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Nebraska Cooperative Extension Service—EC 81-220

1981–82 DAIRY REPORT

NEBRASKA

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Mastitis Dollars and Sense

Don J. Kubik[1]

How costly is mastitis? It is estimated that the annual cost of mastitis (the most costly disease of dairy cattle in the United States) amounts to 1½ to 2 billion dollars. In Nebraska, mastitis costs about 20 million dollars per year.

Types of Mastitis

There are two basic types of mastitis—clinical and subclinical.

Clinical mastitis cases are serious and obvious. Losses are readily apparent to the dairyman. Premature culling, milk that is discarded because of mastitis, and death are examples of clinical losses.

Subclinical mastitis cases are less apparent to dairymen. Reduced milk production results from subclinical mastitis. For example, a mastitis infection in only one quarter can reduce total milk production by 10 to 15%. The National Mastitis Council estimates that a mastitis infection in one quarter reduces the income potential per cow by about $150 per lactation. Subclinical cases are truly the most important source of mastitis losses, accounting for about 70% of the total monetary loss.

Mastitis treatment is costly. Antibiotics, drug costs, time required to treat cases, and cost for required veterinary services amount to a substantial expense.

Progress Made

Many Nebraska dairymen are making significant progress in mastitis control in their herds as evidenced by reduction of their SCC (somatic cell counts).

The profit potential from reducing SCC in a 60-cow herd producing 13,000 lb milk at $13 per cwt is shown in Table 1.

The increase in milk production is only half to two-thirds of total potential dollar savings. Other savings include cost of treatment, labor, premature culling, discarded milk, death, and milk quality. Two groups of dairymen involved in mastitis control to various degrees were studied. The first group (Table 2) was a representative sample of dairymen who attended Area Dairy Days '79-"Mastitis" and who increased the number of preventive mastitis practices employed. Table 2 shows the actual change in SCC and estimated dollar savings by these herds (using a 60-cow herd producing 13,000 lb of milk per cow at $13 per cwt). Remember, this is only half to two-thirds of the total dollar savings.

A second group which shows remarkable change is the Mastitis Demonstration Herds. Their progress and dollar savings are shown in Table 3 (60-cow herd at 13,000 lb milk per cow at $13 per cwt.).

As in the other illustrations this represents only half to two-thirds of the total dollar savings.

Potential Is Great

These illustrations show the potential of mastitis control and what has been done by Nebraska dairymen on control programs of different intensities.

An effective mastitis prevention and treatment program will return about five dollars in total benefits for each dollar required to carry out the program.

Such a return on money invested is hard to beat! Mastitis control pays well and should be the goal of every dairyman. It pays off in more milk, better quality milk, and reduced disease losses.

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[1]Don J. Kubik is Extension Dairyman, Northeast Station.

Table 1. Lost income potential from mastitis control at various SCC levels.

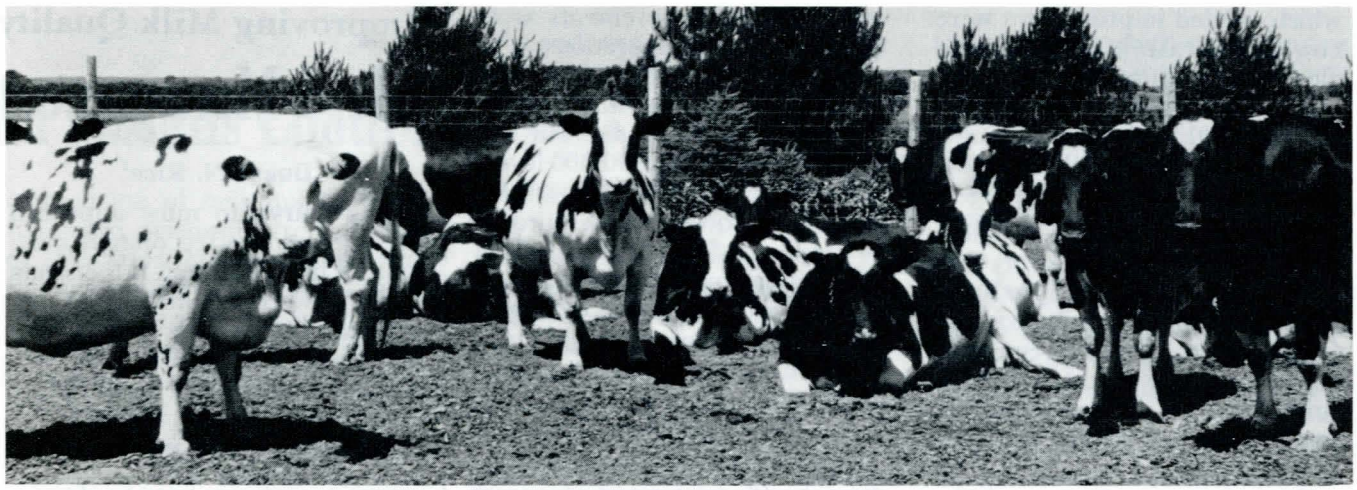
SCC/ml	Estimated milk loss	Estimated milk loss	Milke income: Potential lost per cow	Milke income: Potential lost per 60-cow herd
	(%)	(lb)	---- (annual loss, $) ----	
Below 300,000	4	520	68	4080
300,000 to 600,000	7	910	118	7080
600,000 to 900,000	10	1300	169	10,140
Above 900,000	15	1950	254	15,240

Table 2. Changes in SCC and added income by four groups of dairymen attending Area Dairy Days '79-"Mastitis".

Change in SCC/ml: From	To	$ Savings in milk per cow	$ Savings in milk per 60-cow herd
225,000	195,000	$7	$420
465,000	420,000	11	660
730,000	565,000	25	1500
990,000	730,000	50	3000

Table 3. Mastitis demonstration herd progress and dollar savings when divided into four groups by level of SCC

Change in SCC/ml: Before	After	$ Savings in milk per cow	$ Savings in milk per 60-cow herd
200,000	160,000	$8	$480
400,000	325,000	15	900
700,000	300,000	60	3600
1,050,000	570,000	110	6600



In 1980 thirty-two dairy herds enrolled in the Nebraska Mastitis Demonstration project.

Progress Report

Mastitis Control Demonstration Herds

Don J. Kubik[1]

The Mastitis Control Demonstration Herd project is an extension of Area Dairy Days '79-"Mastitis". The 32 demonstration herds were established to show how a program can work and to provide hands-on experience for equipment dealers, veterinarians, and fieldmen in the prevention and control of mastitis.

This demonstration herd approach helps our cooperating farmers put into practice those practices presented at the Area Dairy Days. Our help to these herds includes identification of problems that exist at each farm and within each herd and suggestions of how best to deal with them.

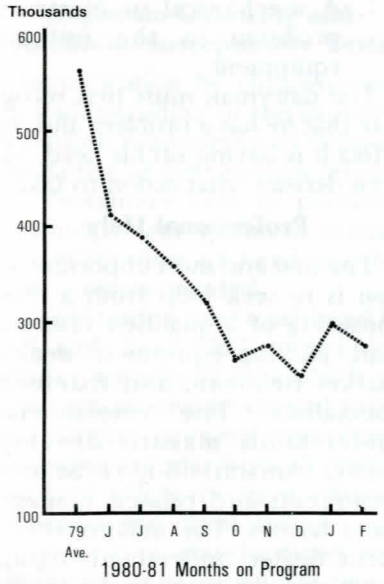


Figure 1. Average of all herds shows a 40% reduction of somatic cell counts in milk as compared to 1979 (preliminary report).

Education Program

We also are working to educate veterinarians, equipment dealers, and fieldmen to deal with these problems. We have had excellent cooperation and support from these groups and feel they are adjusting to better meet the needs of Nebraska dairymen.

Figure 1 shows the average somatic cell counts (SCC) in milk of demonstration herds compared to 1979. Changes represent a 40% reduction. This is better than expected.

Many of these dairymen made changes as a result of Area Dairy Days '79-"Mastitis" and since have made additional improvements as a result of the control program. The reduced SCC levels are the result of the total effort. Continuation of a good control program is essential to maintaining low SCC and infection levels.

Figure 2 shows the herd progress when divided into four different groups based on average somatic cell counts before start of the program. Herds with the highest SCC initially have shown the greatest improvement. Herds with low SCC to begin with maintained their low level.

Demonstration herds, during the program's first year, increased production an average of 648 lb milk and 27 lb fat—about $85 in milk income per cow. This is a reflection of management as well as reduced mastitis.

Problems Identified

Many different problems have been identified. Six common problem areas were identified.

Milking Procedures—Areas

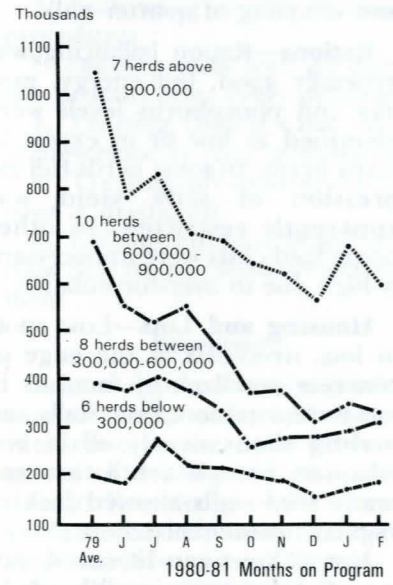


Figure 2. Herd progress when divided into four groups based on average somatic cell counts before start of program (preliminary report).

which needed improvement were: cow preparation for milking, cleanliness, stimulation for let-down, drying the udder with unsanitary cloth, fore-milk stripping, on time-off time, milker adjustment, and lack of teat dipping.

Milking Equipment—Problems were found in nearly every conceivable area. These included overall vacuum capacity, vacuum leaks, poor responding regulators, small line sizes, restrictions in lines, lack of needed slope, too many units per slope, and poor maintenance.

Extraneous Voltage—Unacceptable levels have been identified in over half the dairies surveyed. These have been primarily caused by poor wiring. Poor or lack of ground and neutral wires and deteriorated wire insulation were most common causes of problems. Malfunctioning meters, pumps and waterers were next—with problems originating off the farm of least importance.

Veterinary—Most farms are using a dry cow treatment program. Common areas needing improvement were in identifying causative organisms and treating with correct products, treating long enough, multiple dry cow treatment of selected cows, and avoiding contamination in treatment and sampling of quarter milk.

Rations—Ration balancing was generally good, but energy, protein and phosphorus levels were identified as low or in excess in many herds. In some herds full expression of milk yield was apparently restricted. In other herds feed costs were unnecessarily high due to over-formulation.

Housing and Lots—Low spots in lots, drop-offs at the edge of concrete and lack of mounds in lots were common. Free stalls and loafing sheds nearly all lacked adequate natural ventilation and many free stalls showed lack of regular maintenance.

Not all cows can be cured, nor can all deficiencies in all herds be corrected. At the same time, herd owners on this program are doing many important things and making as many improvements as are practical in their operations.

The program's long range objective is to reduce mastitis level. A goal to reduce somatic cell counts to below the 300,000 level is possible by reducing new infections and shortening the duration of existing infections. This will insure higher milk production, lower drug costs, and lower culling for mastitis—resulting in higher profits from milk and breeding stock.

Necessary Practices

Here is a list of practices necessary to effectively control mastitis on your dairy farm.

*Check milking equipment each six months.

*Service milking equipment regularly.

*Prepare udders correctly.

*Stimulate for milk let-down.

*Attach and remove milkers properly.

*Avoid contamination when treating teats.

*Dip teats only with approved product.

*Use screening tests regularly and on all new additions to the herd.

*Sample clinical cows and new additions.

*Maintain yards and housing.

*Treat for minimum of three days.

*Provide fresh cow care.

*Feed for production.

*Keep adequate records.

*Treat all dry cows.

*Cull chronic cows.

You must employ the practices continually and correctly over a long period of time if you are going to effectively *control* mastitis in your herd.

The success of the herds on the program has not come from magic drugs, secret techniques, or other miracle cures. Success has come from identifying the problems in dairy herds and from adopting a control program as presented to all producers in Area Dairy Days '79-"Mastitis". The same approach can work for you.

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[1]Don J. Kubik is Extension Dairyman, Northeast Station.

Improving Milk Quality

Herd Management

Duane N. Rice[1]

The dairyman must approach mastitis and its effect on milk quality as a herd problem rather than just a cow problem. Mastitis not only decreases milk quality but also lowers production. However, several things usually occur before a dairyman will take action:

1. Threatened loss of market due to poor milk quality:
   a. High somatic (leucocyte) count indicating mastitis.
   b. High bacteria counts—may be due to mastitis.
   c. High coliform numbers—not from mastitis, but from poor sanitation.
   d. High post-pasteurization bacteria—not from mastitis.
2. Lowered milk production.
3. A high number of positive CMT tests (California Mastitis Test).
4. Increased number of first calf heifers or cows, or both, with mastitis.
5. Poor response from mastitis treatments.
6. High incidence of acute mastitis cases causing sick cows.
7. A mechanical or electrical problem in the milking equipment.

The dairyman must first recognize that he has a problem and the effect it is having on his herd. He then decides what action to take.

Professional Help

The first and most important action is to seek help from a team consisting of a qualified veterinarian, milking equipment dealer, market fieldman, and Extension specialists. The veterinarian understands mastitis development, transmission, resistance, treatment, and related management factors. The milking equipment dealer understands equipment and can provide the service needed for proper machine function. The fieldman can help in monitoring milk quality and in in-

and Mastitis Control

terpretation of milk quality tests. Extension personnel are a source of educational information and can aid in program coordination.

The dairyman must provide them with records and other information about the herd to be helpful.

Records

Study of herd records can reveal the quality of milk, the duration and complexity of the problem. Herd records will show herd trends, and indicate sudden changes in mastitis incidence and duration. Records of the California Mastitis Test (CMT), Wisconsin Mastitis Test (WMT) or somatic cell counts can indicate the level of mastitis in the herd. Clinical cases, infection type, number of cows being treated and treatment response can also be helpful. Evaluation of these records by the veterinarian should reveal the incidence relative to the stage of lactation, indicating certain types of problems. The producer must be willing to reveal all information for help to be most effective.

Organism Culturing and Antibiotic Susceptibility Tests

Identification by culturing and an understanding of the causative organisms is important in defining the nature of the problem (Figure 1). Veterinary help in planning treatments, segregation of animals and evaluation of herd mastitis level is recommended.

Initial testing can be achieved by bulk tank, herd CMT, and clinical quarter samples of milk which reveal high mastitis levels and primary disease causing organisms. Culturing samples from all cows in the herd offers the most accurate determination of infection.

Laboratory standardized susceptibility or sensitivity testing is the best estimate available for predicting the effectiveness of an antibiotic against a certain organism. Antibiotic susceptibility testing on cultured organisms is valuable when it receives professional interpretation from a veterinarian familiar with the problem.

Management of Specific Infections

Staphylococcus aureus, Streptococcus agalactiae, Streptococcus uberis, and *Streptococcus dysgalactiae* are the bacteria causing 95% of the infections with the remaining 5% consisting of coliforms and other disease causing agents.

Streptococcus agalactiae can be eliminated from the herd with appropriate therapy (treatment).

Staphlococcus aureus is probably the most prevalent in Nebraska herds. It is considered by some to be nontreatable, therefore, a complete mastitis control program becomes an absolute necessity. The staphylococcus organism tends to spread rapidly. Since this usually occurs during milking, infected cows should be permanently identified, isolated, and milked last, or at least separately, with different equipment. At freshening, these "staph" cows, ideally, should return only to the "staph" infected group of segregated cows. They should be checked very closely before they are put back in with clean animals. Successful treatment of lactating cows is unlikely, making the dry period the time of choice to expect reasonable improvement. A complete and continuous control program and multiple dry cow treatment is a necessity. Cows that continually "flare-up" or are chronically infected, provide a "staph" reservoir and must be culled.

Coliforms: This infection is more likely to occur near freshening. Coliform mastitis is not highly contagious, therefore, segregation is of less value. An outbreak of coliform mastitis may be traced to poor environmental conditions and/or poor equipment sanitation. Clean, dry areas for calving and proper nutrition of the dry cow is necessary to minimize coliform mastitis.

