PROCEEDINGS
OF THE
ELEVENTH ANNUAL

FLORIDA DAIRY
PRODUCTION CONFERENCE

Institute of Food and Agricultural Sciences

TEACHING
RESEARCH
EXTENSION

IFAS

University of Florida

"Effective Management"

University of Florida
Gainesville
April 30 and May 1, 1974

SPONSORED BY
DEPARTMENT OF DAIRY SCIENCE
COOPERATIVE EXTENSION SERVICE
AGRICULTURAL EXPERIMENT STATION
OF THE
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES
WITH COOPERATION OF STATE DAIRY ORGANIZATIONS
TO: Florida Dairymen and Those in Related Enterprises

SUBJECT: PROCEEDINGS

ELEVENTH ANNUAL FLORIDA DAIRY PRODUCTION CONFERENCE

April 30–May 1, 1974

Dear Dairy Cooperators:

The Eleventh Annual Florida Dairy Production Conference brought together authoritative speakers on topics of current major interest to the progressive minded dairymen and agri-business friends in attendance. Use of dairymen who have carried out specific practices successfully along with college men and other speakers assured a practical approach to the problems and information on their solution.

Appreciation is expressed to all who participated in making it a successful Conference. We think the Proceedings with resumes on the different topics will serve as a reminder and source of information for reference.

Special appreciation is expressed to Dairy Farmers Inc. (DFI), South Florida Independent Dairy Farmers Association (IDFA), the Tampa IDFA, the Upper Florida Milk Producers Association, Suncoast Milk Producers Cooperative, U. S. Sugar Corporation and others for helping to finance and publicize the Dairy Conference.

Special thanks is given to the Dairy Division of the State Department of Agriculture and Consumer Services for their support and participation in the awards program on Tuesday evening, April 30.

A list of those attending the conference is included.

Sincerely,

Barney Harris, Jr.
Extension Dairy Nutritionist
and Conference Chairman

BHjr:rt
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WHAT'S AHEAD FOR DAIRY FARMERS?

Eugene C. Meyer, Managing Editor
Hoard's Dairymen
Fort Atkinson, Wisconsin

Predicting what is ahead for dairy farmers is risky business. Certainly the year 1973 was one of the most frustrating ever experienced. Someone has said that politics, economics, and milk have been mixing vigorously and the result has been more problems than solutions.

If you base your knowledge of the dairy business on what you see on television or what you read in the urban press, you get the impression dairy farmers are rolling in money and that they are the only "special interest" group trying to bring influence to bear in Washington. Recently, Consumer Reports called the milk business one of the "scandals of the American economy." A headline in the April 8 issue of "Time" magazine said, "Milkmen skimming off more cream."

No mention is made in the urban press of the fact that 85 percent of all dairy farmers have gone out of business since 1950. There's seldom reference made to the fact that we experienced a milk production drop of over 3 percent this past year, the first decline in 3 years. It's true we're finally seeing higher milk prices, and gross dairy incomes were up 12 percent last year. However, due to skyrocketing feed costs (soybean meal prices that hit $4.50 per ton last summer) along with other higher production costs, prices paid by dairy farmers went up 20 percent. This resulted in a drop in milk production per cow for the first time in 30 years. The decline in production is continuing this year--March production was down 3 percent from last year bringing output for the first three months to 27.9 billion pounds, down 2.9 percent from a year earlier.

It appears to me that dairying's future depends largely on three major factors:
1. Milk production costs.
2. Government's policy on imports.

You dairymen know that the major costs of milk production are feed and labor. While it is foolish to try to predict what feed prices will be the rest of this year, we can expect some moderation. Prices have leveled off quite a bit from the peaks of last summer. Last week we paid $140 per ton for 44 percent soybean oil meal--and just 2 months ago it was still $200 per ton.

This should improve the milk-feed price ratio which has been extremely unfavorable to dairymen for several months. In March it was down to 1.48, lowest since 1965.
You all know the situation on dairy farm labor. The inability to find and keep good help continues to be one of the major reasons why dairymen quit. The number of dairy farmers advertising in our "Help Wanted" column keeps growing. Most of these are in herds of 100 or more. While that still is small compared to Florida standards, it means that unless those dairymen find help soon, they, too, will have to sell out. Nationally, we lost 9 percent of our dairymen last year, that's 44,000 herds. In Wisconsin, 3186 herds were sold--that's 9 per day. Only 800 went out the previous year in Wisconsin.

With today's technical dairy operations, just any old help won't do. Dairymen can operate no longer with what is unacceptable to other industries. The problem is twofold. There are fewer people who know how to milk cows, and those who know how have been able to find alternative employment opportunities that are more attractive. This means it will cost more in the form of more bonuses and incentive payments for dairy farm labor.

Obviously, dairymen can't pay more for labor unless they receive a higher price for milk at the farm. That leads into the second point...will government permit higher prices or will the import button be used to keep dairy prices down?

Based on what has been happening, I believe it is safe to say that reliance on dairy import quotas may be a thing of the past. Dairy imports this past year were equivalent to 3.9 billion pounds of milk, more than double the 1972 total, and the most on record.

Without going into detail on the Flanigan Report or the Atlantic Council plan, both call for greatly expanded feed grain exports in exchange for a tremendous increase in dairy imports. Some estimate that by 1980, more than 10 percent of our manufactured dairy products will be imported. While administration officials deny this will happen, continuing Presidential proclamations for increased imports of dairy products give every indication it already is happening.

I'm sure you all remember that on January 2, President Nixon authorized import of 100 million pounds of cheddar cheese, in addition to the regular annual quota. Regardless of what some people have been saying, including many within the industry, the current drop in the price of cheese is evidence that allowing these extra cheese imports was a serious mistake. Since January of this year our domestic cheese production has increased 19 percent and cheese stocks in storage have shot up 40 percent. In February cheese production in this country was up 28 percent from a year earlier, the highest for the month on record. In addition to the imports, consumers have been shifting back to meat since meat prices have leveled off from their high levels a year ago that caused consumers to switch to cheese.

On March 4, the President authorized 150 million pounds of nonfat dry milk imports for the period ending June 30, 1974. Imports normally are limited to 1.8 million pounds of nonfat dry milk. Four days later the Secretary announced that the price of manufacturing milk would be supported at $6.57 per hundred (80 percent of parity), the lowest level required by law. To me it makes no economic sense to set prices at their lowest legal level at the same time we call for emergency imports of dairy products.
It's understandable why dairy farmers lack confidence in what the administration plans to do with respect to imports. It appears that subsidized dairy imports are going to be used in an effort to keep a lid on dairy prices here at home, regardless of how much it costs dairy farmers to produce milk. Some say that if we cannot compete with foreign dairy farmers, we have no reason to impose quotas. Our contention is that if the countervailing duty law were imposed which was passed 30 years ago, we could compete with dairy farmers throughout the world.

It seems inconsistent that we should develop a program of dependence on other countries for a food as vital as dairy products at the same time that we find it desirable to develop a program of independence for fuel production.

Right now there is a surplus of manufactured dairy products in Western Europe, particularly the European Community. If weather conditions are favorable, this surplus will continue for the foreseeable future. It's easy to understand why. For their production year beginning this April, the support levels are $7.34 per hundredweight; $96.3 cents per pound for butter; and 43.2 cents per pound for nonfat dry milk. Originally they intended to lower the support price for butter, but producer groups pushed for higher support levels to compensate for higher costs, and they won. It is estimated that production in the EC during 1974 will increase nearly 4 percent over 1973.

The problem for us is that they continue to heavily subsidize butter going into export. Throughout last year the price in Lebanon for EC butter was about 45 cents a pound compared to the EC support price of 96.3 cents per pound; They also shrunk their butter mountain considerably by selling 441 million pounds of butter to Russia for 19 cents a pound.

