture was formulated so that the diet provided 1978 NRC recommendations for protein, energy, and vitamins A, D, and E. Major minerals were supplied to provide 1978 NRC recommendations and a K:Na ratio of 3 to 1. One group received concentrate with lasalocid added at 25 mg per lb. Within each treatment, heifers were housed together from 10 to 18 wk of age and from 18 to 26 wk of age. The experiment ended when the heifers were 26 wk of age.

Individual weight gains were recorded weekly. Average hay consumptions for the four lots were calculated weekly.

Results

Weight gains and hay consumption are shown in Tables 1 and 2. In the 10 to 18 wk period, lasalocid-fed heifers gained .11 lb/day more than the control heifers, while eating .23 lb/day less hay. In the 18 to 26 wk period, lasalocid-fed heifers only gained .02 lb/day more but also ate .05 lb/day more hay than the control heifers. None of the differences between groups were statistically significant.

Table 1. Body Weight, Total Gain, and Average Daily Gain (ADG) of Heifers[1]

Ration	Weight of heifers, lb			Gain, 10 to 18 wk		Gain, 18 to 26 wk	
	10 wk	18 wk	26 wk	Total	ADG	Total	ADG
Control	171 ± 3.48	258 ± 5.38	350 ± 7.45	87 ± 3.15	1.55	92 ± 3.04	1.64
Lasalocid	168 ± 3.36	261 ± 5.21	354 ± 7.22	93 ± 3.04	1.66	93 ± 2.95	1.66

[1]Average ± SE.

Table 2. Average Daily Hay Consumption (lb/day) of Control and Lasalocid-fed Heifers[1]

Ration	Age of heifers	
	10 to 18 wk	18 to 26 wk
Control	2.24 ± .157	5.20 ± .158
Lasalocid-fed	2.01 ± .157	5.25 ± .158

[1]Average ± SE.

A RAPID METHOD OF ANALYSIS OF CORN GRAIN FOR DAIRY CATTLE

G. Garcia, R. Malvetti, and L. H. Harbers

Summary

Calibration equations for near infrared reflectance spectroscopy (NIRS) have been either purchased from the manufacturer or developed in the laboratory. Comparative analysis with standard laboratory procedures indicate that NIRS may be used for analyzing dairy feedstuffs, when proper calibration is made with local feedstuffs.

Introduction

NIRS is a new, rapid method of analyzing feedstuffs that reduces the time from several days to one minute or more after grinding and subsampling. The instrument needs to be calibrated from nutrient analyses made in the laboratory. Many calibrations may be purchased from the manufacturer of the instrument; however, we have found that many Kansas feedstuffs do not lend themselves well to purchased equations. Purchased equations that do appear to give acceptable results include those for alfalfa hay, mixed hay, grass hay, and corn silage. Sorghum silage equations are inadequate for the many cultivars in this state, and those for corn and milo were too expensive to purchase.

This is a report on progress with the development of an equation for corn grain.

Procedures

Three hundred corn grain samples were collected from Peterson's Laboratory, Manhattan Milling Co., and the Farmers' Cooperative. Samples were ground in an impact mill and scanned by NIRS in duplicate. Samples different from each other were chosen by using a subset routine in the computer and analyzed by wet chemistry for moisture, crude protein, crude fiber, and crude fat (ether extract). The laboratory data were matched with spectra of the samples, a procedure called calibration. From this we obtained information on means, standard error of calibration, and correlation coefficients. Multiple linear equations were developed for each nutrient, then validation tests with other samples were conducted to determine correlations and standard errors of validation.

Results and Discussion

Variation among the corn samples was low, so only 17 samples were picked by the computer to be different from each other. It is usually necessary to use at least 50-55 samples for calibration. The current equation developed for corn does appear acceptable (Table 1); however, additional samples for the calibration equation would increase the correlation coefficient (r^2) and decrease the standard errors of calibration. Collection of samples over several harvests will improve both calibration and validation.

Table 1. Calibration Results from Corn Grain

Variable	Mean	Standard error of calibration	r^2
Dry matter	89.69	.424	.899
Crude protein	9.43	.309	.837
Crude fiber	1.05	.171	.656
Ether extract	4.57	.196	.860

COMPARISON OF GROWTH OF HOLSTEIN HEIFERS FED 100% OR 115% OF NRC REQUIREMENTS

M. G. Daccarett and J. L. Morrill

Summary

One hundred and one Holstein heifers from the KSU Dairy Unit were used in this experiment. They were assigned to two treatments in which they were fed either 100% or 115% of the 1988 NRC requirements of energy, protein, major minerals, and major vitamins. Body measurements (height, length, heart girth, weight, body condition scores, and backfat thickness) were recorded. Rations for each group were formulated using the average wt of the heifers. Results suggest that feeding 115% of NRC requirements produces larger frame heifers (without excess body condition), with potential for earlier calving, compared to feeding 100% of NRC requirements.

Introduction

Cost of raising dairy heifers is a significant expense in any dairy operation. Lowering age at first calving offers a way to reduce this cost. This is possible if the heifer reaches the desired body wt and size for the first service at a young age. Current recommendations suggest that Holstein heifers should calve at 24 mo of age and weigh from 1200 to 1300 lb (ADG of about 1.6 lb/day). Heifers calving at less than 24 mo produce less milk in the first and later lactations than heifers calving at 24 mo of age. Recent research suggests that this reduction in milk yield is caused mostly by high energy intake during the prepubertal period (3 to 9 mo of age), causing infiltration of fat into the mammary gland, which inhibits the development of secretory tissue.

Body size (weight, height, and length) at first calving appears to be positively correlated with milk production, so larger heifers at first calving should be a goal. However, dairy producers should not confound body size with overconditioning. Overconditioned heifers are not necessarily larger heifers. Fat heifers are not desirable because they are more susceptible to diseases (dystocia, metabolic disorders, and reproductive problems after parturition), and produce less milk. Therefore, overconditioning to increase body size and lower age at first calving is not a good management practice. Instead, proper feeding is needed to get a high quality replacement that will be able to fully express her milk producing ability at a younger age.

The objective of this experiment was to compare results of feeding Holstein heifers 100% or 115% of NRC requirements, with the objective of development of larger, more productive heifers without excess conditioning.

Procedures

One hundred and one Holstein heifers from the KSU Dairy Unit were used from 6 mo until 18 mo of age. In treatment 1 (control), they were fed 100% of the 1988 NRC requirements of energy, protein, major minerals, and major vitamins for large breed, growing dairy heifers to gain about 1.6 lb/day. In treatment 2, the heifers were fed 115% of those requirements. Wither height, body length from point of shoulder to center of the pin bone, and heart girth measurements were taken to evaluate body size. Body condition of heifers was scored using a .5 scale from 1 (severely underconditioned) to 5 (severely overconditioned). Measurements of backfat thickness were taken using ultrasound equipment. Each week, individual body weights were recorded. Rations for each age-group (6-9, 9-12, 12-15, 15-18 mo) were formulated weekly based on the average wt of the heifers in the group. A total mixed ration with alfalfa and prairie hay, milo, trace mineralized salt, and calcium and phosphorus supplements was used. Breeding was begun when the heifers reached 750 lb.

Results and Discussion

Heifers fed 115% of the NRC requirements were younger at first service ($P<.01$) than those in the control group, 13.6 ± .2 mo vs. 14.6 ± .3. Expected age at first calving was also lower for the 115% group ($P<.004$), 22.8 ± .2 mo vs. 23.9 ± .3.

Body weight was greater for the 115% heifers ($P<.0005$). Figure 1 shows the average weights of the heifers from both treatments compared to the Beltsville and Waldo growth standards for Holstein heifers at different ages.

Heart girth and body length were also greater for the 115% heifers ($P<.0054$ and $P<.0238$, respectively). However, wither height was the same for both groups. These data and wither height from Waldo's growth standard are shown in Figure 2.

Body condition scores (Table 1) at 18 mo of age were slightly higher ($P<.062$) for heifers in the 115% (3.2) vs heifers in the 100% group (3.05); however, there was no significant difference in backfat thickness. This suggests that the heifers in the 115% group were getting larger and heavier without excess fat.

The results showed that to this point (18 mo of age), feeding 115% of the NRC requirements produced larger frame heifers without excess of flesh, with the ability to calve at younger ages, compared to feeding 100% of requirements. This experiment will continue through the first lactation to evaluate milk production, reproductive efficiency, calving difficulty, and other factors related to productivity.

References

1. Waldo, D. R., A. V. Capuco and C. E. Rexroad, Jr. 1988. Proceedings of Southwest Nutrition and Management Conference, University of Arizona.

2. Matthews, C. A. and M. H. Fohrman. 1954. Beltsville Growth Standards for Holstein Cattle. USDA Technical Bulletin No. 1099.

Table 1. Average Body Condition Scores of Holstein Heifers Fed 100% or 115% of NRC Requirements

	Age, mo				
Treatment	6	9	12	15	18
100%	2.94	2.97	2.97	3.0	3.05[ab]
115%	3.0	2.97	3.06	3.1	3.21[c]

[a]Different from 115% (18 mo): P<.062.
[b]Standard error = .058.
[c]Standard error = .061.

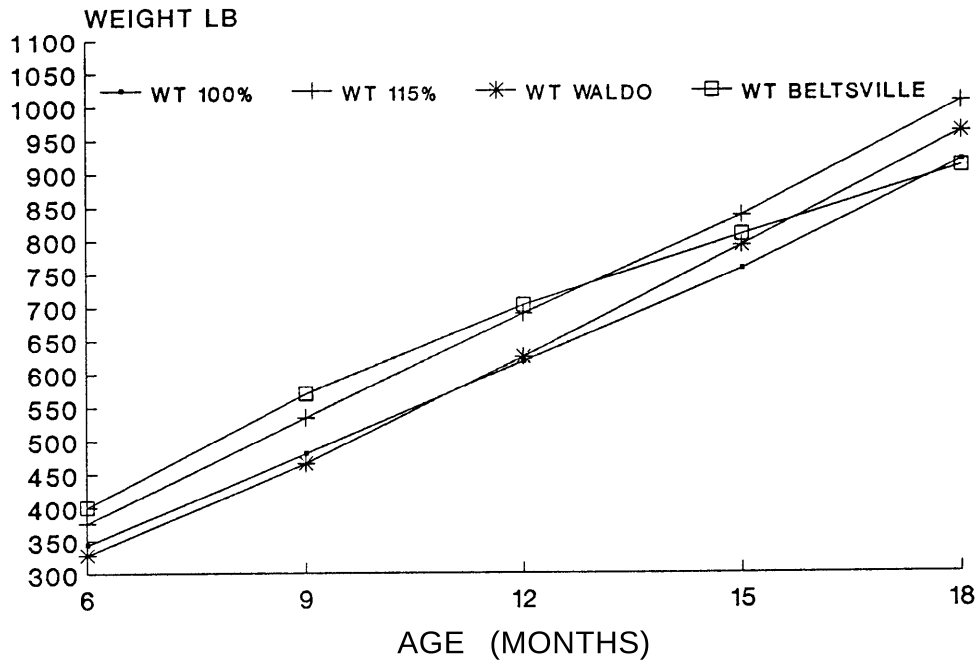


Figure 1. Avg weight (WT) of Holstein heifers fed 100% or 115% of the 1988 NRC requirements, compared to the Beltsville and Waldo growth standards for Holstein heifers.