Metabolic disorders, such as milk fever, exposure of the udder to adverse conditions, and injury are conditions which stress the cow and may result in more coliform infections. When cows "go down" the risk of teat end contamination is greatly increased. Sanitizing teats before milking cannot be over-emphasized.

Monitoring

It is necessary to monitor clinical infection rates, mastitis level, pathogen changes, equipment function and sanitation procedures.

Surveillance of herd status, equipment and facilities:

1. Examine regularly DHI sheets and other records to determine the number of CMT positive cows.
2. Culture samples and get laboratory interpretation by a veterinarian.
3. Check milking equipment two to three times per year.
4. Analyze a monthly sample of milk from the bulk tank for bacteria, somatic cells, flavor and other factors that affect milk quality.

Modern Mastitis Control

To minimize the wide range of problems that cause mastitis, a modern control program is essential. This program consists of:

1. Maintaining functionally adequate milking machines.
2. Following sound milking procedures.
3. Dipping teats with an effective product after every milking.
4. Treating clinical cases early, as prescribed by your veterinarian.
5. Treating all quarters of all cows at drying off.
6. Culling chronic cows, and cows that do not respond to treatment.

Summary

A herd approach to the production of quality milk, and mastitis incidence is the only effective means of dealing with this costly disease. Knowledge of the disease, professional help, and the dairyman's ability and willingness to adopt the required procedures are keys to a successful program.

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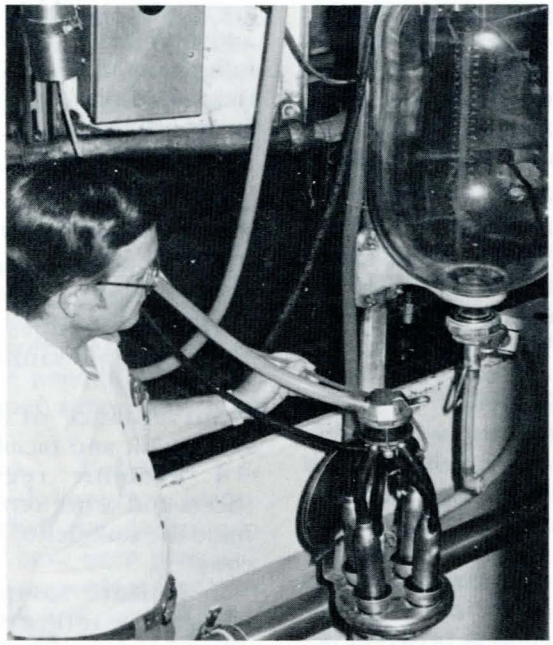
[1]Duane N. Rice is Extension Veterinarian.



Attention to milking equipment is essential for control of mastitis.

Equipment Maintenance Pays

Stan Wallen[1]

During the 1979 UNL Area Dairy Days program about 284 dairymen were surveyed about mastitis control efforts used on their farms. The same dairymen were surveyed again one year later.

One question asked on the survey was, *"How often does a milking equipment serviceman visit your farm?"*

Each dairyman was also asked to report his herd's last somatic cell count. A summary of responses to these questions is given below.

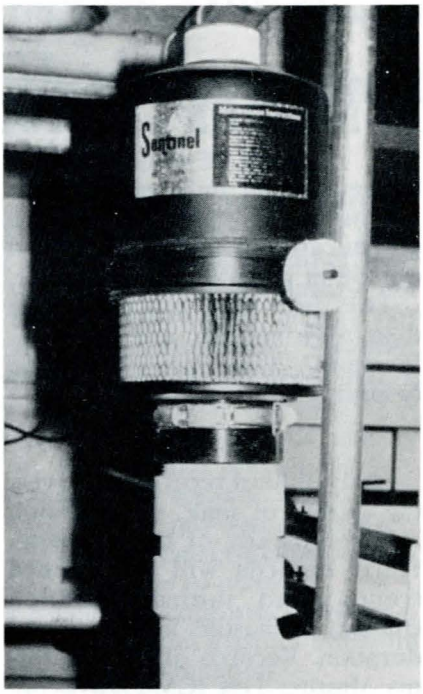
Frequency of serviceman's farm visit	Responses	% response	Avg. somatic cell count
Never	38	13.4	383,661
Once per year	51	18.0	310,721
Every six months	97	34.2	233,918
Between 1 and 3 months	77	27.1	226,445
When called	21	7.4	238,721
Total number of responses	284		

As frequency of visits increased, the average somatic cell count decreased. *Farms visited every six months or more often had a mean SCC that was about 150,000/ml less than those who reported their serviceman never visited.* Farms visited only once per year had a mean SCC almost 80,000/ml higher than those visited every six months or more often.

Decreasing a cow's somatic cell count by 150,000 will result in an additional 218 pounds of milk/lactation. Assuming milk is worth $12/cwt, this additional production returns $26.16 more per cow. In a 50-cow herd, the gross return would be about $1,300. At the same time, dollar losses due to discarded milk, veterinary and drug expenses, as well as average cow life span would increase, thereby improving the overall profit picture.

How often does your dairy equipment service man visit your farm? Make him part of "your" mastitis team.

[1]Stan Wallen is Extension Food Scientist.



The vacuum regulator is a vital component of the milking system. It requires regular maintenance.

Regulation—More Is Better!

Gerald R. Bodman[1]

Regulation! Who needs it? Who says more is better? The answer to the first question is you—you, the dairyman need more regulation. Who is to say more regulation is better? Current research regarding milking systems indicates it is better.

No, we are not discussing regulation by government agencies or government interference in the dairy operation. We are talking about regulation of another kind—regulation of the vacuum level in your milking system.

One goal in designing and operating a milking system is to minimize the variation of vacuum at the teat-end. Stable vacuum minimizes stress on the udder, and reduces the likelihood of infection

and abnormal teat-end development.

Cyclic Vacuum Fluctuations

Some variation of vacuum is normal in operation of a milking system. For example, as an inflation opens and closes, a variation in vacuum occurs at the teat-end. This variation is a necessary part of the milking process. Because this variation in vacuum level is repetitious and occurs in a systematic, routine fashion, it is referred to as a cyclic vacuum fluctuation.

Another form of cyclic vacuum fluctuation is associated with milk-flow through the line. Through venting, air is admitted to the claw to help move milk to the milk-line. Once milk has entered the milk-line, flow is primarily by gravity to the receiver jar or bulk tank. Cyclic vacuum fluctuation occurs since the quantity of milk in the hose leading from the claw to the milk-line varies. Since a column of milk 1 ft (0.3 m) in height produces a vacuum change equal to 0.9″ Hg (3.0 kPa) the vacuum level at the teat is affected by milk in the milk-hose as well as the vacuum level in the milk-line. Thus, vacuum fluctuations at the teat are a function of milk-flow.

As an example, in a high-producing, fast-milking cow, the milk-hose may be nearly full of milk. If we are milking into a high-line that is 5 ft (1.5 m) above the cow's udder, this column of milk will result in a 4.5″ Hg (15.2 kPa) decrease in vacuum level at the teat-end relative to the vacuum level in the milk-line. Then, as the cow nears the end of the milking cycle and milk-flow through the milk-hose decreases, the vacuum level at the teat-end will gradually increase to where it is nearly the same as the vacuum level in the milk-line.

As another example, if we are using a low-line system with the milk-line 2 ft (0.6 m) below the udder and if the milk-hose is full of milk, the vacuum level at the teat-end will be 1.8″ Hg (6.0 kPa) higher than the milk-line vacuum level. Hence, when we talk about teat-end vacuum levels, it is important to define at what point in the milking sequence and with what rate of milk-flow the measurements are being taken.

A third cause of cyclic vacuum fluctuation which occurs as a normal part of the operation of a milking system is changes in vacuum level due to frictional losses associated with the flow of air through a line. Vacuum losses due to friction vary in proportion to the square of the velocity. That is, if the velocity of the air doubles, vacuum losses increase fourfold. Therefore, limiting air velocities to a reasonable level is very important in our attempt to maintain stable vacuum at the teat. An air velocity of about 25 ft/sec (7.6 m/s) or 1500′ per minute (455 m/min) provides an acceptable balance between vacuum losses due to friction and large pipe sizes. This criterion is used in sizing all lines leading from the vacuum pump to the sanitary trap and the regulator. Maximum recommended airflow rates for various line sizes are given in Table 1.

Irregular Vacuum Fluctuations

Some other forms of vacuum fluctuation are termed irregular. Irregular vacuum fluctuations are the result of non-routine happenings within the milking system. Research has shown that new infections are markedly increased when irregular vacuum fluctuations are superimposed on cyclic vacuum fluctuations. Thus, elimination of irregular vacuum fluctuations is an essential part of a mastitis control program.

One cause of irregular vacuum fluctuation is operating too many milker units per slope of milk-line. As the rate of milk-flow varies the space between the top of the milk and the top of the pipe available for airflow also varies. Operating too many units per milk-line slope results in a very small air space above the milk. Very high air velocities are thus necessary for operation of the milking unit. Since pressure or vacuum drop due to friction varies with the square of the air velocity, the consequence is excessive frictional losses and increased vacuum fluctuation at the teat. This source of irregular vacuum fluctuation can be eliminated by assuring that milk-lines are installed at the proper slope for good milk drainage and by not attaching more units per milk-line slope than 3-A recommendations.[2] The recommended milk-line slope is 1″ per 10 ft (8.3 mm per m) for milk-lines with welded joints and 1-½″ per 10 ft (12.5 mm per m) for milk-lines with couplings. The number of milker units per slope of milk line is given in Table 2.

In many situations the performance of a system can be markedly improved by changing from a single slope milk-line and a separate wash-line to a double slope milk-line with half the units attached on each side. This change must be accompanied by a change

Table 1. Recommended airflow rates for various size pipes used as main vacuum supply lines.

Pipe diameter (in)	Pipe diameter (cm)	Airflow rate, maximum cfm (L/min) American Std. (ASME)	Airflow rate, maximum cfm (L/min) New Zealand Std. (NZ)
1-¼	(3.2)	18 (368)	26 (736)
1-½	(3.8)	18 (510)	37 (1020)
2	(5.1)	33 (935)	65 (1869)
2-½	(6.4)	51 (1444)	102 (2889)
3	(7.6)	74 (2096)	147 (4191)
4	(10.2)	131 (3710)	262 (7420)
5	(12.7)	204 (5777)	409 (11,555)
6	(15.2)	294 (8326)	589 (16,652)

Table 2. Milking units per slope of milking pipeline.

Milking pipeline diameter in	(cm)	Maximum number of milking units per slope
1-½	(3.8)	2
2	(5.1)	4
2-½	(6.4)	6
3	(7.6)	9

to a double-inlet receiver jar and a change in the washing system.

A more severe type of irregular vacuum fluctuation occurs when air is abruptly or erroneously admitted to the system. A squawking liner is one example of how this occurs. Two common causes of abrupt vacuum changes and air admissions are inadequate system design and poor operator technique in attachment or removal of milking units. To minimize the occurrence of such irregular vacuum fluctuations, the system must be properly designed and functionally operational. Good design requires attention to airflow capacity, vacuum levels, line sizes, claw design, and inflation selection.

Simply having the vacuum pump start when the switch is thrown does not necessarily mean the system is operating properly. Maintenance is very important and must be performed routinely to assure proper lubrication, clean filters, and tightness of belts. A complete system check should be made every six months or after 500 hours of system operation to check for leaks, line restrictions and worn parts.

Inflations must be selected which best suit the majority of cows in a given herd. Because of variations in teat shape and size, the best inflation for a given herd must be selected over a period of time and may change with time as herd replacements are introduced into the milking string.

The development of good milking techniques by the operator is equally as important as system design in minimizing irregular vacuum fluctuations at the teat end. Any habit such as squeezing inflation stems to sense milk flow must be discontinued. Procedures which minimize the entrance of air during the attachment and removal of the unit must also be adopted. During unit attachment the inflation stem should be held against the claw ferrule until the cup assembly is ready to be slid onto the teat. A vacuum shutoff device should be used at the claw to allow complete removal of vacuum from the teat prior to unit removal.

Table 3. Regulator styles, in order of decreasing sensitivity.

Regulator style	Examples
Servo-diaphragm	Sentinel, De Laval 2-50, Bou-Matic 180, Westfalia Vacurex
Spring-loaded sleeve	Surge Equalizer, Conde, Bou-Matic
Weighted sleeve	Surge oil-bath
Dead weight	Universal, De Laval, Bou-Matic

Assuming that everything is operating correctly simply because a parlor is equipped with automatic detachers is also not a safe practice. Good performance requires the operator to learn proper operational techniques and procedures for the equipment. Maintenance must be performed on a routine basis to assure that vacuum shutoff valves, milk sensing devices and similar components are functioning properly. A build-up of solids on valves and valve seats, damaged valves and clogged vents are frequently observed faults.

Vacuum Regulators

The vacuum regulator is the milking system component primarily responsible for maintenance of stable vacuum levels. Although a vacuum regulator cannot respond instantaneously to abrupt airflow changes, it should be capable of compensating in a very short period of time. Evaluations of regulators have revealed that wide variations exist between the various makes and styles of vacuum regulators. Careful selection and installation of the regulator is an essential part of milking system design.

To help illustrate why the regulator is important, let's consider its function. During the static operation or when no units are attached to cows nearly all of the air being discharged by the vacuum pump is being admitted to the system through the vacuum regulator. Only air entering the milking system through air vents on milk meters, milk sensing devices, claws not equipped with vacuum shutoff valves, or leaks would not be passing through the regulator. In contrast, as the system is loaded or as the demand for airflow through the system increases as more units are attached, the airflow through the regulator decreases to balance pump capacity against air being admitted elsewhere in the system. Hence, during such occurrences as a unit dropoff or a sudden admission of air due to poor operator technique or squawking, the regulator will attempt to close thereby maintaining vacuum levels within the system.

As the air admission valve in the regulator opens and closes, air velocity and associated air turbulence around the control valve can be very high causing unstable vacuum at the regulator sensing point. This is undesirable since inaccurate sensing of vacuum levels at the regulator results in vacuum fluctuations throughtout the system.

Since the ability of a regulator to accurately sense and control vacuum levels is closely associated with the design of the regulator, careful selection of the regulator is essential. Direct-sensing type regulators in which vacuum levels are sensed at the point of air admission or at a single valve will nearly always provide less stable vacuum than will the newer servo-diphragm type regulators. In servo-diaphragm regulators, the sensing of vacuum level takes place away from the point of actual air admission. This distance will range from several inches (cm) to as much as 25 feet (7.6 m) depending upon regulator make and design. The various types of regulators are listed in Table 3.

Current standards for vacuum regulator performance state that the vacuum should be held to within 0.5″ Hg (1.7 kPa) of the regulator set-point when system loading is varied from zero airflow to

an airflow rate within 90 percent of system capacity. The regulator setpoint is determined by allowing all air to enter the system through the regulator and reading the corresponding vacuum level. Regulator response is checked by loading the system by admitting air through a calibrated airflow meter positioned at the receiver jar. As the airflow rate through the meter increases, the airflow rate through the regulator decreases. The vacuum level is checked at each airflow rate through the meter across the full range from setpoint to 90 percent of system capacity. In field checks of approximately 75 different systems and a wide variety of regulators, vacuum level variations across this range of airflow rates have been found to range from zero to a high of 4.5" Hg (15.2 kPa).

The vacuum level of primary concern in a milking system is teat-end vacuum. However, as discussed, teat-end vacuum levels must be defined in terms of the rate of milk-flow and milk production from a given cow. At the same time, however, unless the regulator is performing properly and maintaining a stable vacuum level at the receiver jar, maintaining stable vacuum at the claw is impossible.

Maintenance

Maintenance of the vacuum regulators is very important for proper operation. All makes and models require periodic cleaning and this cleaning must be more extensive than simply relpacing the foam or paper filter which accompanies most regulators or cleaning of the metal filter on some other styles. All vacuum regulators should be completely disassembled and cleaned at least monthly. A mild detergent and water solution should be used to clean all parts. Solvents should not be used on any plastic component. A more powerful solvent can be used for most metallic-type regulators. After cleaning, all parts should be thoroughly rinsed, allowed to dry, and then re-assembled.