As of February 1, 1974, butter stocks in the EC amounted to 638 million pounds. They now have 28 million dairy cows in those 9 countries compared to our 11.2 million. Milk consumption in Europe is dropping, so more milk to going into manufactured products, mainly butter. Naturally, they are looking to an increased market in the United States and so far, they have figured out right.

This brings me to the third factor, what does all this have to do with sales of dairy products? After many years of substantial declines, per capita consumption of milk and dairy products began to hold its own in 1971. In 1972, it actually increased by 3 pounds per capita to 561 pounds. Sales continued to increase through mid-1973 until retail prices turned sharply higher last fall. Since then, we've moved into a new ballgame. Except for some isolated areas, including the Southeast, where there has been an aggressive advertising and promotion campaign, it's pretty hard to find any current encouraging sales data. In 57 Federal Order Markets, there was a steady drop in the last 5 months of 1973 and it has continued in 1974. For February, the latest figures we have, fluid milk sales were off 6.5 percent from a year earlier.

Even though milk still is a good buy, it faces stiffer competition. You're probably all familiar with "Dairene," called the "modern milk" in the Southeast. The label and advertisements claim the same amount of protein as whole milk, more vitamin A than whole milk, no cholesterol, a lot of iron, and fewer calories.
Several weeks ago it was selling for just 69 cents a half gallon in the same market where milk was selling for 80 cents a gallon. Even though it has been found that the product does not contain what the advertisements claim, this is the type of competition milk will be facing in the months ahead. Whenever milk prices increase, interest develops in imitations and substitutes.

Milk faces stiffer competition from other beverages. Soft drink consumption has jumped 100 percent in the past 12 years, while milk drinking has declined 25 percent in the past 20 years. Americans today drink more than 100 quarts of soft drinks annually (equivalent to 400 8-ounce bottles of pop per person). That approaches the 130 quarts of milk consumed per capita. We also drink 130 quarts of coffee per years (same as milk); 78 quarts of beer; and 30 quarts of various fruits and citrus juices.

There's a limit to the amount of liquid the human body can consume. When you look at the way these competitive beverages are merchandised, you realize the job we have ahead of us in order to compete. Even though production and consumption are nearly in balance today, we must constantly support effective dairy promotion efforts. This means a substantial amount of advertising. Without it, we can expect a significant downturn in dairy sales during 1974.

In this connection, we should raise the minimum standards of milk. Milk would taste better and it would be more nutritious if we raised minimum standards on whole milk to 3.5 percent butterfat and 8.5 percent solids. This would insure that the consumer would get a good-quality product, and, based on consumer tests that have been made, we could sell more of it.

Despite some dark clouds on the dairy horizon, I believe the established dairymen can do quite well financially this year and in the foreseeable future. For those who continue in business, supplies will be tight and milk prices are likely to remain strong. There are just 300,000 dairy farmers left, and a lot of folks will decide not to milk cows 365 days a year and be more than $200,000 in debt just to be employed in dairying. No one is forced to milk cows. With opportunities open to them, more people are making other choices.

There are things not being done by all dairymen that would help them earn better returns for their efforts. Every dairymen should be on some form of testing program, for example. Here in Florida, just 16.5 percent of the herds are on test. In some states over half the herds are on test.

There is no reason why a high percentage of all cows and heifers aren't bred to bulls with a high Predicted Difference for milk. Furthermore, a dairymen won't make a profit, regardless of the price of milk, unless he has a sound herd health program and keeps good financial records. While you may choose not to do all these things, remember that many of those you compete with are doing them.

Finally, become involved in your dairy and farm organizations. We need more unity of effort among dairy and farm organizations. See that able men are elected to your boards of directors. Get to know your congressmen on a first name basis. Give support to those who understand your problems. Fight to prevent the dumping of subsidized dairy products on your fellow dairymen. The dairy industry needs strong leadership at every level, and this takes involvement by all dairy farmers.
If our national leadership does not awaken to the vital and essential character of the dairy industry in our national welfare, this country could face a milk famine which would make the current energy crisis pale in comparison.

Hopefully, there is enough strength among us to prevail when decisions are made concerning national dairy policy. I still believe we can have a strong, viable dairy industry. America needs it!
Modern dairying resembles a business enterprise today more than a family way of life. Economic factors dictate the way dairymen operate including his management practices. Dairying is a fast changing industry and is affected by many internal and external economic, environmental, and sociological pressures. If one is serious about staying in the dairying business and making dairying a sound business enterprise, he should organize himself in a way to consistently meet all the pressures pushing in on him, his financial obligations, and provide him and his family with a good standard of living.

**Tools in Successful Dairying.** The modern dairyman, large and small, must use every tool available to help meet the competition. Dairymen should develop an organizational structure to deal with the legal and financial problems that may arise and, yet, allow freedom for making decisions as needed. Another important aspect of running a successful operation is a good recordkeeping system. The legal requirements for reporting to the Internal Revenue Service also makes a good recordkeeping system mandatory.

Dairymen have three of the most powerful and effective tools known, all of which provide information to make wise management decisions. These tools are DHI production testing and recordkeeping programs, USDA-DHIA sire summary, and Artificial Insemination Program. Dairymen should learn to use these tools to his advantage. A dairyman that does not use these tools is cutting himself out of competition, yet he is expected to compete with dairymen that do use them. The national trend in dairy management is the heavy use and increased dependence upon these programs by dairymen everywhere.

**DHI Production Testing and Recordkeeping Programs.** Join your local Dairy Herd Improvement Association. Production testing is the foundation for a good recordkeeping system. DHI gives valuable information for making wise management decisions. A dairyman without records has no idea of a cow's production, product value, income over feed costs, reproductive record, health history, or her break-even point. The cows on test have a real economic advantage over the cows not on test. It is impossible to list all the reasons why you should be in the DHI Program, but any good dairyman can do a better job with DHI records.

**USDA-DHIA Sire Summary.** The USDA-DHIA sire summary gives the genetic ranking of bulls for transmitting milk and fat producing ability to his daughters. Genetic improvement is tied closely to the profit margin in your herd. Dairymen who use bulls of unknown or inferior genetic merit either are unaware of the real cost to them or simply don't care.
The time a dairyman spends in sire selecting and mating his cows is the most productive and valuable time he can spend on the dairy. Suggested steps of how to use the sire summary might include the following:

1. Make a list of superior bulls with predicted differences above a certain level that have repeatabilities above 50%.

2. Determine the semen price and reproductive efficiency. Screen out the bulls that are over priced and those that are below average in reproductive performance.

3. Rank the remaining bulls on transmitting ability for economically important non-yield traits.

4. Use some young unproven bulls with superior pedigrees.

5. Rank cows on milk yield and same economically important traits as the bulls.

6. Plan the matings of each cow.

Artificial Insemination Programs. The AI industry provides semen from superior proven sires that you may select for use in your herd, the quality of which many dairymen cannot afford to own. The most important advantage of using AI is economics. Many dairymen cannot afford to own or house the number of bulls of the quality he wants to use in his herd. Safety is also an important consideration. There is also less disease transmitted with AI.

Animal identification is one of the most important factors in a successful dairy enterprise. Positive identification for each animal is assured in these programs and is essential for positive genetic progress.

National Trends. In discussing the national trend in record management in large herds, we need to recognize some changes or trends in the dairy industry itself. The number of herds continues to decline with environmental and economic pressures. The number of cows per herd continues to increase as the number of herds decreases. As herd size increases, there are increasing demands put upon management, capital, and labor. There is also a corresponding increase in the demands put upon production testing and record management systems. Dairymen are demanding better and more reliable records and more information for making wise management decisions.

In large herds, management necessarily becomes less involved with individual cow management. Systems of managing by groups of cows therefore have evolved. The managing of groups of cows has also increased the efficiency, utilization, and distribution of dairy labor. Dairy labor, however, continues to maintain the close personal contact with individual cows. Adequate and accurate records on individual cows must provide management with all the information needed to make decisions.

