1981-82 MINNESOTA DAIRY REPORT

3 St. Cloud
8 Morris
9 Hutchinson
10 Northfield
11 Winona

21 Braham
2 Waseca
3 Pipestone
4 Watertown, S.D.
16 Crookston
17 Grand Rapids

ial Report 94
cultural Extension Service
cultural Experiment Station
mal Science Department
ersity of Minnesota

Efficiency in
Dairy
Production

CONTENTS

Factors Associated with Stress in Dairy Cows

J. G. Linn and D. E. Otterby

The factors causing stress in dairy cattle are many and certainly not all are known or defined. Seemingly small, insignificant factors in themselves may have no effect on a cow but when several are combined, the symptoms of stress usually appear. The economic loss from stress will depend upon the number of factors causing stress and the length of exposure to the stresses.

Stress Periods

The greatest period of stress in dairy cows is that occurring during metabolic and nutritional changes. The period from drying off to 120 days after freshening is the most stressful. Major changes in body chemistry occur when a cow passes from a dry, gestating state through calving, initiation of milk production, peak milk production and pregnancy. Nutritional requirements are 300 to 700 percent higher during peak milk production than during the dry period. If the stresses associated with these changes are not minimized, loss of profit and animals can occur. Good nutrition and management programs can minimize stresses and increase profits. Consider these management factors to limit stress:

Dry Period

Dry Period Length - Sixty days are optimum and result in the highest milk production in the next lactation. Dry periods less than 40 days do not allow enough time for udder involution while dry periods longer than 70 days can result in excess body condition.

Drying Off - If production is less than 40 lb a day, stop milking. Above 40 lb a day, reduce feed and limit water to decrease milk flow before drying off.

Mastitis Control - Dry-treat selected quarters if mastitis is not a herd problem; otherwise treat all quarters. Use an effective dry cow preparation under sanitary conditions. Continue to teat-dip several days after the last milking.

Nutrition - Feed rations to meet requirements and avoid nutrient excesses or deficiencies. General recommendations for dry cow rations are:

- high fiber from either long hay or other coarse forages.
- Calcium intakes of less than 100 grams per day and phosphorus less than 40 grams per day.
- Adequate vitamins A (50,000 IU/day) and D (15,000 IU/day).
- Evaluate the trace mineral content of ration.

Providing good nutrition and feeding management programs during the dry period can help reduce incidences of metabolic disorders at calving. Common disorders and preventative suggestions are:

Fat cow syndrome - Feed rations low in energy to prevent excessive weight gains. Limit weight gain to about 200 lb during the dry period for cows in good condition when dried off.

Milk fever - Avoid high calcium rations (over 100 grams per day) during the dry period. Feeding specific low calcium rations from 7 to 10 days before freshening helps reduce incidences of the disorder in milk fever-prone cows.

Udder edema - Avoid excess grain feeding and reduce salt intake. Use diuretics under the direction of a veterinarian.

Displaced abomasum - Feed long or coarse forages during the dry period and avoid rapid changes in the ration at calving.

Lead feeding - Under most conditions, no grain or very little grain is needed during the most of the dry period. Grain should be introduced 2 weeks prior to freshening to prepare the cow for the lactation ration. Amounts up to 1 percent of the cow's body weight are adequate.

Calving Stress

At calving the cow's metabolic system undergoes several changes of which Dr. Jenks Britt has defined as calving stress. Ligaments around the tail head relax, appetite is depressed and most of the body functions are concentrated on muscle contractions and delivery of the calf. At calving, tremendous losses of fluid and tissue, totaling 200 lb or more, occur. In addition, initiation of lactation increases the demand for calcium and phosphorus often decreasing blood levels. As a result, three of the cow's primary systems are stressed: digestive system (decreased appetite); muscle and skeletal system (muscle strain and fatigue); and circulatory system (dehydration from fluid losses). Additional stress can worsen the situation and may even threaten life of the cow. The following can contribute to stress and should be minimized or avoided: Slippery floors, rapid feed changes, switching cows between groups, delay in treating obvious problems and inclement weather (cows calving outdoors).

Cows should be provided with high quality feeds and plenty of fresh water after calving. Abrupt change in the ration should not be made for 3 or 4 days following calving. Gradually increase grain feeding (1 to 2 lb/day) after calving to increase energy intake without causing off-feed problems.

Retained placenta problems can be caused by deficiencies of vitamin A and/or selenium in cows without calving problems (twins, early birth, etc.). Selenium can be fed (.1 ppm in total ration dry matter) or injected during the dry period, but care should be taken not to over-supplement. Fat cows are more susceptible to retained placentas and other metabolic disorders.

Early Lactation

Cows in the first part of lactation are under production stress. Feed dry matter often is insufficient to meet energy requirements for milk production and body fat reserves are mobilized to help meet energy needs. Feeding cows to attain maximum dry matter intake will help alleviate some of this stress. Some nutritional pointers for cows in early lactation are:

- Do not over-condition cows as they are prone to more problems and have poorer appetites.
- Top-dress all-natural protein supplements to meet protein requirements.
- Balance rations for all minerals and vitamins.
- Formulate rations to consist of 40 to 45 percent top quality forages and 55 to 60 percent highly palatable grains (dry basis).
- Feed grains and forages frequently (3 times per day for grain and at least 2 times per day for forages) or use a complete blended ration. These practices will help increase dry matter intake.

Sixty to 120 days after freshening, the cow should be bred and should become pregnant. If a nutritionally balanced ration is fed and other stresses are reduced, breeding and pregnancy problems will be minimal.

Management Stresses

Many factors relating to stress have already been discussed. Several of those factors affect cows during other phases of the lactation also, but usually not to the degree they do during the periods discussed above. No further mention of these factors will be made except as they relate to management stresses covered in this section. The following is a list of some management stress factors and how they can possibly be minimized:

Nutrition - The most common nutritional stress factor is to fail to feed rations balanced in all nutrients. Rations need to contain adequate amounts of protein, energy, minerals and vitamins to support milk production, reproduction and to maintain health. The availability of fresh feed and water at all times (especially during hot weather) is necessary for maximum production. Feeds and water must also be of good quality and free of harmful molds, harmful bacteria, chemicals, metal objects, and other foreign debris.

Diseases - All diseases can cause stress. Many bacterial and viral diseases can be controlled through vaccination programs. Providing animals with a clean, healthful environment will help control all diseases. Stress from internal parasites can be reduced by deworming.

Housing - Cows need adequate stall space, non-slip flooring and easy access to feed and water. Comfortable cows will spend almost as much time lying down as they do standing. Clean stalls and exercise lots decrease chances of mastitis infection. Sanitized, well-bedded maternity pens also decrease chances of reproductive diseases and increase chances for calf survival.

Environment - Poor ventilation can cause respiratory and other disease problems. Constant breathing of stale, bacteria-filled air can lead to pneumonia and other diseases in even the most resistant animals. Cold temperatures have less of an effect on cows than hot, humid conditions. Feed intakes increase in cold weather but are depressed during hot weather. Flies, mosquitoes, and lice can also cause stress and should be controlled.

Social interaction - Cows need to interact with one another. The amount of stress by lack of social contact for grooming, heat expression and other activities is unknown. On the other hand, boss cows, establishment of peck orders and cows in heat all have been known to decrease milk production in groups of cows.

Human interaction - People can either create or relieve stress in cows. Good cow managers relieve stress in cows through tender loving care and positive communications. Gentle handling reinforces good behavior in cows. Physical abuse, shouting and other loud noise have never been known to increase milk production.

Routines - Cows are creatures of habit. Disruptions in milking times, feeding schedules, and other day to day management routines can all cause stress in cows. Milking units left on too long can all cause stress on the udder. Lack of adequate stimulation before applying the milker or waiting too long after stimulation before applying the milker are examples of small unnoticable every day stresses which may eventually be observed through mastitis problems.

Summary

Several stress factors in dairy cows have been discussed but certainly others exist. Minimizing or eliminating the effects of stresses will result in increased economic returns. Stress factors just prior to, at, and following calving will have the biggest influence on production. Stresses from other management factors, not including disease control, will not be as noticeable and will become apparent only after long periods or in combination with other stresses.

Controlling Protein Digestion in the Dairy Cow

J. G. Linn, D. E. Otterby and M. D. Stern

Rations for dairy cows contain protein from feedstuffs and sometimes non-protein nitrogen (NPN). Traditionally, these protein forms collectively have been defined as crude protein and the amount of crude protein in the ration described the adequacy of protein feeding. The type and form of protein fed was of little concern except for the guidelines involved when urea was added. During the last 10 years, new information has become available on how protein fractions are utilized in the animal along with new methods for evaluating protein in feedstuffs. In general, the new concepts in protein utilization are concerned with how much protein is broken down in the rumen and the amount and kind of amino acids available for absorption in the small intestine.

PROTEIN DIGESTION IN THE DAIRY COW

Crude protein is made up of two forms - true protein and NPN. Approximately 85 percent of the protein in feedstuffs is true protein. True protein consists of amino acids whereas NPN is any material other than protein which supplies nitrogen such as urea, ammonia, nitrates, etc. The digestion process in cows first subjects both true protein and NPN to microbial fermentation in the rumen. NPN is rapidly and completely degraded into ammonia by bacteria whereas about 60 percent of feedstuff protein is converted to ammonia. As long as an adequate energy supply is present when ammonia is released, bacteria can utilize some ammonia for synthesis of bacterial protein. The efficiency with which bacteria utilize ammonia depends on the rate at which ammonia is released and the energy availability in the rumen. The remaining 40 percent of the feedstuff protein which is degraded in the rumen will pass into the abomasum along with the synthesized microbial protein and into the small intestine for digestion and absorption of amino acids. Figure 1 shows the major changes that occur in protein and NPN sources as they pass through the gastro-intestinal tract of dairy cows.