With some regulators the vacuum level adjustment screw must be loosened to allow disassembly. In such cases the vacuum level *must be re-set* following re-assembly. With most regulators this is not a difficult task, and one which can be easily learned. Vacuum levels must be returned to their previous level following maintenance procedures.

Although most manufacturers recommend that no lubricants be applied to the regulator, it has been found that in some cases the application of a light film of silicone spray will improve regulator response by allowing surfaces to slip by each other more easily. Under no circumstances, however, should oil be used because of changes in viscosity with temperature and because of the tendency to accumulate dirt. In cases where regulators routinely stick, polishing of moving parts with a piece of fine emery cloth will sometimes improve clearances sufficiently to allow better response and improved operation.

Summary

Regardless of your views concerning regulations in other phases of production agriculture and the dairy industry in particular, do remember that in the case of milking systems more regulation is indeed better! The most responsive and sensitive type regulator which is available for systems of your size should always be selected. Following installation, the regulator should be tested to determine its response on your system. Only through good regulator performance and careful design of the entire system can the goal of eliminating irregular vacuum fluctuations be achieved.

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[2]3-A recommendations refer to standards formulated by the International Association of Milk, Food, and Environmental Sanitarians and published as "3-A Accepted Practices for the Design, Fabrication and Installation of Milking and Milk Handling Equipment", Serial No. 606-02. Copies are available from IAMFES, P. O. Box 701, Ames, IA 50010.

Extraneous Voltage on Nebraska Dairy Farms

Gerald R. Bodman[1]

Most dairymen remember their last encounter with electricity—in the form of a shock. Even when the possibility of shock is anticipated, such as when working with an electric fence, the results are nearly always the same—a reflex that moves us away from the source of the shock and a sense of increased timidness as we attempt to continue our work.

Although reactions of cows to low-level voltages may not always be as dramatic as your touching an electric fence, low-level voltages—and associated currents or shocks—may cost you and other Nebraska dairymen many dollars each year.

Extraneous voltages (also referred to as stray voltage, transient voltage, stray current, neutral-to-earth voltage, transvoltage and similar terms) have received much attention during recent years. A question still remains as to whether this phenomenon is a new problem or simply the recognition of an old one. Whatever the case as voltage levels in a milking parlor increase there is nearly always a corresponding increase in the incidence of mastitis and in difficulties encountered in achieving uniform cow movement through the milking area.

Investigations concerning extraneous voltages on Nebraska dairy farms were started in 1980. Goals of the study were to determine the frequency of occurrence and magnitude of extraneous voltages and their role as a factor which pre-disposes cows to mastitis or one which reduces the effective-

ness of other aspects of a mastitis control program.

Effect on Cows

The influence of extraneous voltages on dairy cows is not well understood. However, reasons for concern over extraneous voltages stem from the consideration that low-level voltages may cause a response similar to a nerve impulse signal when passed through the udder and may prevent milk let-down from occurring. The problem is accented by the fact that mastitic milk has a higher electrical conductivity than normal or good quality milk.

An important component of a mastitis treatment procedure is complete and thorough milkout of the udder at frequent intervals. If extraneous voltages in the milking center prevent milk let-down and complete milkout of the udder, mastitis control efforts are diminished. The effectiveness of intramammary treatments and medications is also decreased because of dilution by residual milk.

Within Nebraska, extraneous voltage is defined as any voltage that is not part of a system design which exists between any two points a cow might reasonably be expected to touch simultaneously, or at a location where voltages would not normally be expected to exist. Hence, voltages from as little as 1 millivolt (mV) to levels equal to line voltage [120 or 240 volts (V)] are included in the definition of extraneous voltage. Consequently, extraneous voltages within milking centers are of concern from both a human safety and cow health and production standpoint. Nationwide, voltages in excess of 500 mV (0.5 V) are generally felt to be sufficient to warrant concern and to justify corrective measures.

Causes and Solutions

Extraneous voltages may develop as a result of:

1. *Induced currents.* Induced currents can be caused by electrical wires attached to or in close proximity of and running parallel to metallic conductors. The solution to this problem is to avoid running

Extraneous voltage may be the culprit if cows are fidgety and don't like to come into the parlor.

electrical conductors parallel to metallic objects. One investigator found extraneous voltages being developed in a tie-stall barn due to electric cow trainers which were parallel to a stainless steel milk-line.

2. *Unbalanced load.* Disregard for balancing of 110 V loads between lines of a 220 V service results in greatly increased levels of current flow through the secondary neutral conductor. In turn, this causes higher current flow through ground rods and potential for "leakage". Use of good wiring techniques and, to the extent possible, balancing of connected and demand loads during the milking operation between both lines of the 220 V service will reduce the likelihood of extraneous voltages from this source. The use of only 220 V motors or equipment within the milking center is recommended for new construction.

3. *Improper grounding of services.* Loose connections, undersized conductors and in some cases the total omission of a grounding electrode from an electrical service can result in voltages being present at various locations within the milking center. Avoid this by assuring that all electrical services are installed in accordance with the *National Electric Code* which requires that all service entrance centers have adequate grounding electrodes.

4. *Equipment grounding.* Failure to provide chassis grounds on motors and other equipment can lead to extraneous voltages should a malfunction or short occur in the equipment. Do not use neutral conductors for equipment grounding on branch circuits. Neutrals and grounds must be kept separate outside of the service entrance. The neutral should be grounded at only one location in a building.

5. *Galvanic action.* Voltages may also develop as a result of galvanic or battery action associated with corrosion. A ventilation system should be a part of all milking center installations. Ventilating a milking center helps control relative humidity levels and the rate of structural rusting and deterioration within a milking center. Keep corrosive materials such as feed and manure away from metal objects. Interactions between acid wash water (pH < 7) used in sanitizing and cleaning milk-lines and the basic concrete floor (pH < 7) can cause voltages to develop. Convey all milking system wash water to the drainage system through pipes or defined channels.

6. *Electrical shorts.* Deterioration of conductor insulation in curcuits or windings of motors as well as poor wiring techniques in plugs and receptacles can result in the development of extraneous voltages. The only solution to this problem is to assure that the entire electrical service system is installed utilizing appropriate wire types and good wiring techniques. Where circuits or motor windings show insulation deterioration, they should be replaced.

7. *Utility lines.* The primary neutral of the electric supply system is required to be grounded at specific intervals. If grounds are removed through corrosion, accidents, or acts of vandalism, grounding electrodes located on the farmstead will be forced to carry a larger part of the primary neutral current flow. These increased neutral currents in turn cause greater voltage in undesirable locations. Help your REA do a better job by reporting loose or damaged ground wires.

Where to Start

In surveys of more than 100 Nebraska dairy farms, voltages were found to range from 0 to 120 V (line voltage). Voltages in excess of the 500 mV "threshold of concern" level have been measured in at least one location within the milking center or around waterers on 58% of the farms.

A wide variety of problem areas have been identified in surveys conducted to date. Some of the most frequently observed or encountered problems are listed below. Use them as a check-list to troubleshoot your farm.

1. *Electrical service entrance*—Inadequate grounding. In many cases the water line was originally used as a primary ground. When metallic water lines are replaced with non-metallic piping the quality of the ground is severely diminished. Grounding electrodes are recommended on all service entrances.

2. *Motors and other electrical service equipment*—Improper grounding or lack of grounding.

3. *Switch and control boxes*—Accumulation of dust and debris. The result is an increase in extraneous voltage levels with increases in relative humidity.

4. *Electrically heated stock water tanks*—Deteriorated insulation and faulty heating elements.

5. *Fan motors within the milking center*—Deterioration and corrosion.

6. *Switches and receptacles*—Broken or otherwise short-circuited.

7. *Electrical conductors*—Damage to insulation by rodents.

8. *Fluorescent lighting ballasts*—Faulty. Residential type lighting fixtures should not be used in a milking center. Use industrial quality fixtures with waterproof enclosures.

9. *Milk transfer pumps*—Shorted, corroded, or improperly grounded.

10. *In-parlor feeding systems*—Dust accumulation in electrical components.

11. *Electric fencers*—Improperly grounded.

12. *Electric pulsators*—Deteriorated wire and corroded or loose terminals. This is a common cause of DC voltages within the milking center.

13. *Knock-out closures on service boxes*—Failure to install. When knock-outs have been inadvertently or inappropriately removed, the openings should be closed with knock-out caps. In several cases rodents nests were found in and around electrical contacts. The result is varying voltage levels with variations in moisture conditions.

14. *Stock watering tanks or other watering devices*—Poorly maintained. Accumulations of feed materials and other organic matter frequently increase the deterioration rate of water tanks. The decomposition of the organic matter frequently results in DC voltages in and around stock tanks.

15. *Ventilation of the milking center*—Inadequate or non-existent with the retention of high humidity levels over long periods of time and associated high deterioration rates of metallic components resulting in an increased level and incidence of DC voltages.

16. *Telephone service*—Shorts or poor grounding.

The majority of problems identified have been on-farm and due primarily to improper installation and maintenance of the electric supply system and milking system components. However, off-farm problems in the form of damaged REA ground wires, faulty transformers and problems on adjoining or nearby farms have also been encountered.

In one installation, reported to the author, voltages were being developed by an electrical wire which had rubbed through the tower on a windmill on an adjacent, abandoned farm. The distance from the service box to the windmill tower was great enough to produce sufficient voltage drop so the current flow was insufficient to trip the curcuit breaker. The result was a constant voltage through a neighboring farm milking center.

Measuring Extraneous Voltages

Experience suggests that identification and correction of extraneous voltage problems is best left to individuals with training and expertise in electrical system design. The broad range of possible causes of problems requires an understanding of the overall system installation. A need to make measurements around "hot" wires makes safety a constant concern.

Identification of sources of extraneous voltages is a necessary first step in solving a problem. This requires use of a voltmeter capable of distinguishing between AC and DC voltages and capable of responding to very low voltages. Most needle-type voltmeters do not meet these criteria. In contrast, the circuitry of most digital

Proper grounding is the key to correcting extraneous voltages.

voltmeters allows complete separation of AC and DC voltages. A desirable feature to allow detection of voltage spikes associated with the start of various pieces of equipment is a "peak lock". This feature allows the voltmeter to "lock on" to a voltage spike associated with high starting currents and continuously display it until the re-set button is pushed. Use of a voltmeter with this capability resulted in identification of problems on several farms. On one farm the problem was a faulty crowd gate switch and on the others it was faulty wiring servicing the milk pump. These voltage spikes occurred only when the equipment was first activated.

Solutions

The seemingly "easy" solution to extraneous voltage problems is to arbitrarily bond all metallic components together. This approach is considered unacceptable since it is generally a solution to a symptom of the problem rather than correcting the problem itself and, in some instances, may actually increase the magnitude of extraneous voltage. In all cases conscientious efforts should be made to isolate and correct voltage leakage problems before installation of ground rods and ground wires in and around the milking center. This does not include ground rods associated with the basic electrical system service entrance since these grounds are a necessary first step to meeting code requirements.

In new installations a built-in grounding mat is recommended within the milking center. Construct the mat by utilizing 6 x 6 welded wire steel mesh within the concrete in the milk house and parlor. Tie all steel in the pit floor, pit walls, and cow platform together and assure that all mesh in the parlor and milk house are interconnected. Additionally, all steel parlor support pipes and feeders should be attached to this mesh via welded connections. At the holding area entrance place a 6 to 8 ft width of mesh within the holding area floor immediately outside the parlor. Construct a gradual gradient to extend a further distance out into the holding area. The recommended procedure is to place bars at increasing distances apart, for example, 12, 18, 24, 30 inches as one progresses back into the holding area for a distance of 12 to 15 ft and to interconnect these rods to each other and back to the electrical service grounding electrode. This procedure minimizes the potential for development of high voltages just as the cows step into the parlor from the holding area.

Regardless of the quality of wiring installation or construction techniques employed, experience suggests that it is not a safe presumption that voltages will always remain at low levels in a given system. For example, during the summer of 1980 two farms were found to have voltages below the threshold level. During a follow-up check in the fall of 1980 these two farms were both found to have voltages in excess of 6 volts within the milking center. Hence, periodic re-checks are necessary.

If you suspect you have an extraneous voltage problem as evidenced by shocks, fidgety cows, poor milk let-down, and so on, request help from your electrician and REA service personnel. They can assist you in identifying the source of problems and recommend corrective procedures.

Summary

Extraneous voltages have been found to be a problem on Nebraska dairy farms. Poor equipment installation and wiring techniques, coupled with a general lack of electrical system maintenance, are felt to be the major causes of problems. Use of a competent electrician to install all electric service and equipment plus periodic, thorough checks of the electrical system will help assure that extraneous voltages do not cost you money in terms of lost profits due to mastitis, depressed production, or increased labor.

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Modern Milking Is Different

P. H. Cole[1]

You don't milk cows the same way your grandfather did, and if you tried you'd be disappointed in the results. Milking machine design and operation has changed in recent years. Cows have changed too. They give more milk, and their udders are generally better adapted to machine milking than the cows your grandfather milked.

The other major change during recent years is the increase in herd size. We sometimes hear about one individual milking 75 to 100 cows an hour by himself. This can mean a lot more stress on the milker and the cow unless proper milking procedures are used.

Basic Milking Procedures

The basic steps or procedures for proper milking are simple and straightforward. They are:

1. Provide a stress-free environment.
2. Check foremilk for abnormalities.
3. Wash and sanitize udder.
4. Dry udder with paper towel.
5. Attach teat cups promptly.
6. Adjust milker units during milking.
7. Shut off vacuum before removing units.
8. Dip teats promptly.

Let's look at these procedures one at a time and how some of them have changed in recent years.

Stress-free environment—The milking equipment must be in top working condition. Improperly operating equipment can cause stress for a cow. It can also physically injure the cow, and can result in mastitis. Stress on the milker

also can be a serious problem. It is difficult to do a proper job of milking if the milker is under constant stress.

Check foremilk for abnormalities—Checking the foremilk serves three important functions. First, it serves as a type of early warning system. If the foremilk looks abnormal in any way your cow has a problem that needs prompt attention. Second, taking a foremilk sample is an important part of the stimulation process. Third, this milk of low quality is eliminated from the milk supply.

Wash and sanitize the udder—Washing and sanitizing still serve the same purpose they did in grandpa's time. Wash water should be warm. The major difference is that today we recommend using a single service paper towel rather than the old towel or sponge that grandpa used. Along with stripping, washing and massaging the udder are important parts of the stimulation process. The value of sanitizing the udder is currently being debated. Some research indicates that sanitizing is of little value in preventing mastitis and there is also evidence that it is effective in reducing certain bacteria on the udder. The Grade A law still requires the sanitizing of udders. Certain combinations of udder sanitizer and teat dip are irritating to the cow's teats. When this occurs try a different dip or sanitizer. The current recommendation is to use a sanitizer and dip made to be used together.

Dry udder with paper towel—The key is to use a single service paper towel. That is one way to reduce the chance of spreading infection from one cow to another.

Attach teat cups promptly—Today we recommend attaching the units within 30 to 60 seconds from the start of udder preparation. We used to recommend a little longer wait or lag time. Research in Europe and California indicates no advantage to a long lag time. The reason that the shorter lag time works is that modern milking equipment does a better job of stimulating the cow and that modern cows let their milk down more promptly.

It is also critical to attach units *properly* as well as *promptly*. Proper attachment means getting the units on in a way that allows a minimum amount of air to get into the system. Whenever air is let into the system there is the possibility of "impacts." "Impacts" consist of small droplets of milk being forced back onto other teats and sometimes even into other teats. Avoid this if at all possible.

Adjust milker units during milking—There is no way that a cow is going to milk out evenly in all four quarters unless the milker unit is properly positioned. The present recommendation is to keep the unit on all four quarters until milking is completed. This may result in some overmilking in one quarter. However, it has been clearly demonstrated that a small amount of overmilking is not detrimental when the machine is operating properly. The major function of keeping the machine properly lined up is to prevent liner squawk.