Systems of large herd management have largely dispelled the old adage that individual cow production would suffer in large herds because of lack of personalized cow attention and tender loving care required. The evidence is that the average production per cow has continued to increase as the average
herd sizes increase. This relationship can be explained largely by the fact that large herds can better afford the more capable and qualified management and that they make better use of the information available. It is important to point out that one should not increase size for size sake. The management skills of a dairyman do not automatically increase with herd size. True, dairymen with larger herds have greater opportunities for greater profit, but he also has greater opportunities for increased losses and problems. The income advantage of size comes from a greater income flow generated by more units of production and the reduced cost of production per unit. Maximum profits are the result of management in all operations and applied to all resources.

**Computerized Dairy Records.** The most significant trend in dairy records is the use of computerized dairy record systems in the DHI Program. The DHI production testing and recordkeeping programs have evolved into the most successful computerized recordkeeping systems in agriculture. The dairy industry must not be locked into management systems that do not give dairymen the information needed for making decisions in his herd.

The DHI system is the result of expressed needs of dairymen for more complete, accurate, and reliable information. As a result, it includes a lot of information, probably more than any individual dairyman can possibly use. He quickly learns, however, to manage the figures and papers well in order to get the information he needs and lets the rest fall, so to speak, between the chairs.

The requirements of, and use of, different information by different dairymen is an indication of variations in the needs and type of management skills in the dairy industry today. The level of management ability and skills of dairymen is higher today than it has ever been. Most dairymen in the computerized dairy record program are making good use of their records in management. Of course, many do not.

There is a strong feeling against the sentiments held by some to force all dairymen to use a single or the same type of program of identical information. This would be a real mistake as there is a great range in the different kinds of information needed by different dairymen based on the nature of their operation, management skills and objectives.

There are three basic categories of options or decisions that dairymen should have in order to receive the type of information he desires which include: instructions to the computer options, management and summary options, and special service options.

**Instructions to the Computer Options.** An effective computerized record system should provide dairymen with choices or options in the way he wants his records processed reflecting his needs and management skills. In this way, the dairyman's records become personalized taking on the unique characteristics of the herd and of the management and reflects the type of operation, conditions of herd, herd size, and composition, breeding and health problems, labor and external influences, and the immediate objectives and long range goals of the dairy.
We must constantly strive to make the computerized dairy records system fit the needs of dairymen. We must never make the dairymen conform to the demands of the computer, lest initiative and progress be stifled and result in mediocrity. We must be sensitive to the needs of a dynamic and fast changing industry and be willing to change when need dictates.

Options might include whether or not a dairymen wishes to manage by strings of cows (groups) that are in some way similar. Each string may be handled and processed individually as a complete herd and all groups combined. Another option may be the type of animal identification he wants printed - cow, sire, dam, name, or number depending on the one most beneficial to him and his operation.

He might specify the number of days after calving that he wished to breed his cows. He may pre-determine the requirements and level of feeding as well as the number of days dry and days open that he wishes for the cows in his herd. He may also specify his own minimum culling level or break-even point and choose between several feed and accounting systems.

He may also have his cows ranked or compared by milk, fat, fat corrected milk (FCM), solids-not-fat (SNF), or dollar value of product produced. There might also be a management or miscellaneous column. Any information not already specified to enter the computer in other areas may enter the herd. Dairymen may also design any additional program important to his operation and report information through this channel.

Management and Summary Options. This category includes analysis and reports of all management information in addition to production data. There may be management reports for cows to dry, to breed, to calf, cows that may be potential culls as well as strings and herd summaries. Extra reports might include other services such as CMT, SNF, classification or type scores, sires selected, cows diagnosed pregnant, number of times bred, services per conception, or herd reproductive status.

Herd summaries may also show the deviation from the goals expressed as options. It may show in a distribution chart the average days to first breeding and by age group. It may further show the number that were bred to soon and the number that exceeded the option. Herd summaries may also include the average age at calving, calving intervals, days in milk at first breeding, and the number of days open. Monthly production totals and averages are shown for all cows and for milking cows, for the test interval, and a 30 day interval, and on a rolling 12 month basis. Several of these optional reports also included suboptions that still give more refinement to the information essential to dairymen.

Special Services Options. Special service should enable a dairymen to request from the computer information on his herd that is not provided on a monthly or routine basis. Among the most popular of these reports are the comparisons of daughters by sire groups and dam groups. The current enrollment status report is an important option when enrolling a new herd. Other reports might include the list of cows by milk, fat, FCM, SNF, days in milk, days carried calf, age at last calving, lactation number, index numbers over all strings, registration or ear tag numbers, CMT groups, cows to check for pregnancy, and the mature equivalent of cows by milk, fat, or FCM.
Since there is a tendency to manage by strings, there is also a need to provide herd and string summaries. These summaries are an attempt to analyze the group or herd of cows as a unit. These could more appropriately be considered a measure of progress or analysis of the management to determine if the goals and objectives are being achieved. Is the dairyman accomplishing what he thinks he is? What changes in management are required to achieve the objectives? Should the objectives be revised to be more realistic?

Most of our testing and recordkeeping programs and management recommendations were developed years ago when herds were small, production was low, and the knowledge of nutrition and genetics somewhat limited. We must now work hard to develop new methods, procedures, techniques, management recommendations, and testing and recordkeeping systems more applicable to our large modern dairy herds.

The best way I know to assure that dairymen use their DHI computerized dairy record management system is to provide the information that he feels he needs to make wise management decisions. This information may not be the same information desired by all dairymen.
SOME NECESSARY TOOLS FOR GETTING
AND USING CREDIT

John Holt*

"Complete records of farm income, balance sheets, and
cash flow which indicate past progress and enable projections
of future potential are essential tools in merchandising
credit [3, 170]."

"So what if money costs 12 percent," one dairyman said. "I am in the
20 percent income tax bracket, so a dollar only costs me 80 cents. That
gets the interest down to about 10 percent, and inflation is running 9
percent, so I've only got to make one percent on borrowed money. Any fool
can make 1 percent." This paper will discuss some ways to improve on the
ability to make that one percent.

What a task it has been to stay ahead of inflation and to try and pro-
vide for the unforeseen. The difficulty of doing so gives us the reason for
becoming more interested in using forward planning tools--imperfect as they
are. Likely we will never be able to predict the future adequately. But
attempting to "map the route" we expect to travel over the next accounting
period is a first step in improving the ability to plan effectively. And,
effective planning can be the most important thing a dairyman does.

The ability to sell credit can be improved by planning. Three tools
turn out to be the most help in both selling credit effectively and using
it wisely. They are: income statements, financial statements, and cash
flow plans. Using these basic tools can improve both the physical and
financial management ability of most managers. The problem is that it takes
a lot of work to put them together, and some practice in their use before
they are of much value.

Let's examine these three tools. Since the first two are much more
commonly used, more explanation will be devoted to the cash flow plan.

The Income Statement

This is the summary of profitability. It's main intent is to measure
the net value of the firm's production attributable to an accounting period.
It also goes by other names; the "operating statement" or the "profit and
loss statement" being the most common. Most larger dairymen have accounting
firms prepare income statements for them similar to the one in Table 1.

The income statement is most useful for analysis by lenders when three
to five years of annual summaries are available. They show the profitability
"track record" of a dairy over good years and bad.

Many managers use monthly income statements to spot cost items that
are getting out of line. Percentages can be calculated for major expense
categories like feed and labor and compared with projections.

* Extension Farm Management Specialist in the Food and Resource Economics
Department, Institute of Food and Agricultural Sciences, University of Florida.
Table 1. An Example. Statement of Income and Expense, Year ending December 31, 1972.