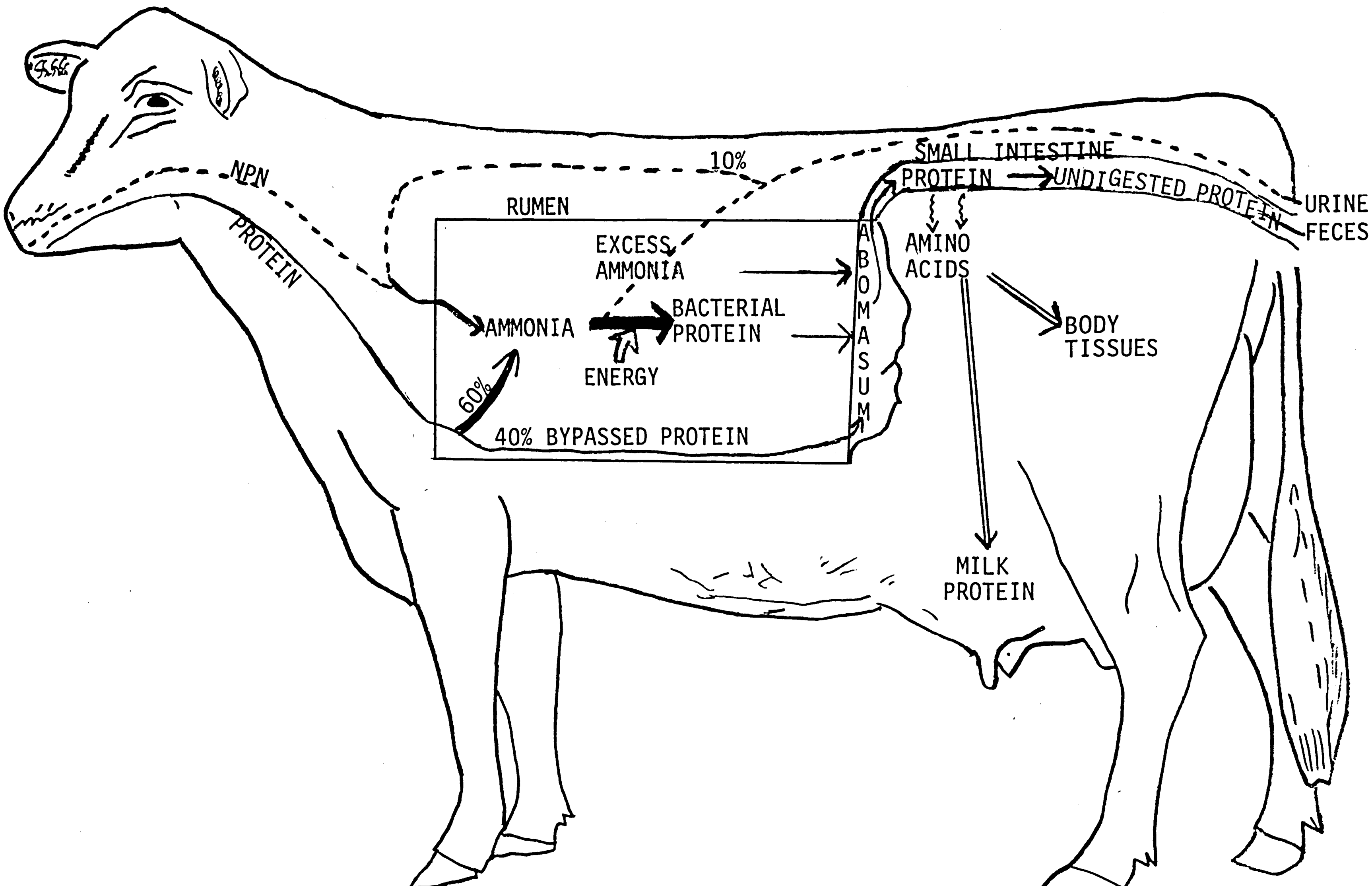

FIGURE 1. Protein digestion in the dairy cow.

NEW PROTEIN CONCEPTS

Microbial fermentation in the rumen is of benefit to the cow because ammonia released from NPN can be converted into bacterial protein. However, the drawback to microbial fermentation is some high quality proteins also are degraded to ammonia and may or may not be re-converted into lower quality bacterial protein. The desired situation would be to use low quality protein or NPN for synthesis of bacterial protein and allow the high quality feedstuff protein intact for digestion and absorption in the abomasum and small intestines. This would increase the overall efficiency of protein utilization in the dairy cow with a larger supply of amino acids available for milk production.

The new concepts in protein utilization attempt to predict the fate of feed protein in the rumen and the lower digestive tract (abomasum and small intestine). Several new terms have been applied to these concepts, and some of the most common will be described here.

Protein solubility refers to the protein in feedstuffs which is soluble in a liquid. Several liquids have been used including hot water, alcohol, mineral solutions, salt solutions and rumen fluid. It is assumed the more soluble protein in feedstuffs will be the most rapidly degraded into ammonia by rumen bacteria. However, protein solubility does not account for varying protein solubility in different liquids and, also, not all soluble proteins are converted to ammonia in the rumen. Some soluble proteins remain intact and pass to the lower tract for digestion and absorption. Likewise, some feedstuff proteins which are insoluble are readily degraded in the rumen. Because of this, degradability of feedstuff protein is a better indicator of protein digestion in the rumen.

Rumen degradable protein refers to feedstuff protein which is degraded to ammonia in the rumen. Not all feedstuff proteins are degraded at the same rate and the rate degradation occurs is influenced by rumen pH rumen, level of feed intake and ingredients used in the ration. Table 1 shows the relationship between solubility and degradability of some common feedstuff proteins.

Table 1. Relationship between protein solubility and rumen degradability of some common feedstuff proteins.[a]

Feedstuff	Crude protein[b]	Solubility[c]	Ruman degradability[c]
	(%)	(%)	(%)
Grains			
Oats	13	31	80
Barley	14	17	80
Beet pulp	8	4	50
Brewers dried grains	26	6	50
Corn	10	15	55
High moisture corn	10	50	
Corn gluten meal	47	6	45
Distillers dried grains	30	30	45
Soybeans-raw	42	30	80
Soybeans-extruded	42	20	60
Soybean meal	50	20	75
Sunflower meal	28	30	75
Forages			
Alfalfa hay	18	25	80
Alfalfa haylage	18	45	75
Corn silage	8	45	

[a]Values are not absolute and can vary but should represent relative differences between feedstuffs.

[b]Percent of dry matter.

[c]Percent of crude protein.

Bypass protein is a collective term referring to feedstuff proteins that pass into the lower digestive tract without being degraded in the rumen. Escape protein, meaning proteins escaping degradation in the rumen, and insoluble available protein are other terms which are synomous with bypass protein.

Bound, unavailable or indigestible protein are terms which refer to feedstuff protein that is totally unavailable to the animal. Protein from heat-damaged forages is common to this group and is neither degraded in the rumen or digested in the lower digestive tract.

PROTECTING PROTEINS FROM RUMEN BREAKDOWN

Three common methods are available for reducing protein degradation in the rumen and increasing protein available for digestion and absorption of amino acids in the lower digestive tract. These are: (1) selection of low rumen degradable protein ingredients for the ration, (2) chemical treatment of protein in feedstuffs, and (3) heating of protein sources. Feeding management can also influence rumen degradation of protein and this will be discussed later.

Feed ingredient selection - Research from two universities on protein solubility are reported in Table 2.

Table 2. Research trials on protein solubility.

University	Item	Ration protein level (%)[a]			
Texas A & M		13		15	
		22% Sol[b]	42% Sol[c]	22% Sol[b]	42% Sol[b]
	Milk (lb/day)	54.2[c]	47.4[c]	61.1[d]	50.3[c]
	Fat test (%)	3.7	3.4	3.6	3.6

University	Item	Ration protein level - 13%[a]				
Illinois		22% Sol[b]	24% Sol[b]	25% Sol[b]	31% Sol[b]	24% Sol[b]
	Milk (lb/day)	67.9	74.3	72.5	72.8	66.4
	Fat test (%)	3.3	2.8	3.2	3.1	3.2

[a]Protein percentages are on a dry matter basis.

[b]Refers to solubility of protein in total diet.

[c,d]Means within a row with different letters are significantly different ($P < .05$)

Results from Texas A & M where corn meal, wheat middlings and other ingredients were used to change the protein solubility of the diet, suggest diets of low solubility and containing 15 percent crude protein are the most optimal for milk production. However, Illinois research with 13 percent crude protein diets indicates the level of protein solubility has no influence on milk production and fat test. Soybean flakes were heated to different temperatures to change solubility of the diets. Changing the protein solubility in diets by use of dried inplace of ensiled feedstuffs also had very little effect on milk production (Table 3).

Table 3. Effect of ration type on protein solubility and milk production.

	Trial 1		Trial 2	
Item	Dry	Ensiled	Dry	Ensiled
Ration dry matter (%)	86.1	55.6	87.0	48.4
Ration protein (%)[b]	14.9	15.4	15.9	14.0
Protein solubility (%)	31.5	56.9	26.0	41.3
Dry matter intake (lb/day)	40.6	39.9	45.6[c]	43.0[d]
Milk (lb/day)	55.3	54.9	69.9[c]	67.2[d]
Fat test (%)	3.4	3.6	3.4[c]	3.2[d]

[a]Research reported from Canada using hay or hay crop silages with either dry or high moisture shelled corn to alter protein solubility of the diet.

[b]Protein percentage on a dry matter basis.

[c,d]Means within a row with different letters are significantly different ($P < .05$)

Several research trials have been conducted where urea has been used to change protein solubility of the diet. A recent study at Minnesota (reported elsewhere in this publication) indicates that cows utilized urea as well or better than soybean meal in complete diets containing 15 and 18 percent crude protein. Other universities have found little response in lactating cows when urea has been used to increase dietary crude protein above 13 percent. In general, there is not a specific level of solubility under all feeding conditions which appears to be optimal for milk production. Cow responses appear to vary with dietary protein level, protein source, ration ingredients, and method of feeding.

Chemical treatment of proteins - Various chemicals have been used to decrease protein degradation in the rumen. The chemicals protect feedstuff protein from rumen but have no effect on the acid digestion in the abomasum. Thus, the amino acids become available for absorption in the small intestine. Formaldehyde has been the chemical primarily used in research trials for protein protection, but has not cleared the Food and Drug Administration for general use.

Recent research trials using formaldehyde protected proteins are reported in Table 4. In general, formaldehyde protected protein has failed to give consistent improvements in milk production across all research trials. The under-or over-protecting of proteins and use of cows past peak lactation, may account for some of the variability in response.

Table 4. Research trials using formaldehyde protected proteins.

Country	Item	Ration protein level (%) and source[a]			
Canada		14		17	
		Formaldehyde canola meal	Untreated canola meal	Formaldehyde canola meal	Untreated canola meal
	Dry matter intake (lb/day)	40.1	42.5	44.5	43.0
	Milk (lb/day)[b]	63.9	67.5	73.0	74.7
	Fat test (%)	4.2	3.8	4.0	4.1

Country	Item	Ration protein level (%) and source[a]		
Israel		16		20
		Formaldehyde soybean meal	Untreated soybean meal	Untreated soybean meal
	Dry matter intake (lb/day)	39.6	39.5	40.2
	Milk (lb/day)	40.4	38.9	38.4

[a]Protein percentages are on a dry matter basis.

[b]Formaldehyde treatment of canola meal had no effect on milk production but the 17% diet significantly increased milk production over the 14% diet ($P < .05$)

Heat treatment of proteins - One of the easiest ways to increase the resistance of protein to breakdown by rumen bacteria is by heating. Many feed processing methods involve heating or generate heat which increases the proportion of bypass protein in the feedstuff. Extruding or roasting of soybean meal are common methods. Recent research trials comparing heat treated soybean protein are shown in Table 5. Again, responses to inclusion of heated protein in diets of lactating cows have been variable. Milk yield responses of cows fed heated protein generally have been only slightly improved over that of cows fed unheated protein. An exception to this is a California study where milk yield increases of 6 to 10 pounds per day during the first 15 weeks of lactation were reported for cows fed extruded soybeans as compared to cows fed a control 20 percent crude protein ration.