Many dairy farms use some type of randal arm to keep the milker unit properly lined up with the udder.

Shut off vacuum before removing units—*How* a milker unit is removed from the cow is a lot more important than *when* it is removed. It is absolutely essential that the vacuum be shut off before removing the unit. Liner squawk at this time is a very serious matter. If the vacuum is not shut off before machine removal it is almost certain to cause liner squawk, or at least will let air into the system. "Impacts" are a serious problem anytime but are the most serious at the end of milking. The teat end is open, there is little or no milk leaving the teat and the possibility of milk being forced back into a teat is great. Research has shown that cows are more susceptible to contamination and infection late in the milking period.

On many farms automatic take off units are being used. Do they improve milking efficiency? What effect do they have on production and mastitis? Most studies have shown the automatic take off units do save time and thus increase milking efficiency. In some operations they do reduce the amount of overmilking, but they do not make good milkers out of poor milkers. Automatic removal units do not appear to have a major effect on production or mastitis.

Dip teats promptly—The recommendation is to dip all teats on all cows at every milking. Dipping is more effective than spraying. Use a recommended teat dip, and if it proves irritating to the cows, try another brand. Teat dipping and dry cow treatment are the two most effective mastitis control measures available to dairymen. Dipping is effective in preventing new mastitis infections and dry cow treatment is the most effective way to eliminate existing infection.

For many years it was recommended that milking units be rinsed by dipping into a bucket of sanitizer between cows. This was shown not to be effective in reducing the spread of infection, and it is not commonly practiced today. However, today automatic backflushing (rinsing and sanitizing) equipment is on the market. Current research shows that this equipment is more effective in reducing the spread of mastitis than the old hand method.

Summary

Modern milking demands equipment in excellent condition, careful attention to milking procedure, and a high level of sanitation. To put it in the dairymen's language, it should be Quick, Clean and Comfortable.

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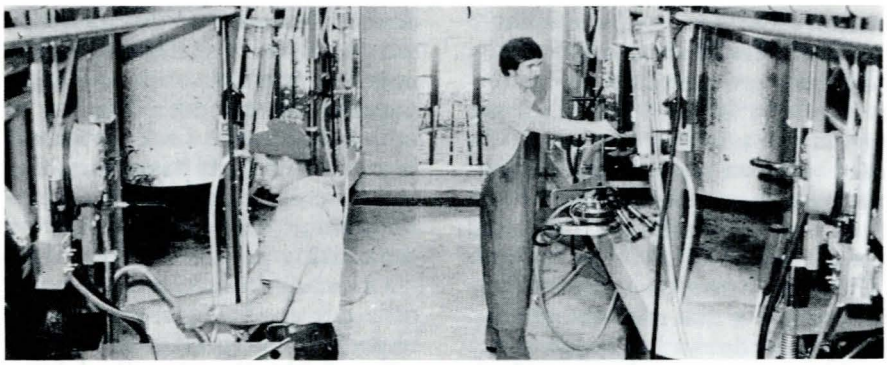

A well-organized milking operation can save many hours and dollars.

Nebraska Style!

Milk Production, Milking Systems

Gerald R. Bodman[1]

Every dairyman at one time or another has been told or has read about the importance of proper design and installation of his milking system. Every dairyman has probably also been told that if his milking system is going to operate properly, complete routine maintenance is required. Further, he has been advised that development of good milking procedures or habits is essential.

As part of a comprehensive mastitis control program started in spring of 1980, 32 Nebraska dairymen were selected to serve as cooperators in a demonstration herd program. The purpose of the demonstration herds was to show how implementation of a modern mastitis control program can reduce costs and losses. A survey and thorough evaluation of milking equipment was conducted. Results indicate that Nebraska dairymen suffer from a combination of poor design and installation as well as poor or inadequate maintenance. Too frequently, dairymen see maintenance as changing filters or filling the oiling system of the vacuum pump. While these factors are important, they are inadequate to assure proper milking system function.

Contract Arrangements

Many dairymen now subscribe to service contracts with their equipment dealer. With such arrangements a dealer representative stops at the farm on a periodic basis—usually every six to eight weeks—to deliver any required supplies and to conduct minimal maintenance procedures on the milking system. All too often this maintenance check involves little more than changing filters on the vacuum pump and possibly on the vacuum regulator. A number of other items require periodic evaluation and maintenance. Among them are vacuum pump performance, check of system air leaks, belt tension, line cleanliness, changing of oil within the vacuum pump, complete disassembly and cleaning of the vacuum regulator and careful inspection of the milking system. The inspection must be thorough to check for deteriorated or damaged hoses or pipes and to insure thorough and proper cleaning of all milk contact surfaces.

The survey also revealed that Nebraska dairymen are using a number of poor or improper milking procedures. The net result is increased mastitis levels or the potential for spreading infections thereby resulting in decreased milk production, increased veterinary expenses, increased culling rates, and increased labor demands in handling infected cows. Additionally, these things mean decreased dividends or profits both directly from on-farm operations and indirectly due to decreased milk market outlet profits.

Decreased milk market outlet profits are associated with loss of milk due to antibiotic contamination, decreased cheese yields due to high somatic cell counts and potentially lowered intake of dairy products by the consumer due to undesirably short shelf life. Although significant, the findings of the Nebraska survey are not unique to Nebraska, but typical of milking system conditions throughout the U.S.

A summary of findings follows.

Housing Facilities—The most frequently found problems with both free-stall and bedded-pack facilities were:

a. Poor ventilation resulting in high odor and moisture levels. These conditions can predispose cows to mastitis and other illnesses.

b. Poorly designed, improperly sized or poorly maintained free-stalls. This leads to lack of use, great potential for cow injury, and dirty cows.

c. Inadequate space for the number of animals housed. This increases the potential for udder injury and contamination plus dirty cows.

Extraneous Voltage—More than 50% of the farms surveyed had voltages in the milking center in excess of the 500 millivolts (0.5 volts) considered to be the maximum acceptable level. Poor electrical and milking system installation and maintenance were the primary causes of these voltages.

Milking Systems—The survey included parlors and milking barns. High milk-lines were found in 75% of the installations. Other findings:

a. Vacuum leaks and line losses ranging from 3 to 48% of pump capacity. Losses should not exceed 10% of pump capacity for systems up to 100 cfm (2800 L/s), New Zealand (NZ) standard, or 5% for systems up to 200 cfm (5650 L/s) (NZ). In one situation, losses in excess of 62% of pump capacity were discovered.

b. More than 60% of the vacuum regulators were poorly maintained or of such a design as to be insensitive to system loading (increases in airflow demands) resulting in extreme variations in vacuum levels. A vacuum regulator should be able to maintain

vacuum levels within 0.5" Hg (1.7 kPa) of the set-point as airflow rates through the system are varied from zero to 90% of system capacity.

c. Airflow capacities were insufficient for proper system operation. Inadequate airflow capacity may be caused by undersized vacuum pumps, lack of maintenance, line restrictions, or vacuum lines which are too small.

d. Loss of vacuum system efficiency. Even where the vacuum pump was of adequate size, system airflow capacity was insufficient in numerous systems. Among causes were leaks, undersized piping, or lack of care in the use of bushings, reducers, elbows, and so on.

e. Milk-lines installed at slopes less than the current 3-A standards of 1½" per 10'. This caused vacuum fluctuations and increased milk foaming.

Preparation for Milking—Udder preparation is important. Good procedures are necessary to clean and sanitize the udder, check for abnormal milk, and aid in the let-down of milk. Primary problem areas were:

a. Failure to use a sanitizer in the udder wash solution. This increases the potential for contamination of milk and udder.

b. Use of cloths or sponges to wash the udder. This results in high potential for spread of bacteria from one cow to another.

c. Failure to use single-use towels to dry cows before unit attachment.

d. Too much time between udder preparation and unit attachment. This time should generally be 30 to 60 seconds.

e. Failure to foremilk or use a strip cup to observe milk quality. Foremilking helps assure good milk quality and aids in detecting mastitis.

Milking Procedures—Operator technique or habits can stress the cow and cause teat irritation. The result can be increased infection rates and mastitis. Survey findings were:

a. Squeezing inflation stem to sense milk flow. The result is extreme vacuum fluctuations at the teat.

b. Failure to provide vacuum shut-off devices for use before unit removal. Removing units while vacuum is still being applied is a cause of teat irritation.

c. Failure to use an approved, effective teat dip after milking. A teat dip must be non-irritating and should contain a bactericide.

Rations—Good nutrition is necessary for maximum production. Findings showed:

a. Failure to use forage analysis services. The nutrient make-up of the feedstuff necessary in providing a balanced ration.

b. Improper ration balancing. This causes increased operating costs because of increased ration prices and/or poor utilization of nutrients. Table 1 indicates the range of problems found with rations in the Nebraska project. The bases of comparison are University of Nebraska–Lincoln recommendations.

Veterinary Practices—Good veterinary practices are necessary in a mastitis control program. The first requirement is consultation with your local veterinarian to determine appropriate treatments and treatment procedures. Shortcomings found:

a. Failure to monitor all cows for identification of causative organisms. Proper treatment requires knowledge of the infective agent.

b. Failure to culture all clinical cases before infusion of any intramammary treatment. Culturing is for identification of the organism causing problems.

c. Failure to develop a long range treatment program based on the infective agents found in a given herd.

d. Failure to treat all clinical cases for a minimum of three days to help cure the problem rather than simply subdue it to a subclinical status.

e. Failure to dry-cow-treat all animals as they go dry. Staphylococcus organisms are most effectively treated during the dry period.

Table 1. Percentage of ration samples found to be improperly balanced.

	Low	High
Energy	52%	16%
Protein	32%	36%
Phosphorus	16%	-
Salt	36%	-

The survey showed that a higher number of cows than anticipated were infected with *Staphylococcus aureus* bacteria. These cannot be effectively treated during lactation. Dry cow therapy is essential to control mastitis caused by these organisms. In some cases multiple treatments were prescribed.

Infections due to *Streptococcus agalactiae* were lower than expected. This indicated good treatment procedures during lactation on the part of the dairymen.

A finding of extreme concern was the high infection rate of first lactation heifers. More than one-third of first lactation heifers surveyed were found to have a staphylococcus infection. Because contamination of heifers occurs primarily after freshening, this high infection rate indicates a general lack of care in the handling of mastitic cows. Among procedures to help avert contamination of udders of heifers are (a) milk heifers first, (b) milk convalescing cows last, and (c) exercise special care in the handling of all mastitic cows.

Summary

A good mastitis control program requires careful attention to a broad range of management factors. It is only through the development of a cooperating local team involving the dairyman, veterinarian, market fieldman, and equipment dealer backed up by expertise located at the Land-Grant University that an effective mastitis control program can be accomplished. It is essential that a habit of paying attention to seemingly unimportant details be developed and carefully followed.

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Shifting From Liquid to Dry Feed

Foster G. Owen
and
Larry L. Larson[1]

Dairymen generally recognize the importance of a sound calf raising program. Well bred heifers are the basis for genetic advancement of the herd. Successfully raising a high percentage of heifers born is necessary to permit the culling intensity required for maintaining a high-producing herd.

To reduce losses and health problems special attention is necessary at the high stress periods. Weaning, when the calf has shifted to dry feed, is considered one of these periods.

When Should Calves Be Weaned?

Over the last 30 years there has been a general trend toward earlier weaning of dairy replacement animals. There are a number of reasons:

1. Feed cost can be reduced by minimizing the milk or milk replacer fed and substituting less expensive dry feeds.

Calves should be provided a highly nutritious, palatable starter ration to assure successful early weaning.

2. Less labor is required in feeding dry feeds compared to liquid diets.

3. The tendency for calves to scour is less on dry feed compared to liquid diets.

By the early 1960's research had established that Holstein calves could be successfully weaned by six weeks of age. During this period Nebraska began research to determine whether earlier weaning would be possible.

Our first experiment compared weaning Holsteins at either three or six weeks of age. No difference in growth was found by 12 weeks of age. No difference in terms of health or death losses were found. On both treatments calves were weaned abruptly, according to age.

Since some of these calves, especially those weaned at three weeks, had gained very little and were eating practically no starter at time of weaning another experiment was conducted to compare weaning strictly on age with weaning on the basis of a specific level of starter intake or on the basis of the amount of weight gained from birth.

Table 1. Criteria for weaning.[a]

	Weaned at 21 days of age	Weaned at 1 lb starter intake	Weaned after gain of 12 lb
Gain in weight, birth to:			
6 wk, lb/day	.71	.98	.92
12 wk, lb/day	1.3	1.4	1.4
Withers height, birth to:			
6 wk, cm/day	.11	.14	.13
12 wk, cm/day	.15	.18	.15
Starter intake, birth to:			
6 wk, lb/day	1.4	1.5	1.6
12 wk, lb/day	3.1	3.3	3.2
Scours, % of days	14	9	8
Calf losses, No.	0 of 16	0 of 16	2 of 16
Age at weaning, days	21	28	23

[a]Regardless of treatment no calves were weaned later than five weeks; none of the differences in growth or scours were significant (at P<5%).

Table 2. Age at weaning and calf performance during winter months.

	Weaning age	
	21 days	31 days
Calves assigned	24	26
Starter intake:		
To weaning, lb	9.5	21.3
To 42 days, lb	53	66
Body weight gain:		
To 42 days, lb	37	42
Calves treated for scours, No.	3	6
Calves treated for other problems, No.	1	3
Calves lost, No.	1[a]	0

[a]Calf died at 31 days, a twin weak at birth.

Calves were weaned either at three weeks of age, when they had eaten 1 lb (454 gm) of starter the preceding week, or when they had gained 12 lb from birth. Results (Table 1) showed that weaning on the basis of starter intake and gain practically eliminated the depressed growth rate noted between three and four weeks of age in some calves arbitrarily weaned at three weeks of age. The most significant outcome of this study was that, although calves weaned on the basis of age may have incurred greater stress at weaning, they soon caught up with the other groups. In terms of growth, livability, and health these calves were not significantly different from calves weaned by other methods.

Weaning at three weeks was a marked departure from common recommendations and there were many unanswered questions. A large scale, long term, experiment was started to test effects of early weaning on the health, livability, growth rate, reproduction and milk yield through the first lactation. (Details were reported in the 1977-1978 Dairy Report).

Twenty animals were assigned to each of these treatments. The calves weaned at three weeks were fed surplus colostrum milk, once daily, throughout the liquid feeding period, whereas those on the six week weaning program received normal milk after the first day on colostrum and were fed their diets twice daily. They were

fed the same starter and handled alike other than for those differences. These two programs were equally successful in terms of growth, health, livability, reproduction and milk yield during the first lactation. Up to six months of age only two calves were lost on the control and three on the early weaning program. Calves on this experiment were started in a warm type house, whereas today many calves across the midwest are being started in outside huts. Consequently, we tested the 21-day weaning concept with calves in outside huts.

The experiment compared the 21-day program with a 31-day program. The experiment was begun in November and continued through the coldest months of the year. Table 2 shows the growth and health data from this experiment. There were essentially no important differences between these two schemes. Only one calf died of the 50 which were assigned.

Although few health problems were encountered with our calves through the liquid feeding period and immediately following weaning, in recent years we have had a significant level of respiratory disorders in calves between about three and six months of age. English workers noted in their research that calves weaned early seemed more susceptible to respiratory problems.

Recently we started an experiment to evaluate age of weaning on calf health, especially respiratory problems. Table 3 gives some preliminary data. Comparing treatments 2 and 3 shows that, thus far, weaning at three weeks has produced gains in weight equal to those weaned at nine weeks. Earlier weaned calves consumed about 375 lb less milk, but 82 lb more starter ration by 12 weeks of age. Abnormal feces has been somewhat less common for early weaned calves. Health of all calves has been considered good and no deaths can be attributed to treatments. Group 1 calves that shifted to group pens at six weeks show a depression in growth compared to those shifted at 12 weeks. However, health apparently has not been adversely affected by the move.

Wean Abruptly or Gradually?