<table>
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<td>Calves</td>
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<td>Dividends</td>
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<td>Labor</td>
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<td>Fertilizers &amp; Lime</td>
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NET PROFIT (OR LOSS) ON OPERATIONS $ 17,460

OTHER INCOME & DEDUCTIONS

Gain—132 Culls Sold $ 25,000

NET INCOME $ 42,460
Another common use of income statements is to help in income tax management. Quarterly, nine-month, or 11 month summaries are particularly useful in trying to soften Uncle Sam's bite.

Profitability comparisons between different investments can be made by dividing profits by total equity. This provides a measure of return on equity. These are common uses for income statements.

Somewhat less common is the practice of making "pro-forma" income statements. That is, projections for the next time period. Comparing actual profit with the level which was projected in the pro-forma income statement a year ago can be educational, to say the least. The really important thing about comparing projected and actual profitability is to see if the differences between "planned" and "actual" can be explained. The major intent of this effort is to improve the ability of management to get on top of change by learning to plan for it.

The Finance Statement

Lenders may reach for the finance statement first and study it longest. Small wonder, because its purpose is to reveal the liquidity and solvency of the dairy. Also known as the balance sheet, or net worth statement, it is a picture of the financial condition of the firm at a specific moment in time, whereas the income statement summarizes economic events over a specific period. The example income statement reflected things going well. If they did not we might see a finance statement like Table 2. Notice the liquidity problem.

Liquidity concerns both dairymen and lenders because it refers to the dairy's capacity to generate enough cash to meet its financial commitments as they fall due. The "current" section of the finance statement provides measures of liquidity. "Working capital"—current assets minus current liabilities—is a commonly used measure of liquidity. (A minus $36,230 in Table 2). However, the finance statement is usually taken January 1, and most of the cash outflow associated with the dairy will not be reflected in current liabilities at the beginning of the year. Therefore, the cash-flow projection may be a more important source of information for liquidity analysis than is the finance statement. Cash flow projections will be discussed later. Let's turn to solvency.

Solvency deals with the dairy's ability to meet long-run claims. From the lender's point of view, measures of solvency indicate the problems of recovering loans if the business fails. Most lenders "don't want to be more than an equal partner" in a dairy. Therefore, they frequently will not extend credit to anyone whose leverage ratio (leverage = debt / equity) is greater than one.1/ This is understandable because lending institutions have rather narrow profit margins, high leverage ratios and relatively rigid liquidity requirements. Since many lending institutions themselves have leverage ratios

---

1/ If real-estate lenders require a one-third equity in land, this means a maximum debt-to-equity ratio of two. Since market values for Florida land are high, it is quite possible for a dairymen to use land as collateral and generate a greater debt load than the cash flow from the dairy will support.
Table 2.—An example—Finance Statement, January 1, 1971

<table>
<thead>
<tr>
<th>ASSETS</th>
<th>1971</th>
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<tbody>
<tr>
<td><strong>CURRENT ASSETS</strong></td>
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<tr>
<td>Cash</td>
<td>$ 3,400</td>
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<td>Accounts Receivable:</td>
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<tr>
<td>Upper Florida Milk Producers</td>
<td>12,620</td>
</tr>
<tr>
<td>Inventories: (At Cost)</td>
<td></td>
</tr>
<tr>
<td>Feed</td>
<td>3,000</td>
</tr>
<tr>
<td>Raised Calves - (40 head)</td>
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<tr>
<td>Prepaid Interest</td>
<td>600</td>
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<tr>
<td><strong>Total Current Assets</strong></td>
<td>$28,120</td>
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<tr>
<td><strong>FIXED ASSETS (At Cost)</strong></td>
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<tr>
<td>Cows &amp; Bulls (400 Head)</td>
<td>$185,000</td>
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<tr>
<td>Dairy Equipment</td>
<td>39,000</td>
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<tr>
<td><strong>Sub-total</strong></td>
<td>$224,000</td>
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<tr>
<td><strong>Less Accumulated Depreciation</strong></td>
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<td><strong>Total Fixed Assets</strong></td>
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<td><strong>OTHER ASSETS</strong></td>
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<tr>
<td>Accounts Receivable:</td>
<td></td>
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<tr>
<td>Upper Florida Milk Producers</td>
<td>$ 1,900</td>
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<tr>
<td>Neighboring Dairyman</td>
<td>2,700</td>
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<tr>
<td>Milk Base - non depreciable</td>
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<td>Prepaid interest</td>
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<tr>
<td><strong>Total Other Assets</strong></td>
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<table>
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<tr>
<th>LIABILITIES</th>
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<td>Accounts Payable</td>
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<td>Notes Payable - Current Portion</td>
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<tr>
<td>Accrued Taxes Payable</td>
<td>500</td>
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<td>Accrued Interest Payable</td>
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<td>Accrued Salaries Payable</td>
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<td><strong>LONG-TERM LIABILITIES</strong></td>
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<td>Notes Payable - Due after one year</td>
<td>$185,000</td>
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<td><strong>Total Liabilities</strong></td>
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<td><strong>Net Worth</strong></td>
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Table 3.—The Effect of Leverage on Growth Rates at Different Rates of Earning: Demonstrating the Principle of Increasing Risk

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<thead>
<tr>
<th>L</th>
<th>.25</th>
<th>.10</th>
<th>.00</th>
<th>-.10</th>
<th>-.25</th>
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<td>-32.0</td>
<td>-76.0</td>
<td>-142.0</td>
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</tbody>
</table>

(Annual percentage change in equity)

1/This table assumes rates of consumption, taxes, and interest of .50, .20, and .08 respectively.

ranging from 10.0 to 20.0 \[ p. 386 \], it is easy to see why they need proof
of financial management ability from dairymen who wish to extend their lever-
age ratio much beyond one.

Concern about leverage is well founded, as Table 3 illustrates. Notice
that unfavorable events have a greater impact on the business than do favora-
ble events. The effect of risk is magnified when borrowing is used to in-
crease leverage. In the left hand column head of Table 3, "r" refers to rates
of return that range from a positive 25 percent to a negative 25 percent. The
letter "L" identifies leverage ratios ranging from 0 (a debt free operation)
to 10—an operation with ten times as many liabilities as equity. Notice
that even with a leverage ratio of one, when the firm realizes no profit
\( r = .00 \), there is a loss in equity. This is due to the fixed interest
obligation on borrowed capital. It must be paid, whatever the rate of return.

Besides leverage ratios, changes in net worth are followed closely by
lenders. They are a useful gauge of solvency, provided there are no great
changes in total debts.

Leverage and other financial ratios are easily calculated from balance
sheets and are a convenient basis for comparison with the dairy's past ratios;
with industry standards; or more importantly, with the dairymen's projected
future goals. But ratios, at best, only serve as warning signals—some-
thing like the way a doctor relies on knowing a patient's temperature. Some
lenders calculate financial ratios and rely heavily on them in screening
loan applications. Their boards of directors may even require them to do so.
But, most lenders will let borrowers know what ratios they calculate and how
they are used. That information can be very helpful in preparing a loan
application.

Dairymen who do the most effective job of merchandising their credit
have accumulated financial statements which document their financial progress
over the years. As was the case with income statements, preparing "pro-forma"
or financial statements projected over the next accounting period can be a
very worthwhile exercise. It may even be required by lenders, if some par-
ticularly important expansion is being planned.

Cash Flow Planning

To paraphrase a biblical expression, there are few that enter the straight
and narrow way of cash flow planning. The process is simple; making a re-
corded projection of the amount and timing of expected cash inflows and ex-
penditures. But doing it right takes a lot of thinking and quite a bit of
pencil pushing. These projected cash flows are usually summarized on a monthly
basis, although quarterly or semi-annual summaries may be adequate for those
dairymen whose cash flows aren't expected to vary greatly.