Table 5. Research trials using heat treated protein.

University	Item	Ration protein source		
Oklahoma		Unheated soybean meal	Heated soybean meal	Heated soybean meal & urea
	Dry matter intake (lb/day)	37.6	37.8	37.5
	Ration protein (%)	14.4	14.2	15.1
	Milk (lb/day)	52.0	51.7	51.6
	Fat test	3.8	3.8	3.8
South Dakota		Ration protein source		
		Soybean meal	Heated soybean meal	
	Dry matter intake (lb/day)	44.8	43.1	
	Ration protein (%)	13.5	13.8	
	Milk (lb/day)	58.6	58.6	
	Fat test (%)	3.3	3.2	
		Ration protein source		
		Unheated soybean meal	Unheated soybeans	Heated soybeans
	Dry matter intake (lb/day	46.7	47.4	47.4
	Ration protein (%)	13.0	12.3	12.6
	Milk (lb/day)	63.0	62.4	64.1
	Fat test (%)	3.6	3.5	3.6
Penn State		Ration protein source		
		Soybeans	Heated soybeans	
	Dry matter intake (lb/day)	45.0	46.6	
	Ration protein (%)	15.7	15.9	
	Milk (lb/day)	74.7	76.3	
	Fat test (%)	3.5	2.5	

FEEDING FOR MAXIMUM PROTEIN UTILIZATION

Method of feeding, which feedstuffs are fed together, type of feedstuffs fed, and other feeding management factors can all affect the overall protein utilization in cows. Proteins which are rapidly degraded in the rumen are best utilized by bacteria for synthesis of bacterial protein. These should be fed frequently and in small amounts with a readily available source of energy (ex., corn). Feeding urea and other highly soluble proteins in complete rations or mixing them in the bunk with forages such as corn silages are ways to optimize use of these proteins. Feeding grain more than twice a day to high producing cows will be of benefit, especially when urea is used. In parlors and other places where feeding is limited in both amount and frequency, protein of lower solubility or more resistant to rumen degradation should be considered.

Protein degradation also can be minimized by feeding cows for maximum feed intake, which reduces the time feeds remain in the rumen. This not only increases the protein supply to the lower digestive tract but also increases total nutrients available to the cow for maximizing milk production.

Forage harvesting and storage methods can greatly alter forage protein degradation in the rumen. Ensiling hay crop silages increases protein solubility, but recent studies at Wisconsin have shown alfalfa hay and haylage (50% moisture) are similar in protein degraded in the rumen (75 to 80%). Heating of forages during storage lowers protein degraded in the rumen and has similar effects to those discussed under heat treatment of proteins. However, overheating or severe heat damage ties up the protein so that is totally unavailable to the animal. Corn silage proteins also are highly soluble but appear to be more resistant to rumen degradation than protein from hay crop silages. Treating corn silage with anhydrous ammonia does not increase the solubility of corn silage protein but actually reduces it. This occurs because bacteria utilize the readily available ammonia during storage fermentation rather than the lower soluble protein in the corn silage.

SUMMARY

It has been shown in several studies that heating, chemical treatment or feeding proteins low in rumen degradability will increase passage of protein to the lower digestive tract. However, increases in animal performance from increased bypass of protein have not always occurred. Dairy research trials on feeding diets containing protected protein or protein of low solubility have not consistently shown improvements in milk production. Conditions influencing bypass protein such as feeding management and interaction of feed ingredients have not been fully investigated. As a result, predicting with any degree of certainty when protein of low degradability will improve milk production is almost impossible. Some producers will see increased milk production when protected protein is added to the ration while others will not. The ultimate test of benefit from protected protein

will be in economic returns. Table 6 is a guideline to help determine milk production responses necessary to pay for the often higher priced bypassed proteins.

Table 6. Milk production increases necessary to break even for different grain mix and milk price differentials[a].

Increased cost/ton of grain mix[b]	Milk price ($/cwt)								
	11			12			13		
	lb grain/cow/day			lb grain/cow/day			lb grain/cow/day		
	10	20	30	10	20	30	10	20	30
$	lb milk increase/cow/day								
10	.5	.9	1.4	.4	.8	1.3	.3	.7	1.1
20	.9	1.8	2.7	.8	1.7	2.5	.7	1.5	2.3
30	1.4	2.7	4.1	1.2	2.5	3.7	1.1	2.3	3.5
40	1.8	3.6	5.5	1.7	3.3	5.0	1.5	3.1	4.6

[a]Adopted from Sniffen. 1980

[b]Increase cost of grain mix by adding protected or other bypass proteins to the mix.

Calf Environment and Health

J. K. Reneau

Introduction

The future of any herd lies in its young animals. If good AI breeding is being used, the calves should be genetically superior to their dams. Continued progress is therefore dependent on keeping that genetic harvest alive.

It is not the intention of this article to cover all aspects of calf raising. Main consideration will be given to calf environment and housing as it relates to calf health. At the onset it needs to be made clear that construction of the very best, well-designed calf facility may not cure all calf raising ills. A good share of successful calf raising is attributable to the attitude and management skills of the person(s) caring for the calves. One poor management practice may outweigh several that are being done correctly.

What is a healthy calf? To some, perhaps the definition is fulfilled by the mere presence of life itself. The query of "how many calves did you lose last year?", is often met with a prideful reply of "not a one", etc. Yet, personal experience will tell us that there is often a great difference in the health status among calves. On some farms the calves always seem bright, alert, show more bloom and are growing well. On other farms, the calves are not only unthrifty, but often show evidence of disease.

Some diseases are only transient in their effects while others, even though experienced in calfhood, may have profound effects on future productivity. A calf, surviving scours or pneumonia, for example, may not necessarily experience a stunting of either its growth or expression of its genetic production potential later in life, but the facts are that many do. Obviously, life-death statistics may not accurately define losses.

This realization brings into clear focus the need for a well-balanced nutrition, management, and disease prevention programs. There are several very basic principles that must be followed if we are to consistently succeed in raising healthy calves.

I. Colostrum Management

The single most important factor in successful calf raising is colostrum management. The idea of getting a sufficient amount of the dam's first milk into the calf as soon as possible cannot be over-emphasized. Leaving the cow and calf together the first 24 hours of life is no assurance that the calf will nurse. In one study where the cows and calves were left together the first 24 hours, 25% of the calves were without antibody protection.

Observation that the calf nursed is not assurance that adequate colostrum was received. The preferable way to assure the calf receives adequate colostrum is to clean the dam's udder with udder wash solution, milk 2 quarts into a clean and sanitized nurse bottle or pail and feed it to the calf within the first 15 min.-30 min. of life. If the calf will not nurse, the colostrum should be administered with an esophageal feeder. Another 2 quart feeding should be fed 6-8 hours later and then fed @ 8% of body wt. at least for the first 3 days of life.

Some calves are left with the dam for the first 24 hours of life regardless of whether they are fed colostrum by the farmer. There is some evidence that association with the dam enhances colostral antibody absorption. Many calves are immediately taken from the cow at birth and isolated in individual stalls, pens, or calf hutches. Both are reasonable and accepted practices as long as you are sure that adequate consumption of colostrum has occurred.

II. Calf Housing and Environment as it Relates to Calf Health

The main purpose of calf housing is to provide shelter and confinement. For normal, healthy growth, a calf needs to be well fed, clean, dry, comfortable, and protected from severe weather and drastic changes in temperature and humidity. Confinement allows efficient use of space and labor as well as offering control of calf to calf contact.

Sanitation

a. Good sanitation is vital to successful calf raising. A 1979 North Carolina study demonstrates the importance that cleaning and disinfecting procedures have on calf mortality. When facilities are cleaned after each calf, there are considerably fewer calf losses.

Effect of Cleaning and Disinfecting on Calf Mortality

When	No. Herds	No. Calves	% died before three months
After each calf	50	1722	6.1
2X per year	57	1980	8.4
1X per year	46	1480	10.9
Never	35	1125	10.5

Calf housing design should allow ease in cleaning. Partitions should be easily removed to facilitate mechanical cleaning. Hutches should be designed for easy moving to a new spot before each calf is introduced. Placement of hutches on a 6"-12" gravel base will assure good drainage and thereby improve sanitation and calf comfort. If possible, calf facilities should be cleaned and allowed to remain idle for 4-6 weeks each year. This is especially true for intensively confined temperature controlled facilities.

Good sanitation begins in the calving area. Up until birth, the calf has been isolated in a sterile, uterine environment. Birth itself is normally a great shock to the calf. Add to that the shock of being dumped into a cold, contaminated environment with absolutely no antibody protection against disease producing organisms.

The calving environment must be clean. It should be free from manure and placental material of previous calvings. A muddy exercise lot, a maternity pen on a manure pack, or calving into a gutter are not acceptable environments for a calf to be born. There is evidence that suggests if the first mouthful of material a calf swallows is bacteria-laden filth rather than colostrum, the subsequent bacterial colonization of the gut wall causes a decrease in antibody absorption by the gut. In addition, a grossly contaminated navel offers another avenue of infection for the very vulnerable newborn calf.

The ideal calving area would be a small, well maintained pasture that is low in cow population, free from mud and the build up of manure and placental material, with easy access and opportunity for observation. A confinement maternity facility should provide adequate space, light, ventilation, footing, and offer easy cleaning and disinfection between occupants. Guidelines for actual dimensions and maternity pen design may be found in a list of publications at the end of this article.

Equally important as a clean environment is clean feeding utensils. A good rule of thumb would be that everything going into the calf's mouth should meet grade A standards. Too often none of the utensils, milk or milk replacer being fed these calves could meet such a standard of sanitation. Bottles, nipple, pails, buckets, etc., all need complete sanitation between feedings. Ideally, whomever feeds the calves should have a convenient place where utensils can be properly cleaned and stored as well as feeding formulas prepared. This should be a factor considered in the location and or construction of calf facilities.

b. Bedding

Both maternity pens and calf pens need to be well bedded. Present opinion is that clean straw is the bedding of choice for maternity areas and calf pens. It offers the least amount of gross contamination likely to adhere to or be inhaled by the wet, floundering, new-born calf. It also offers good absorption as well as good insulation capacity during cold weather.

The important thing is that bedding provides a dry, comfortable environment. A good criterion to determine bedding adequacy is to ask the question...is the bedding clean, dry, and comfortable enough so that you would be willing to lie down on it for any length of time? One experienced and very successful calf raiser comments that there is no such thing as wasted bedding in calf raising.

c. Observation

Treatment of disease is always more successful when diagnosed and treated early in the disease process. Frequent observation of calves will help in early diagnosis. Week-old calves should be observed every 4 hours. Older calves should be checked a minimum of 2 times per day. Pay close attention to these details:

Is the calf aggressive and alert?