There appear to be no established benefits from weaning gradually compared to abrupt weaning. Observations suggest that when calves are put on gradual weaning, they generally do not suddenly increase consumption of starter as when calves are abruptly weaned. Calves can change to dry feed, even when the liquid diet is abruptly removed from their rations, without digestive problems. Consequently, abrupt weaning has the advantage of being less complicated, gets the calf weaned more quickly and successfully, and is now a commonly recommended practice.

Getting the calf to eat the starter feed at an early age is critical in a successful early weaning program. We have evaluated a number of ingredients, additives and feeding practices. Results of these experiments are presented in a separate article in this Dairy Report. Through the years we have obtained excellent results with formulas high in nutrients, containing mainly rolled or cracked grains and having a minimum of fines and dust. Special ingredients which benefited intake, growth or both were antibiotics and a coarse fiberous material.

Some people report that placing starter feed on the calf's nose, in his mouth, or in the bucket immediately after its liquid feeding encourages early dry feed consumption. However, in our research neither putting starter up to the calf's nose or forced feeding via capsule improved starter intake.

We have found that the most effective means of inducing the calf to eat starter feed is to abruptly discontinue its liquid diet. Average starter intake almost doubles five days after weaning when liquid feeding is stopped at three weeks of age. Only 1 or 2% of calves do not make the shift successfully. If they are not eating starter within two to three weeks after weaning, a few feedings of liquid diet on alternate days will tide them over.

How Soon to Group?

We have an experiment under way to help answer this question. It is generally accepted that when calves are put into groups too soon problems may arise because of persistence of the nursing instinct. Calves sucking on ears, navels and

Table 3. Effect of age at weaning and age at shifting from huts to group pens on calf performance and health (preliminary summary).

	Treatments		
	(1) 3 wk wean 6 wk Group	(2) 3 wk wean 12 wk Group	(3) 9 wk wean 12 wk Group
Weight gains at:			
6 wk, lb	32	37	36
12 wk, lb	82	116	116
16 wk, lb	131	149	153
Total starter intake to:			
6 wk, lb	44.3	52	33
9 wk, lb	---	151	97
12 wk, lb	---	291	209
Abnormal feces:			
cases/calf	.8	.6	1.3
treatments/calf	1.5	1.0	1.8
Calves with elevated (>102.5°F) body temperature, No.	1	0	2
Calves with respiratory problems, No./No. assigned	9/22	5/20	8/19
Death losses, No.	0	0	1[a]/19

[a]Calf died of shock following vaccination.

premature udders are often observed. Another concern with early grouping is the exposure of calves to others harboring disease organisms to which the younger animal has insufficient immunity. Preliminary results in this experiment suggest that moving calves at six weeks following three weeks weaning may hamper growth rate compared to leaving calves in huts until 12 weeks of age.

Recommended Weaning Plan

Since much of our research has been done with calves in outside huts and with animals of the Holstein breed, the following recommendations are based on these conditions:

1. Following the first days' feeding of colostrum, feed a liquid diet of surplus colostrum plus any other milk discarded from the herd. If additional liquid feed is needed, use normal milk or a high quality reconstituted milk replacer. This may be fed once daily and at the level of about 8 or 10% of body weight (10% suggested in cold months) and may be fed cool during the warmer months of the year.
2. Wean Holstein calves, routinely, at three weeks of age, but delay weaning in extremely cold weather or if the calf has suffered health setbacks.
3. Feed the calf a set amount of diet (7 to 10 lb daily for Holstein) based on body weight from the second day of life and maintain this same level until weaning, when liquid feeding can be abruptly discontinued.
4. Provide a top quality starter from the first week of life along with fresh water.
5. Following weaning at three to four weeks of age calves may be shifted to groups when about nine weeks old.

Weaning the calf does not have to be complicated and difficult. It may be simple and easy, yet highly successful.

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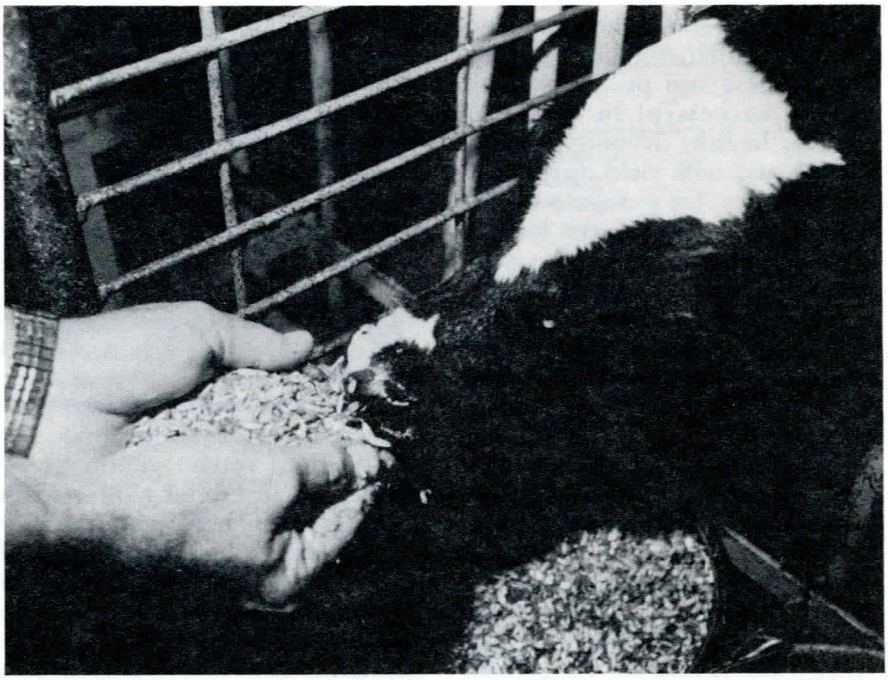

Starters with a built-in roughage material improve early intake, weight gains and rumen development.

Developments in Calf Starters

Foster G. Owen and Larry L. Larson[1]

When calves are weaned, they are shifted entirely from very nutritious diets of either milk or milk replacers to dry starter feeds, greatly different in both physical and chemical qualities. Thse rations are digested and utilized differently. To help assure continued sound calf nutrition it is important that the starter feed have a high nutritional value and be palatable. To help insure adequate starter intake special consideration must be given to the nutrient makeup, selection of ingredients and physical preparation. These concerns are of greatest importance for starter rations fed to calves weaned at an early age.

Starter Nutrient Composition

The nutrient specifications of starters are given in Table 1. The National Research Council's starter requirements are based on calves weaned at about six or eight weeks of age, whereas the early weaning starter requirements are for calves weaned at three to five weeks of age. The higher nutrient

Table 1. Nutrient specifications for starter rations.

	NRC starter[a]	Early weaning starter	
Nutrient	Min	Min	Max
	(% of dry matter)		
Protein, %	16.0	20.0	
TDN, (%) or ENE (Mcal/100)	72.0	75.0	
Ether extract, %	2.0	3.0	5.0
Crude fiber, %		10.0	
Calcium, %	.41	.70	.90
Phosphorus, %	.32	.50	.60
Vitamin A, I.U./lb	750	2000	
Vitamin D, I.U./lb	150	500	
Antibiotic, mg/lb		20	

[a]Recommended formulation for calves weaned 6 to 8 weeks of age by the National Research Council (1978).

requirements of the starters for early weaned calves is to compensate for the low intake of the starter immediately following weaning.

A minimum requirement of 10% fiber is included because of recent findings that a low level of coarse fiberous material benefits starter intake and calf growth. This will be more beneficial for calves raised on slatted non-bedded stalls. Calves bedded with straw or edible coarse material will probably consume sufficient extra fiber.

Starter Ingredients

Coarse, bulky ingredients with a minimum of dust are desired. If the ration is fed as a meal type preparation, it should consist primarily of coarsely ground, cracked, or rolled grains. Many commercially produced starters include the finer ground and more dusty ingredients in a pellet that is mixed with the coarser ingredients in the final product. Dust can be controlled by adding 5 to 10% liquid molasses or by including about 2% animal fat. The addition of molasses increases the intake of some starters, but should not be included at higher than 10% of the ration because of its laxative nature. Fats have the advantage of longer effectiveness in dust control compared to molasses which dries out in a few weeks after ration preparation. Reducing the dust appears to improve the palatability of starters.

Certain fats may improve energy intake and energy digestibility. The more saturated fats such as lard or tallow are preferred. Use of oils (soybean or cottonseed oils, etc.) could have a detrimental effect on ration utilization.

As primary energy sources, oats and barley appear the ingredients of highest palatability. However, corn, wheat and wheat bran are widely used. In calf preference studies soybean meal was a more palatable high protein source than linseed meal, milk powder, fish meal, or meat and bone meal. Urea is generally not recommended in starter formulations because of its low palatability and the calf's limited ability to utilize nonprotein nitrogen until beyond six weeks of age.

Table 2. Starter ration for early weaned calves.

	(%)
Corn, rolled or cracked	16.4
Oats, rolled	25.0
Corn cobs, ground	15.0
Molasses, liquid blackstrap	10.0
Soybean meal (44%)	28.45
Animal fat	2.00
Trace min-vit premix[a]	1.00
Antibiotic (oxytetracycline)[b]	.15
Limestone	.90
Dicalcium phosphate	.60
Salt	.50

[a]To supply 2,000 IU of vitamin A and 500 IU of vitamin D/lb of starter.
[b]To provide 15 mg of antibiotic/lb of starter.

Of the various possible additives for starters, it appears that antibiotics have the most proven effectiveness for stimulating consumption and improving growth. The benefit from antibiotics in the starter appears to come via its effect in the rumen. Consequently, the effect of antibiotics in the starter is independent of the effect of antibiotics administered in the milk or milk replacer which bypass the rumen in the course of digestion. Benefits from antibiotics are not consistent, but are more likely when calves are being raised in an old, contaminated facility, or a stressful environment.

We have also evaluated various other additives, none of which produced beneficial responses. They include dried molasses, sodium bicarbonate, a growth promotant (Ralgro), a hormone TSH (Thyroid Stimulating Hormone), and a rumen "stimulant". Others have tested various flavoring compounds with only butterscotch and butter flavor showing promise.

The basic starter now used in our studies is given in Table 2. It includes the nutrient and other qualities we feel are most important. Since it contains 15% corn cobs it is classified as a complete starter. This is a rather recent innovation in starters.

All-in-one Starters

A complete, or all-in-one type, starter feed had advantages compared to starters fed along with separate roughages. When the roughage and grains are combined into a single feed then the composition of the ration can be well controlled, wastage of feed practically eliminated, and the feeding process simplified.

Addition of added fiber to the concentrate has generally increased feed consumption and growth. In addition, built-in roughages appear to reduce the incidence of bloat, off-feed conditions and to stimulate the development of muscles in the rumen wall.

Nebraska research involved the comparison of dehydrated alfalfa, beet pulp and corn cobs in starter rations. These were included at ⅓ of the total concentrate and formulated as a ¼" pelleted starter. Results are shown in Table 3. Considerable improvement in intake was seen with addition of corn cobs. However, both beet pulp and corn cob additions proved effective for improving weight gain. The cob ration proved superior in stimulating both intake and additional growth, as measured by both weight gain and withers height.

Since inclusion of cobs at 33% gave considerably better performance than the control starter, another experiment was designed to determine the optimum level of cobs needed for best results. For this experiment we used 0, 12, 24 and 36% cobs. These were rather

Table 3. High fiber ingredients in calf starters.

Starter rations	Total starter intake to 8 wk	Body wt. at 8 wk	Withers height at 8 wk
	(lb)	(lb)	(cm)
Control	46	123	78.6
1/3 Dehy	46	117	77.9
1/3 Cobs	65[a]	136[a]	79.8[a]
1/3 Beet pulp	49	134[a]	78.7

[a]Significantly greater than other values.

Table 4. Corn cobs in calf starters.

Starters	Starter intake to 6 wk	Body wt at 6 wk	Withers height at 6 wk
	(lb)	(lb)	(cm)
Control	48	110	78
12% cobs	50	114	80
24% cobs	64	116	78
36% cobs	56	112	78

Table 5. Brome hay and soyhulls as fiber sources in calf starters.

Starters	Starter intake 3-6 wk	Body wt. gain 3-6 wk	Withers height at 6 wk
	(lb)	(lb)	(cm)
Control	56	27.9	78.3
17% soyhulls	58	28.2	78.3
15% brome	57	26.6	78.6
Soyhulls and brome	52	23.1	78.6

finely ground and mixed in with the regular starter ingredients. In this experiment, the ration was not pelleted. Results (Table 4) indicate that cobs again were beneficial in terms of intake and growth. The maximum intake of the cob starter was at the 24% level. However, further evaluation of withers heights, body lengths and body weights, taken after shifting calves to a standard ration, indicate that maximum growth was produced with the 12% cob ration. With these benefits, and no observed detrimental effects from the cob ration, we now use 15% cobs routinely in our calf starter feeds.

Since research elsewhere indicated that various kinds of chopped hays, straws, grasses and other high fiber materials were also beneficial, a third experiment was started to evaluate brome hay as a fiber source along with soybean hulls. Both of these are commonly available in Nebraska and offer different physical types of fiber sources. The soyhulls represent a material of fine particle size whereas the brome has a physical coarseness and scratch effect. We evaluated the two singly and in combination.

Table 5 shows results of this experiment. It was somewhat surprising that neither of these ingredients produced beneficial effects as related to intake or growth. However, both were satisfactory ingredients in starter rations. In addition, both of these high fiber ingredients appeared to improve capacity of the rumen. The combined treatment of brome and hulls resulted in development of the most ideal rumen lining and the condition of the rumen fluid was more nearly that of a mature animal than for those fed the control starter. This suggests that inclusion of some coarse fibrous material may improve the transition from higher grain type rations to the higher roughage rations generally fed during the growing phase, which immediately follows the starter feeding period.

Although various experiments have shown some benefits with different hays and some with straw, it appears that most consistent benefits from an added roughage source to calf starters come from the use of corn cobs and cottonseed hulls. Not only do these ingredients improve the starter, but also lower their cost.

Pelleting the Starter Ration

A number of experiments have used starter rations in pellet form and others have used them in the meal form. However, apparently there are few studies in which the two forms have been compared. Advantages of pellets have generally related to eliminating ingredient dust, and the fact that the pellets are more readily fed through certain feeders and feeding systems. The main disadvantage of pellets is that the control of hardness is very important, yet difficult to accomplish. Pellets that are too soft will tend to crumble, whereas those that are too hard are less acceptable to the calf. In either case consumption will probably be reduced.

Feeding the Starter

It is generally recommended that the starter be fed along with free-choice water, but hay or other roughages not be allowed during at least the initial couple of weeks. It is suggested that starters be presented to the calf during the second week of age or soon thereafter. Maintain starters fresh and free from contamination. Offering starter to the calf by hand for a few days may help start consumption. We usually recommend the continuation of starter feeding until the calf is consuming about 4 lb per day. At that time, it can be readily shifted onto a grower ration. They are usually limited to about 4 lb of grower ration daily to encourage roughage consumption. It seems preferable to make the shift to a grower ration before moving calves to group facilities. This may minimize the additional stress from making a shift to both a new facility and to a new ration at the same time.

Summary

Dairy calves can be safely shifted to a dry feed after three to five weeks of liquid feeding, if the starter is highly nutritious and palatable. Inclusion of molasses, or a low level of fat and about 15% of coarse roughage material are new advances in the formulation of starters to make them more palatable and effective in promoting growth and advancing rumen development. Calves may be shifted to a grower type ration at the time they are consuming about 4 lb of the starter feed. At that time the ration cost is considerably reduced and the calf will soon be able to be shifted to a group situation in which the cost of both feed and management are considerably less.

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Feeding for Better Breeding

Foster G. Owen
and
Larry L. Larson[1]

Reproductive problems appear to be increasing as dairy herds are continually challenged for higher milk production. During the last 10 years we have learned that many reproductive problems are related to nutrition and feeding of the herd.

Research on this subject in the last several years has demonstrated that the dry cow feeding program is critical. Essentials of a sound dry cow feeding program are presented in another University publication (NebGuide 77-373). This report is concerned with feeding of the milking cow.