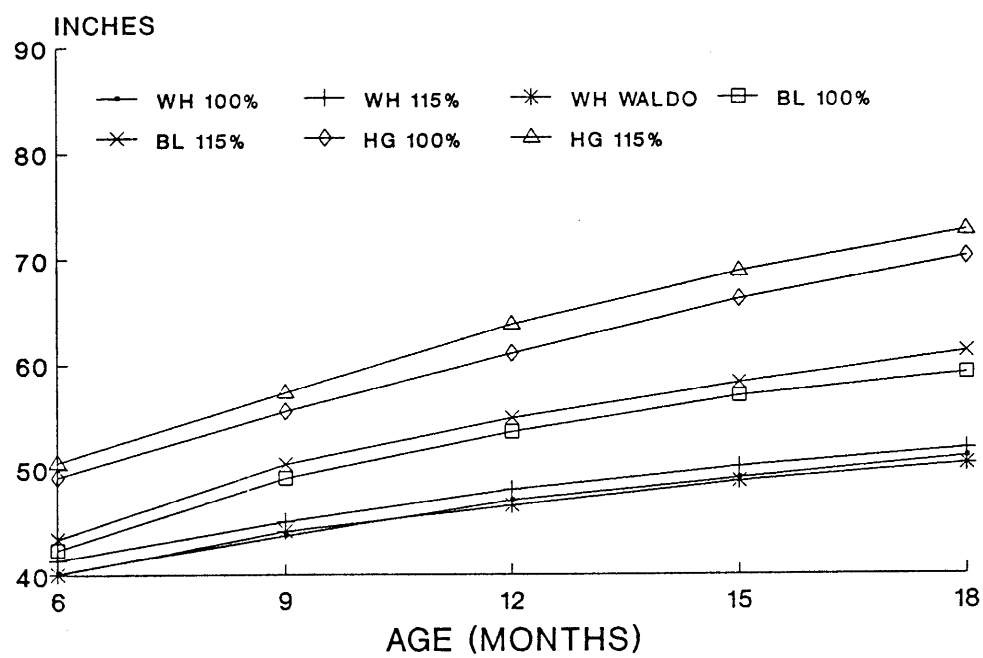


Figure 2. Heart girth (HG), body length (BL), and wither height (WH) measurements of Holstein heifers fed 100% or 115% of the 1988 NRC requirements, plus wither height standard from Waldo.

WHOLE-PLANT GRAIN SORGHUM AND INOCULATED CORN SILAGES IN MID-LACTATION DAIRY COW DIETS

K. K. Bolsen, J. E. Shirley, A. Laytimi, and J. Dickerson

Summary

Whole-plant grain sorghum silage and Silo-Best-Soluble[1] inoculated and uninoculated control corn silages were compared in complete-mixed diets for mid-lactation dairy cows. Cows fed the inoculated corn silage yielded .6 lb and those fed the grain sorghum silage yielded 1.7 lb more fat-corrected milk than those fed the control corn silage. Fat percentage for the cows fed the grain sorghum silage was .2 units greater than for those fed the control and the inoculated corn silages. Similar percentages were obtained for milk protein and solids-not-fat. Cows fed the inoculated corn silage had the highest weight gain (+150 lb), those fed the control corn silage had intermediate gains (+132 lb), and those fed the grain sorghum silage had the lowest gains (+106 lb). We conclude that dairy farmers can derive positive responses from inoculation of corn silage and that grain sorghum silage can be substituted for corn silage in mid-lactation dairy cow diets.

Introduction

Corn is the silage crop preferred by Kansas dairy farmers. Under favorable environments, corn will usually have adequate nutrients, sufficient dry matter, and a natural microflora that often leads to a successful silage fermentation. Therefore, farmers often question the benefits to fermentation from microbial inoculation of corn silage and whether these benefits would translate into better animal gains and more milk production. In addition, in Kansas, the leading state in sorghum silage production, rainfall does not always favor optimum corn production. Because of its greater drought resistance, grain sorghum silage would be a more available feed than corn under limited rainfall. The objectives of this experiment were to examine the effect of inoculation of corn silage on milk production and to compare the feeding value of whole-plant grain sorghum silage to that of corn in diets for mid-lactation dairy cows.

Procedures

The two whole-plant Hoegemeyer 2689 corn silages compared were: (1) control (no additive) and (2) inoculated with Silo-Best Soluble®. The two silages were ensiled in two 16 × 50 ft concrete stave silos on August 6, 7, and 8, 1987 using the alternate load method. Prefermented inoculant was prepared 20 to 24 hr prior to use. On each of the three filling days, a PVC laboratory silo experiment was started, and silos were opened at 6, 12, 24, 48, and 96 hr postfilling to follow the ensiling dynamics of the control and inoculated corn silages. Grain sorghum NC+ 174 was used and ensiled

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[1]Silo-Best Soluble® contains *S. faecium* M-74, *L. acidophilus, Pediococcus sp.,* and *L. plantarum* and is a product of Medipharm-USA, Des Moines, IA.

in an 8 × 125 ft Kelly Ryan bag on August 23 and 24, 1987. (For details on farm scale and PVC ensiling and sampling procedures see KAES Reports of Progress 448, 514, 539, and 567.)

Each of the three silages was fed to 20 Holstein cows (1380 lb average initial weight) in a 90-day mid-lactation (54 lb average initial milk per day) feeding trial. The cows were allocated to the silage rations according to days in milk, previous milk production, and lactation number. During a 15-day preliminary feeding period all cows were fed a diet containing corn silage (from a different source than the experimental corn silages), alfalfa hay, and a balanced concentrate mix. Three, consecutive, daily body weights were measured at the end of the preliminary period and averaged for an initial body weight. Cows in all three treatment groups were fed the experimental diets for a 6-day adaptation period. The diets were then fed for a 90-day period. The diets were completely mixed; contained 42% of the respective silage, 44% grain mix, and 14% chopped alfalfa hay; and were balanced for milk production according to NRC (1988) recommendations.

Individual cow milk production and group feed intake were recorded daily. Milk was sampled weekly for determination of milk fat, protein, solids-non-fat (SNF), lactose, and somatic cell count.

Cows were housed according to treatment and fed the total mixed diet in a fence-line bunk via a feed mixer wagon equipped with an electronic scale. Cows were fed twice daily in accordance with group average milk production, milk fat, and body weight.

Results and Discussion

Silage fermentation dynamics for the PVC control and inoculated corn silages are shown in Table 1. Both control and inoculated silages underwent very rapid fermentations, reaching a pH of 3.90 within the first 48 hr. Although inoculated silage fermented faster during the first 24 hr, as indicated by its pH drop and lactic acid production, the differences compared to the control were not significant. The 90-day fermentation end-products of both silages were very similar.

The fermentation products and composition of the control corn, inoculated corn, and grain sorghum silages at feeding are shown in Table 2. Fermentation products and pH were very similar for the control and inoculated corn silages. However, the grain sorghum silage had higher pH and acetic acid and lower lactic acid levels than the corn silages. The dry matter content, which averaged 35%, was similar for all the silages. The grain sorghum silage had higher protein (9.8 vs 7.5% of the dry matter) but lower content of acid detergent fiber (ADF) (23.5 vs 25.0% of the dry matter) than the corn silages.

Average daily dry matter intake, milk production and composition, and cow weight change are shown in Table 3. Although dry matter intake for all the silages was similar, total dry matter intake tended to be higher for the grain sorghum silage ration than for the corn silage rations.

Although daily milk production was also similar for all the silages, averaging 46.4 lb of fat-corrected milk (FCM), cows fed the inoculated corn silage yielded .6 lb and those fed the grain sorghum silage tended to yield 1.7 lb more fat-corrected milk than those fed the control corn silage. Cows fed the grain silage tended to produce 1.1 lb more fat-corrected milk than those fed the inoculated corn silage.

There were no differences among the silages for milk fat percentage (3.7% for the corn silages vs 3.9% for the sorghum silage). However, fat percentage for the cows fed the grain sorghum silage was .2 units greater than that for cows fed the control and the inoculated corn silages. Similar percentages were obtained with milk protein and solids-not-fat.

Weight change of the cows was different ($P<.05$) among the silages. Cows fed the inoculated corn silage had the highest weight gain (+150 lbs), those fed the control corn silage had intermediate gains (+132 lbs), and those fed the grain sorghum silage had the lowest gains (+106 lbs).

We conclude that dairy farmers may derive positive responses from inoculation of corn silage and that grain sorghum silage can be substituted for corn silage in diets for mid-lactation dairy cows.

Table 1. Initial Dry Matter, pH, and Fermentation Products over Time for Control and Inoculated Corn Silages

Time post-filling and item		Control	Inoculated
Initial dry matter, %		36.35	36.65
Hour 6:	pH	5.16	5.06
	Lactic acid[a]	.82	.88
Hour 12:	pH	4.44	4.35
	Lactic acid	1.91	2.13
Hour 24:	pH	4.34	4.25
	Lactic acid	2.91	3.13
Hour 48:	pH	3.91	3.90
	Lactic acid	4.56	4.71
Day 4:	pH	3.86	3.85
	Lactic acid	5.32	5.45
Day 90:	pH	3.92	3.91
	Lactic acid	7.10	7.29
	Acetic acid[a]	1.07	1.06
	Ethanol[a]	.83	.59
	NH_3-N[a]	.08	.08

[a]Expressed as a percentage of the silage dry matter.

Table 2. Fermentation Products, pH, and Chemical Composition of Corn and Grain Sorghum Silages Fed to Cows

Item	Corn		
	Control	Inoculated	Grain sorghum
pH	3.8	3.8	4.2
Fermentation products:	------------------- % of the dry matter -------------------		
Lactic acid	6.3	6.7	4.4
Acetic acid	1.5	1.5	3.6
NH_3-N	.10	.11	.17
Chemical composition:			
Dry matter, %	35.6	34.9	34.5
	--------------------- % of the dry matter -------------------		
Crude protein	7.5	7.4	9.8
Acid detergent fiber	25.1	24.8	23.5

Table 3. Intake, Milk Yield and Composition, and Weight Change of Cows Fed Three Silage Rations

	Corn		
Item	Control	Inoculated	Grain sorghum
No. cows	20	20	20
Dry matter intake, lb/d:			
Silage	20.9	20.7	21.8
Grain	22.2	22.0	22.5
Hay	6.8	6.8	6.8
Total	50.0	49.5	51.1
Milk:			
Yield, lb			
Daily	47.8	48.4	48.0
Fat-corrected milk	45.6	46.2	47.3
Composition, %			
Fat,	3.7	3.7	3.9
Protein, %	3.4	3.4	3.4
Solids-not-fat	12.5	12.4	12.7
Weight change, lb	+132.0[a]	+150.0[b]	+106.0[c]

[abc]Means in the same row with different superscripts differ (P<.05).

EVALUATION OF WATER OXYGENATION ON MILK PRODUCTION: MILK COMPOSITION AND SOMATIC CELL CONCENTRATION IN MILK[1]

J.E. Shirley, C. Galdamez, and J. Estrada

Summary

Forty Holstein cows in mid-lactation were utilized to evaluate the effects of water oxygenation on milk production, milk composition, and somatic cell count. Cows were fed a total mixed ration consisting of 25% alfalfa, 25% corn silage, and 50% corn-soy concentrate on a dry matter basis. Treatments included a 7-day preliminary period followed by two 28-day periods in which the treatments were reversed.

Water consumption, milk production, milk composition, and somatic cell count were not different between treatments. Cows receiving oxygenated water were more docile and easily managed than control cows. Ozone introduced into water forms hydrogen peroxide, nitrous oxide, and increases the redox potential of the water.

Introduction

The ruminant animal survives by providing an environment suitable for the anaerobic fermentation of feedstuffs. The end-products of this process are predominantly volatile fatty acids (acetic, propionic, and butyric), methane, and microbial cells. Any process that alters ruminal dynamics can influence the production of these end-products and, ultimately, animal efficiency.

The process of oxygenation of drinking water may impact animal production by a number of mechanisms. Since the majority of the ruminal microbes are strict anaerobes, increasing the supply of oxygen to the rumen would be detrimental to these organisms. The most sensitive of these organisms would be the methane-producing bacteria. Any process that reduced methane production would potentially improve the efficiency of fermentation and, ultimately, improve animal performance. An analysis of fermentation end-products is needed to evaluate these effects.

Alternatively, the effects may be mediated through altered water consumption, which would alter ruminal fluid dynamics and fermentation.

The purpose of this study was to analyze critically the production traits of lactating cows offered only oxygenated water for drinking.

[1]Project support by grant 5-21677 from Jim Persinger, Hugoton, Kansas.

Materials and Methods

Forty Holstein cows were utilized to evaluate the effects of water oxygenation on milk production, milk composition, and somatic cell count.