Does the calf eat?

Does the calf act slow or depressed?

Are the ears droopy?

What is the manure like?

Is the calf breathing normally or coughing?

When one calf becomes sick, closer observation of all the others is essential. Daily recording of rectal temperatures is advisable when other calves in the herd are sick. The normal temperature for a calf is 101.5^{o} F. Rectal temperatures greater than 103^{o} F. should be considered significant.

Well designed calf housing should take into consideration observation ease. The location of pens or hutches should lend itself to frequent and effective observation. Adequate light must also be considered to facilitating good observation.

Feeding frequency has a direct effect on observation. For this reason, many recommend that calves be fed 2 times per day for a minimum of the first 3 weeks of life.

d. Treatment

The objective of any good calf raising program is to avoid or certainly minimize the necessity to treat calves. However, occasional treatment may still be necessary. It is important that calf housing be designed for ease in catching and restraint of calves allowing medical procedures to be accomplished quickly, efficiently, and thereby causing minimal stress to the calf. This is particularly important when calves are weaned and placed in group pens. It is counterproductive for calves to experience unnecessary struggle and exertion resulting from attempting medical procedures where poor restraint facilities exist.

e. Isolation

It is desirable to keep preweaned calves isolated from each other and from older animals in the herd. The practice of tying calves either in the manger or to stall dividers beside their dams or of placing newborn calves in a group with older calves is very risky. Such contact with older animals almost assures perpetuation of scours and pneumonia or other disease to the younger calves. In addition, grouping of preweaned calves encourages sucking habits. Complete separation of preweaned calves prevents transmission of disease and allows a better opportunity for observation of feed intake, fecal consistency and the calf's general attitude. As previously mentioned, observation of these criteria are extremely important in early detection of disease.

f. Space Requirements

Caution should be taken not to overcrowd calf facilities. Overcrowding can compromise calf comfort and sanitation as well as overburden the ventilation system. This will usually greatly amplify calf disease problems.

In general, floor level individual calf pens for calves up to 2 months need to be a minimum of 16-24 sq. ft. Elevated stalls for this age-group calf should be 2' X 4' with ample room (approximately 1') on the stall front for the feed box and milk pail.

Calves 2-8 months old should be grouped in pens with no more than 10 calves/pen. The pens should provide 20-25 sq. feet of bedded floor space and 12"-18" of manger space per calf. More detailed information concerning space requirements of calves can be found in those publications listed at the end of this article.

g. Ventilation

One of the worst enemies to the calf is to have an excess of moisture in its environment. Moist, soiled, bedding improves the opportunity of bacterial buildup thereby increasing the incidence of scours. Disease organisms aerosoled into the air make animal-to-animal spread of respiratory disease more likely. Dampness of hair coat thus destroying its insulatory capacity, along with wet floors and bedding, contribute to calf chilling and stress, making them more susceptible to disease.

The important functions of ventilation are to provide fresh air and to remove moisture. Not only is removal of moisture-laden so called "stale" air important but also direction of air movement is critical. It is important that air flow always be from the younger animals toward the older animals. This further enhances the principle of isolation by mechanical removal of disease-laden moisture particles away from the more susceptible young animals.

Air should be removed from confined housing continuously at a minimum rate of four air changes per hour. Removal of this air via a duct from near the floor will save energy by removing the cooler air from the floor while accomplishing the task of exhausting the "stale" moisture laden air from the building. It is important to emphasize that there is need of a continuous minimum air flow of 4 air changes per hour no matter how cold the ambient temperature is. This of course will require that heating units be installed if a uniform temperature is desired. Heated buildings must always be adequately insulated. During summer months, higher air flows are needed to keep the animals comfortable. For this purpose, a second fan providing an exhaust capacity of 30 changes per hour should be installed. In confinement calf housing over a manure pit, ventilation design should never allow pit gasses to be exhausted through the calf facilities. In the construction of confinement calf housing, there needs to be careful consideration of the ventilation. There can be no question that adequate exhausting and uniform distribution of air is important to the health of the calf.

In calf hutch housing there is less concern over ventilation as long as the hutch front is open for the free exchange with outside air and hutch positioning is such that the open front is opposite prevailing winds. Other cold housing ventilation can be achieved adequately without the use of mechanical devices by utilizing open rigid sheds and adjustable wall openings. Detailed information on the insulation and ventilation of calf housing can be found in the publications listed at the end of this article.

h. Temperature

Temperatures above freezing are not required. There are many calves raised without heat in subzero weather. The ideal temperature for optimal growth according to research data is said to be in the neighborhood of 70^{o} F. However, field studies comparing calves housed in "warm" vs. "cold" environment show no significant difference in growth rates provided nutrient requirements are adequately met. Calves in subzero temperature do however require additional energy and should be fed accordingly.

Temperatures between 35-45^{o} F. are preferable because drinking cups do not freeze, less bedding is required, and the calf feeder is more comfortable. Far too many calf barns are too warm and in these cases, if ventilation and sanitation are not optimal, more disease problems will exist.

III. "Cold" vs. "Warm" Calf Housing

Usually, the issue as to whether or not "warm" or "cold" calf housing is used is resolved on the basis of personal preference rather than scientific evidence. Either system managed properly will work well. Both systems have their inherent advantages and disadvantages. From the standpoint of capital investment and energy useage, "cold" housing is favored. "Warm" housing on the other hand is usually more labor efficient and provides a more comfortable environment for those caring for the calves.

In a 3 year controlled study, the University of Wisconsin, Marshfield, compared two types of warm housing (floor level individual pens and elevated individual stalls) with 2 types of cold housing (calf hutches and individual pens in a pole building).

There was no significant difference in average daily gain of calves. Death losses were significantly higher in warm housing (8%) than in the cold housing (3%). None of the calves in calf hutches died. Fewer calves raised in the cold environment (36%) had scours than those raised in the warm environment (56%). The only calf with a respiratory problem was in the warm housing.

Labor efficiency favored the warm housing. The average time spent per calf per day for the warm housing was 4.8 minutes compared to 5.9 minutes for the cold housing.

Another study recently reported in Hoard's Dairyman reported 4% calf losses raising calves in hutches compared to 11% losses from farms not using hutches.

One conclusion that could be drawn from these studies is that it is easier to create and maintain a healthier environment in calf hutches than other forms of calf housing. Dairy farmers may have to choose between saving time or saving calves.

The following material is available on request from your County Extension office or by ordering directly from the Agricultural Extension Service Bulletin Room, 3 Coffey Hall, University of Minnesota, St. Paul, MN 55108.

1. Insulated Calf Barn with Individual and Group Pens, M-Sheet 149.

2. Building and Managing Calf Hutches, Agricultural Engineering Fact Sheet 24.

3. Home Insulation and Heat Loss, Agricultural Engineering Fact Sheet 18.

4. How to Plan a Mechanical Ventilation System for the Dairy Barn, M-Sheet 128.

5. Midwest Plan Service Dairy Housing and Equipment Handbook, $5.00 plus tax.

Reproductive Efficiency

N. B. Williamson

The potential to improve reproductive performance exists in most herds. Discussions on reproductive efficiency once centered on infertility caused by diseases such as Vibriosis, Brucellosis, Trichomoniasis and the possible role of Leptospirosis and viral agents such as B.V.D. virus. Currently, techniques are available to control these diseases, mainly through the use of vaccines and artificial insemination. It was expected that the control of these infectious causes of infertility would lead to high reproductive efficiency, but this did not prove to be so. Reproductive performance in dairy cows in Minnesota, like in the rest of the world, still has considerable potential for improvement.

This is because management and not disease is not most limiting reproductive performance. DHIA figures show that in Minnesota herds, calving intervals exceed 13 months despite a culling rate of over 30 percent of the herd per year (with many cows being culled for infertility or failure to conceive). Conditions in dairying have changed as most of the diseases which caused infertility were brought under control. Dairy herds are generally larger now than they once were and the number of cows looked after by one man has increased. New techniques which have altered breeding management such as artificial insemination, have on the one hand helped to control disease and improve genetic gain, but on the other have placed additional demands on farm managers. The net result of these changes is that reproductive performance has not changed much in most herds, despite considerable advances in the control of diseases.

Why is Reproductive Efficiency Important?

Reproductive efficiency is more than just getting a cow back in calf again before she goes dry. There are now many studies, including several conducted in the United States, which all show that a calving interval of 12 or less months is associated with optimum milk production levels and maximum economic returns. This is because the lactation level of any normal and adequately nourished cow reaches its peak by about 2 months after calving and then falls after that time. Therefore the more early lactation periods which can be achieved in a cows lifetime, the more she will produce, except that cows do need a non-lactating dry period to allow udder regeneration between lactations. This also limits production if dry periods occur too frequently. Dry periods and the normal 9 month pregnancy of cows means that the optimum calving interval for production purposes is 12 months. In terms of calf production, too, the shorter the calving interval of a cow the more calves she has. Thus if calving intervals are reduced to 12 months or less, additional income is produced due to the increased number of calves born. If the value of milk is assumed to be $12.50 per hundred weight and the average value of calves (male and female) is set at $100, then the net cost of an extra day in the calving interval beyond 12 months is around $2.20. More importantly, the potential gain from improving reproductive performance and reducing the calving interval by 1 day earns up to this amount in additional income. Improved reproductive performance means that fewer cows need to be culled for infertility or for not being in calf and therefore the potential for culling for low production is enhanced. This results in improved genetic gain occurring in a herd.

Reproductive Targets Related to High Productivity

High productivity is associated with an annual calving cycle which should approximate closely to:

1. 83 day open (calving to conception) interval
2. 282 day pregnancy
3. 305-323 day lactation
4. 42-60 day dry period
5. 365 day inter-calving interval
6. Less than 10 percent of the herd culled for infertility.

These aims are the ideals for individual cows in a herd, although it is expected that herd averages for calving and open intervals will be 5 to 10 days on. longed calving intervals and excessive culling for infertility are the major reproductive problems existing today.

What are the Causes of these Problems?

The only way to start to be able to determine the causes of inadequate reproductive performance in most herds is by analyzing a complete set of reproductive records. The most satisfactory types of reproductive records are those which have a cow's total reproductive history for the lactation in one place. These include individual cow cards, barn sheets on which the cow's names are entered in order of their date of calving or computerized herd health program records.

The information needed for reproductive management and assessment includes:

1. Clear and permanent cow identification
2. The age and lactation number
3. The date and ease of calving
4. The dates of all heats which are observed
5. The dates and sires for all breedings
6. The nature and date of any disease
7. The dates and details of any treatments

When this information is recorded, important reproductive indices can be calculated which allow herd performance to be monitored and causes of inadequacy to be diagnosed.