It can be especially helpful to project annual cash flow summaries over
the period of time necessary to determine the payout of some new investment.
Table 4 gives an example of such a plan. It is the third year of a plan we
projected in 1972. This detailed a plan would likely not be done unless some
Table 4. General Crop and Livestock Farm Annual Cash Flow Summary by Month, 1974\(^{a}\)

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<td>3,376</td>
<td>13,855</td>
<td>8,725</td>
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<td><strong>Total Cap. Expenses</strong></td>
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<tr>
<td><strong>Total Expenditures</strong></td>
<td>5,481</td>
<td>3,376</td>
<td>13,855</td>
<td>8,725</td>
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Table 4. Continued

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<tr>
<td>Machinery</td>
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<td>6,709</td>
<td>2,908</td>
<td>1,077</td>
<td>1,636</td>
<td>63,992</td>
</tr>
<tr>
<td>Total Expenditures</td>
<td>2,167</td>
<td>3,896</td>
<td>6,709</td>
<td>2,908</td>
<td>1,077</td>
<td>1,636</td>
<td>63,992</td>
</tr>
<tr>
<td>Living Expenses</td>
<td>840</td>
<td>840</td>
<td>840</td>
<td>840</td>
<td>840</td>
<td>1,260</td>
<td>11,060</td>
</tr>
<tr>
<td>Repayment other loans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8,340</td>
</tr>
<tr>
<td>Cash Position</td>
<td>(3,007)</td>
<td>8,914</td>
<td>29,441</td>
<td>30,212</td>
<td>(1,917)</td>
<td>(2,021)</td>
<td></td>
</tr>
<tr>
<td>Payments: Principle</td>
<td>2,401</td>
<td>28,687</td>
<td>29,658</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest</td>
<td>6,513</td>
<td>754</td>
<td>554</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulated Borrowings</td>
<td>121,478</td>
<td>112,564</td>
<td>83,123</td>
<td>51,911</td>
<td>53,828</td>
<td>55,849</td>
<td></td>
</tr>
</tbody>
</table>
major expansion was being planned. Here we were projecting the effect of renting additional land and adding a beef cow herd to a general farm in North Florida. You will notice that it was the third year before our projected borrowing peaked out (July) and we began to reduce the absolute size of the debt load.

Several valuable features of cash flow planning can be seen. From a money management standpoint, the last four lines are the most important. The 'cash position' line reveals the monthly (deficit) or surplus cash flow after considering income, operating expenses, and the expected family drawdown on income. The bulges in family 'living expenses' in February and December are for income taxes and Christmas, respectively.

Both the borrower and lender can see when additional borrowing will be necessary and when payments will be made. Managers who have used this type of plan to establish a 'credit line' have more than paid for their planning effort with the interest saved by borrowing only what they needed, when they needed it.

One major value of such a plan cannot be seen in the cash flow summary. It comes from the process of pulling the information together to make the plan. Existing records must be studied; future production must be estimated; and future prices must be 'quesstimated' for both purchased inputs and products which will be sold. An humbling and a learning process.

The first step in preparing a cash-flow projection is to summarize the physical information for all the enterprises being considered. Table 5 gives an example of the labor requirements for a beef cattle operation (I haven't one this good for a dairy). This labor summary can have a host of direct uses by managers, including the coordination of work on separate farms. For example, from its preparation and use, both the owner and the on-site manager are aware of what should be done, when. Labor summaries are not normally a part of a cash flow plan, I included this one because of the importance of labor management on dairies, and to illustrate how the physical operation is finally reflected in the cash flow plan. These labor hours finally become labor expenses in the cash flow. Using this type of plan can improve communication and execution, even without any further planning.

Compiling financial data requires a similar kind of summary for all enterprise activities, using much of the same data that is summarized in the income statement. Operating and overhead expenses can be estimated from previous records and modified by any planned changes anticipated for the forthcoming period. Debt repayments would be listed, also.

Accumulating these data over something like a five year span will not only be useful to the manager in planning the course of his dairy, it will be invaluable in negotiating financing. Such data may even be required in the near future in order to merchandise debt effectively.
Table 5.--Schedule of production practices by months and time required, Situation 3: 2000 acres of permanent pasture, Flatwoods soil in Florida.

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Checking cows</td>
<td>72</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>72</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semen testing bulls</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Feeding hay</td>
<td>155</td>
<td>140</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>155</td>
<td></td>
</tr>
<tr>
<td>Branding &amp; vac. calves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>108</td>
<td>135</td>
</tr>
<tr>
<td>Pregnancy testing</td>
<td></td>
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<tr>
<td>Selling cows</td>
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<td>Selling calves</td>
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<tr>
<td>Selling heifers</td>
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<tr>
<td>Renovating pasture</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>160</td>
<td>160</td>
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<tr>
<td>Dipping cattle</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td>27</td>
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<tr>
<td>Weaning calves</td>
<td></td>
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<tr>
<td>Making hay</td>
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<td></td>
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<td></td>
<td></td>
<td>311</td>
<td>311</td>
</tr>
<tr>
<td>Putting bulls out</td>
<td>a</td>
<td></td>
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<tr>
<td>Mowing pasture</td>
<td>80</td>
<td>80</td>
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<td>80</td>
<td>100</td>
<td>100</td>
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<td>80</td>
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<tr>
<td>Draging pasture</td>
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<td>30</td>
<td>162</td>
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<td>162</td>
</tr>
<tr>
<td>Checking fences</td>
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<td></td>
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</tr>
<tr>
<td>Worming cattle</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total man-hours</td>
<td>353</td>
<td>354</td>
<td>196</td>
<td>146</td>
<td>274</td>
<td>326</td>
<td>326</td>
<td>490</td>
<td>377</td>
<td>377</td>
<td>170</td>
<td>337</td>
<td>3726</td>
<td>$6,393</td>
</tr>
<tr>
<td>Hrs. available (1 man)</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>85</td>
<td>170</td>
<td>1955</td>
<td>$6,393</td>
</tr>
<tr>
<td>Operator's labor</td>
<td>100</td>
<td>100</td>
<td>26</td>
<td>--</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>100</td>
<td>1011</td>
<td>3,306</td>
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<tr>
<td>Extra labor</td>
<td>83</td>
<td>84</td>
<td>--</td>
<td>--</td>
<td>4</td>
<td>56</td>
<td>56</td>
<td>220</td>
<td>107</td>
<td>107</td>
<td>--</td>
<td>67</td>
<td>784</td>
<td>2,062</td>
</tr>
</tbody>
</table>

a Hours included in dipping cattle.
b Hours included in branding and vaccinating.
c Hours included in above combined practices.
d Calculated at $3.27/hr. for the operator and full time employee and $2.63/hr. for extra labor. Includes employer's share of Social Security.

Table 6.--Expected Annual Returns--240 Dairy Cows.

<table>
<thead>
<tr>
<th>Month</th>
<th>1971&lt;sup&gt;a/&lt;/sup&gt; Average Production Per Cow&lt;sup&gt;b/&lt;/sup&gt;</th>
<th>Pounds Milk</th>
<th>1972, 1973, 1974</th>
<th>Future Receipt&lt;sup&gt;d/&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>688</td>
<td>165,120</td>
<td>7.90</td>
<td>13,044</td>
</tr>
<tr>
<td>Feb.</td>
<td>724</td>
<td>173,760</td>
<td>7.40</td>
<td>12,858</td>
</tr>
<tr>
<td>Mar.</td>
<td>732</td>
<td>168,360</td>
<td>7.60</td>
<td>13,351</td>
</tr>
<tr>
<td>Apr.</td>
<td>862</td>
<td>206,880</td>
<td>7.20</td>
<td>14,895</td>
</tr>
<tr>
<td>May</td>
<td>908</td>
<td>217,920</td>
<td>7.10</td>
<td>15,472</td>
</tr>
<tr>
<td>June</td>
<td>1033</td>
<td>247,920</td>
<td>6.90</td>
<td>17,106</td>
</tr>
<tr>
<td>July</td>
<td>794</td>
<td>190,560</td>
<td>6.90</td>
<td>13,148</td>
</tr>
<tr>
<td>Aug.</td>
<td>892</td>
<td>214,080</td>
<td>7.10</td>
<td>15,199</td>
</tr>
<tr>
<td>Sept.</td>
<td>822</td>
<td>197,280</td>
<td>7.50</td>
<td>14,796</td>
</tr>
<tr>
<td>Oct.</td>
<td>730</td>
<td>175,200</td>
<td>7.50</td>
<td>13,140</td>
</tr>
<tr>
<td>Nov.</td>
<td>717</td>
<td>172,080</td>
<td>7.60</td>
<td>13,078</td>
</tr>
<tr>
<td>Dec.</td>
<td>629</td>
<td>150,960</td>
<td>7.80</td>
<td>11,774</td>
</tr>
<tr>
<td>Total</td>
<td>1,941,240</td>
<td>167,861</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a/</sup> Returns for 1972-1974 are estimated for a herd of 240 cows.