Treatments were balanced for production, parity, days in milk, and body weight. Cows were fed a total mixed ration consisting of 25% alfalfa, 25% corn silage, and 50% corn-soy concentrate on a dry matter basis. Forage:concentrate ratio was changed during the trial in accordance with milk production. Forty percent of the daily ration was fed in the A.M. and 60% in the P.M. Daily feed consumption per treatment group was recorded.

Cows were weighed on two consecutive days at the beginning and end of each treatment period. Individual milk weights were recorded daily, and milk samples (A.M. + P.M.) were collected weekly for analysis of milk fat, protein, lactose, total solids, and somatic cells (SCC).

Water intake per group was monitored with an in-line meter and recorded daily. Water intake per cow was calculated by dividing daily intake per group by the number of cows per group.

Treatments included a 7-day preliminary period, a 28-day period, and a second 28-day period, in which the treatments were reversed (switchback design).

Results and Discussion

Cows offered oxygenated water (O group) as their sole source of drinking water consumed similar amounts per day (23.9 gal) as control (C group) cows (24.4 gal) and did not require a significant adjustment period. Body weights increased over the 56-day experimental period (1,468 lb in period 1 vs 1,497 lb in period 2) and were not different between groups (1,489 lb for O vs 1,481 lb for C). Cows consuming the treated water were more docile and easier to manage than control cows after approximately 1 wk on treatment. This difference was observed in both groups of cows in the switchback design used. Theoretically, the system used to increase the oxygen content of water produces hydrogen peroxide and nitrous oxide. Although these were not measured in this experiment, increased amounts of nitrous oxide could produce the animal behavior effects observed when the cows were exposed to the oxygenated water.

Treatment effects on milk production and composition (Table 1) were not different for any traits measured.

Table 1. Treatment Effects on Milk and Milk Composition

Treatment	Milk, lb	Fat, %	Protein, %	Lactose, %	Total solids, %	SCC[a] (x1000)
Control	57.8	3.44	3.32	4.74	12.08	345
Oxy. water	58.1	3.47	3.34	4.76	12.14	424
Standard error[b]	.18	.034	.015	.011	.044	56

[a]SCC = somatic cell count.
[b]Standard error for each measurement.

Cows utilized in this experiment were in midlactation and in positive energy balance, as indicated by an increase in body weight. They were well adjusted to the facilities and personnel, because all cows used were born at the unit. The cows were prescreened for health problems, and only those with a record of reasonable health were included in the study. Thus, they were relatively free from the most common stress factors. Beneficial effects of oxygenated water by the means used herein have been observed in the field with sick steers and heifers or cattle under stress. The lack of response in this study could be due to the absence of major stress conditions.

If the major benefit of the treatment is to reduce the effects of stress on performance, a suitable test of its effectiveness would be first-calf heifers during early lactation. The observed "calming" effect noted herein might be beneficial in adjusting heifers to the milking process.

NEUTROPHIL AND LYMPHOCYTE RESPONSE TO VITAMINS C AND E SUPPLEMENTATION IN YOUNG CALVES

S. D. Pruiett, J. L. Morrill, F. Blecha[1], J. J. Higgins[2], N. V. Anderson[3], and P. G. Reddy[1]

Summary

Calves were bottle-fed milk replacers at 10% of weekly adjusted body weight for 8 wk. Treatments were 1) no supplements (control), 2) .16 oz vitamin C, or 3) .16 oz vitamin C plus 125 IU/lb vitamin E. Lymphocytes and neutrophils isolated from day 14 and day 28 blood samples were assayed for neutrophil-mediated S. aureus phagocytosis and antibody-dependent cellular cytotoxicity, and for mitogen induced lymphocyte proliferation. Eye and nasal discharges of calves supplemented with vitamin C and vitamins C plus E were less than those of control calves for wk 1 to 8. Lymphocyte proliferation with the mitogens showed a trend for higher responses at wk 2 in vitamin C plus E supplemented calves. Neutrophils of calves supplemented with vitamin C showed decreased phagocytosis and lysis functions compared to those of control calves at wk 2 and 4. Neutrophil function of calves supplemented with vitamins C plus E was near or slightly higher than that of controls at wk 2 and 4, suggesting that the addition of vitamin E negated the adverse effects that vitamin C alone had on neutrophil functions.

Introduction

Ascorbic acid (vitamin C) is produced by the liver of many animals, including cattle. Ascorbic acid synthesis begins in calves between the second and third wk of life and reaches adult concentrations of vitamin C around 3 mo of age. Milk, which has a relatively low ascorbic acid content, is often exposed to air and light before being consumed by the calf. Both are destructive agents of vitamin C. Therefore, vitamin C deficiency is a potential problem with the young milk-fed calf. This would be especially true for dairy calves, whose only source of vitamin C for the first few wk of life is bucket- or bottle-fed milk or milk replacer.

Vitamin C deficiency has been linked to decreased immune response, and elevated ascorbic acid concentrations have been linked to increased immune response in catfish, poultry, cattle, and swine. Conversely, others have found that vitamin C supplementation had no beneficial effect on the immune responses measured. The value of vitamin E to the immune system of the young calf has been established. It is primarily responsible for protection of the cell membrane. In other species, vitamins C and E have been shown to work cooperatively to protect the cell membranes against peroxidation.

The purpose of the present study was to determine the effects of supplements of vitamin C alone and vitamins C and E together on the function of neutrophils and lymphocytes of the young calf's

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immune system, as well as their effect on the growth and general health of the calf during the first 8 wk of life.

Procedures

Thirty Holstein bull calves were removed from their dams at 24 h following birth. They were given transition milk for 2 more days, then assigned to each of three treatment groups. The treatments consisted of milk replacers 1) without supplemental vitamins (control), 2) with .16 oz vitamin C per kg, or 3) with .16 oz vitamin C plus 125 IU vitamin E per lb. Milk replacer was reconstituted to 13.5% dry matter and was fed at 10% of body weight, adjusted weekly, which was divided into two equal daily feedings. Calves were housed in individual hutches with straw bedding. Water was available ad libitum.

Body weights were measured and milk replacer allocations were adjusted weekly. Twice daily fecal and general appearance scores were recorded, and eye or nasal discharge or signs of enteric or respiratory illness were noted. Blood samples were collected in heparinized tubes on experimental day 1, 14, 28, and 56 for vitamin C and E determinations. Day 14 and day 28 samples were used to assay lymphocyte proliferation and neutrophil function. A lymphocyte transformation assay (LTA) and neutrophil-mediated antibody-dependent cellular-cytotoxicity (ADCC) and S. aureus phagocytosis assays were used to determine lymphocyte and neutrophil cellular function.

Results and Discussion

Vitamin C was stable in the milk replacers after a decrease that occurred prior to sampling. Plasma vitamin C concentrations of the control group dropped throughout the study until wk 8, when concentrations for all treatments were approximately equal (Figure 1). The vitamin C-only group maintained a high concentration until wk 8. The plasma vitamin C content of vitamin C plus E-supplemented calves decreased greatly at wk 2, but later recovered to levels near those of the vitamin C-only group. Plasma vitamin E concentrations reflected the supplementation with that vitamin.

No significant differences occurred between treatments in gain or feed efficiency until wk 6 (Table 1). The vitamin C plus E supplemented group had greater gains over the entire 8 wk period than the vitamin C supplemented group and was more efficient in feed conversion (lb feed/lb gain) than both the control and vitamin C supplemented group.

Table 2 shows weekly mean fecal scores and discharge observations for all groups. The control group tended to have the lowest fecal scores (more solid feces) throughout the 8 wk, and the vitamin C supplemented group tended to have the highest scores. The control and vitamin C supplemented groups were different ($P<.10$) at wk 2, 6, and 8, and at wk 8 the vitamin C group was also significantly higher than the vitamin C plus E supplemented group. Mean eye and nose discharges tended to be higher for the control group for all 8 wk. At wk 3, the vitamin C plus E supplemented calves had significantly less discharges than the control group, and the vitamin C only supplemented group was significantly lower than the control calves at wk 7.

Table 1. Total and Daily Gain by Week and Feed Efficiency

	Gain, lb/d			Feed efficiency, lb feed/lb gain		
	Vitamin supplementation			Vitamin supplementation		
Wk	None	C	C + E	None	C	C + E
1	1.19	1.08	1.54	1.3	2.5	1.0
2	.75	.81	.99	1.5	1.5	1.6
3	.77	.90	.31	2.2	2.0	1.9
4	.90	.92	1.03	1.7	1.8	1.8
5	.99	1.12	.99	2.2	1.9	1.9
6	1.34[ab]	.81[a]	1.76[b]	1.8[b]	3.6[a]	1.2[b]
7	1.50[a]	1.39[ab]	.92[b]	1.8[b]	1.7[b]	4.6[a]
8	1.32[ab]	1.19[a]	1.91[b]	1.9	1.5	1.6
Totals	61.8[ab]	57.6[a]	64.5[b]	1.65[a]	1.61[a]	1.41[b]

[ab]Differing superscripts within the same week denote means with statistically significant differences ($P<.10$).

Because of variability in the lymphocyte functions of the 2- and 4-wk-old calf, no significant differences between the treatment groups could be noted in the Con-A and PHA mitogen-induced proliferation means. Week 2 lymphocytes of vitamin C plus vitamin E supplemented calves showed trends toward greater proliferation. By wk 4, the lymphocytes of vitamin C supplemented calves had proliferative responses equal to or greater than those of the C plus E supplemented calves. The lack of differences in lymphocyte proliferation between treatments may have been partly due to very little environmental stress experienced by these calves. Environmental stress has been shown to increase the use of vitamin C and antibody production in young calves supplemented with vitamin C. Increased antibody production would be preceded by increased lymphocyte proliferation.

The neutrophil mediated ADCC at wk 2 (Figure 2) showed significant differences between the two vitamin supplemented groups, and at wk 4 between the vitamin C supplemented group and the control as well. The S. aureus phagocytosis assays showed the vitamin C group to be significantly different from the control at wk 2, but no significant differences were detected at wk 4.

Table 2. Weekly Eye and Nasal Discharge and Weekly Fecal Scores

	Eye and nasal discharge				Fecal score			
	Vitamin supplementation				Vitamin supplementation			
Wk	None	C	C + E	SE	None	C	C + E	SE
1	1.5	.2	.4	.26	2.0	2.2	2.1	.13
2	2.5	1.6	1.3	.47	2.0	2.6	2.2	.15
3	3.4[a]	1.9[ab]	1.5[b]	.85	2.3	2.3	2.1	.16
4	3.1	2.8	1.6	.92	1.8	1.9	1.9	.10
5	1.7	.9	1.6	.64	1.6	1.8	1.8	.12
6	1.9	.7	.8	.56	1.5[b]	1.9[a]	1.7[ab]	.12
7	2.0[a]	.5[b]	.7[ab]	.59	1.6	1.6	1.6	.12
8	1.9	1.9	.6	.54	1.5[b]	1.8[a]	1.6[b]	.12
Totals	17.0	10.5	9.0	3.61	--	--	--	--

[ab]Differing superscripts within the same week denote means with statistically significant differences (P<.10).

Conclusion

Supplementation with vitamin C alone and vitamins C and E together did not have a beneficial effect on any of the immune responses measured here. However, the lower incidence of mucous discharge from eyes and noses suggests a beneficial effect that was not reflected by the cellular functions we measured. The use of vitamins C and E together appeared to negate the adverse effects of vitamin C alone on neutrophil functions at both 2 and 4 wk and on lymphocyte proliferation at wk 2.

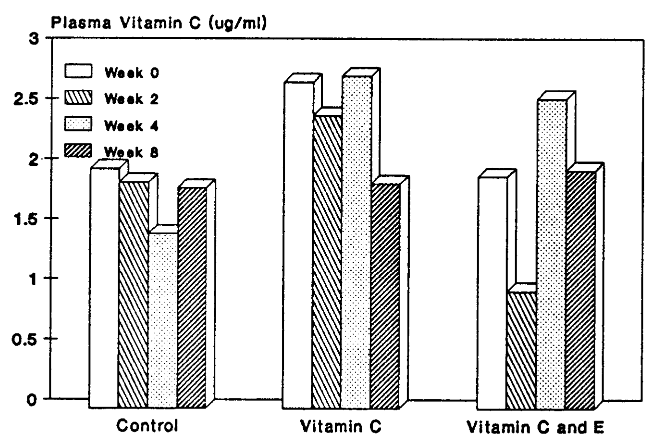

Figure 1. Plasma vitamin C concentrations at 0, 2, 4, and 8 wk of treatment.