Reproductive Management

Controlling the reproduction of a dairy herd is a management function which is important to the profitability of the dairy enterprise and should be taken seriously. Management tasks including reproductive management, have a number of components which should occur if management is to be successful. These components are:

1. The development of an objective
2. The formulation of a plan to achieve the objective
3. The implementation of the strategies of the plan
4. The monitoring and evaluation of the plan
5. The modification of objectives or plans in the light of experience and new information.

The objectives for reproductive performance should be the targets listed earlier. The plan to achieve these targets must include a program of heat detection, and a plan for breeding cows which will maximize fertility. This will involve using high quality semen and a proven competent inseminator. The time after calving when breeding begins is an important decision. It should not be too long. If breeding commences at 80 or 90 days, it is impossible to achieve 12 month calving intervals without excessive culling. There should be a determined effort to observe cows for returns to service after every breeding as a critical part of estrus detection strategy. The major preventable barrier to efficient reproductive performance in Minnesota dairy herds is the failure to detect heat in cows which have been bred but have not conceived.

Monitoring and Evaluating Reproductive Performance

Keeping a complete set of reproductive records achieves nothing unless the records are used. Reproductive records should be used to monitor the reproductive performance of herds to determine if performance is adequate. If inadequate, then record analysis can help to determine why.

1. The average calving to conception (open) interval. This is number of days between the last calving date for all adult cows in the herd and the date on which they become pregnant, divided by the number of cows. This interval may be calculated for all cows which calved in a particular year and which eventually conceived, to give a true picture for that year. It may be necessary to delay analysis of this index for quite some time after the completion of the year that the index applies to allow all cows to conceive. As a monitoring index, the calving to conception interval can be calculated for all cows which are confirmed pregnant for the month or in the interval between analyses. It is important to become aware of inadequate performance or adverse trends in this index early, so that the cause of problems can be identified and dealt with. Having pregnancy diagnosis conducted on a regular basis by your veterinarian can allow adverse trends to be detected 1 to 2 months after they occur. Although this seems a long time, it is sooner than is generally the case and does allow remedial action to overcome problems sooner than would otherwise be possible. If a cow is found to be abnormal at examination, she can be treated on the spot.

   Average calving to conception intervals should be about 80 to 85 days, but if they are less than 90 days then they are acceptable. If they are longer than 120 days, then a considerable financial benefit can be obtained by reducing them.

   Open Intervals are Influenced by:

   1. The time to breeding
   2. The success of breeding

   The time to first breeding can be measured by adding the number of days between calving and first service for all cows served in the herd and dividing by the number served. This should average about 65 days if average annual calving is to be achieved. Breeding needs to commence at 50 to 65 days for this to be possible. If the time to first breeding is long, this may be due to:

   1. Voluntary deferral of service
   2. A failure ot estrous cycling in cows
   3. A failure to detect estrus.

   Voluntary deferral of service is the easiest factor to deal with since it simply requires that you make a change in policy, to breed cows earlier. A failure of estrous cycling after calving can occur, but it is a relatively rare occurrence in Minnesota. In general, a failure to cycle is due to nutritional inadequacy or deficiencies and a specific diagnosis of likely causes requires an examination of rations and feeding practices. Veterinary examination of ovaries to determine the absence of cycling is required to detect this type of problem. Individual cows with specific diseases may also fail to cycle.

Most problems and the greatest potential for improvement are related to the estrous detection efficiency in herds. Failure to detect estrus delays first breedings of cows and delays repeat breeding when cows do not conceive to first service, with each missed heat contributing an average of 21 days to the cows calving interval. Remembering what was discussed earlier, 21 days at $2.20 per day means that up to $46.20 could be spent to detect each heat in each cow, and you would still break-even.

In fact, improvements in heat detection can occur with very little expense occurring but some increased effort required. The effort can be financially rewarding. A number of useful indexes of heat detection exist. The average interval from calving to first heat should be (and can be) 35 to 40 days. Eighty-five percent of cows (or more) should show heat by 60 days after calving. If cows are checked by your veterinarians for pregnancy, 85% or more of those examined at 5 to 9 weeks after breeding should be pregnant, or too many return heats are being missed. Also the heat detection index for a herd should be higher than 85%. The heat detection index is 21 divided by the average interval between all heats and services, multipled by 100 (to make it a percentage), i.e.

$$\frac{21}{\text{average interval between heats}} \times 100$$

Conception rates are measures of the success of breeding. Conception rates can be influenced by many factors including cow factors, e.g. nutrition, disease, bull or semen factors, e.g. semen quality; management factors, e.g. timing of insemination.

One would like first-service conception rates to be at 65% or more, but where they have been studied in the United States, they average between 40 and 45%. A realistic aim is to have conception rates of 55% or more. Conception rates are calculated by dividing the number of pregnancies to breedings in a defined period by the number of breedings occurring in the period and multiplying by 100 to give a percentage. Breedings may include first breedings only, for a first service conception rate, or all breedings, for a total service conception rate. Conception efficiency can be monitored readily using a conception efficiency graph. To do this it is most convenient to record all services as they occur in a chronological record. Then as cows are confirmed to be pregnant (30 or more days after breeding if veterinary examination is used) or found to not be pregnant, the outcome of the breeding is recorded on a graph. The results of each successive breeding are represented by a plot which moves across one column from the previous breeding. If the breeding is successful an X is placed in the next column and up one row from the previous breeding. If it is unsuccessful (i.e. the cow is not pregnant to that service) and 0 is placed in the next column and down one row. This type of graph can easily be kept on the farm to monitor conception efficiency and to alert the manager when problems are occurring. These problems can then be investigated and dealt with.

Conclusion

An investment of time, effort and money in improved reproductive efficiency can produce considerable financial returns for most Minnesota dairy farmers, since a potential for improvement exists in most herds. The achievement of improved performance requires a management effort. This effort includes setting targets for performance levels which should be achieved on your farm and which are related to high production efficiency. It is essential to monitor performance using adequate records to allow progress towards target performance to be monitored and to detect the occurrence of inadequate performance. Records are also necessary to determine the factors contributing to the inadequacy. Monitoring can be done most effectively if it is associated with regular veterinary reproductive checks. Standards of performance which should be achieved for various aspects of reproductive performance have been outlined. The performance of your farm can be compared with these standards using on farm records which you analyze yourself, DHIA reproductive summary information or veterinary health and management computer programs such as the one available through the University of Minnesota. The most important factor with any of these systems is that performance is monitored and that intervention or an improvement of strategy occurs if performance is inadequate.

For help in evaluating your herds reproductive performance you may wish to contact your local veterinarian to enable the current status of the herd to be determined. Your County Extension Director can arrange to provide further information in the following publications:

1. Unit 1. Dairy Reproductive Correspondence Course. "Identifying Problems" Extension Folder 441.
2. Unit 2. Dairy Reproduction Correspondence Course. "Heat Detection and Pregnancy Rates" Extension Folder 442.

West Central Experiment Station, Morris

Mechanized Teat Washing in a Tie-Stall Barn

D. G. Johnson, R. D. Appleman and R. J. Farnsworth

Stimulation and cleansing of the teats and udder is the critical, but often unappreciated, first step in a milking procedure. Complete vigorous stimulation helps insure a rapid and complete milk letdown. Thorough cleaning helps control bacteria counts and reduces access of mastitis causing organisms to the teat end.

The objective of our research was to compare conventional udder washing practices with a partially mechanized system which combined compressed air and water. Response was measured in labor efficiency, milking performance and teat cleanliness.

Two 30-cow sets on either side of a face-in stable were assigned to treatment groups for mechanical washing (M)* or hand washing (H). A six-week experimental period was subdivided into three two-week periods such that wash and stimulate methods were:

	Week		
	1-2	3-4	5-6
Set 1	M	H	M
Set 2	H	M	H

Milking performance was measured at both milkings one day each week. Teat end bacteria and time and motion measures were obtained at milking Week 2 and Week 4. Cows were milked by one individual using three units at 5:00 a.m. and by another individual using two units at 3:00 p.m. Milking equipment was an around-the-barn pipeline system. Pipeline diameter was 2 inches, height was approximately 7 feet and pipeline vacuum was set at 14.5 inches. Machine stripping was discouraged.

Procedure for H was to dip a single service paper towel in sanitizer solution and wipe dirt and material from teats. A second dry paper towel was used to dry teats and provide additional stimulation. Procedure for M was to fill and set the tank with sanitizers at recommended levels. Each teat was washed by short bursts of air and water, and dried-stimulated with single service paper towels. With either system, milkers were urged to continue stimulation until they detected letdown and conclude preparation by drawing one or two strips of milk from each quarter.

*We appreciate equipment and installation provided by Traeger Agricultural Sales, Foley, Minnesota and Northwest Environmental Systems, Oshkosh, Wisconsin.

Total herd milking labor was recorded twice. Milking procedure was timed with half the herd washed and prepared with the system under evaluation, and groups were reversed for the second occasion. With M the washing equipment needed to be moved more often to be placed close to each cow. Teats and udders were wetter after washing with M, requiring more towels and time for drying and stimulating. More cows prepared by H required machine stripping so time spent machine stripping was approximately double that of M. As the same cows are included in both groups, M stimulation may have reduced the need for machine stripping. Differences in preparation time and machine stripping time tended to be offsetting. Differences per cow are small, but 23% more time was devoted to preparing for milking with M. Increased preparation time may have helped reduce machine stripping time.

Immediately following washing and stimulation, nine cows on each treatment had the bottom one inch of each teat flushed with sterile liquid medium. The runoff was collected in a sterile vial, immediately refrigerated, and bacteria were counted the next day. Teats prepared by M had more ($P<.001$) bacteria than teats prepared by H, 1514 vs 810. Iodine disinfectant in udder wash was added to provide equal concentrations in both systems. Because M exposed the udder to pressurized spray, perhaps bacteria were obtained from the flow of solution back across contaminated portions of the udder at the base of the teat and the entire length of teat. With both M and H the teat was dried with paper towels before the teat end was flushed.

Complementary milk (CM) is that which is left in the udder after normal milking is complete. CM can be removed following intramuscular or intravenous administration of oxytocin and remilking. Amount of CM varies with level of production, stage of lactation, adequacy of stimulation and other factors. In this experiment CM was considered an index of adequacy of premilking stimulation. Eight cows from each treatment sequence were injected with oxytocin twice per period during afternoon milkings. Average CM was 2.86 lbs but stimulating system had little effect ($P>.30$).

Preparation time, lag time, peak flow rate and total milking time were obtained from 24 cows per treatment sequence during morning and afternoon milking twice per treatment period. Only differences in preparation time approached significance ($P<.20$), where M required 9.7 seconds more than H. Most of the difference in preparation time appeared to be related to additional time required to dry teats with M. While washing system may affect some milking characteristics, organization of the milking routine and other factors were greater influences.