Research suggests that the major problem with the dry cow is due to over-feeding of energy. In contrast, the major problem with feeding the high producing milk cow is an energy shortage. This occurs in the first part of lactation. The energy requirement for milk production reaches a peak at about six weeks following freshening. However, feed consumption, even when the cow is full fed, does not reach its maximum until 10 to 12 weeks after freshening. Until this time, the high producer will be taking in less energy than she is putting out in milk plus that needed for body maintenance. This results in a negative energy balance for her body. This difference between energy intake and need is the problem area. Any and all factors which tend to widen this area will increase the reproductive problems for the cow. One of these factors is milk production. The high producing cow will have a much higher requirement relative to her ability to consume and results in a larger negative energy balance. Any feature of ration quality that would detract from maximum intake will also aggravate this problem.

It is important to recognize how reproduction is affected when a cow suffers from an energy deficiency. It interferes with the normal function of the ovaries and tends to suppress their activity, causing a delay in the development and growth of follicles. More silent or weak heat periods will occur and the interval to first heat is lengthened. The end result will be a lower conception rate and more days open.

How can you determine whether a cow is short of energy? The best evidence is loss of body weight. Research shows that cows losing weight are much more difficult to get pregnant than are those gaining weight. One report indicates that 67% of cows bred when gaining weight conceived, requiring only 1.5 services per conception, compared to 44% conception and 2.3 services per conception in cows bred during a period when losing weight. This points to the importance of a feeding program following freshening to bring the cow into a positive energy balance as soon as practical. It also emphasizes the critical importance of the fresh cow ration.

Ideal Ration?

From the standpoint of both high milk production and reproduction, what is an ideal ration for the fresh cow? We have known for many years that nutrient makeup of the ration is important, but only in recent years have we recognized the significance of physical qualities and factors related to palatability and feed intake. Roughage should preferably be a high quality hay during the period just after freshening. If silages are used they should be limited to about 30 lb per head per day. This is especially important if the silages are relatively high in moisture. The level of silage may be gradually increased over the first several weeks after freshening, but at least six lb of hay or haylage should be fed daily. It is best that the concentrate ration contain bulky materials and other ingredients to make it as palatable as possible. Coarse ground grains, possibly rolled or crimped oats, brans and beet pulp are excellent. Feed ingredients of less than good palatability should be restricted in amounts and any questionable feeds omitted. A little animal fat or molasses to help minimize dust may also benefit the ration.

In a recent Nebraska experiment we found that including 21% soybean hulls in the grain ration improved feed intake in the first several weeks of lactation and resulted in a higher level of milk production and an improved conception rate (Table 1). This was in comparison with a similar grain ration primarily composed of corn and soybean meal. Both the soyhulls and beet pulp rations resulted in less severe uterine infections, fewer days open and a more normal first cycle length.

Method of Feeding

The method of feeding concen-

Table 1. Effect of rations containing beet pulp or soyhulls on reproduction and health.

	Rations		
	Control	Beet pulp	Soyhulls
Uterine infection, score[a]	.76	.64	.62
First cycle length, days[b]	27	22	18
Services/conception, No.[c]	3.8	3.1	2.3
Days open, No.	135	119	111
Calving interval, days	393	393	388
Mastitis treatments, No.			
To 98 days postcalving	2.3	1.1	2.0
Total lactation	6.1	3.4	4.3

[a]Uterine infection score: 0 = none; 1 = mild; 2 = severe.
[b,c]Soyhulls treatment effect was significantly different from the control ration.

trates to the fresh cow is also important. At the time of freshening she should be eating about 10 to 15 lb of concentrate daily. After freshening this should be increased at the rate of about 1 or 2 lb daily. If complete mixed rations are being used, they can be shifted to a high energy ration about two weeks following freshening.

A maximum of about 2% of body weight or about 30 lb concentrate is usually as much as most Holstein cows can be fed without some risk of off-feed or other digestive problems. However, if this grain can be portioned out in more than two feedings daily or included as part of a complete mixed ration, higher levels of grain can be fed successfully. When feeding these high levels of grain it is necessary to take all precautions to insure that cows receive their required amount of roughage. The minimum amount of roughage is slightly more than 1% of average body weight or about 15 lb daily for a Holstein cow.

Results from Michigan State University point out the importance of level of grain feeding just following freshening. The service per conception were reduced from about 2.0 to 1.5 when the grain level was increased from a low level to a high level. It was also shown that the feeding of a high level of grain (20 lb/day) before freshening was of no additional benefit.

However, research evidence indicates that excessive energy during the dry period and immediately after freshening can have a detrimental effect on reproduction. In one study, cows fed a ration consisting of 20 lb of grain before freshening followed by full-feeding of grain after freshening suffered a higher incidence of cystic ovaries, required more services per conception, had more abortions and a longer calving interval compared to control animals fed only 6 lb of grain prepartum and 20 lb after freshening. This illustrates the importance of restricting grain during the dry period and controlling the level of grain after freshening.

Ration Protein

In addition to the concerns with energy in the cows ration during early lactation we also know that fresh cows need a high level of protein. Between 16 and 19% protein in the total ration dry matter is needed for top milk production. If cows are not fed enough protein, reproduction may suffer. Low protein can cause silent heats, failure to cycle, a low rate of conception and reduced feed intake. The adverse effect of poor intake was previously discussed.

However, recent research evidence indicates that excess of protein may also cause reproductive problems. To maintain optimum reproductive performance, dairymen should maintain a continuous forage testing program and frequently check their ration balance to be sure of keeping the protein, as well as other nutrients, at their proper levels.

Urea has frequently been implicated as a possible cause of reproductive problems. However, an evaluation of a large collection of commercial herd data demonstrated no relation between use of urea at recommended levels and the common measures of reproductive performance. Limited information, however, does suggest that feeding urea beyond the recommended levels may increase abortions and retained placentas. Urea could also reduce feed intake in early lactation because of its low palatability. We recommend that urea not be used in early lactation rations or that it be fed as part of complete mixed ration, preferably including silages.

Vitamin and Minerals for Reproduction

Vitamin A is the primary vitamin of concern in normal reproduction. However, it is generally felt that vitamin deficiencies are not a common cause of reproductive difficulties in Nebraska dairy herds. Vitamin A is known to be important in preventing abortions and minimizing retained placentas. Ordinarily there is no need to supplement the ration with vitamin A. Conditions under which supplemental vitamin A may be needed are:

1. When feeding forages that are mature, or that have suffered from rain damage.
2. When the hay fed is more than a year old (vitamin A value will drop about 50% during a years storage, whether under cover or not).
3. When feeding hay or haylage that has undergone heat damage.
4. When feeding very high levels of grain causing roughage intake to be minimal.
5. When feeding corn silage harvested after maturity.

Several experiments have evaluated high supplemental levels of vitamins to determine whether reproduction or health of the reproductive tract can be improved. Generally, no benefits have been found (details of research at Nebraska on this subject are in another article of this report). Recent reports from Germany have indicated benefits to reproduction from supplemental carotene in rations with ample vitamin A. Work is now underway in the United States to determine whether their results are reproducible here (see special article on carotene in this report).

The major mineral requirements for reproduction are phosphorus and calcium. A phosphorus deficiency is of most concern in rations for growing heifers, however, a low level of supplemental phosphorus also is usually needed for the milking herd. A calcium deficiency could occur in animals being fed high levels of grain along with corn or sorghum silage as the primary roughage. However, none of our rations should ever run short of this mineral because of the low cost of calcium supplements.

Some trace-minerals are known to be directly related to reproduction. Iodine, copper, zinc and sulphur are all important, especially when feeding rations high in corn, sorgo, or other cereal crop silages. To assure adequacy of these minerals a periodic mineral analy-

sis on feedstuffs being used in the herd is advisable.

Selenium is essential to prevention of retained placentas, however, the selenium naturally present in feeds in Nebraska appears to be sufficient for the needs of dairy cattle.

Recommendations

1. Forage testing and continual attention to maintenance of a balanced ration is the basis of a good feeding program that assures good production and reproduction.

2. Feed the high producing cow in the early lactation a ration primarily of coarse hay and grain ration ingredients of high palatability to minimize the chance of off-feed and to maximize energy intake. Introduce moisture silages gradually following freshening. Increase feeding of grain gradually through about a two to three week period.

3. Vitamin A, though essential for reproduction, is usually adequate in commonly fed Nebraska rations. However, under some conditions supplemental A is important. Whether supplemental carotene is beneficial is still unsettled.

4. Supplementation with calcium and phosphorus will vary greatly with the source of roughage fed to the herd.

5. The trace mineral requirement usually can be met through the addition of a trace-mineralized salt or through a commercial protein supplement included at recommended levels. However, it is important to periodically obtain an analysis of feeds being used to assure adequacy of these required minerals and to prevent feeding excess levels that might be toxic.

6. Recent University experiments indicate that supplementation with selenium or administration of additional vitamins is not beneficial when using common Nebraska forages of good quality and customary levels of vitamin additions to the grain ration.

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Control of retained placenta and uterine infection is necessary for normal calving.

Selenium, Vitamins A, D, E

Treatments for Placental Retention

Larry L. Larson
and
Foster G. Owen[1]

Placental retention is a serious problem in many dairy herds. A placental retention rate of about 10% is common but varies from year to year and from herd to herd. An incidence of 50% or more may occur in some herds. Cows that have retained placentas frequently develop uterine infections and require a longer rebreeding time, resulting in an economic loss to the dairyman.

Several Ohio studies have found that the incidence of placental retention could be reduced by treating cows with selenium during the dry period. Other studies suggest that vitamin treatments (various combinations of vitamins A, D and E) could also reduce the problem. Both selenium and vitamin treatments are now commonly recommended during the dry period.

Since Nebraska soils are not usually deficient in selenium (in the past we have been more concerned with selenium toxicity due to excessive levels) and cows consuming good quality forage are expected to receive adequate amounts of both selenium and vitamins, we conducted a trial to determine the value of these treatments under Nebraska conditions.

One hundred twenty Holstein cows were used, with 30 cows receiving no treatment, 30 receiving selenium only, 30 receiving vitamins only and 30 receiving both the selenium and vitamin treatments. The selenium treatment contained 50 mg selenium and 680 IU of vitamin E. The vitamin treatment contained 3 million IU

Table 1. Effect of selenium and vitamin treatments on the incidence of retained placentas and other health and reproductive measures.

	Treatment			
Health parameter	Control	Selenium	Vitamins	Selenium + Vitamins
Live births	90%	87%	93%	86%
Retained placentas	27%	33%	30%	24%
Uterine infections	17%	7%	20%	22%
Milk fever or ketosis	10%	15%	10%	4%
Foot problems	28%	48%	30%	69%
Days to 1st ovulation	22	27	27	21
Ovulated by 98 days postpartum	100%	89%	82%	79%

vitamin A, 450,000 IU vitamin D_3 and 300 IU vitamin E. The treatments were given three to four weeks before expected calving date. A second vitamin treatment was given two to three weeks after calving.

Treatments Not Effective

The 28% overall placental retention rate of cows in this study was relatively high. However, none of the treatments were effective in preventing retained placentas (Table 1). The rate of retained placentas for all cows receiving the selenium treatment was 28%—the same as for untreated controls. The average retention rate for all cows receiving a vitamin treatment was also similar, 27% for those receiving the injections and 30% for the controls. In addition, the selenium and vitamin treatments had no obvious beneficial effect on any other health and reproductive measure studied.

Although the higher incidence of foot-related problems found in cows receiving the combined selenium and vitamin treatments cannot be fully explained, they were not thought to be directly a result of the treatments. However, this emphasizes the need to be cautious about excessive supplementation, especially when using treatments that are potentially toxic.

Complex Problem

Placental retention is a complex problem. Results from this and other studies indicate that the selenium and vitamin status of the cow are only two out of numerous factors that might cause placental retention. The results emphasize the need for feed analysis to determine its nutrient content. Selenium and vitamin treatments are only likely to benefit cows receiving a diet deficient in these nutrients. Since no benefits would be expected in cows receiving an adequate diet, and excessive vitamin A and selenium supplementation could even be detrimental, avoid their indiscriminate use.

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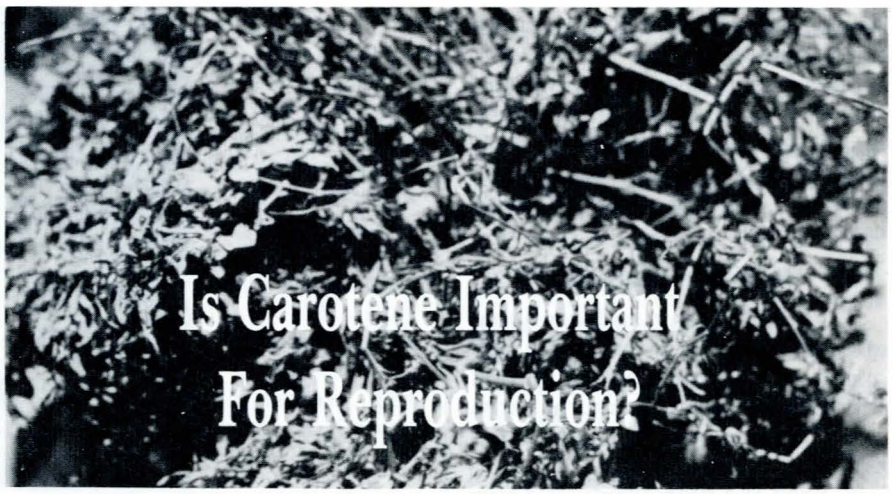
[1]Larry L. Larson is Associate Professor, Dairy Physiology. Foster G. Owen is Professor, Dairy Nutrition.



Is Carotene Important For Reproduction?

Larry L. Larson
and
Foster G. Owen

Poor reproductive performance is a major problem in many dairy herds. Many factors may contribute to poor reproduction. Correcting any one factor is not likely to improve fertility in all situations. Recently, beta-carotene has been suggested as another factor that might influence reproductive performance in dairy cattle.

What Is Beta-Carotene?

Beta-carotene is the natural source from which cows get their vitamin A needs. It is found in high quantities in most green grasses and legumes. Much of the beta-carotene consumed is converted to vitamin A in the animal's body. Animals require vitamin A for normal health and reproduction, and vitamin A is commonly added to many rations.

In the past, the only function of beta-carotene was thought to be that of the precursor from which vitamin A was formed. However, recent evidence from European researchers suggest that beta-carotene might have a specific role in reproduction that cannot be satisfied by vitamin A.

Is Beta-carotene Deficient in Nebraska Rations?

Although beta-carotene in green grasses and legumes is high, it is low in concentrates, mature corn silage and hays that have been rain damaged, stored for long periods, or are mature and of poor quality. Heifers and cows on pastures during the summmer months should receive adequate amounts of beta-carotene that can be converted to vitamin A. However, milking cows fed rations high in concentrates and corn silage could be deficient in beta-carotene and these rations would commonly be supplemented with vitamin A.

Table 1 gives the beta-carotene levels found in four Nebraska herds. Herd A was feeding one- to two-year-old alfalfa hay; these cows had the lowest blood levels of beta-carotene. Herds B and C were feeding new crop alfalfa haylage and these cows had the highest carotene levels. Herd D was fed stored haylage and corn silage. It was evident that the beta-

Table 1. Carotene status of some Nebraska dairy herds.