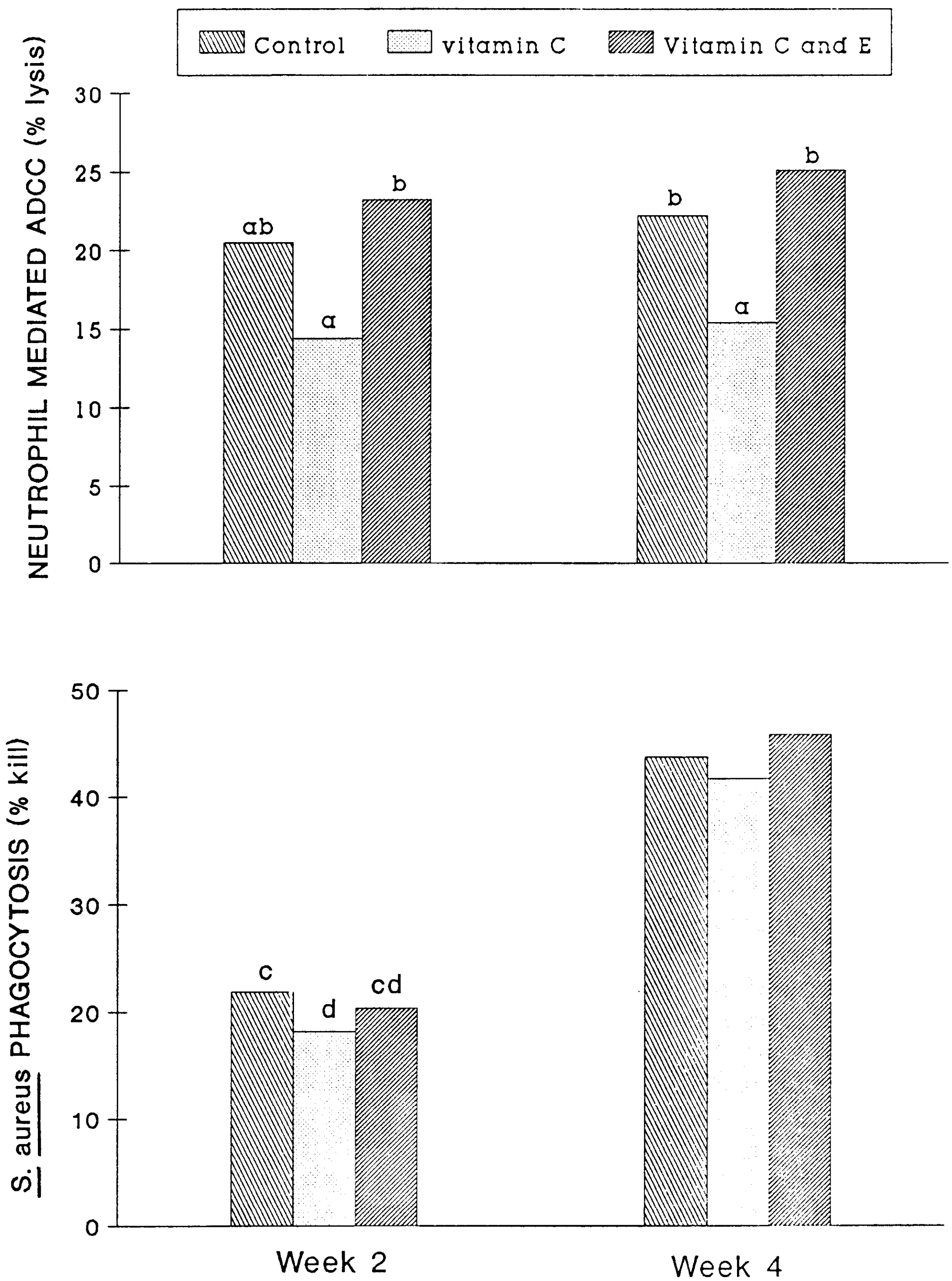

Figure 2. Neutrophil-mediated antibody-dependent cellular cytotoxicity % specific-lysis and S. aureus phagocytosis % kill. [ab]Differing superscripts within the same wk denote means with significant differences (P<. 10). [cd]Differing superscripts within the same wk denote means with significant differences (P <.05).

UTILIZATION OF NEAR INFRARED REFLECTANCE FOR THE DETERMINATION OF FAT, MOISTURE, AND PROTEIN IN CHEDDAR CHEESE

G. S. Zink, I. J. Jeon and L. H. Harbers

Summary

Near infrared reflectance spectroscopy (NIRS) was used to develop calibration equations for the rapid determination of moisture, protein, and fat in Cheddar cheese. Most mean values from NIRS data had lower standard deviations than values obtained by standard laboratory procedures. A larger number of samples is needed to refine calibrations and validate the equations.

Introduction

The use of rapid methods for composition determination of dairy products would lead to increased market efficiency and decreased quality control costs. Near infrared reflectance spectroscopy has the potential to provide these benefits. Currently, the standard methods for determination of the chemical composition of cheeses are time consuming, require hazardous chemicals, and destroy the sample. Although NIRS requires standard composition methods for initial "start-up" (calibration) and occasional checks (periodical validation), the method offers a definite advantage of reduced time, chemicals, and sample required.

Near infrared reflectance spectroscopy measures the intensity of light reflected from the surface of the sample. The wavelength and the intensity of the reflected light can be related to the chemical composition of the sample. Initially, standard methods are conducted parallel to the NIRS scans to facilitate calibration of the sample composition to the intensity of light reflected at a particular wave length. After calibration and validation, occasional chemical checks are required to ensure that the instrument is operating efficiently.

The ability to determine accurately and efficiently the chemical composition of Cheddar cheese could greatly assist cheese makers in the evaluation of the quality aspects of their product. The purpose of this study was to compare NIRS with the standard methods for determining chemical composition of Cheddar cheese.

Procedures

Forty commercial Cheddar cheeses from several manufactures and of various ages were collected from local supermarkets. The fat, protein, and moisture contents of the samples were determined using the Babcock fat test, Kjeldahl procedure, and vacuum oven drying, respectively. These are all standard methods currently utilized by the dairy products industry. The samples were simultaneously scanned with a Pacific Scientific 4250 Near Infrared Reflectance Spectrophotometer. The instrument's statistical software package selected the wavelengths that best correlated with the contents of fat, protein, and moisture in the samples.

Results and Discussion

As seen in Table 1, the NIRS-determined composition was close to the values obtained by the standard methods. Most NIRS values had lower standard deviations than the those of standard methods.

Table 1. Fat, Moisture, and Protein Composition of Cheddar Cheese at Different Stages of Aging Determined by Wet Chemistry and NIRS

	NIRS Values		Laboratory Values	
Age	Mean %	STD	Mean %	STD
		Fat Composition		
Mild	32.99	0.5	32.72	1.6
Medium	32.70	0.8	34.78	1.8
Sharp	32.51	0.7	32.69	1.0
Extra-sharp	33.12	0.9	32.46	0.3
		Moisture Composition		
Mild	37.36	0.9	37.61	1.8
Medium	36.64	1.0	36.79	1.6
Sharp	36.73	1.1	36.83	1.3
Extra-sharp	36.51	0.7	36.48	0.3
		Protein Composition		
Mild	24.00	0.6	23.84	0.8
Medium	24.58	0.7	24.29	0.7
Sharp	24.48	0.9	24.63	1.2
Extra-sharp	24.70	0.7	24.80	0.5

Our results indicate that utilization of NIRS for determining the composition of Cheddar cheese is feasible and capable of providing rapid and reliable results. The accuracy of predicting a cheese's composition would be increased by scanning a greater number of samples.

PREGNANCY RATES OF DAIRY COWS AT FIRST SERVICE: INFLUENCE OF GONADOTROPIN-RELEASING HORMONE AND TIMING OF AI RELATIVE TO ESTRUS

J. S. Stevenson, M. O. Mee,
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Summary

We demonstrated that gonadotropin-releasing hormone (GnRH or Cystorelin®) failed to improve pregnancy rates at the first service. When GnRH injection and insemination are both carried out either in early or late estrus or if cows are bred in early estrus and given a GnRH injection later in estrus, pregnancy rates are reduced by 9 to 13 percentage points compared to breeding according to the am-pm rule without GnRH treatment (control). Pregnancy rates of cows injected with GnRH early in estrus and bred in late estrus were similar to controls injected with saline and inseminated late in estrus (46 vs 43%). Altering the time of breeding and the time of GnRH injection to either early or late estrus did not improve pregnancy rates. We continue to recommend using GnRH only for repeat breeders, because GnRH consistently improves pregnancy rates at 3rd or 4th service, but not at first services.

Introduction

Pregnancy rates are increased in repeat breeders when GnRH is given at the time of 3rd or 4th service (1988 Dairy Day, KAES Rep. Prog. 554, pp 16-18). In contrast, we further reported that injecting GnRH at the time of insemination failed to increase pregnancy rates of dairy cows bred at first services after calving (1984 Dairy Day, KAES Rep. Prog. 460, pp 26-27), and this has been confirmed in several other U.S. studies since 1984. However, research in Europe, Japan, and other foreign nations have reported increased pregnancy rates at first services after GnRH treatments. Why is there an inconsistency among these studies? It could be that U.S. cows, which are fed more concentrates than other dairy cows throughout the world, are inherently different. Although this may be true and may influence when cows begin their estrous cycles after calving, there appeared to be more obvious reasons for the differing fertility effects of GnRH on pregnancy rates.

In all previous studies except one, GnRH injections were given at the time of AI. The timing of GnRH treatment and the timing of insemination relative to the beginning of heat may be very important determinants of the pregnancy-rate response. We know that the am-pm rule of breeding produces the best fertility results, and breeding too early reduces fertility. The objective of our study was to determine the effect of GnRH injection on pregnancy rates, when it is given in either early or late estrus and the timing of inseminations are altered from the am-pm rule.

Procedures

Dairy cows were given 25 mg Lutalyse® on Monday mornings to induce estrus for first services after they were at least 45 days fresh (October, 1987 to May, 1989). Cows were observed for

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heat (beginning at 0730 on Tuesday until Friday night at 2100) four times daily (0730, 1100, 1730, and 2100) and, when detected in estrus, were assigned randomly to each of six treatment groups (Table 1). Blood was collected at the time of hormone injection (0 hr) and again 2 hr later to monitor changes in luteinizing hormone (LH), a pituitary hormone whose secretion is stimulated by injections of GnRH.

Table 1. Treatments of Dairy Cows at First Services after Calving

Treatment group	Hormone injected	Time relative to first detected heat	
		Injection	Insemination
1	GnRH	Early[a]	Early
2	GnRH	Early	Late[b]
3	GnRH	Late	Early
4	GnRH	Late	Late
5	Saline	Early	Early
6	Saline	Late	Late

[a]Injection and/or insemination was conducted within 1 hr after first detected heat.
[b]Injection and/or insemination was given 12 to 16 after first detected heat.

Results and Discussion

Normally at the onset of estrus, when cows first stand firm for a mounting herdmate, a large discharge of LH is released from the pituitary gland, which increases blood concentrations of LH for about 8 to 12 hr. This release of LH, known as the preovulatory surge of LH, induces maturation and ovulation of the egg from a follicle on the ovaries. We would expect concentrations of LH in blood serum to be higher in cows that were injected earlier than later in estrus. Table 2 summarizes the changes in serum LH at 0 hr and 2 hr after injections of GnRH or saline for each of the six treatment groups.