Results above show no advantage for a mechanized compressed air--sanitizer solution wash and stimulation system when compared to a commonly used single service paper towel system. The herd used in this study was confined, and most udders were dry and relatively clean before being washed and stimulated. Comments from personnel milking cows suggest some advantage in washing with M when udders were badly soiled or teats were injured. Whether method M or H is chosen, we recommend that teats be carefully stimulated and dried before the milking machine is applied.

Northwest Experiment Station, Crookston

Long-Stemmed Dry Hay Not Necessary in the Milking Dairy Cow Ration

G. D. Marx

A number of articles have been published indicating that dairy cattle, especially milking cows, should be fed some long hay in their ration. The question of whether long or dry hay is necessary in dairy rations is raised frequently by dairymen and, depending on who they ask, may get two different answers or opinions.

The dairy herd at the Northwest Experiment Station, Crookston, has not been fed any long-stemmed hay for 15 years nor are they exposed to any long fiber-type roughages. An all-chopped forage material is fed to all classes of dairy animals including baby calves, replacement heifers, dry and lactating cows without any unusual nutritional problems. Promoters of the hay theory indicate the dairy cows need a "roughage effect" or "rumen tickler" to maintain optimum digestion in order to maximize milk production and reduce digestive disorders.

The last time the milking herd was fed hay was an experiment comparing hay and haylage in 1964-65. That experiment resulted in a 1.92 pound milk production advantage for cows fed chopped haylage as their only forage over cows fed forage as good quality long-stemmed hay. Since that time, many different types of low or medium moisture haylages and silages have been fed on various nutritional studies and none have shown a need for or even a limited amount of hay in the diet. The chopped forages used at various times during the last 15 years have been alfalfa haylage, corn silage, small grain silage (oatlage, oat and pea mixture, barlage, wheatlage, triticalage), beet toplage, sunflower silage and a potato-alfalfa haylage. The basic forage ration has been alfalfa haylage or a combination of two-thirds alfalfa haylage and one-third corn silage on a dry matter basis. Forages are all finely chopped with a cut of 1/4 or 3/8-inch theoretical setting on the forage harvester. The grain portion of the ration has been either dry or high moisture. The conventional dry grain fed was barley and corn, sometimes one-third beet pulp was added if the price was competitive. More recently, the grain ration has been primarily high moisture barley or high moisture corn. Barley and corn are the major feed grains raised in this area and generally are the most economical grains available for livestock feeding.

Presently, half the milking herd is receiving high moisture shelled corn and half are on high moisture ear corn with a combination of alfalfa haylage-corn silage as the forage portion of the diet. Dry cows are fed similar chopped forages but no grain is fed until two to three weeks prior to calving. Currently, the DHI 12-month rolling herd average is 19,942 pounds milk and 727 pounds milk fat with a 3.6 percent fat test. This places the herd in the top one percent of herds in Minnesota. Certainly the lack of any hay in the diet has not hurt production of these cows that have received all of their forage in the chopped form either as haylages or silages since birth.

Baby calves get their first exposure to alfalfa haylage while still on milk and by the time they are weaned at four weeks of age, they are accustomed to eating this forage along with their calf starter grain. At nine months of age, replacement heifers are taken off the starter and fed only haylage or limited haylage-corn silage without any additional grain. A mixture of dicalcium phosphate, monosodium phosphate and trace mineral salt is fed to balance minerals. These same minerals are fed to dry and milking cows according to their requirements. Minerals are mixed with grain (force fed) for all lactating cows and cows with high production receive more grain, therefore, automatically receive more minerals.

Many people have associated some nutritional disorders, particularly displaced abomasum, to diets not containing any long-stemmed hay. This assumption has not been proven and is not the case with this herd nor is it noticeable in other herds receiving an all-chopped forage ration. The incidence of nutritional disorders such as displaced abomasums, milk fever, and ketosis is low and not affected by feeding an all-chopped forage diet. Additionally, a recent survey shows that the incidence of displaced abomasums (twisted gut) is no greater on herds fed haylage than those fed hay for forage.

The cause of displaced abomasums for example, has not been completely characterized, but is probably related more to problems of a genetic, atony, or mechanical nature. Genetically, dairy cattle are more prone to getting a displaced abomasum than beef or sheep. Atony, or lack of muscle tone, could be caused by nutrition, stress conditions or metabolic diseases. Mechanical or abnormal rumen movement conditions occurs more at the end of pregnancy or just after calving because of uteral conditions, reduced rumen volume and fill, high grain, off-feed or disease. Most important of these seems to involve the dry fat cow syndrome or overconditioning, or the nonlactating cow by overfeeding, particularly grain, or feeding a nutritionally imbalanced ration. This sets up a potential stress situation for the cow predisposing her to more favorable conditions for displaced abomasum. One of the stresses involves the mobilization of excess body fat to energy and milk whereas the cow can more easily convert feed energy to milk. Also, an obese cow is more likely to lose her appetite and go off feed at calving time, causing her to break down body fat faster than she can handle resulting in an excess fat accumulation in the liver predisposing her to possible nutritional disorders.

In summary, present trends strongly indicate that more forage will be fed as haylage or silage rather than hay primarily because of its ease of handling, requires less labor, reduces harvesting losses particularly leaves which are high in protein and the system adapts well to automated feeding. Increasing, numbers of dairymen are finding that hay is not necessary in the dairy cows diet and thatone can still maximize production if the other factors of production can be controlled primarily by feeding a nutritionally balanced diet, breeding for good genetics, good herdsmanship, and maintaining a high level of management through application of the latest technological and managerial skills and practices.

The herd at the Northwest Experiment Station, Crookston, is a closed herd on the female side. The herd has been upgraded genetically through artificial insemination. Dr. Charles Young is involved in making the mating selections for this herd. A reliable, responsible crew, including Marlyn Jacobson, Assistant Scientist, and Alex Johnson, Senior Animal Technician, are key personnel in the everyday operation and management of this herd. Research studies occasionally deter top production, yet, the careful concern for the everyday handling of this herd produces useful research for the dairy industry with the ability to achieve and maintain high production.

Feeding Sodium Bicarbonate to Dairy Cattle

G. D. Marx and J. D. Donker

Many dairymen are inquiring about the feasibility of using sodium bicarbonate as a feed supplement for lactating dairy animals. This compound is widely known as baking soda and functions as a buffering agent. Cattle produce large amounts of sodium bicarbonate and similar types of buffers in their saliva which helps to stabilize pH in the rumen. The question occurs as to whether the cow produces enough of these buffers in her own system or would additional added material, like baking soda, promote more efficient digestion, particularly with rations that result in high acid production. Research has shown that an unfavorable pH environment in the cow's stomach, particularly an acidosis condition, can reduce milk and fat output sometimes causing a drastic reduction in fat percentage. Feeding high amounts of concentrates and low forage rations for example, may cause acidosis problems resulting in abnormally low fat content in milk.

Interest among dairymen about the addition of buffers in the cow's diet prompted this study to determine the feasibility of using sodium bicarbonate in current modern dairy rations. The high producing herd at the Northwest Experiment Station, Crookston, was chosen to conduct this study. Input for the project came from many experts in the field and the decision was made to use a level of 1½% sodium bicarbonate in the grain of the experimental group and no sodium bicarbonate in the control grain ration with half the herd on each treatment for a full lactation period. Grain was fed at fairly high levels with one pound of grain fed for each two pounds of milk produced above the first 20 pounds of milk.

The initial experiment, involving the use of sodium bicarbonate, was completed with 62 lactations, data analyzed and published in a recent full length scientific paper in the Journal of Dairy Science (63:931-935, No. 6). The results are summarized as follows: (1) grain consumed by both the control and experimental treatment groups was equal, (2) no palatability problems occurred with feeding sodium bicarbonate, (3) cows receiving the bicarbonate consumed more forage (alfalfa haylage and corn silage) which increased their total dry matter intake by 0.11% of body weight which was statistically significant, (4) the cows receiving the bicarbonate buffer did produce slightly more milk (54.24 lb vs. 53.14 lb daily) especially the first half of the lactation cycle but the difference was not statistically significant, (5) milk fat percentage was considered to be normal for both groups (3.71 controls vs. 3.74 experimentals) with no advantage for the cows fed the bicarbonate of soda.

Amount of sodium bicarbonate consumed by the milking cows averaged 136 grams (4 oz) per head daily. This quantity did not show any dramatic responses or differences from the controls at this level of feeding. After reviewing the project, it was decided to conduct another trial and to increase the amount of sodium bicarbonate in the grain offered. This trial is now in the final stages of completion and data will be analyzed to determine if this higher level of buffer affected the various measurements of consumption and production as compared to control cows not offered any sodium bicarbonate in the ration.

You Can Change Cow Size and Still Use Top A. I. Sires

C. W. Young, G. D. Marx and J. D. Donker

For the past 15 years, the Northwest Experiment Station Holstein herd at Crookston has been bred to produce big or little cows. Originally, half of the cows in the herd were bred to bulls whose daughters had been evaluated as large, and the other half were bred to bulls whose daughters had been evaluated as small. Thereafter daughters of "large" bulls were mated to other "large" bulls, and daughters of "small" bulls were mated to other "small" bulls. This mating plan has continued with only progeny tested AI bulls being used.

Averages for weight and wither height for large-sired and small-sired two-year-olds that freshened during three two-year periods are shown in Table 1.

Table 1. Average weight and wither height for two breeding groups at five-year intervals, and differences between the two groups.

Period of freshening	Large sired			Small sired			Difference	
	N	Weight (lb)	Height (cm)	N	Weight (lb)	Height (cm)	Weight (lb)	Height (cm)
1970-1971	30	1097	131.8	26	1056	130.4	41	1.4
1975-1976	31	1098	132.6	27	1025	128.2	73	4.4
1980-1981	29	1179	135.7	22	1074	128.2	105	7.5

The differences in Table 1 are not large, but they do represent genetic differences for traits where variation is less than for production. The following observations from this project should be of interest to dairymen:

1. If your cows don't fit your facilities, you can change the size of your cows although it will be a slow process. Even a two inch change in height at withers can make a lot of difference in how comfortable a cow will be in a stall that is too small.

2. Most AI organizations recommend matings that will produce an intermediate sized cow. If you want to breed a cow that is large or small, you should do exactly the opposite of what they recommend. If you want smaller cows, you should breed to bulls that are recommended for use on the tall cows or on cows that do not need improvement in stature. Conversely, if you want larger cows, you should breed to bulls recommended for use on lowset cows. The Crookston herd has been bred this way for 15 years without ill effects. The current herd average is 19,942 pounds of milk and 727 pounds of fat.

3. There is very little correlation between cow size and production. Little cows at Crookston produce approximately the same as big cows. Bulls with high Predicted Differences (PD's) for milk or product value ($$) will sire high production regardless of the size of their daughters.