	Roughage fed	Number cows sampled	β-carotene, μg/100 ml blood serum	
			Mean	Range
Herd A	2-yr.-old alfalfa hay	9	63	39-85
Herd B	Fresh alfalfa haylage	10	212	110-330
Herd C	Fresh alfalfa haylage	7	209	79-390
Herd D	Stored haylage and corn silage	81	170	64-415

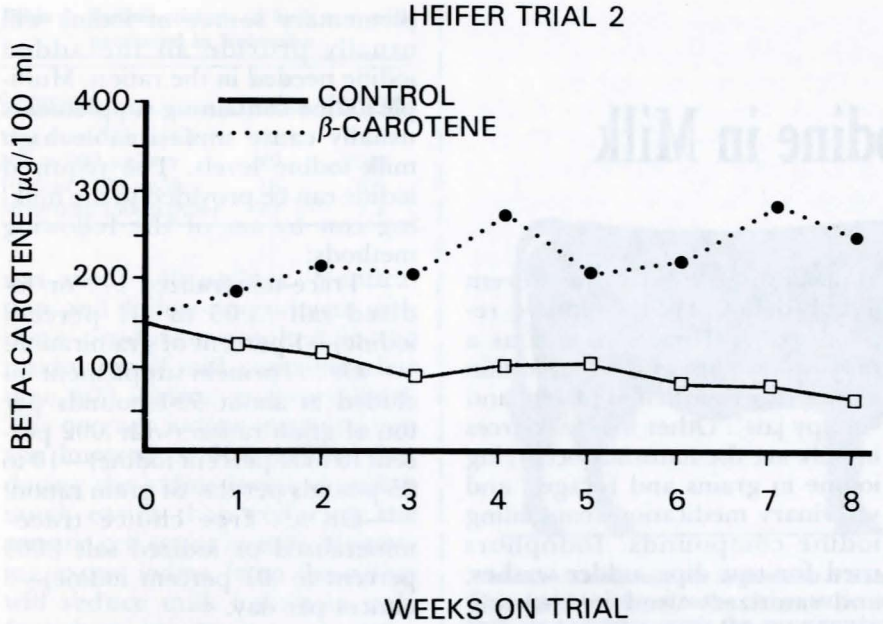


Figure 1. Beta-carotene concentrations in blood of heifers fed either control or beta-carotene supplemented rations.

carotene levels found in the blood reflected the amount received in the feed.

Is Beta-carotene Supplementation Beneficial?

Several European studies reported that beta-carotene was benefical, but an extensive study in Israel revealed no benefits. We have started experiments to answer this question under Nebraska conditions.

Three trials have been conducted to determine the effect of beta-carotene supplementation on the reproductive cycle and conception rate in 50 Holstein heifers (trial I: August, 18 heifers; trial II: December, 14 heifers; trial III: April, 18 heifers). All heifers were fed year-old alfalfa hay free-choice. Heifers in trial I received 2 lb and in trials II and III, 4 lb of grower ration per head per day. Each pound of the grower ration contained 2,500 IU vitamin A. Half of the heifers in each trial received 300 mg beta-carotene daily mixed in their grower ration. The test period for each trial was about two months. Heats were synchronized with prostaglandin $F_2\alpha$ so that all heifers could be inseminated after one month of receiving beta-carotene and would continue to receive it during the first critical month after being bred.

In each study, beta-carotene levels in the blood of supplemented heifers were higher after only one week of feeding and it remained higher for the entire trial (Figure 1). Beta-carotene apparently had no effect on the number of heifers that came into heat or the length of the heat period. The interval from the prostaglandin treatment until the heifers came into heat was longer in the heifers receiving the beta-carotene (Figure 2). This suggests that the carotene status of dairy heifers might be important if heifers are to be bred at a set time (without heat detection) after heat synchronization.

Possible improvement in reproduction was noted in two of the three trials with heifers (Figure 3). Heifers in trial I had been on pasture before the start of the trial and their blood carotene was maintained at relatively high levels throughout the study. This may be the reason for the lack of a response in trial I. Although conception rates in trials II and III average 10 percentage units higher for those receiving carotene, additional data are required to draw a sound conclusion on its value because of the small number of animals involved. No other benefits were observed.

It seems logical that if beta-carotene does have a specific role which is independent of vitamin A, it would be more critical in lactating cows. Studies with cows are now in progress.

Conclusions

Beta-carotene appears to affect some reproductive functions, including the time at which heifers return to heat after heat synchronization with prostaglandin $F_2\alpha$. Initial results at Nebraska suggest that beta-carotene supplementation might improve conception under some conditions. However, additional studies with larger numbers of animals are required to reach a sound conclusion on the relationship of carotene to fertility.

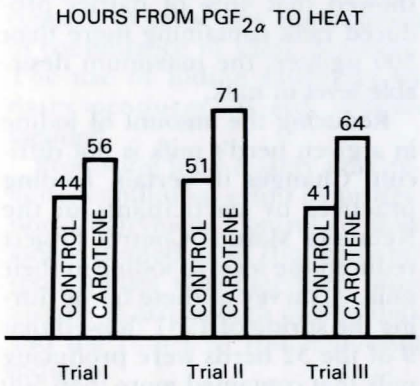


Figure 2. Effect of beta-carotene supplementation to heifers on the interval from prostaglandin $F_2\alpha$ injection to onset of standing heat.

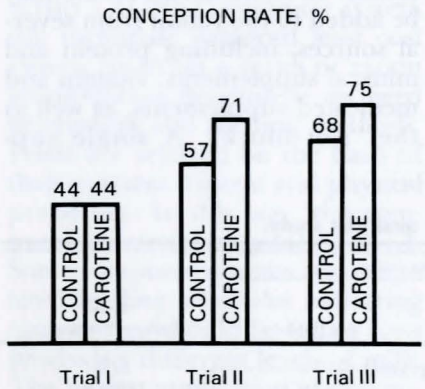


Figure 3. Effect of beta-carotene supplementation to heifers on first conception rates.

[1]Larry L. Larson is Associate Professor, Dairy Physiology. Foster G. Owen is Professor, Dairy Nutrition.

Controlling Iodine in Milk

Stan Wallen, Foster Owen and Duane Rice[1]

You **owe ($$$)** it to yourself to avoid excessive iodine in the milk you produce. Recently, one of the largest food companies in the U.S. threatened to reject milk produced by members of Nebraska's largest dairy cooperative unless the level of iodine in their milk was reduced to less than 500 μg/liter. The reason for this *potential market loss* is the concern by some public health officials that Americans may be consuming too much iodine—particularly from milk. The American Thyroid Association stated that further increasing dietary iodine by Americans may present health problems.

Table 1 shows the average amount of iodine that Americans consumed in 1978 was more than the amount needed for adequate nutrition and that most of this iodine came from dairy products. Over the period of time (1974 to 1978) that the Food and Drug Administration conducted the Total Diet Study, the amount of iodine contributed to the diet by dairy products increased significantly.

Excess Iodine Source—Feed

The primary source of excess iodine in milk is feed. Iodine is added to animal feeds or made available in salt blocks to prevent iodine deficiency, to improve reproductive efficiency, and as a preventative measure for certain animal diseases such as footrot and "lumpy jaw". Other iodine sources in milk are the naturally occurring iodine in grains and forages, and veterinary medications containing iodine compounds. Iodophors used for teat dips, udder washes, and sanitizers used in cleaning milking equipment and housing for animals contribute only small amounts of iodine to milk.

Even though iodine has nutritional and health benefits for cattle, it can be detrimental to animal health if fed at excessive levels. It can lower milk production and decrease reproductive efficiency. The primary source of excess iodine in the dairy cow ration is organic iodine (EDDI)—this despite the fact that manufacturers of EDDI currently put the following warning on their products label: "Prevention and treatment levels should *not* be administered to animals whose milk will be used for human consumption or food processing."

Another important source of excess iodine in dairy cow rations is "multiple dosing" of supplemental iodine. In some herds, iodine may be added to the ration from several sources, including protein and mineral supplements, vitamin and medicated supplements, as well as the "salt block". A single supplementary source of iodine will usually provide all the added iodine needed in the ration. Multiple iodine-containing supplements usually cause undesireable high milk iodine levels. The required iodine can be provided to the milking cow by *one* of the following methods:

—Trace-mineralized . . . or iodized salt (.005 to .01 percent iodine)—1 percent of grain ration.

—Or . . . protein supplement included at about 500 pounds per ton of grain ration (with .002 percent to .004 percent iodine)—10 to 25 pounds per day of grain ration.

—Or . . . free choice trace-mineralized or iodized salt (.005 percent to .01 percent iodine)—3 ounces per day.

The upper levels of iodine given above should be used when feeding high protein grain rations.

Controlling Intake

Suggestions for controlling iodine intake:

—*When practical, use only one source of supplemental iodine.* Check feed tags to determine whether other ingredients include iodine (EDDI, iodates and iodides).

—Include iodine in the grain ration mixture rather than free-choice, because of widely varying intakes of free-choice minerals.

Nebraska dairy farmers should adopt these recommendations to help ensure a continuing strong market for their milk.

In 1981 a survey for iodine in 169 samples of Nebraska-produced bulk milk (Table 2) showed that 46% of dairies produced milk containing more than 500 μg/liter, the maximum desirable level in milk.

Reducing the amount of iodine in a given herd's milk is not difficult. Changes in certain feeding practices by participants in the Nebraska Mastitis Control Project reduced the level of iodine in their milk. A survey of these herds during the spring of 1981 showed that 9 of the 32 herds were producing milk that contained more than 500 μg of iodine per liter. Initially, the average iodine concentration in the milk produced by these herds

Table 1. U.S. Food and Drug Administration total diet study.

	Daily iodine intake		
	Required[a]	Avg. intake	From dairy products
	(micrograms)		(%)
Infants	45	576	80.8
Toddlers	70	728	55.6
Adults	150	696	56.0

[a]U.S. Recommended daily allowances.

Table 2. Iodine content of bulk raw milk produced in Nebraska.

Concentration	No. of samples	Percentage
Less than 500 μg/liter	92	54.4
500 to 999 μg/liter	49	29.0
1000 to 1499 μg/liter	16	9.5
More than 1500 μg/liter	12	7.1

was about 546 μg/liter. Notification and follow-up contacts with these producers resulted in the production of milk containing less than 500 μg/liter in every herd. The average iodine concentration was lowered to 304 μg/liter. Reducing the iodine levels in milk is much easier than reducing the somatic cell count in milk. Removing excess iodine from the ration will reduce milk iodine in only four days.

Currently used teat dips (that contain iodine) when used properly, probably contribute less than 100 μg of iodine per liter of milk. Washing the cow's udder before milking helps reduce the amount of iodine getting into the milk from teat dips. In some herds iodophors are used as a premilking sanitizer to sanitize the udder. Such a practice increases the milk iodine level by only 35 μg/liter.

Backflushing the claws and teat cups between individual cows with iodine sanitizers to reduce the incidence of mastitis is gaining in popularity. The small amount of iodine which this practice adds to milk (50 μg/liter) should not deter its use. Only small amounts of milk iodine can be attributed to teat dipping and sanitizing milking equipment. This is not of such concern to cause any reservations in continuance of these practices. The use of iodine sanitizers by dairy producers is still recommended.

Producing high quality milk requires continuous effort by professional dairymen. Control of milk iodine is another of the many responsibilities that dairymen must assume to assure high quality milk and the future of this important industry.

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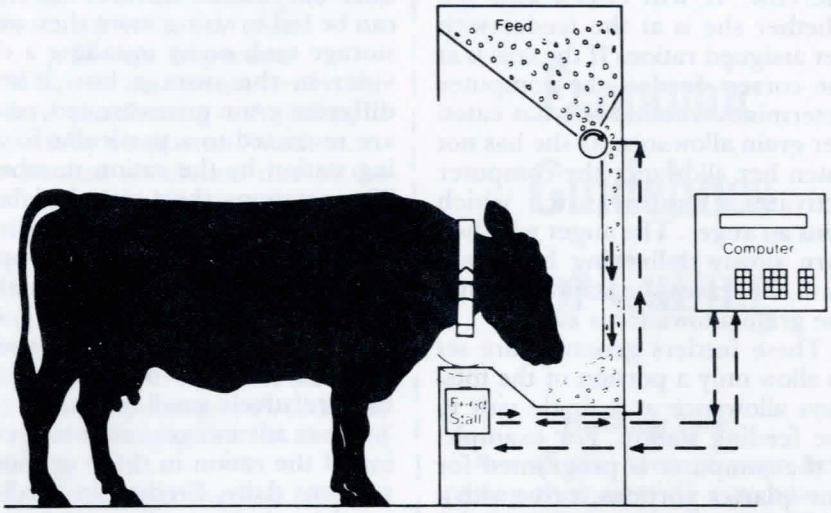
[1]Stan Wallen is Extension Food Scientist. Foster Owen is Professor, Dairy Nutrition. Duane Rice is Extension Veterinarian.



When the transponder is in position it transmits its code number to the feed stall receiver. This signal is relayed to the computer for memory search. If this cow number is entitled to feed the computer sends the quantity signal to the motor drive dispenser via the power supply.

Computers Help Feed Cows

Foster G. Owen
and
Kelly Keaschall[1]

Many advances have been made in using computers for feeding dairy cows. Today the computer can practically "do it all".

For years the computer has been used to formulate dairy rations. Computers were first used by commercial feed manufacturers, but more recently they have been used through our extension programs, for the formulation of rations for individual dairy herds. The FEED-MIX DAIRY program on the University's AGNET computer system will formulate balanced least cost rations based on a series of ration requirements dependent on herd production and feeding methods. Feeds are selected on the basis of their nutrient content and physical properties. In this way, the computer determines *what* to feed. Some computer systems also calculated feeding schedules indicating *amounts* that should be fed to cows producing different levels of milk. The newest application of computers is in the job of actually *feeding* the cow. The computer activates a mechanical system that actually does the feeding—or puts the ration in front of each cow.

Computer Feeders

These systems consist of three main components. First, there is the feed storage tank having feeding stations for from one to four cows. The number of storage tanks and feeding stations depends on the herd size. Generally, one feeding station can accommodate from 15 to 20 cows. Second, there is the necklace pendant that the cow wears around her neck. The pendant contains a component that serves to identify each individual cow. Third, there is the computer itself, which connects with each feeding station.

The system works like this. Each cow is given a necklace with her specific identification (several hundred cows may be handled by a single computer). Next, the dairyman inputs on the keyboard of the computer each cow's ration number, (if different rations are to be fed) then the amount of grain ration that each should receive daily. The cow goes to a feeding station where her identifier contacts a metal plate on the feeder allowing the computer to identify

the cow. It will check and see whether she is at the feeder with her assigned ration. If the cow is at the correct feeder, the computer determines whether she has eaten her grain allowance. If she has not eaten her allowance the computer activates a motor switch which runs an auger. The auger will then turn slowly delivering her grain until she leaves the station or until the grain allowance is eaten.

These feeders generally are set to allow only a portion of the total days allowance at a single visit to the feeding station. For example, if the computer is programed for one-quarter portions, a cow with a 20 lb daily allowance will be fed 5 lb during each 6-hour period. There are a number of variations in portioning and feeding the daily allowance with different computer equipment.

Benefits of Computer Feeders

Computer feeders offer dairymen a number of advantages. The allocation of grain through the systems is much more closely controlled than is possible under conditions usually found on Nebraska dairy farms. Since the job is done mechanically, it also saves time. On most of our dairy farms grain feeding is done during the milking operation. This chore must be done for each cow twice daily, year-around. The total time saved by the computer systems would vary, depending on the extent of present mechanization and the time waiting for cows to finish eating. The time savings made possible by feeding the grain ration automatically outside the parlor may be needed for getting the crops seeded in the spring, harvested in the fall, or for other purposes.

These systems also make possible the feeding of several different grain rations on dairies that find this impractical in their present operation. Special rations for cows in different stages of lactation can improve both performance and economics of feeding. With many of the automated feeding systems it is not necessary to divide cows into separate lots for feeding the different rations. Different rations can be fed by using more then one storage tank or by installing a divider in the storage bin. When different grain mixes are fed, cows are restricted to a particular feeding station by the ration number. These systems, then, save the labor otherwise required for handling cows in several production groups. A high percentage of Nebraska dairymen consider grouping of cows impractical because of their present facilities or because of their relatively small herds.

Other advantages relate to feeding of the ration in three or more portions daily. Feeding in smaller portions helps reduce digestive disorders, promotes higher grain consumption and better utilization of nutrients. The computer system also helps dairymen "check" cows. A computer provides a daily listing of cows, showing which cows ate their total grain allowances during the previous 24 hours and which did not. Depressed feed intake is often an early sign of some disorder. Such cows can be observed closely for detection of some possible health or other problems. Timely attention to these conditions may avoid a serious production drop.