Concentrations of LH in blood serum were higher ($P<.01$) at 0 hr in all cows that were injected early in estrus than those injected later in estrus, regardless of treatment (blood samples preceded hormone injections). Two hr after injections, LH concentrations were increased ($P<.05$) by 43% for GnRH, early-injected cows and by 153% in all GnRH, late-injected cows. As a result of increased LH in serum 2 hr later, all GnRH, early-injected cows had higher ($P<.01$) LH (by 94%) than saline, early-injected cows, and GnRH, late-injected cows had higher ($P<.01$) LH (by 109%) than saline, late-injected cows.

Table 2. Concentrations of LH (ng/ml) in Blood Serum at 0 hr and 2 hr after Injections of GnRH or Saline

Hormone injected	Time of injection[a]	Hours after GnRH or saline 0	2
GnRH	Early	5.6 ± .7[b]	7.9 ± .8[cd]
GnRH	Early	5.8 ± .8[b]	8.4 ± 1.1[cd]
Saline	Early	4.5 ± .7[b]	4.2 ± .8
GnRH	Late	1.1 ± .7	2.5 ± .8[ce]
GnRH	Late	0.7 ± .8	2.1 ± 1.1[ce]
Saline	Late	1.1 ± .8	1.1 ± 1.0

[a]Injections were given early (1 hr) or late (12 to 16 hr) in estrus, based on 4× daily heat detection in which first detected estrus is 0 hr.
[b]Different (P<.01) from all late-injected groups at 0 hr.
[c]Different (P<.05) from 0-hr concentrations within treatment for all GnRH-treated cows (early and late injections).
[d]Different (P<.05) from 2-hr concentrations of saline-treated cows injected in early estrus.
[e]Different (P<.05) from 2-hr concentrations of saline-treated cows injected in late estrus.

Pregnancy rates are summarized in Table 3. Pregnancy rates for all cows inseminated early in estrus tended to be lower (33%) than those for cows inseminated later in estrus (44%), except for the GnRH group that was injected and inseminated late in estrus (30%). Only those cows injected with GnRH early in estrus and then inseminated late in estrus had pregnancy rates (46 vs 43%) similar to those of the control group (injected with saline and inseminated late in estrus).

Based on our results, we do not recommend the use of GnRH as a profertility aid for cows inseminated at first breedings after calving. These results agree with our earlier report (cited above) in which GnRH injections were all given at the time of insemination. Even though cows were inseminated early after calving, control cows had pregnancy rates of 43%. Use of GnRH lowered pregnancy rates except for one group, which was similar to controls. In contrast, utilizing GnRH at the time of insemination of repeat breeders (3rd and 4th services) will improve pregnancy rates.

Table 3. Pregnancy Rates of Dairy Cows at First Service

Hormone injected	Time of injection[a]	Time of AI[a]	No. preg/ no. AI	Pregnancy rate, %
GnRH	Early	Early	18/52	34.6[b]
GnRH	Late	Early	18/53	34.0[b]
Saline	Early	Early	15/50	30.0[b]
GnRH	Late	Late	16/53	30.2[b]
GnRH	Early	Late	23/50	46.0
Saline	Late	Late	29/67	43.3

[a]Relative to first detected heat (0 hr). See footnotes in Table 1.
[b]Lower (P<.05) pregnancy rate (32 vs 44%) than cows in the remaining experimental groups.

EVALUATING DHI RECORDS WITH THE DAIRY HERD ANALYZER

J. R. Dunham

Summary

A computer program was developed for analyzing DHI records to evaluate potential losses from 1) reproduction, 2) nutrition, 3) milk quality, and 4) genetics. Production-tested Kansas Holstein herds were grouped according to Rolling Herd Average (RHA), with the groups averaging 13,587, 15,988, 17,938 and 20,227 lb milk/cow/yr. Losses were directly related to RHA, amounting to $573, $426, $300, and $160/cow/yr, respectively.

Introduction

The Dairy Herd Improvement (DHI) program provides valuable information to dairy farmers for making feeding, breeding, and management decisions. Yet, the only economic information provided by the program is feed cost/cwt milk produced and income over feed cost. Hence, the Dairy Herd Analyzer (DHA) computer program was developed to evaluate economic losses in dairy herds, using information from the Herd Summary (DHIA-202) and Somatic Cell Count Report (DHIA-230). The program is intended to be used by dairy farmers, consultants, researchers, and Extension personnel.

Procedures

Economic loss from reproductive performance is calculated at the rate of $1/day for calving intervals from 366 to 395 days, and $3/day over 395 days. Loss from long or short dry periods is included in the reproductive loss at the rate of $3/day over 60 days or under 45 days dry. The effect of less than optimum conception rate is accounted for by adding $2/0.1 service/conception over 1.7. Reproductive loss also includes the effects of age of first calving by adding $30/mo over 24 mo of age at first freshening.

Reproductive performance is also evaluated by calculating conception rates after first and second services, using the number of pregnant cows conceiving from the first and second service, as shown on the DHIA-202. Heat detection efficiency is determined by comparing the number of repeat service cows bred between 18 and 24 days following the last service.

Nutritional loss is evaluated by assuming that a herd should be fed to produce 125% of breed average FCM, if mastitis and genetic losses are not limiting herd production. Nutritional loss is also adjusted for the additional feed required to produced 125% of breed avg FCM. The formula for calculating nutritional loss is: (1.25 × Breed Avg FCM – Herd Avg FCM) × (Milk Price/cwt – Feed Cost/cwt Milk) – (Milk Quality Loss) – (Genetic Loss).

Loss because of milk quality (somatic cell count) is determined by the following formula: (Milk Price) × (Milk Loss – 1) × 305. The amount of milk loss from somatic cell count is reduced 1 lb, because most herds will experience a 1 lb milk loss under the best of conditions. The milk quality loss also accounts for any quality premiums that may be available in certain markets.

Genetic loss is evaluated by comparing the PTA$ value of sires of the cows, as shown on DHIA-202, to the 80 percentile rank PTA$ value. The PTA$ value used for cows sired by unproven sires is zero. It is estimated that the PTA$ value of sires available when the cows were conceived was 70 percent of the current PTA$ value of sires. The genetic loss is also adjusted for the feed cost associated with producing additional milk, when high genetic value sires are used. This value is estimated to be 50 percent of the value of milk. The following formula is used to calculate genetic loss: [(80th Percentile PTA$ – Sire Avg PTA$) × (No. Cows with Proven Sires) + (80th Percentile PTA$ × No. Cows with Unproven Sires)] × .70 × .50.

Results and Discussion

The DHA program was used to compare economic losses in four production groups of Kansas Holstein herds. The results shown in Table 1 were calculated from the input information shown in Table 2.

Table 1. Comparison of Economic Losses in Four Production Groups of Kansas Holstein Herds

	Production average, lb/yr			
Item	13,587	15,988	17,938	20,227
Number of herds	98	146	175	79
Cows/herd	61	72	74	79
Reproductive loss, $	133	151	116	106
Nutritional loss, $	187	162	132	29
Milk quality loss, $	253	70	18	0
Genetic loss, $	50	43	34	25
Total loss/cow, $	573	426	300	160
Total loss/herd, $	34,990	30,724	22,160	12,638
Conception 1st service, %	55	50	45	46
Conception after 2nd, %	77	77	73	73
Heat detection efficiency, %	38	38	38	39
Days to 1st service	83	84	81	81

Economic loss in dairy herds is directly related to herd average. However, the results indicate that lower producing herds could make the most improvement by improving milk quality, whereas higher producing herd should emphasize improvement in reproduction. Improved nutrition programs would benefit the three lower production groups.

Reproductive loss is lower in higher producing herds, even though conception rates are lower, since higher producing herds freshen heifers at a younger age. Higher producing herds tend to breed cows earlier after freshening, which also helps shorten the calving interval.

The DHA is useful for evaluating economic losses on dairy farms. In most cases, profitability could be improved with very little additional investment.

Table 2. Dairy Herd Analyzer Input Form

Rolling herd average--milk	13,587	15,988	17,938	20,227
Rolling herd average--fat	487	581	654	736
Number producing cows	61	72	74	79
Freshening interval--days	401	409	407	406
Average days dry	71	67	63	61
Services per conception	1.8	2.0	2.1	2.1
Pregnant cows bred once	12	15	15	17
Pregnant cows bred twice	5	8	9	10
Number pregnant cows	22	30	33	37
Breeding intervals				
18 to 24 days	3	5	6	7
<18 days	1	1	1	1
>24 days	4	7	9	10
Number lactation 1 cows	17	25	27	28
Lactation 1 cows' age	30	29	27	27
Milk price per cwt, $	11.55	11.55	11.55	11.55
Feed cost per cwt milk, $	5.89	5.96	5.54	5.61
Loss per day due to S.C.C.	6.0	3.0	1.5	1.0
Quality milk premium available, $	0.15	0.15	0.15	0.15
Quality milk premium received, $	-0.05	0.15	0.15	0.15
No. cows sired by proven sires	19	39	53	67
Avg PTA of proven sires, $	39	48	62	73
No. cows sired by unproven sires	42	33	21	12
Breed (Enter Code for Breed)	4	4	4	4
1. Ayshire 2. Brown Swiss				
3. Guernsey 4. Holstein				
5. Jersey 6. Mixed				

DAIRY FACILITY DESIGN

J. P. Murphy[1]

Introduction

When planning new construction or major modification of a dairy system, consider:

- calf, heifer, dry cow, and milking cow housing;
- feed types, handling equipment, and storage;
- manure handling method;
- milking system and equipment;
- labor requirements;
- building environment;
- sanitary and pollution control regulations;
- future expansion.

Many dairy farmers produce their own feeds and raise their own herd replacements. The needs of each groups require different housing, feeding, storage, and handling systems.

Herd Makeup

Herd size can mean either the number of cows actually milking or the number of both dry and milking cows. In this paper, herd size is the total of dry and milking cows. Add calves and heifers to the herd makeup, if you raise replacements. Table 1 gives typical herd makeups, assuming uniform calving year-round.

Feeds and Cropland

Determine the best ration for each group of animals based on available feeds, feed quality, animal size, and milk production levels. Estimate cropland and storage needs based on your ration and total number of animals. Without a specific ration, use Table 2 to determine approximate storage needs.

Cropland needed is affected by milk production, ration, forage choice, crop yields, etc. See Table 3 for estimated cropland needs. If all feeds except supplements are raised on the farm, a good estimate is 3 to 4 acres per cow and replacement.

[1]Department of Agriculture Engineering (Extension).

Table 1. Typical Herd Makeup

Item		Number			Avg. weight, lb
Cows milking	33	62	83	208	1,400
Dry cows	7	13	17	42	1,550
Herd size = total mature cows	40	75	100	250	1,450
Heifers					
16-24 mo	15	28	38	95	1,050
13-15 mo	5	9	12	30	800
9-12 mo	7	13	17	43	600
5-8 mo	7	13	17	42	400
3-4 mo	3	6	8	20	250
Calves 0-2 mo	3	6	8	20	150
Total replacements	40	75	100	250	

[a]Replacement numbers assume uniform calving year-round, 12-month calving interval, no death loss or culling, 50% male and 50% female calves, and all males sold at birth.

Housing

Provide housing for different animal groups based on Table 1. More than one group can be housed in the same building, but allow for managing each group separately. Also allow for different requirements for sanitation, environment, etc. In larger dairies, separate facilities may be provided for each group.

Farmstead Planning

Many factors determine the best plan, and although some are common sense, overlooking one can cause a poorly planned farmstead. Collect ideas from publications, farm visits, county agents, experienced producers, scientists, and engineers. Plan on paper, where mistakes can be easily corrected. It is less costly to correct a mistake during the planning stage than after construction begins. Stake out the best arrangements on the site to see how they fit.

Table 2. Annual Feed Requirements[a]

Level of silage	% Dry matter	Lb milk/cow-year 12,000	14,000	16,000	18,000
		-------- quantities/cow and replacement -------			
Medium					
Hay silage, T	40-50	11.0	11.6	12.3	12.9
or hay, T	80-85	4.3	4.5	4.7	4.9
Corn silage, T	30-35	12.0	12.0	12.0	12.0
Shelled corn, bu	84.5	52	64	86	106
High					
Hay silage, T	40-50	6.7	6.9	7.1	7.5
or hay, T	80-85	2.6	2.7	2.8	2.9
Corn silage, T	30-35	16.5	16.5	16.5	16.5
Shelled corn, bu	84.5	52	64	86	106

[a]Table values are for each cow and replacement. Determine total needs based on herd size. If using high moisture grain, multiply shelled corn figures by 1.267 to get bushels based on 30% moisture grain and a density of 60 lb/bu (1.25 ft^3/bu).
Source: *Chore Reduction for Free Stall Dairy Systems, Hoard's Dairyman*, Fort Atkinson, WI.