Southern Experiment Station, Waseca

Protein Levels in Calf Starter

K. P. Miller

Introduction

Early weaning is now widely practiced by dairymen but little information is available on starter rations for these early weaned calves. The effect of different starters on health, later growth and performance is important, as well as the immediate effects. It was previously reported that a starter containing 15% or 30% ground alfalfa provided a good nutritional base for later growth. These studies are with bull calves fed for beef; however heifer calves will respond in a similar manner. Suitable steer calf rations for the first 6 to 8 months will be desirable for heifers during that time. Later steers are fed a high energy finishing ration while heifers are continued on a growing ration.

Procedure

Male calves were purchased from several dairymen and moved to the Southern Experiment Station at approximately one week of age. Milk replacer was fed for 28 days and one of three corn-soybean meal starter rations containing 20% ground alfalfa hay was offered 2 to 3 days later. These starter mixtures were formulated to contain 12, 14 and 16% crude protein. Actual levels (by analysis) were 11.8, 13.6 and 15.5% protein (13.1, 15.1 and 17.2% on a dry matter basis). These rations were full fed until the lot averaged 400 pounds. From 400 to 700 pounds, all were fed a growing ration of 4 parts corn silage and 1 part rolled corn and urea supplement. After 700 pounds, 1 part corn silage: 1 part corn and supplement was provided. When the lot averaged 1050 pounds, the steers were marketed.

Results

Gain and feed data are shown in Tables 1 and 2. During the starter or calf phase, daily gain increased as protein level in the starter increased. Daily gains were 1.67, 1.80 and 1.88 pounds per day by calves fed the 11.8, 13.6 and 15.5% protein starters, respectively. Feed required per pound of gain decreased with increased protein in the starter (4.11, 3.77 and 3.64). These results would indicate that the higher protein ration was more desirable. However, during the growing phase when all were fed the same silage growing ration, daily rates of gain were 2.96, 2.80 and 2.68 pounds per day by calves fed 11.8, 13.6 and 15.5% protein starter to 400 pounds. During the growing phase 10.1, 10.2 and 10.7 pounds of corn silage and concentrate were required per pound of gain.

During the finishing phase, those started at the lowest protein level continued to gain at a faster rate on less feed. For the entire period from 93 to 1050 pounds, all groups gained at essentially the same rate and required about the same amount of feed. Death losses and frequency of health problems were similar among treatments.

Even though the recommended level (16%) of protein resulted in better performance to 400 pounds, the extra cost cannot be justified over the longer growth and development period. These results indicate that a 14% protein starter is adequate and when protein supplement is very expensive the lowest level used in this trial would be recommended.

Table 1. Average Daily Gain at 3 Protein Levels to 400 Pounds.

	Protein %		
Weight - Lb.	11.8	13.6	15.5
93 - 400 (calf phase)[a]	1.67	1.80	1.88
400 - 700 (growing phase)[b]	2.96	2.80	2.68
700 - 1050 (finishing phase)	2.87	2.81	2.73
93 - 1050	2.34	2.37	2.37

[a]Linear relationship (P <.05) treatment period

[b]Negative linear relationship (P <.05) growing period

Table 2. Feed/Gain - As Fed.

	Protein %		
Weight - Lb.	11.8	13.6	15.5
93 - 400 (calf phase)[a]	4.11	3.77	3.64
400 - 700 (growing phase)[b]	10.1	10.2	10.7
700 - 1050 (finishing phase)[b]	10.5	10.8	11.1
93 - 1050	8.5	8.4	8.5

[a]Linear relationship (P <.05) treatment period

[b]Negative linear relationship (P <.05) growing period

A Simple Program for Breeding a More Profitable Dairy Herd

C. W. Young, K. P. Miller and R. W. Touchberry

In 1964, the University of Minnesota began a dairy breeding project at its Southern Experiment Station at Waseca. The herd there was divided into two breeding groups called the selection group and the control group. The selection group has since been bred to active AI bulls having the highest Predicted Differences (PD's) for milk yield. No other trait has been considered, and four new bulls are used each year. The control group has since been bred to 20 control bulls that were selected in 1964. Frozen semen from those 20 bulls was obtained at that time and the same 20 have been used continuously since then. These 20 bulls had 50 or more daughters in many herds and had been summarized as being near breed average at the time they were selected. The purpose in using these bulls has been to maintain the control group at the same genetic level as existed in both it and the selection group at the start of the project in 1964.

In order to avoid changing the genetic level of the control herd, there has been no selection of cows based on production. Instead, cow removals from the control herd have been done randomly by drawing numbers from a hat. On the other hand, DHI records have been used to cull the lowest producers from the selection herd. Hence, this project is intended to measure the total genetic improvement that a dairyman could achieve over a period of time by

1. Using the best available AI sires chosen on the basis of PD milk, and
2. Testing for production and using production records to make culling decisions.

What have been the results?

After 17 years, the selection group averages 4500 pounds more milk per lactation than does the control. The selection group does have a little higher incidence of problems that are almost certainly associated with the stress of their higher production. However, intense selection based on PD production values has caused no detrimental problems of any kind. The daughters of high PD sires are far more profitable than the daughters of control sires.

Our conclusion is that dairymen who wish to have profitable, high producing herds should put major emphasis on the use of the very best AI sires available based on production PD's (preferably PD $$). They should also test for production and use their production records to eliminate low producers. These two programs are easy to use and have been proven effective by this project and by others similar to it.

Genetic Relationships of Yield and Fertility

L. B. Hansen

Many dairymen believe that high producing cows have more difficulty reproducing. Are high producers really more difficult to breed back? Or is the suspected antagonism between yield and fertility simply the irritation that results when a prized producer fails to reproduce? A study was recently completed at Iowa State University to clarify the relationships of yield and fertility in dairy cattle.

Breeding receipts from Eastern Artificial Insemination Cooperative, Ithaca, New York were matched with DHI production records for the period from February 1, 1974 to January 31, 1980. Numerous measures of yield and fertility were evaluated. Heritabilities for yield were from .20 to .23, whereas heritabilities for fertility were from zero to .03. The extremely low estimates of heritability for fertility suggest that selection for improved female fertility may be unsuccessful.

Genetic correlations between yield and fertility during first lactation were sizable and positive, indicating antagonism does exist between yield and fertility during first lactation. Antagonism moderated during second lactation, and most genetic correlations were not significantly different from zero for third lactation. Later lactations were not considered because these cows probably receive much preferential care.

Likewise, genetic correlations for virgin heifer fertility with first lactation yield were obtained, but were usually negative and opposite in sign from genetic correlations involving fertility during first lactation. Perhaps daughters of high PD sires are more thrifty and growthy and/or earlier maturing than daughters of low PD sires. Apparently, daughters of high PD sires may have improved fertility as heifers, but hindered fertility when the stress of increased yield is realized, particularly during first lactation. Therefore, it may be concluded that selection for higher yield may improve genetic potential for fertility, but the stress of increased yield may override this genetic potential for improved fertility.

A theoretical procedure based on index selection was applied to the estimated heritabilities and correlations, and incorporated with the economic values of yield and fertility. This procedure provides the appropriate amount of emphasis that should be placed on traits to maximize profit. Fertility had negligible influence. With the extremely low heritabilities of female fertility and the great economic values of yield, any deemphasis of yield in dairy cattle decreases economic returns to dairymen.

In conclusion:

1) daughters of high PD sires may have improved fertility as heifers.
2) daughters of high PD sires may have hindered fertility during first lactation, with less antagonism in later lactations.
3) economically, antagonism between yield and fertility in lactating cows is of little consequence since the heritability of fertility is very low and the value of yield is great relative to fertility.

Dietary Protein Requirements and Methionine Hydroxy Analog Supplementation During Early Lactation

R. G. Lundquist, D. E. Otterby and J. G. Linn

The first three to four months of lactation are extremely important when considering how to feed the high producing dairy cow. Peak milk production occurs during this period which in turn influences the amount of milk produced during the remainder of lactation. Normal feed intakes may not supply adequate protein to support the enormous demands for milk production during this time. Hence, the amount of protein supplied by the ration must be increased to make up for any deficit in this nutrient. Another concern in early lactation is the depression in milk fat test frequently encountered when milk production is high. Methionine hydroxy analog (a synthetic compound, which can be converted to the amino acid, methionine, in the animal) has been shown to increase fat test, especially during early lactation.

An experiment was conducted at St. Paul to evaluate the response to additional protein in early lactation and the effects of methionine analog supplementation at high levels of dietary protein. Holstein cows were fed either 13, 15, or 17.5% crude protein during the first 16 weeks of lactation. Half of the cows on each protein level were supplemented with approximately 30 grams of methionine analog per cow per day. Diets were 60% grain and 40% forage. Results of the experiment are presented in the following table:

	Protein percentage			Methionine analog	
Item	13.0	15.0	17.5	None	Added
Milk, lb/day	57.8	57.8	63.3	59.5	59.7
Milk fat, %	3.57	3.46	3.64	3.43	3.69
Milk protein, %	3.15	3.32	3.36	3.26	3.30

Cows fed 17.5% crude protein produced 5.5 lb more milk/day and tested slightly higher in milk fat and protein. Cows fed 15% protein did not produce more milk than those fed 13% protein. This may have been due to a lower genetic potential for milk production for some of these cows. Methionine analog supplementation resulted in a .26 percentage unit increase in milk fat. This response was consistent at all protein levels.

Economic Considerations

Supplemental protein is only beneficial if income from the additional milk produced is greater than the cost of the added protein. With soybean meal at $200/ton, cows fed 17.5% protein in our experiment netted about 35¢ more/cow/day than cows fed the two lower protein diets, or $42 more/cow during the first four months of lactation. The higher protein content of the milk also may be an important economic consideration if milk protein becomes a part of the pricing scheme. At this writing (butterfat differential of .17) milk from cows supplemented with methionine analog was worth 44¢/cwt more than that of nonsupplemented cows due to the higher fat test. Methionine analog supplementation cost about 10¢/cow/day.

Summary and Recommendations

Supplemental Protein

High producing cows need additional protein in early lactation. At least 16% crude protein in total ration dry matter is needed to support a peak production of about 85 lb/day. Higher producing cows may require higher dietary protein. Not all cows will respond to additional protein. The genetic potential for high production must be considered. Supplemental protein may be topdressed individually or fed as a separate grain mix or in a complete blended ration.

Supplemental Methionine Hydroxy Analog

Recommended rates of supplementation are approximately 30 grams/cow/day or about .25% of the grain mix. Topdressing methionine analog is not recommended as it is unpalatable unless well mixed with other ingredients. A fat test response is most likely to occur in cows fed high energy diets in early lactation. Normal protein levels fed during this period should not limit its effectiveness. This research was supported in part by The E. I. DuPont DeNemours & Co., Wilmington, DE.

Urea in Total Mixed Rations for Dairy Cattle

R. G. Lundquist, D. G. Johnson and D. E. Otterby

Urea can be an economical substitute for high priced natural protein supplements, but it has not always been utilized in high protein rations fed during early lactation. Urea is rapidly broken down to ammonia in the rumen. If ammonia production is too rapid and/or dietary energy is insufficient, the ammonia is not effectively utilized for protein synthesis by rumen microbes and is excreted by the animal as a waste product. These problems can be avoided or minimized if proper precautions and feeding recommendations are followed.