<sup>b/</sup> Based on average production per cow in previous years (from the milk sold ÷ # cows on DHIA Report).

<sup>c/</sup> Taken from gross value ÷ pounds milk sold. (Note: Pounds of Class II milk may critically affect the average price received, as was the case in June and July).

<sup>d/</sup> Based on 240 cow herd maintaining average production shown and present milk prices.
Table 7.--Estimated Expenses--240 Dairy Cows.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs not projected to increase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debt payments (1) Land, parlor, etc.</td>
<td>$1,900</td>
<td>$1,900</td>
<td>$1,900</td>
<td>$1,900</td>
</tr>
<tr>
<td>Debt payments (2) 25 additional cows</td>
<td>280</td>
<td>280</td>
<td>280</td>
<td>280</td>
</tr>
<tr>
<td>Debt payments (3) 2 house trailers</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Debt payments (4) Front end loader &amp; wagon</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Utilities</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Costs projected to increase 5%/annum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor (3 men)</td>
<td>1,600</td>
<td>1,680</td>
<td>1,764</td>
<td>1,852</td>
</tr>
<tr>
<td>Supplies (soap, semen, medicine)</td>
<td>300</td>
<td>315</td>
<td>331</td>
<td>348</td>
</tr>
<tr>
<td>Withhold (Social Security)</td>
<td>150</td>
<td>158</td>
<td>166</td>
<td>174</td>
</tr>
<tr>
<td>Feed costs (w/ 240 cows)</td>
<td>5,400</td>
<td>5,670</td>
<td>5,954</td>
<td>6,252</td>
</tr>
<tr>
<td>Family expenses @ $100/wk.</td>
<td>400</td>
<td>420</td>
<td>441</td>
<td>463</td>
</tr>
<tr>
<td>Taxes</td>
<td>60</td>
<td>63</td>
<td>66</td>
<td>69</td>
</tr>
<tr>
<td>Seed, fertilizer, maintenance</td>
<td>100</td>
<td>105</td>
<td>110</td>
<td>116</td>
</tr>
<tr>
<td>Land lease</td>
<td>50</td>
<td>53</td>
<td>56</td>
<td>59</td>
</tr>
<tr>
<td>Hauling</td>
<td>200</td>
<td>210</td>
<td>221</td>
<td>232</td>
</tr>
<tr>
<td>Repairs</td>
<td>125</td>
<td>131</td>
<td>138</td>
<td>145</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$11,065</strong></td>
<td><strong>$11,485</strong></td>
<td><strong>$11,927</strong></td>
<td><strong>$12,390</strong></td>
</tr>
</tbody>
</table>

*a$450 each, 9% interest amortized over 4 years.
A "Rough and Ready" Example

The detailed information discussed in the preceding section would be ideal, and will become increasingly necessary in the future, it seems to me. But in the heat of battle, we sometimes use something just a little short of ideal. Tables 6 and 7 contain a "first cut" at a cash flow plan by a Florida dairyman who wanted to get four-year financing on 25 head of replacement cows. He had been on a three year repayment schedule for his purchased replacements. He was heavily mortgaged, and like the hunter up in a tree with a bobcat, needed some relief. He was having trouble with his liquidity.

This effort took place in 1971. The tables are unedited. Retrospect and 20/20 hindsight give us some clues about what that planning effort lacked.

This plan was successful in one respect. With it, he got four year financing on his cows. But he didn't stay in business. He couldn't keep current. Probably the first mistake was an overly optimistic projection of the number of cows in the herd. He couldn't maintain it without buying more cows. But on a different note, we all can breathe a sigh of relief as we look at the milk prices in Table 6.

In Table 7, there is no projection for buying more cows to maintain the herd. On the other expenses, probably the records from which these estimates came were a little too skimpy. Almost certainly, the family living expenses were underestimated. And we all know what has happened to feed costs. By underestimating expenses, he projected more net income than he was able to make.

This example illustrates at least two major points. First, it is easy to borrow more money than can be paid back. Secondly, the planner must be realistic about what can be done. Making production estimates calls for conservatism, it seems. It is, for example, very difficult to maintain a high level of milk production per cow when herd size is being rapidly expanded. This kind of "management adjustment lag" is frequently underestimated in planning.

Planning for an uncertain future is difficult at best. Nobody needs the extra burden of paying off a mortgage developed with a set of rosy production assumptions.

Conclusion

Each individual must decide for himself how much debt he is willing, and able, to handle. Income statements, financial statements and particularly cash flow plans can help determine how much debt can be managed by a dairyman. Then he can effectively merchandize his credit with any lender by projecting profitability (pro-forma operating statement), improved solvency (pro-forma balance sheet) and projected repayment ability (cash-flow projection).
The beauty of it is that preparing and using these documents can't help but increase management ability. Many of the top dairymen in Florida are using them now.

REFERENCES


THE STRATEGY AND ECONOMICS OF MASTITIS CONTROL

W. Nelson Philpot, Ph.D.
North Louisiana Hill Farm Experiment Station
Louisiana State University
Homer, Louisiana 71040

STRATEGY

Two main approaches may be made to mastitis control. The first involves conducting individual herd investigations in an attempt to discover the causes of existing infections. This approach includes extensive use of laboratory services and specific advice for each herd. Such an approach is not practical on a large scale because half of the cows in most herds are infected and require special investigation. Also, even with the best technical equipment it is often impossible to discover the precise reasons for a high level of infection.

The second, and more practical approach, is the use of a control system that is effective in most herds and does not require investigations by specialists. The primary objective of such a system must be to reduce subclinical staphylococcal and streptococcal infections to low levels. To be acceptable, the control system must cost less than the disease itself, be relatively simple to carry out, work under most management conditions, and substantially reduce clinical mastitis soon after being adopted.

For practical reasons the effectiveness of a mastitis control scheme is assessed in terms of the reduction in level of infection (i.e., the proportion of cows or quarters infected) rather than the reduction in the rate of new infection. The level of infection in a herd depends both on the rate of new infection and on the duration of each infection. At first glance the influence of duration of infection may not be obvious but it can be illustrated with a simple example. If one new infection occurs once each week and infections last for 1 week, then one new infection will be present at any given time. However, if the infections last 4 weeks, then four infections will be present at any given time.

The duration of infection has another important effect in that it determines the rate of change in the level of infection. If the rate of new infection in a herd is reduced, the level of infection will fall to a new equilibrium, and the time taken to reach the new level will be the average duration of the infections. The factors influencing level of infection are simplified as follows:
Average level of infection = Total cows infected in period x Average duration of infected cows remain infected

(% cows infected) (as % of total cows) (as % of period)

If either B or C are reduced by 50%, the level A will fall by 50% and if both B and C are reduced by half, the level will fall by 75%. This means that effective control could be obtained with modest reductions in both rate and duration of infection. It must be recognized that if such a control is started and the level falls by 75% the new level will not be maintained unless the steps taken to reduce both rate and duration are continued. If either B or C increase then there will be a directly proportionate increase in the level of infection.