Are They Practical?

One may ask, "Are these computer feeders practical for Nebraska dairyman at this time?" Some of our dairymen must think so, because several systems have already been installed. Probably 12 to 15 systems were put into use during the last 12 months. Whether such a system is economic depends on several factors—the cost of the system, herd size, feed and labor cost and the extent to which the dairyman will fully exploit the capabilities of the system. Some suggest at least 100 cows are needed to justify computerized systems, however, units for herds of around 40 cows are said to be in developmental stages. Several non-computerized mechanical systems appear practical for smallers herds also.

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[1]Foster G. Owen is Professor, Dairy Nutrition. Kelly Keaschall is Extension Assistant.

Ventilation—

Gerald R. Bodman
and
David P. Shelton[1]

Ventilation is required in all livestock housing facilities. Livestock facility ventilation means introducing fresh air and expelling foul air. The discharged air might contain dust, moisture, odors, excess heat, or other contaminants considered detrimental to animal health and good animal performance.

While the concept of replacing foul air with fresh air is easy to visualize, accomplishing this feat is more difficult. Careful planning of all aspects of a livestock production facility is required to insure that the completed structure can be efficiently and properly ventilated. Most important, plans for the ventilation system must be incorporated into the facility plans at the initial stages of the overall planning process.

Buildings may be ventilated mechanically using fans to move fresh air throughout the building or non-mechanically by relying on air movment resulting from the wind and air density differences due to temperature. Non-mechanical ventilation is often called "natural" ventilation. However, as with a mechanical system, special design features must be built into the facility to achieve good ventilation. Calf and tie-stall barns are commonly ventilated mechanically, whereas free-stall and bedded-pack barns are usually non-mechanically ventilated.

Ventilation "Musts"

For a ventilation system to provide a healthful environment within the animal space, three features or characteristics are necessary:

1. **Good quality air** must be brought into the space being ventilated. Almost always, this means introducing outside air into the building. Air should not be moved from one animal building to

Plan It Carefully

another. If air being removed from one facility is of such quality (temperature, moisture, odors, etc.) to qualify as good quality air in a second structure, the first building is probably being ventilated more than necessary. Overventilation means higher operating costs and more potential problems due to drafts.

2. **The proper quantity of** air must be provided. In mechanical systems, the quantity of air introduced into a building is controlled primarily by the fan and air inlets (negative pressure system) or outlets (positive pressure system). In non-mechanical systems, the quantity of air moved through a building is controlled by inlet and outlet size and the relative positions of these openings.

3. **Good distribution of ventilation air** is necessary to eliminate dead-air spaces within the animal zone and be draft-free. Good distribution is primarily a function of inlet location and air velocity through the inlet.

Many mechanically ventilated livestock facilities are poorly or improperly ventilated due to a failure to adequately consider the essential design elements required for good ventilation, especially fan selection and inlet design. High quality fans capable of moving air at the desired rate and having reliable performance characteristics should be selected.

A recommended practice is to buy only fans having an Air Movement and Control Association (AMCA) "Certified Rating" seal. Once installed, controls and fan blades, housings, and shutters must be kept clean to maintain a high level of operational efficiency. Additionally, inlets must be adjusted to provide an opening consistent with fan operation if the desired ventilation rate is to be achieved. No screening with openings smaller than ½" x ½" (1.3 x 1.3 cm) should ever be used on inlets. Small mesh screening reduces the effective size of the inlet and quickly becomes plugged with accumulated dirt and dust.

Design Important

Design of the ventilation system before purchasing a building is especially important with non-mechanical ventilation due to the difficulty in changing structural components during construction. The basic design requirements for non-mechanical ventilation systems in free-stall and bedded-pack barns are:

1. Roof slope—4:12 or steeper.
2. Eave openings—1" (2.5 cm) of opening height per 10' (3 m) of building width.
3. Ridge openings—2" (5 cm) clear horizontal measurement per 10' (3 m) of building width.
4. Sidewall openings—minimum of 2' (0.6 m), or for buildings over 40' (12.2 m) wide, 6" (15 cm) of panel height per 10' (3 m) of building width.

Openings at the ridge, eaves, and sidewalls should be continuous the full building length. Eave and sidewall openings should be provided along both sidewalls.

In addition to opening sizes, opening position is important. Eave and ridge openings must be positioned to allow warm moist air to escape through the open ridge as cool fresh air enters along the eaves. Sidewall openings must be kept low enough to provide the required airflow through the animal zone during warm or mild weather.

For additional information in ventilating dairy facilities, write to the Agricultural Engineering Department, University of Nebraska–Lincoln, and request the following publications: Ventilating Warm Buildings (No. 710), Environmental Control Systems for Calf Nurseries (No. 701), Ventilation System Design for Tie-Stall Dairy Housing (No. 702), Diagnosing and Trouble-shooting Ventilation Problems in Calf Barns (No. 707), or Non-Mechanical Ventilation of Animal Housing Facilities (No. 706).

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Economic Guidelines for Culling

H. Doug Jose[1]

Are all the cows in your herd paying their way? If not, how do you determine which cows should be culled? Or, how do you decide which cow to replace with a first calf heifer you want to put into the milking herd?

There are six basic considerations involved in determining which cow to cull. These are:

1. Production level.
2. Breeding efficiency.
3. Other health conditions.
4. Age.
5. Genetic potential.
6. Temperament.

The next step is to determine what specific culling measures or criteria to use. What, for example, is defined as "low production" and what is the minimum acceptable production or breakeven production level to keep a cow in your herd? In this article, we'll look at:

1. Production levels required to break even and pay all production costs.
2. Costs of keeping a cow with conception problems.
3. The number of times it is economically feasible to re-breed a cow before culling her.

Low Production

Breakeven Production—The minimum required level of production to keep cows in the herd is the level of production which covers all costs except return to equity capital, labor, and management. This is the production level required to break even if only cash costs are considered. In the short run, the operator can continue operation without receiving a return

for equity capital, labor, and management. The cows producing below this short run culling level will actually be making no contribution to the operator's family living costs and limit the ability of the operator to expand the operation.

In the long run, all costs must be covered. This includes a return on your equity capital or the capital you have invested that is not borrowed as well as a return to family labor and management. The family living costs of the dairy operator, as well as capital for reinvestment and farm growth, must come out of these returns. The *long run breakeven point* is the production level which covers all the costs of production including a return to equity, all labor and management.

Production Costs—An itemization of costs for a herd with an average production level of 13,000 lb milk per cow per year is presented in Table 1. A summary of the annual breakeven calculations based on data in Table 1 is presented below:

Net cost of Producing milk (Table 1)
$1,788.79 (1)

Breakeven production to cover *all* costs with milk at $12.50/cwt.*
(1) ÷ $.125 per lb
14,310 lb per cow (2)

Equity, labor and management charges:

Interest on equity capital	$167.70**
Labor charge	275.00
Management charge	78.08
	$520.78 per cow (3)

Net total costs excluding interest on equity capital, labor, management charges (1)-(3)
$1,268.01 per cow (4)

Breakeven to cover cash costs only
(4) ÷ $.125 per lb
10,144 lb per cow (5)

*The $12.50 per cwt. figure used for milk sales is designed to represent a blend of all milk sold.
**Assumes 50% equity. Investments are $990 per cow for fixed facilities or $495 for average depreciated value and $2,300 per cow for livestock investment. Interest charged is 12%.

The producer receives no return for equity capital, labor, or management if a cow produces below an average annual production level of 10,144 lb. With production at the 14,310 lb per year level, all costs are covered including labor at the rate of $5 per hour and equity capital at the rate of 12 percent.

Table 1. Estimated costs of maintaining a dairy herd including replacements per cow, eastern Nebraska, 1981[a]

Costs			
Feed		$791.00	
Bedding		13.00	
Milk Hauling		85.80	
Breeding fees		16.00	
Fuel and oil—tractor & machinery		30.93	
Interest on cattle at 12%		276.00	
Interest on feed and operating expenses		88.54	
DHIA and other records		18.00	
Veterinary and medicine		25.00	
Utilities		30.00	
Supplies		30.00	
Repairs on buildings, machinery & equipment		40.63	
Insurance on cattle		7.20	
Total "cash" costs			$1,452.10
Operator's labor at $5.00 per hour		$275.00	
Death loss		69.00	
Fixed costs on facilities & equipment		143.55	
Overhead: 5% of cash costs		33.06	
Management: 4% of total receipts		78.08	
Total "non-cash" costs			$598.69
Total costs			$2,050.79
Credits			
.3 Cull cows	$169.00		
.06 Cull heifers	48.00		
.53 Day-old calves	45.00		$262.00
Net cost of producing milk			$1,788.79

[a]Source: *Estimated Crop and Livestock Production Costs, 1981*, EC 81-872 (Rev. 1981) Nebraska Cooperative Extension Service, Lincoln

As the average production of the herd increases, the breakeven levels of production will also increase slightly. The reasons for this are:

1. Feed costs per cow increase.
2. Interest costs on the cow increase as the value of the cow is higher.
3. Other costs which remain constant per pound of milk such as milk hauling, increase on a per cow basis.
4. The management charge per cow is higher as it is assumed management is worth more for a higher producing cow.

The breakeven level of production to cover all costs for a 16,000 lb average production herd is 15,597 lb with milk at $12.50 per cwt. The cash costs to be covered are $1,382.05 per cow and the short run breakeven to cover the costs is 11,056 lb per year.

Each individual producer needs to compute his own costs and production levels to determine the applicable culling point. The above figures can serve as a useful guideline.

To summarize, two production guidelines were discussed. Their definitions are:

1. Total Breakeven Production: Production level which covers all costs including return on equity, family labor and management charges.
2. Short Run Breakeven Point: Production level which covers all costs except return on equity, labor and management charges.

A summary of these production levels is presented in Table 2.

Poor Conception

The second major reason for

Table 2. Breakeven and culling production levels according to herd average production with milk at a blend price of $12.50 per cwt. [a]

Average annual herd production	Total breakeven production level	Short run breakeven production level
	Pounds Per Cow	
16,000	15,600	11,100
13,000	14,300	10,100

[a]Production levels are rounded off.

culling cows is breeding problems. The producer must make a decision when an open cow will be culled. A non-producing cow eats and takes up space but makes no contribution to farm income. She could be replaced by a producing cow. There are two costs the dairyman incurs for the non-producing cow:

1. The direct maintenance costs of the cow.
2. The lost net income by not having a producing cow in her place in the herd.

Maintenance Costs — The monthly costs of direct maintenance for the non-producing cow are shown in Table 3. The total cost is $86.95 per month.

Let's assume the goal of the operator is to have a 13-month calving cycle. Assuming a 305-day, or 10-month, lactation period, the acceptable dry period is three months. What we are determining is how many months you can afford to keep an individual cow beyond this acceptable three-month dry period. A cow could, for example, have been milking seven months and still not be pregnant. If she conceives now, the calving interval will be 16 months. She will be dry at least six months beyond the 10-month lactation period, or 3 months more than the acceptable standard. And each additional month it costs you $86.95 just to keep her around. Should this cow be re-bred again? Or, should the cow be culled when she finishes the current lactation? To answer this, another cost must be taken into account and that is the lost potential income.

Foregone Income—Foregone income is the net income that would have been generated by a producing cow in place of one that is not producing. In the above example, the open cow will be non-producing at least six monts. If you decide to cull her at the end of the 10-month lactation, she could be replaced by a producing cow for those 6 months.

To calculate the foregone income we will assume the milk production for the current lactation is 13,000 lb per year. The extra costs of the producing cow will be the additional costs for production, above the costs of maintenance specified in Table 3.

These costs are presented in Table 4. The fixed costs for interest on the cow and fixed costs for the buildings were already included in Table 3 and so are not included as costs in Table 4. The net income lost is $89.35 per month.

Total costs of repeat breedings beyond the normal dry period are:

Direct costs (Table 3)	$86.95
Lost income (Table 4)	89.35
Total	$176.30 per month

This is equivalent to about $5.88 per day for each cow *not* producing milk beyond the normal dry period of 3 months.

Developing Culling Strategy—The cost of breeding problems are substantial. The monthly cost is $176.30 or $123 for each three-week heat cycle. This represents a loss in net farm income.

When should a cow be culled? Or, how many repeat breedings should be attempted before the cow is culled? Here are the calculations to make that determination:

1. Added cow depreciation by replacing problem breeder with purchased first calf heifer (assuming problem cow is replaced two years sooner than herd average re-

Table 3. Maintenance costs for non-producing dairy cow, per month.[a]

Feed	$25.00
Bedding	1.10
Breeding fees[b]	16.00
Fuel and oil for tractor and machinery	2.50
Interest on cow ($1,400 X .01)	14.00
Interest on feed and operating expense	.75
Veterinary and medicine	2.50
Utilities	2.00
Repairs	3.00
Insurance on cows	.60
Labor 1.5 hrs. @ $5.00	7.50
Fixed costs on facilities and equipment	12.00
Total	$86.95

[a]Source: Table 1
[b]The breeding charge is the artificial insemination fee.

Table 4. Income lost because cow was not in production, per month.

Returns: Avg. monthly production is 1,300 lb at $12.50 per cwt. (13,000 lb produced annually in a 10-month lactation)		$162.50
Production costs		
Feed: Total feed costs less costs for maintenance = $65 minus $25 =	$40.00	
Milk hauling	7.15	
Interest on feed and operating expenses	6.00	
DHIA and other fees	1.50	
Utilities	.50	
Supplies	2.50	
Repairs	.50	
Labor: Total labor less labor for maintenance = 4.5 minus 1.5 hrs. = 3 hrs. @ $5.00	15.00	
Total production costs	$73.15	73.15
Net income lost		$89.35

placement rate): Average cow depreciation =
$200 per year
Total added depreciation =
2 yrs X $200 $400.00

2. Lower production of replacement:
500 lb per year for two years =
1,000 lb
Value =
1,000 lb X
$.125 per lb. 125.00

3. Higher value of a heifer calf produced by higher producing culled cow 25.00

4. Total potential cost of replacing a cow after two years rather than the normal four years $550.00

5. Breakeven period to attempt to get original cow to conceive =
$550 ÷ $123/cycle =
4.5 or about 5.0 cycles
or about 3 months

After about three additional months or four extra services the potential costs of keeping the problem breeder are higher than the potential added costs of replacing her with another cow of unproven production. This means the total acceptable dry period is 6 months after a 10-month lactation period. A total dry period of three months is an acceptable goal given the normal physiological problems of cows in highly productive herds.

Summary

Calculations in this analysis are based on some broad assumptions but are designed to represent the general situation for dairymen in Nebraska. The situation would differ slightly for purebred cows which have had a history of relatively high production and have produced productive progeny.

In general we can say—"keep that problem breeder only as long as you think the added costs of keeping her an additional month are lower than the added costs of purchasing a replacement." Remember, the costs to consider are the added depreciation and interest on the replacement over and above the depreciation and interest presently being incurred with the problem breeder.

Factors other than production and conception that influence culling decisions include other health problems, such as acute and persistent mastitis, age, or the cow's temperament. Production and conception are, however, the two most important factors from an economic point of view. It is also important to note that specific acceptable rules or guidelines can be established for both production and conception. If a cow is producing less than 11,000 lb per year or if she is going to be open longer than seven months she should be a prime candidate for culling.

Further, if she produces more than 11,000 lb but less than about 15,000 lb, she is making only a partial contribution to equity, unpaid labor and management and hence is not contributing her full share to family living, savings or business re-investment.

If the herd average production is 16,000 lb, the total breakeven production level is 15,600 lb or 97% of the herd average and the short run breakeven level is 11,100 lb or 69% of the herd average. If the herd average is only 13,000 lb the total breakeven is 14,300 lb or 110% of the herd average and the short run breakeven is 10,100 lb or 77% of the herd average.

A quick rule of thumb is if a cow is producing less than about 75% of the herd average, get rid of her quickly.

It is also important to note the average herd production to break even in the long run is about 14,000 lb. Herds which average less than this will find it difficult to make the necessary re-investment to keep the business in operation.

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