A 3-year study with 39 first-lactation and 81 older cows was conducted at the West Central Experiment Station at Morris to measure milk production of cows fed one of three levels of dietary protein during the first 90 days of lactation and to determine whether urea could substitute for a portion of the soybean meal in the higher protein rations. Complete blended rations composed of corn, corn silage, alfalfa haylage, vitamins, minerals, soybean meal and/or urea were fed. The control ration was 13% crude protein with no urea. Experimental rations were either 15 or 18% crude protein with no urea or 15 or 18% crude protein containing 1% urea.

Responses of two-year olds differed from that of older cows. Two-year olds were more variable in production and did not respond to dietary protein greater than 13%. However, older cows fed 15 or 18% protein produced more milk than those fed 13% protein. This response was observed whether supplemental protein was from all soybean meal or from soybean meal and urea, indicating urea was effectively utilized in the total mixed rations. Feed intake was slightly higher on the higher protein rations, which is consistent with other studies which showed that supplemental protein sometimes stimulates feed intake. Daily intake and milk production of older cows are shown in the following table:

	Protein source:	Soybean meal			Soy + urea	
Item	Protein, %	13	15	18	15	18
Dry matter intake, lb		39.5	41.9	41.0	41.2	42.5
Milk, lb		56.9	62.2	63.1	64.6	64.6
Fat, %		3.6	3.6	3.7	3.6	3.4
Fat-corrected milk, lb		52.5	56.9	59.1	60.6	58.4

This study indicates that urea can effectively substitute for a portion of the natural protein in complete blended rations if urea feeding recommendations are followed:
- Urea should be fed in high energy (corn, corn silage) rations for maximum utilization.
- Urea is unpalatable and should be mixed well with other ingredients.
- Cows should be adjusted to urea gradually (7-10 day period) to avoid off-feed problems.
- No more than 1% urea in the grain mix or .4 to .5 lb/head/day should be fed.

Influence of Sodium Bicarbonate on Growth and Health of Young Calves

P. J. Eppard, D. E. Otterby, R. G. Lundquist and J. G. Linn

Sodium bicarbonate has been used as an additive in rations for dairy cows and steers. Recently, Minnesota research showed that acceptability of very sour colostrum or acid-preserved colostrum (pH about 3.9 instead of 4.6) could be improved by addition of sodium bicarbonate (.6% of total weight fed). Other workers have suggested that performance of calves might be improved by addition of sodium bicarbonate to calf starters. In this study, we examined the starter in a 12-week trial with dairy calves.

Fifty-four Holstein and Jersey calves were assigned at 4 days of age within breed and sex to one of the following dietary treatments: 1) colostrum, milk replacer and starter, 2) colostrum, milk replacer and starter, all with added sodium bicarbonate, 3) acid-treated colostrum, milk replacer and starter, 4) acid-treated colostrum, milk replacer and starter, all with added sodium bicarbonate.

All colostrum had been collected and frozen before the trial. It was thawed, pooled, mixed, and divided into four portions. One portion was refrozen for use in diet 1. A second was treated with sodium bicarbonate (.6% of weight) for use in diet 2. A third (diet 3) was acidified with propionic acid and a fourth (diet 4) was acidified with propionic acid and then buffered with sodium bicarbonate. After treatment the colostrum was frozen in gallon containers for later feeding. Colostrum was fed from day 4 to 14 of life. Commercial milk replacer was fed to 28 days of age at which time the calves were weaned. Calf starter was fed free-choice beginning at day 4. The control starter consisted of 41.7% shelled corn, 22.9% oats, 20.9% soybean meal, 4.2% molasses, .8% trace mineral salt, .4% ground limestone, .4% dicalcium phosphate, and .4% vitamin premix. The sodium bicarbonate was added to the test starter at the rate of 2% of weight. Weight gains, feed intake and health data were recorded.

Calves fed the acid-colostrum diet 3 refused an average of 10.6 lb of colostrum (an average of 87 lb was offered/calf during the colostrum feeding period), whereas calves in the other groups refused 3 to 5 lb. The refusal occurred during the first two or three days of the experiment. Addition of sodium bicarbonate to acid-colostrum (diet 4) reduced feed refusal. Starter and total dry matter intake and average daily gains (Table 1) were similar and did not differ statistically among treatments. Calf health was good throughout the trial. Other than improving intake of acid-colostrum during the early part of the feeding period, there appeared to be no beneficial or detrimental effects of adding sodium bicarbonate to diets for young calves. This research was supported in part by Church & Dwight Co., Inc., New York, NY.

Table 1. Feed intake and performance of calves fed diets with or without sodium bicarbonate

	Diet			
Item	1	2	3	4
No. of calves	13	13	14	14
Daily gain, lb				
Day 4 to 14	.33	.64	.24	.24
Day 15 to 28	1.26	.99	1.30	1.30
Day 29 to 42	1.41	1.23	1.34	1.28
Day 43 to 84[a]	1.70	1.57	1.52	1.68
Daily dry matter intake, lb				
Day 4 to 14	1.26	1.32	1.19	1.16
Day 15 to 28	2.33	2.12	2.25	2.07
Day 29 to 42	2.98	2.84	3.09	2.82
Day 43 to 84[a]	4.91	4.59	4.63	4.81

[a]Data from heifers only.

Stray Voltage Problems with Dairy Cows

R. J. Norell, R. D. Appleman and R. J. Gustafson

Many dairymen are losing milk production and experiencing cow movement and cow health problems due to small currents of electricity passing through the cows' bodies. Research data collected at the University of Minnesota confirms field observations that a dairy cow can perceive a voltage of less than 1.0 volts across her body. It has become apparent that dairy cows are more sensitive than humans.

The source of these objectionable currents is generally a voltage (measured with respect to true zero-potential earth) that exists on the neutrals and all grounded equipment and facilities. A number of possible causes of excessive voltage on the neutral conductor have been identified from both on-farm and off-farm sources. With increasing loads on rural electrical distribution lines and increasing mechanization of farms, exposure of animals to stray voltages is increasing. Thus, a cooperative research project between the Departments of Animal Science and Agricultural Engineering was undertaken at the University of Minnesota St. Paul dairy.

Voltage is the product of "current times resistance". The electrical resistance of eight pathways through the dairy cow were measured. Preliminary analysis of data collected on 28 cows shows that "mouth to all four hooves" is the pathway of least resistance (360 ohms average, with 25% of the animals between 250 and 300 ohms).

More recently, the authors have undertaken an operant response suppression study to determine the aversive level of electrical shock. Six cows were taught to push a "nuzzle" plate for a food reward. Change in the time interval between each series of "nuzzle" plate activity was used to estimate the current required to cause a temporary suppression of eating activity. Some habituation (increased tolerance) occurred with repeated tests. On the average, plate pressing activity slowed noticeably when currents equaled or exceeded 3.0 ma. This shock intensity is equivalent to 1.2 volts (3.0 ma x 400 ohms = 1.2 volts).

While the "mouth to hoof" pathway is probably one of the primary pathways causing stray voltage problems, it is by no means the only one. Cows may be more sensitive to electrical shock through other pathways (front to rear hooves, teat to mouth, teat to hooves, etc.). More research is needed before definitive conclusions on maximum acceptable voltages can be determined.

Ongoing Dairy Research Projects

Controlled Selection Project (Waseca)

The objective of this project is to estimate the direct and correlated changes resulting from single trait selection for milk yield. One-half of the herd is bred to top PD milk sires, the other half to sires that were breed average in 1964. Among traits measured are milk yield, fat and protein percentages, body and udder measurements, reproductive traits, and health care costs.

Cow Size and Type of Ration Interaction Project (Crookston)

The objective of this project is to determine the size of cow and kind of ration that combine to give the most efficient production. Holstein cows are bred for large or small size and are fed rations that are high, medium, or low in forage content.

Mating System Comparison with Guernseys (Grand Rapids and Rosemount)

This is a comparison of linebreeding versus outcrossing to the best AI sires available based on PD milk. The breeding phase has been completed, but data collection and analysis continue.

Line Development with Holsteins (Morris, Rosemount, Grand Rapids and Waseca)

The objective is to develop four Holstein lines of different ancestry, and to make all crosses among them to determine the merits of linebreeding and linecrossing as an alternative to mass selection.

New Breed Development (Rosemount)

The objective of this project is to combine the best individuals from several breeds into a competitive dairy breed. Breeds being combined are all red or red and white.

Effect of Sodium Bicarbonate and Dietary Fat on Fat Content of Milk from High Producing Cows (Crookston)

The objective of these experiments is to measure the influence of these additives on milk composition and production and feed intake of cows of very high genetic potential.

Effect of Different Diets and Lactation Number on Protein Components of Milk (St. Paul)

Alfalfa and Brome in Rations for Lactating Cows (St. Paul and Rosemount)

The objective of these experiments is to determine the effects of high quality forages fed in different concentrate: forage ratios on milk production and to determine differences in the digestive processes of cows fed these rations.

Influence of Increasing Feed Particle Density on Rate of Passage (St. Paul)

The experiment involves increasing feed particle density by chromium mordanting of plant cell walls. Rates of passage of forage are being determined.

Influence of Particle Size on the Determination of Feed Components (St. Paul)

The objective of these experiments is to study the influence of particle size of a range of forages, altered by grinding or sieving, on forage components - total cell walls, hemicellulose, cellulose and lignin. Methods for calculating particle size also are being investigated.

Methionine Hydroxy Analog in Diets for Lactating Cows (St. Paul)

The objective of this study is to determine the effect of analog on milk composition and production in diets containing alfalfa and brome in 3 forage: concentrate ratios.

Growing Rations for Heifers (Morris)

The objective of this experiment is to evaluate the effects of grower diets and breeding age on performance of young lactating cows.

Effect of Housing, Season, Birth Weight and Milk Solids Intake on Performance of Young Calves (Morris, Rosemount and Waseca)

The objectives are to evaluate nurseries or hutches, feed intake (1.2 or 1.5% of weight), season, small, medium or large size at birth as to the effects on health and performance.

Protected Protein for Lactating Cows (St. Paul)

Formaldehyde-treated soybean meal is being compared to untreated meal as protein supplements for cows in early lactation.

Level of Moisture in Total Mixed Rations (St. Paul)

Four moisture levels (24 to 60%) in complete, blended diets are being compared to determine effects on intake and production.

Physiology of Early Bovine Embryos and Clones (St. Paul)

The objectives of these experiments are to obtain genetically identical cattle and to develop an early pregnancy detection test.

Stray Voltage Problems with Dairy Cows (St. Paul)

The objectives of this project are to determine resistances of the various electrical pathways through the cow, determine current sensitivity levels and quantify behavioral and milk production responses to low-level stray voltages.

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