It is important to note that the relationships discussed do not give any indication of the time required for the reduction in level of infection to occur, but a control relying on reducing new infection alone would act very slowly because of the high average duration of infection. The reason for this can be seen by expanding the B term in the equation given above.

Total cows infected in period = Cows infected at start of period + Cows uninfected at start becoming infected in period

(as % of total cows) (% of total cows)

Data from an extensive field experiment revealed that B = 80% of cows, D = 56% of cows, and E = 24% of cows. Therefore, even if a preventive system was completely effective and no new infection occurred the total cows infected would decline by less than one third during a 12-month period. Long-term programs for mastitis control should be based on the prevention of new infection, but it must also be recognized that with any control system designed to reduce staphylococcal and streptococcal infections the rate of decline of infection in the first year will depend much more on how much the duration of infection is reduced than on the reduction in the rate of infection.

Prevention of Infection

The Streak Canal. The streak canal is the portal of entry into the udder for mastitis organisms. Thus, in any effort to effectively prevent infections emphasis must be given to protecting the integrity of the canal.

The streak canal is normally a very effective barrier to the
penetration of bacteria. It is approximately 10 mm long and is closed by the sphincter muscle except during milking. A healthy canal provides an environment that is continually repressive to microbial growth due to the presence of cationic proteins. On the other hand, a damaged streak canal is easily colonized by bacteria which invade the udder at a rate at least tenfold higher than in the case of normal canals.

Bacteria may overcome the barrier of the teat canal by multiplication, mechanical movement, or propulsion during milking. It seems likely that in most cases a combination of factors is involved.

Transfer of Pathogens. Bacteria from quarters with clinical or subclinical mastitis, together with those from infected teat lesions, are spread from cow to cow on the milker's hands, udder cloths, and milking machine clusters. Most milking routines include foremilking, udder washing, and some degree of machine stripping. Therefore, even with the best hygiene methods, some transfer of pathogens will occur at milking time. Methods that aid in reducing this transfer include incorporating a sanitizer in the water used for preparing the udder and the use of a single-service paper towel.

Teat Dipping. The dipping of teats immediately after milking with a safe and effective product is the most important single practice that a dairy farmer can employ for preventing new infections. Teat dipping does not exert a rapid effect on the level of infection in a herd because it does not affect existing infections, but its importance in a long-term program of mastitis prevention cannot be over-emphasized.

An efficient teat dipping program is normally very effective in preventing intramammary infection even when the teats are experimentally exposed to bacteria immediately before milking. This implies that pathogens contaminating teats before and during milking are important mainly because they leave teats contaminated after milking and permit colonization of the teat duct. Thus, the main effect of a post-milking teat dip is to destroy pathogens left on teats after milking and to prevent streak canal colonization. This observation suggests that a significant percentage of new infections occur during the interval between milkings. Effective dips also reduce the number of infected teat lesions and increase the healing rate of existing ones.

During the past 5 years extensive studies have been conducted in Louisiana on teat dips. The findings have revealed that the rate of infection is reduced by more than 50% when teats are dipped with effective products. Recent work on 59 teat dip products revealed that approximately 20% of the products were not effective against common mastitis pathogens. Fortunately, most of the ineffective products are being modified or removed from the market by the manufacturer.

Role of Milking Machines. It is well known that milking machines influence the incidence of udder disease by acting as a vector for transferring pathogens between and within cows, and as a traumatic
factor causing external lesions on teats if they are not properly maintained and used.

Recently, extensive research studies were undertaken on milking machines in England. Though this work is still in its early stages, a few important conclusions can be gleaned from the data. These are summarized as follows.

1. The combination of cyclic and irregular fluctuations in vacuum, coupled with fast movement of the inflation wall, caused an increase in the infection rate.

2. Most machine-induced infections occurred near the end of milking, thus confirming the long-standing recommendation that cows should not be overmilked.

3. A close correlation existed between new infections and the occurrence of impacts on the end of the teat. Impacts may be defined as tiny droplets of milk that are propelled from the short milk tube (inflation stem) back against the teat end as the liner opens and when cyclic and irregular vacuum fluctuations occur.

4. The impact force of milk droplets returning to the opening liner can implant contaminated milk in the teat canal. The chances of such contaminated milk being washed out by other milk is obviously reduced the nearer implantation occurs to the end of milking. Too, organisms implanted in the teat canal are out of reach of teat dips applied after milking.

5. It was further concluded that contaminated milk may be propelled through the teat canal and into the teat cavity where the chances of infection are greatly enhanced.

6. Impacts may be suppressed in three ways: (a) by using short milk tubes and claw nipples of very large bore in conjunction with a slow rate of re-evacuation of the pulsation chamber to reduce cyclic fluctuations in vacuum; (b) by bringing the short milk tube at an angle into the exit end of the liner or at such an angle of attachment as to prevent impact on the end of the teat; or (c) by providing a deflector device or shield near the exit end of the liner to intercept milk droplets returning from the short milk tube.

7. Extensive studies revealed that the use of shields reduced significantly the number of impacts as well as the number of new infections under research conditions.

8. Large-scale field trials are now underway in commercial dairy herds to test the value of shields in inflations for preventing machine-induced infections. Preliminary results indicate that the shields are working satisfactorily in some herds but not in others. Obviously, more research is needed to establish which herds are likely to benefit from the use of protective shields. It is a source of
encouragement, however, that some fundamental research is finally being conducted on milking machines and their relationship to udder health.

In summary, fluctuations in vacuum should be minimized by having the milking machines checked by a qualified serviceman at least twice a year. Any observed deficiencies in machine function should be corrected immediately. Also, the teat cups should be removed from the udder as soon as milk flow ceases in order to prevent many machine-induced infections.

**Role of Vaccination.** Vaccination against the common mastitis pathogens has been of little value in reducing the incidence of new infections. It may be of some value in specific herds for reducing the severity of clinical cases but will not affect the incidence of clinical cases.

**Elimination of Infection**

Once infection occurs, it can be eliminated only by spontaneous recovery, culling, or therapy. These methods are discussed separately.

**Spontaneous Recovery.** Approximately 20% of all streptococcal and staphylococcal infections are eliminated in this way; however, most spontaneous recoveries occur in quarters with mild or recent infections and only rarely in the case of well-established infections. A greater proportion of streptococcal infections (24%) disappears by spontaneous recovery in the dry period than of staphylococcal infections (8%).

The mechanism of spontaneous recovery appears to be independent of the natural defense mechanisms which prevent the establishment of new infections. Since we do not understand the mechanism of action here we cannot capitalize on spontaneous recovery as a means of eliminating infection.

**Culling.** Culling is often the only practical means of eliminating chronic infections from a herd. There are obvious economic limits, however, to the proportion of cows that can be culled due to clinical mastitis. In one extensive study, it was revealed that only 7% of the cows account for 40% of all clinical mastitis. This level of culling is probably acceptable for most herds and would remove a primary source of mastitis pathogens from the premise as well as a substantial percentage of the clinical cases.

**Therapy.** It has been shown that both spontaneous recovery and culling have serious limitations in terms of utility for reducing the duration of infections. It has also been shown that if a mastitis control system is to reduce infection to low levels in months rather than years, it is necessary to treat subclinical as well as clinical mastitis. Probably, the best time to accomplish this is at drying off. Treatment at drying off has the following advantages: the efficacy
of treatment is higher than when administered during lactation; high-persistence antibiotic formulations may be used; the number of infections that occur during the dry period is reduced significantly; damaged tissue may be regenerated before freshening; clinical mastitis at freshening is reduced by up to 90%; and salable milk is not contaminated.