Table 3. Estimated Cropland[a]

Level of silage	% Dry matter	Lb milk/cow-year 12,000	14,000	16,000	18,000
		---------- acres/cow and replacement ---------			
Medium					
Hay silage, 6 T/A	40-50	1.8	1.9	2.1	2.2
or hay, 3 T/A	80-85	1.4	1.5	1.6	1.6
Corn silage, 15 T/A	30-35	.8	.8	.8	.8
Shelled corn, 80 bu/A	84.5	0.9	1.1	1.3	1.5
High					
Hay silage	40-50	1.1	1.2	1.2	1.3
or hay	80-85	.9	.9	.9	1.0
Corn silage	30-35	1.1	1.1	1.1	1.1
Shelled corn	84.5	.7	.8	1.1	1.3

[a]Acreage to produce annual feed required per cow and replacement. If using high moisture grain, adjust shelled corn figures. Values based on Table 2 and yields shown.

Consider the entire farmstead when planning a new or modified housing system. Solving one problem may create another. With proper planning and attention to details, a well organized, functional farmstead can result.

Site Selection

Many factors determine the best site for dairy facilities. Provide for these items during construction.

Space for buildings, clearance between buildings (at least 35 ft for most buildings and 50 ft for naturally ventilated buildings), lots, and expansion. Assume the operation will double in size, and plan accordingly. Provide lanes for vehicle access and room for parking. Allow for a feed center and adequate separation from family housing. A typical 100-cow dairy farmstead requires 2 to 6 acres for barns, lots, home, machinery, and feed storage.

Drainage away from barns and lots. Ditch and fill low areas. Divert runoff away from buildings and traffic areas. Provide a 2% to 5% slope on outside lots. Use mounds to provide dry resting areas. Earth moving is inexpensive compared to facility costs.

Wind and snow control. Windbreaks help deflect winter winds and control snow. Take advantage of trees, buildings, hills, and haystacks for winter wind protection. Allow for summer air movement and drainage when locating windbreaks. Consider prevailing wind directions for reducing odors, snow drifting, insects, and noise.

Water. A year-round supply of potable water is essential for watering animals and sanitation. Water also is needed for fire protection and waste dilution.

Milking cows need 35 to 40 gal/head-day (4½ to 5 lb water/lb milk produced). Peak water consumption is shortly after feeding. Provide a system that meets peak and total daily requirements. Where ground water supplies are not adequate, use surface sources such as farm ponds or community water systems. Approval of your water system may be required. For more information, see MWPS-14, *Private Water Systems Handbook*.

Access. Provide all-weather roads for milk trucks, repair persons, technicians, veterinarians, feed handling equipment, etc. Provide adequate parking for visitors. Minimum road width is 12 ft. Minimum turning radius for large milk trucks is about 55 ft. A hay wagon can turn 180^0 in about 50 ft.

Manure storage, handling, and disposal. Select a site with sufficient land for spreading manure. Minimum acreage required by many state pollution agencies is based on satisfying the nitrogen requirement of the growing crop.

Avoid steep slopes where manure runoff can cause water pollution, and avoid land adjacent to neighboring residences.

Feed storage and handling is a consideration, but not an overriding concern, in choosing a site. Transport wagons can link a grain-feed center to dairy facilities.

Electric power is needed for heating, lighting, pumps, and motors. A 200 amp, 220 volt barn entrance is common. Thorough grounding reduces stray current problems. Provide standby emergency power in the event of a power outage. Some producers install three phase power; consult your power supplier.

Security. Consider theft, vandalism, and fire safety. Limit farm visitor access to control disease and to reduce interference with farm work. If located on the same farmstead as the manager's residence, run the access lane near the home. If a second access is used for feed, manure, and animal transport vehicles, provide an alarm system to guard against unauthorized traffic.

Facilities remote from the manager's residence pose the most problems. Provide only one access road—unauthorized persons are less apt to visit if there is no escape route should the manager return. If possible, make access roads at remote sites visible from a public road or neighboring residence.

Remodeling

When planning to expand, you may have to decide whether to remodel or abandon an existing building. Carefully consider future as well as present needs. Evaluate these general factors:

- compatibility with final setup;
- structural integrity;
- location of existing building;
- cost of remodeling vs new building.

Remodeling is not always the cheaper route, especially when future needs are considered. If remodeling cost is more than 1/2 to 2/3 new building cost, a new building is usually best. Sometimes, it is possible to use some materials from an existing building in a new one.

Plans, Specifications, and Contracts

Detailed documents help provide needed communication and understanding between owner and builder. **Plans** show all necessary dimensions and details for construction. **Specifications** support the plans; they describe the materials to be used, including size and quality, and often outline procedures for construction and quality of workmanship. The **contract** is an agreement between the builder and the owner; it includes price of construction, schedule of payments, guarantees, responsibilities, and starting and completion dates.

The following tables (Data Summary; Tables 4 to 16) give basic planning information for designing dairy facilities.

Data Summary

Table 4. Cow Stall Platform Sizes[a]

	Stanchion stalls		Tie stalls	
Cow weight	Width	Length	Width	Length
Under 1,200 lb	4'0"	5'6"	4'0"	5'9"
1,200-1,600 lb	4'6"	5'9"	4'6"	6'0"
Over 1,600 lb	Not recommended		5'0"	6'6"

[a]Use electric cow trainers. Dimensions from edge of curb to edge of gutter.

Table 5. Recommended Stall Barn Dimensions

Alley width	
Flat manger-feed alley	5'8"-6'6"
Step manger-feed alley	6'0"-6'6"
Step manger	24"
Feed alley	4'0"-4'6"
Service alley with barn cleaner	6'0"
Cross alley[a]	4'6"
Manger width	
Cows under 1,200 lb	20"
Cows 1,200 lb or more	24"-27"
Gutters	
Width[b]	16" or 18"
Depth, stall side	11"-16"
Depth, alley side	11"-14"

[a]Taper the end stalls inward 6" at the front for added turning room for a feed cart.
[b]Or as required for barn cleaner.

Table 6. Free Stall Dimensions[a]

Age	Width	Length
Heifers		
5-8 mo	2'6"	5'0"
9-12 mo	3'0"	5'6"
13-15 mo	3'6"	6'6"
16-24 mo	3'6"	7'0"
Cows (average herd weight)		
1,000 lb	3'6"	6'10"
1,200 lb	3'9"	7'0"
1,400 lb	4'0"	7'0"
1,600 lb	4'0"	7'6"

[a]Stall width measured center-to-center of 2" pipe dividers. For wider divider dimensions, increase stall width accordingly. Stall lengths are measured from front of stall to alley side of curb.

Table 7. Typical Free Stall Alley Widths

Feeding and stall access alley	10'-12'
Access alley between 2 stall rows	
Solid floor	8'-10'
Slotted floor	6'-9'
Feeding alley	9'-10'

Table 8a. Replacement Animal Space Requirements: Calf Housing

Housing type	Pen size
0-2 mo (individual pens)	
Calf hutch (plus 4'×6' outdoor run)	4'×8'
Bedded pen	4'×7'
Tie stall	2'×4'
3-5 mo (groups up to 6 head)	
Super calf hutch	25-30 ft^2/hd
Bedded pen	25-30 ft^2/hd

Table 8b. Heifer Housing

	Age, months			
Housing type	5-8	9-12	13-15	16-24
	---------- ft^2/animal ----------			
Resting area and	25	28	32	40
paved outside lot	35	40	45	50
Total confinement				
Bedded resting area[a]	25	28	32	40
Slotted floor	12	13	17	25

[a]Assume access to 10' wide scraped feed alley.

Table 9. Feeding Space Requirements

	Age, months					Mature
	3-4	5-8	9-12	13-15	16-24	Cow
	--------------- in/animal ----------------					
Self feeder						
Hay or silage	4	4	5	6	6	6
Mixed ration or grain	12	12	15	18	18	18
Once-a-day feeding						
Hay, silage, or ration	12	18	22	26	26	26-30

Table 10. Floor and Lot Slopes

Handling facilities	1/4"-1/2"/ft
Lots	
Paved	1/8"/ft minimum
Earth	1/2"-3/4"/ft
Mound sideslope	1'/5'
Bunk apron	3/4"-1"/ft nearly self-cleaning 1/2"/ft minimum

Table 11. Water Requirements

	Gal/hd/day
Calves (1-1.5 gal/100 lb)	6-10
Heifers	10-15
Dry cows	20-30
Milking cows	35-45

Table 12. Dairy Manure Production[a]

Animal size, lb	Total manure production lb/day	Total manure production ft^3/day	Total manure production gal/day	Nutrient content N lb/day	Nutrient content P lb/day	Nutrient content K lb/day
150	12	.19	1.5	.06	.010	.04
250	20	.33	2.4	.10	.020	.07
500	41	.66	5.0	.20	.036	.14
1,000	82	1.32	9.9	.41	.073	.27
1,400	115	1.85	13.9	.57	.102	.38

[a]Provide 2.5 ft^3/d of storage per 1,000 lb live weight for solid manure with bedding. Table values based on manure at 87.3% water and 62 lb/ft^3.

Table 13. Bunk Design

Throat height (max.)	
Calves	18"
Heifers	20"
Mature cows	24"
Bunk width (max. 60")	
Both sides feeding	
Calves	36"
Heifers	48"-60"
Mature cows	48"-60"
One side feeding	18" bottom width
Mechanical feeder	Add 6"-12" up to max width
Step along bunk	
Height	4"-6"
Width	12"-16"
Bunk apron	
Slope	3/4"-1"/ft
Width	10'-12'
Neck rails	
3/8" cable, 2" pipe, 2×6 plank	16"-24" opening

Table 14. Dairy Barn Ventilating Rates[a]

	Ventilating rates: Cold weather[b]	Ventilating rates: Mild weather	Ventilating rates: Hot weather
	cfm/animal		
Calves 0-2 mo	15	+35=50	+50=100
Heifers			
2-12 mo	20	+40=60	+70=130
12-24 mo	30	+50=80	+100=180
Cow, 1,400 lb	50	+120=170	+300=470
Milkroom			600 cfm
Milking parlor		100 cfm/stall	400 cfm/stall

[a]Size the system based on total building capacity. Table values are additive—e.g., for calves, mild weather requires 15 + 35 = 50 cfm/calf.

[b]An alternative cold weather rate is 1/15 the room or building volume; ft^3/15. An alternative hot weather rate is the building volume divided by 1.5.

Table 15. Conversions[a]

Unit	Times	Equals
Acres	43,560	ft^2
	4,840	yd^2
	160	square rods
	1/640	square mile
Acre-ft	325,851	gallons
	43,560	ft^3
Acre-in	3,630	ft^3
Acre-in/hr	453	gpm
	1	cfs (approximate)
Bushels	1.25	ft^3
	2.5	ft^3 ear corn
ft^3	7.48	gallons
	1728	in^3
	62.4	lb water
	.4	bu ear corn
	.8	bu grain
cfs	448.8	gpm
	646,317	gal/day
Cubic yard	27	ft^3
concrete	81	ft^2 of 4" floor
concrete	54	ft^2 of 6" floor
Gallons	231	in^3
	.134	ft^3
	8.35	lb water
Miles	5,280	ft
	1,760	yd
	320	rods
Pressure, psi	2.31	ft of water head
Rods	16.5	ft
	5.5	yd

[a]Multiply to the right: acres × 43,560 = ft^2.
Divide to the left: ft^2 ÷ 43,560 = acres.

CHANGES IN GENETIC EVALUATION OF DAIRY CATTLE: THE ANIMAL MODEL

Keith Heikes[1]

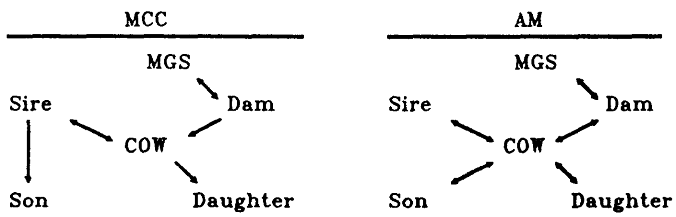
Introduction

The July 1989 USDA Sire Summary introduced a new system for genetic evaluations in dairy cattle. These evaluations, known as the Animal Model (AM), include several new features that help to increase the accuracy of evaluations compared to the way sire summaries were calculated in the past.

Background

Since 1974, the United States Department of Agriculture (USDA) has calculated dairy cattle evaluations using the Modified Contemporary Comparison (MCC) method. It included the MCC-evaluated animals that calved in the same herd/year/season and also accounted for the genetic levels of herdmates by including the sire of contemporaries in calculations.

The Animal Model makes the following enhancements to the MCC calculations: 1) merit of mates; 2) cow families; and 3) change in accuracy calculations. Probably the most publicized change in the animal model has been the inclusion of more information from the maternal side of pedigrees (cow families). The illustration below shows how each evaluation system works:



Lines signify the direction of information flow

With the AM, the performance of a cow's offspring is included in a cow's evaluation. Using MCC, the offspring's performance affects only a sire's evaluation. What the son or daughter of a cow did had no effect on the evaluation of the COW. In addition, a bull's pedigree information used in his evaluation includes only the sire's and maternal grandsire's characteristics and no information from the dam or any of her relatives.

[1]Dairy Specialist, Kansas Artificial Breeding Service Unit.

Evaluations according to the AM use all known relatives of an animal. This task involves tracing pedigrees back as far as all relatives are known. Not only will information from a cow be used in calculating an evaluation of her dam and sire, it will also be used in the evaluations of her daughters and sons. The advantage of using all the known relatives is that it provides us with more information (thus more accuracy) in predicting the true genetic merit of an animal.

The merit-of-mates feature of the AM ties closely to the use of all known relatives. Since all of the relatives in the pedigree of an animal are now included, an adjustment can be made to account for the merit of mates. If a bull is only used on superior cows, his daughters should have a certain amount of superior-producing genes that they inherited from their dams. An adjustment can be made to increase or decrease a bull's evaluation depending on the genetic merit of the cows to whom he was bred. This is also the case now in calculating a cow's evaluation, depending on the type of bulls to whom she was mated.

Another facet of the AM is the change in accuracy calculations of bulls. Because of the inclusion of more pedigree information in evaluations, accuracy figures are higher than in the past. This is particularly true for bulls with few progeny.

Terminology Changes

In addition to a new method for calculating proofs, several new terms for genetic evaluations are being used by USDA. Predicted Difference (PD) or Cow Index (CI) are now both called Predicted Transmitting Ability (PTA). This is the estimate of the genetic level an animal will transmit to its offspring. PTA's will be calculated for milk, fat, protein, and component percentages as they have been in the past.

The accuracy of evaluations also has a new name. Under MCC, the term Repeatability was used as a measure of accuracy. Using AM, the term Reliability (Rel) will be used.

Economic indexes are calculated using the AM, just as using MCC. Instead of PD$, the term will now be PTA$. These indexes will be calculated for milk-fat dollars (PTA$), milk fat-protein dollars (PTAP$), and Cheese Yield dollars (CY$). Something that has changed in the economic indexes is that bulls in most listings are now ranked by PTAP$. As more and more emphasis is put on protein nationwide, there is a strong move to include protein production in the way a bull or cow ranks. This is done with the amount of milk, fat, and protein transmitted all being included in the PTAP$ index.

Conclusions

Although there will certainly be some changes and refinements in the AM, it uses more information in computing genetic evaluations than did the MCC. As before, one should remember that this is a ranking system and the best way to select animals for use in a breeding program is to start at the top of the list and work down.

THE USE OF BOVINE SOMATOTROPIN (BST) IN DAIRY CATTLE

Jorge Estrada and J. E. Shirley

General Information

We all have heard about the use of BST in lactating dairy cattle during the last 6 to 8 years, but what is BST? Bovine somatotropin is another dairy management tool developed to improve the efficiency and reduce the cost of producing milk. It is the newest in a list of technological advances in the dairy industry, such as genetic improvements, nutrition, health, housing, milking equipment and techniques, embryo transfer, and DHI records.

BST is a natural protein produced in the anterior pituitary gland of all cattle. Like other proteins, BST is composed of various amino acids (190-199). BST is bovine growth hormone, somatotropin. It helps to allocate energy from feed to meet the physical needs of the cows, such as growth in young animals, milk production in mature animals, and other functions in the body.

What does BST do? Supplemental BST stimulates cows to produce more milk from a proportionately smaller increase in feed consumption. Therefore. less feed is required to produce a pound of milk (Figure 1).

Peak milk production is normally reached in the second to third mo (50 to 65 days) of the 10-month lactation period, then it decreases until lactation finally ceases. Supplemental BST extends the duration of near-peak milk production consistent with the genetic and environmental potential of the cow (Figure 2).

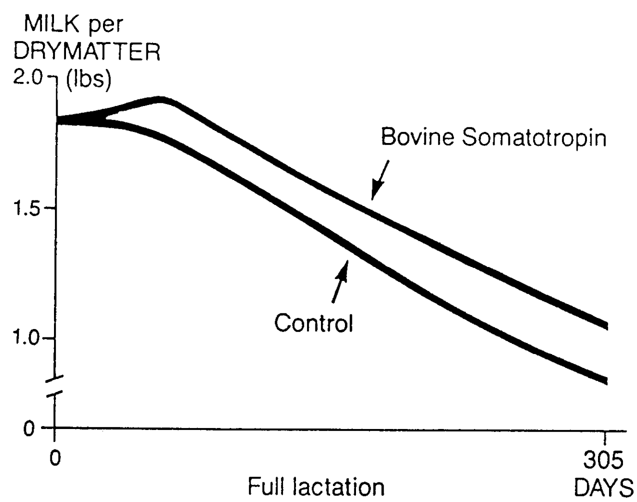


Figure 1. Feed efficiency improvement.

How does BST work? Scientific research shows that BST is produced in the anterior pituitary, released to the bloodstream, and activates "BST receptors" for specific needs of the body. For example, "Growth receptors" in young animals direct food energy into normal growth; when the animal matures, the growth receptors shut down. In mature animals, "Mammary receptors" are activated as cows complete pregnancy. These receptors help direct energy in the feed into milk production.

It is known that cows receiving supplemental BST consume more feed. Additional feed consumption and milk production are related to the amount of BST administered. Therefore, BST stimulates the cow to produce more milk, which results in increased intake to provide the extra energy required. More of that energy is directed into milk production rather than body maintenance.

How is BST made? BST can be produced in commercial quantity using recombinant DNA technology. The gene responsible for natural BST production in dairy cows has been isolated and can be transferred to ordinary bacterial cells. The bacteria are then used to produce large quantities of BST through fermentation techniques. After this process, the bacteria are killed, and BST is separated, highly purified, and formulated for use in cattle (Figure 3).

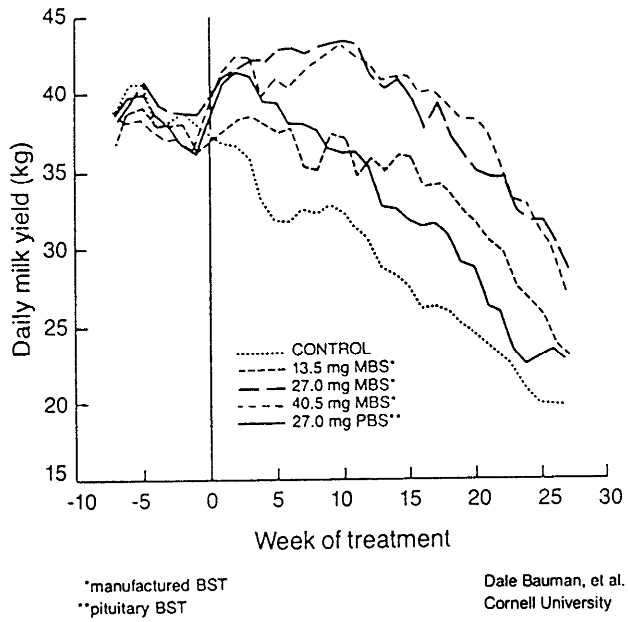


Figure 2. BST effectiveness.

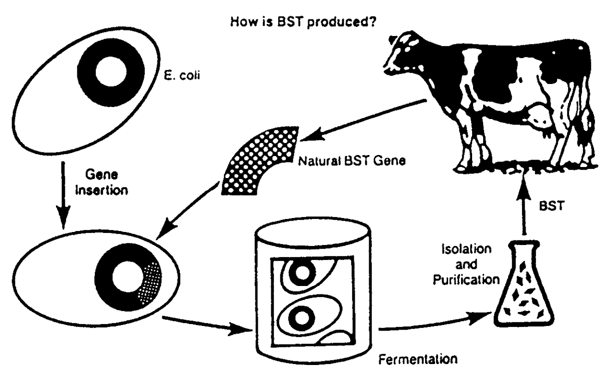


Figure 3. Production of BST.

How safe is BST? Before a new animal drug such as BST may be marketed commercially, it must be found to be safe and effective in the target animal, safe from the standpoint of human food consumption, and safe for the environment. FDA's Center for Veterinary Medicine (CVM) is responsible for assuring that these standards are met prior to commercial marketing. With BST, the sponsors were able to demonstrate very early in the process that there were no changes in residues of BST in the milk from lactating dairy cows treated with BST and that even if there were, such residues would represent no risk no changes in residues of BST in the milk from lactating dairy cows treated with BST and that even if there were, such residues would represent no risk to humans consuming the milk. This finding by the FDA's Division of Human Food and Environmental Safety is based on four facts about BST:

a. BST is a protein that, when ingested, is broken down or digested in the human gastrointestinal tract and thus inactivated. (BST is inactive even in cows when given orally.)

b. BST is species specific. That is, even if BST is injected into humans, it is still inactive. The somatotropins from some species are fairly similar and may cross-react. However, that is not the case with respect to BST in humans. A number of years ago, BST was investigated as a drug for treatment of growth disorders in children and was found to be INACTIVE in humans even when injected.

c. No difference has been detected in the milk from cows receiving supplemental BST and the milk from other cows or from the same cows before they received supplemental BST. Milk from cows treated with BST cannot be distinguished from milk from nontreated cows. Trace amounts of BST occur naturally in cows' milk at variable levels, generally less than two parts per billion but occasionally ranging up to 10 parts per billion. No increase in BST levels in milk has been observed in cows receiving supplemental BST at expected use levels.

d. Humans consuming animal derived food products always have been exposed to small amounts of naturally produced BST in milk and meat.

The composition of milk (with respect to lactose, protein, and fat) obtained from BST-supplemented cows is not different than that of milk from cows that are not supplemented (Table 1).

Table 1. Milk Composition

	Supplemental BST (mg/day)			
Measurement	0	12.5	25	50
Milk fat, %	3.65	4.00	3.65	4.00
Milk protein, %	3.00	3.04	3.03	2.98
Total solids, %	12.31	12.99	12.55	12.78

University of Pennsylvania
38 wk beginning at wk 4 to 5 of lactation

Milk and meat from cows in a limited number of continuing BST trials conducted under Investigational New Animal Drug procedures have been authorized by FDA for sale and commercial use. Registration and commercial availability of BST are expected about 1990.

How safe is BST for the animals? BST used at anticipated commercial dosages has shown no undesirable effects on cows receiving it or on their calves. Long-term trials are continuing to confirm that supplemental BST used through multiple lactations is safe for cows. Researchers have found that cows receiving supplemental BST at the tested dosages showed no significant difference in:

- incidence of mastitis, milk fever, or ketosis;
- conception rates and services per conception;
- birth weights of calves and calf growth rates after birth;
- normal late-lactation weight gain;
- temperament or behavior of treated cows; or
- production of cows during the following lactation when they did not receive BST.

Studies at more than 20 universities, over 15 private herds, and other countries confirm many of these observations.

<u>How will cows perform with respect to milk production and feed efficiency</u>? Supplemental BST is expected to lower the cost of milk production by increasing the milk produced per pound of feed consumed. Cows receiving supplemental BST produce an average of about 12% (range 10 to 25%) more milk. Increased milk response begins within 24 hr after BST administration and continues as long as BST is administered (Figure 4).

Results in different trials show that supplemental BST, with diets properly adjusted to provide the required nutrients, can improve feed efficiency or the amount of milk produced per pound of feed consumed by about 5 to 15% (Figure 5).

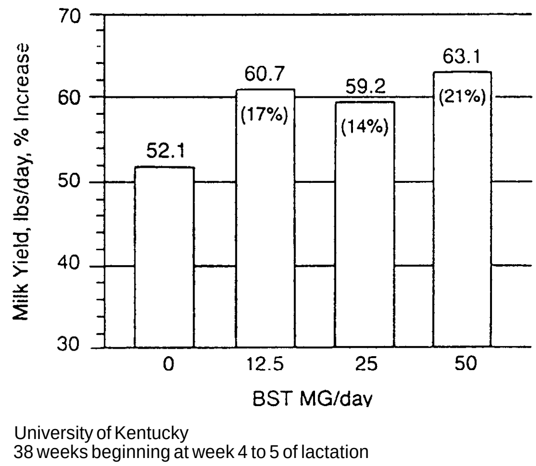
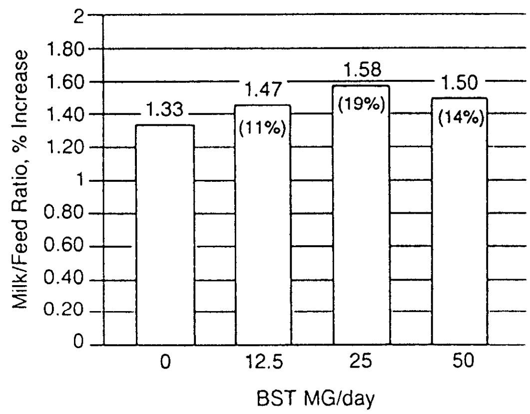


Figure 4. Milk production.

Feed consumption increases with the amount of additional milk produced, but it does not increase proportionately. Cows receiving supplemental BST must be fed according to their higher milk production level. Voluntary feed intake may increase sufficiently to support the increased milk production, allowing use of the same diet in greater quantities, but voluntary feed intake may be limited by stomach capacity, requiring ration reformulation at higher nutrient densities.

What are the economic effects and industry impact of BST? The economic effects of BST have been researched and are highly predictable. Cows on BST produce from 10 to 25% more milk and consume about 5 to 15% more feed to produce the additional milk. Thus, cows require about 5 to 10% less feed to produce a lb of milk, resulting in lower costs and a higher return for dairymen. BST will require little if any capital investment, unlike many dairy industry advances. It will be equally accessible to small herds and to larger, well capitalized operations. The cost of BST has not yet been established, but BST must be priced to yield a desirable profit to dairymen or they will not use it. The speed with which BST takes effect will offer dairymen an increased range of options to manage milk production and farm income. BST will provide the ability to increase herd average by producing the same amount of milk from fewer cows or more milk from the same cows; adjust milk production up or down to meet changing market or farm conditions within days; raise or maintain desired farm income without the need for more cows or farm facilities; and adjust farm operations to realize the same production/income with a reduced workload. Adoption of BST is expected to be gradual. It is unlikely that the maximum adoption rate will exceed 50 to 60% and even people that use it will not use BST immediately on their entire herds.



University of Minnesota
38 weeks beginning at week 4 to 5 of lactation

Figure 5. Feed efficiency.

Conclusions

There is an important interaction between the dose of somatotropin, the time of the initiation of treatment, and the nutrition and management of the herd. The BST-treated cow is like the high-producing cow, and similarly, poor nutrition can restrict and superior nutrition can augment responses. BST can improve feed efficiency and milk performance, but it does not work alone. Improved performance and increased efficiency will be realized only when the level of management, nutrition, and herd health are concomitant with the management of our good and better-producing herds today. To be competitive in world and domestic markets, agricultural enterprises in the U.S. must strive for economic efficiency. Advances in nutrition, management, and sire-proofing programs have resulted in impressive increases in productivity and efficiency, and BST is the first product of biotechnology with potential to have a major impact upon productivity.

INVOLUTION OF THE UTERUS OF DAIRY CATTLE

E.P. Call

Summary

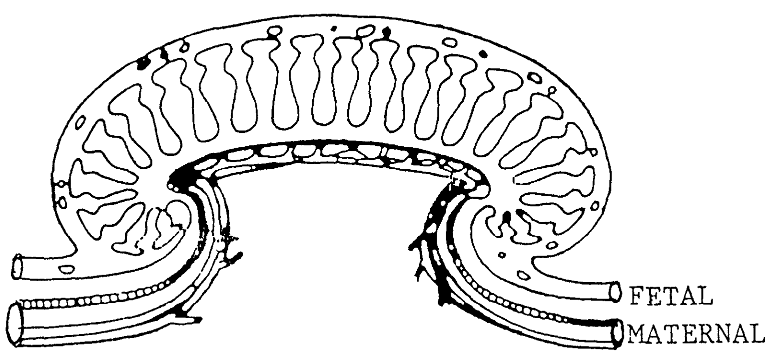
The rate of involution of the bovine uterus is remarkable. By 20 days after calving, tissue sloughing and hemorrhaging have ceased, and the size of the uterus has been reduced by more than 80%. By 40 days, the uterus has completely involuted except for isolated pockets of leukocytes. Any reproductive or metabolic disorders around calving will delay involution. A preventive herd health program (PHHP) including a reproductive examination of cows within a month after calving will pay dividends in improved reproductive performance. With a sound PHHP, servicing cows on the first heat after 42 days fresh is recommended.

Introduction

Few feats of nature are more phenomenal than the return to normalcy of the cow's uterus after calving. Even though the uterus is an internal organ, managers have an appreciation for the traumatic changes that occur during birth and the necessary sloughing and tissue repair required during the postpartum period. Since reproductive goals of the dairy suggest a 12-mo calving interval, the next pregnancy must be established by 85 days postpartum.

The Pregnancy

The fetal membranes or placenta–an outgrowth of the embryo-is detectable by 15 days after conception using ultrasonography and completely fills both horns of the uterus by 30 days, when it may be palpated per rectum. Between 30 and 40 days, the membranes commence to attach to the small raised structures known as caruncles. About 120 caruncles line the uterus, and 45 to 70 become functional during pregnancy.



THE BOVINE PLACENTOME

Figure 1. The bovine placentome is composed of an interlocking mass of maternal (caruncle) and fetal (cotyledon) tissue. Adapted from Bearden and Fuquay.

As the fetal membranes grow over the caruncles, fetal blood vessels (villi, referred to as cotyledons) penetrate into the caruncle and come into close contact with maternal blood vessels (Figure 1). As pregnancy progresses, these structures, known as placentomes, are stimulated to grow rapidly, and those nearest the fetus become 4 to 5 in. in diameter.

During the first month of gestation, the embryo is nourished by secretions from the uterine glands, known as uterine milk. As placentomes are established, nourishment is by diffusion of nutrients across the tissue barrier between maternal and fetal blood vessels. The exchange of blood per se does not occur. As gestation progresses, the fetal-maternal components of the placentome become tightly interlocked.

Parturition or Calving

At the moment of birth, the umbilical cord ruptures, and blood pressure within the placenta drops, allowing the fetal blood vessels to collapse. The cotyledonary villi loosen, allowing the placenta to be delivered, except in cases when it is retained. As the placenta detaches, maternal blood vessels are exposed, resulting in hemorrhage that may persist for several days.

Involution and Repair

An understanding of the task of regression or involution may be realized simply by viewing the cotyledons on the delivered placenta. The enlarged caruncles of the uterus remain intact and must undergo tremendous sloughing and reestablishment of the epithelial layer. Evidence for this repair is noted for about 2 wk by discharges that range from bloody to yellowish and purulent. During this period, the vaginal discharge or "lochia" is sometimes mistaken for uterine infection.

By 3 wk postpartum, the sloughing of necrotic tissue and hemorrhaging have ceased. The epithelial layer is being established by the outgrowth of cells from the uterine glands. As noted in Figure 2, both the weight of the uterus and diameter of the previously pregnant horn have decreased more than 80% during this 3-wk period. Rectal palpation at this time will detect the previous horn of pregnancy and any ovarian activity. In most dairy cows, a new corpus luteum has formed by 20 days. In the normal cow, the uterus will be void of accumulated fluids, even though the size of the uterus will continue to regress.

Grossly, both weight and size have become static by 40 days, as noted in Figure 2, with no discernible changes thereafter. The uterine epithelium has been completely repaired, and the environment appears healthy. Microscopically isolated pockets of white blood cells (leukocytes) may persist in the lining for indeterminant periods of time. The cause and effect of this condition remain obscure.

Factors Affecting Involution

Although season of calving has some effect on the rate of involution, the only significant delay is seen in cows calving when ambient temperature exceeds 90^0F. Parity or age at calving favors involution in first-calf heifers by 1 wk. As would be expected a retained placenta delays uterine involution by about 7 days, regardless of the age at calving.

Any reproductive or metabolic disorder around calving time will have a depressing effect on uterine involution and other reproductive measures, such as days to first heat, conception to first service, and services per conception. Prophylactic measures to reduce the probability of reproductive disorders and/or the early diagnosis and treatment of problems through a preventive herd health program (PHHP) will pay dividends in the overall health, productivity, and profitability of the dairy herd.

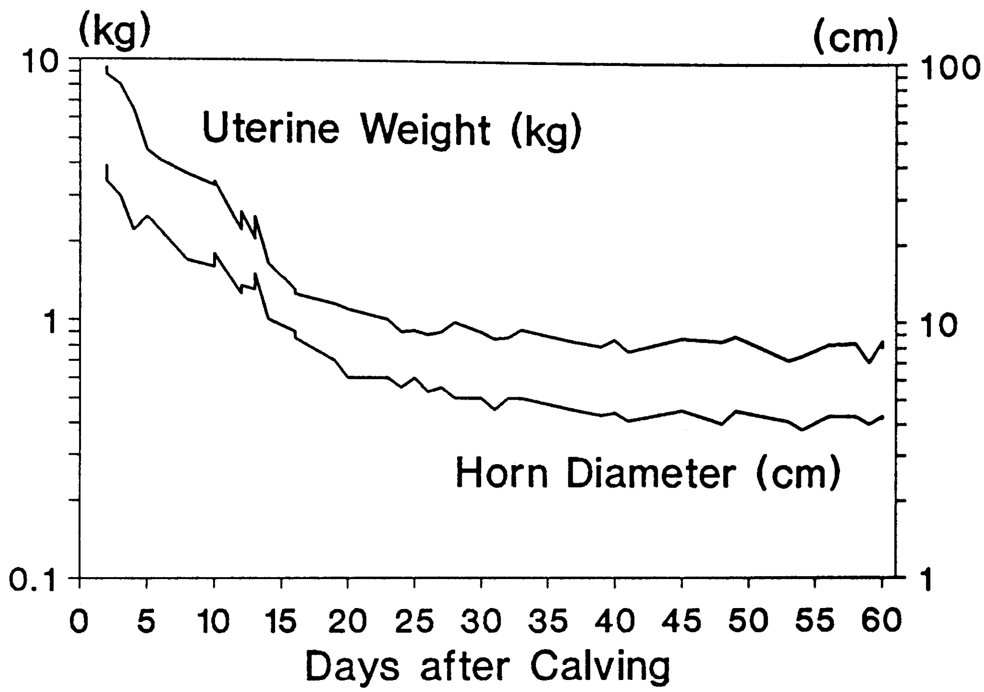


Figure 2. Rate of uterine involution as measured by weight (kg) and diameter of previously pregnant horn (cm). Adapted from Gier and Marion.

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