Most programs for treating dry cows call for treating all quarters of all cows at drying off with a specially formulated, high persistence antibiotic formulation. Some workers feel that only selected quarters should be treated in herds with a low level of mastitis. In such instances, treatment is limited to cows with a clinical history, or those positive to the California Mastitis Test during the last month of lactation.

The prognosis regarding effective treatment of S. agalactiae mastitis is excellent because the organism is an obligate parasite of the bovine udder, a low-grade pathogen, highly sensitive to penicillin; and a normal inhabitant of the milk ducts of the udder where it can be reached by drugs. In most herds a single infusion of 100,000 units of penicillin will result in the elimination of approximately 90% of the infections due to S. agalactiae. Larger doses of penicillin are seldom, if ever, needed in the treatment of S. agalactiae mastitis. This organism can be eradicated from a dairy herd by repeatedly culturing milk samples from each cow and treating all infected quarters. Other strains of streptococci often cause a more severe type of mastitis than S. agalactiae and effective treatment is more difficult.

The likelihood of effective treatment of staphylococcal mastitis is low. Many strains of staphylococci secrete toxins which enable the organisms to readily penetrate the duct walls of the udder where they become established in numerous foci that are walled off with fibrous tissue, thus creating a habitat virtually impenetrable by drugs.

The ability of some staphylococci to develop resistance to antibiotics is well-known. It appears, however, that tissue barriers formed within the udder as a result of the presence of the organisms are of much greater importance in therapeutic failures than the matter of drug resistance. As a general rule, a treatment efficacy of only about 50% can be expected from the treatment of subclinical staphylococcal infections. The efficacy will be much lower in instances of well-established infections. A study in Louisiana showed that the efficacy of treatment was 68, 67, 28, and 13% for staphylococci-infected quarters producing milk with California test scores of 0, 1, 2, and 3, respectively.

Sensitivity Tests. Drug sensitivity tests should be conducted on all organisms cultured from quarters with acute or clinical mastitis. A high percentage of the organisms involved in such cases are usually resistant to one or more of the commonly-used therapeutic agents. It is not necessary, however, to conduct sensitivity tests on all isolates from quarters with subclinical mastitis because only
a small percentage of these organisms have been found to be resistant to the commonly-used drugs. While sensitivity testing provided the best guide to the selection of an effective therapeutic agent for treatment against a particular organism, successful treatment depends upon the antibiotic diffusing to all sites of infection within the udder in sufficient concentration to kill all the organisms present.

Drug Residues. Prevention of drug residues in milk is critically important. Milk should be discarded in strict accordance with the instructions on the label of any therapeutic agent used.

ECONOMICS

Practically every person who has any association with the dairy cow is familiar with the clinical manifestations of mastitis. Unfortunately, only a relative few appreciate the prevalence and economic significance of the subclinical form. Subclinical mastitis is important because it is 15 to 40 times more prevalent than the clinical form, usually precedes the clinical form, is of long duration and difficult to detect, reduces milk production, and adversely affects the quality of milk. Thus, in efforts to abate mastitis, emphasis should be focused on the subclinical disease.

Money Losses. Research conducted by numerous researchers has documented the high cost of mastitis. The losses are divided as follows:

- Death and premature culling-------------------14%
- Milk discarded-----------------------------8%
- Treatment and veterinary expenses----------8%
- Reduced milk production---------------------70%

These figures confirm that the greatest losses result from a decrease in milk production from subclinically affected animals. Indeed, work in Louisiana revealed an average loss of 46% in milk production from quarters which were shown to harbor subclinical infections and which yielded a California Mastitis Test score of 3. In each case, the milk was visibly normal and the presence of the disease would not have been recognized by dairy farmers.

Recent research conducted at Cornell University revealed that milk losses from a single infected quarter averaged 1,700 pounds per lactation. In other words, a single infection resulted in a milk loss of well over 100 dollars per year.

A close correlation also exists between lost herd milk production and the number of somatic cells present in bulk tank milk. Most herd milk contains between 500,000 and 1,000,000 somatic cells per milliliter. Yet, such herds are losing an average of 12% in milk production. These figures again translate to losses in excess of 100 dollars per cow annually.
Response From a Control System. Large scale field trials conducted in the U.S. and abroad have measured the effect on level of infection of dipping teats immediately after milking with an effective teat dip and treating each quarter at drying off with a specially-formulated antibiotic preparation. These simple procedures were shown to be highly effective. The level of infection in the commercial herds was reduced by 50% within 1 year and 75 to 85% within 2 to 3 years. In addition, the somatic cell content of the bulk tank milk decreased from 730,000 to 320,000 over a 3-year period and the incidence of clinical mastitis declined at least 40%.

Money Returns. The significant reductions in level of infection were accompanied by an increase in herd milk production of more than 1,000 pounds per cow annually. At current milk prices this amounts to an increased yearly income of approximately 100 dollars per cow from following the simple and effective control procedures. The total cost of the program, i.e., teat dip, antibiotic treatment tubes, and extra labor, amounted to less than 15 dollars per cow per year. This left a net profit of about 85 dollars per cow. Another way of viewing these figures is that the dairy farmer realized 5 to 7 dollars in return for every dollar invested in the control program.

Herds with a high level of infection obviously stand to realize greater profits than herds with a low level. Nevertheless, the implementation of an effective mastitis control program is a wise and prudent decision. The challenge to everyone in the dairy industry is to try to achieve greater implementation of these effective mastitis control methods on dairy farms.

Acknowledgement

Free use has been made in this paper of findings published by mastitis research workers at the National Institute for Research in Dairying, Shinfield, Reading, England.
POTASSIUM, MAGNESIUM, AND SULFUR IN DAIRY NUTRITION

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Animal Health and Nutrition Division
International Minerals and Chemical Corporation
Libertyville, Illinois 60048

Potassium, magnesium, and sulfur have traditionally been classified as essential elements for the maintenance of life. Nutritionists, however, have not been concerned with them in formulating dairy feeds. The feeling has been that the common feed ingredients supply an adequate amount of these elements to meet the animal's needs. Because of this, research on feed levels and animal requirements has not been as extensive as for some other elements such as calcium or phosphorus. With today's dairy management systems it is no longer profitable to ignore these elements in our feed formulations. My objective is to provide you with a greater appreciation for the importance of these three mineral elements in your dairy feeds and the levels of each which are needed for optimum production.

Potassium is the third most abundant mineral element in the animal body - surpassed only by calcium and phosphorus; therefore, from a quantitative standpoint, it is one of the most important of the mineral elements.

<table>
<thead>
<tr>
<th>MINERAL CONTENT OF ADULT CATTLE (Average Values)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Elements</strong></td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Phosphorus</td>
</tr>
<tr>
<td>Potassium</td>
</tr>
<tr>
<td>Sulfur</td>
</tr>
<tr>
<td>Sodium</td>
</tr>
<tr>
<td>Chlorine</td>
</tr>
<tr>
<td>Magnesium</td>
</tr>
</tbody>
</table>

In contrast to sodium, which is found primarily outside the cell - in the plasma and extracellular fluids, potassium is found primarily inside the cell. Potassium is involved with cellular acid-base balance, ionic balance, water balance, and is one of the body's most important electrolytes. These functions are essential in the life processes and potassium plays a key role in them.

Potassium activates or functions as a co-factor in several enzyme systems. These include energy transfer and utilization, protein synthesis, and carbohydrate metabolism. Potassium is concerned with many metabolic reactions involving phosphorus. Since phosphate metabolism is so fundamental, a great diversity of metabolic reactions of the cell seem to be influenced by potassium.
Potassium also plays an important role in the electrical activity of nerve and muscle cells and the transmission of nerve impulses. This involves an active transport of potassium and sodium across cell membranes.

Proper balance of potassium and calcium at the cellular level is required for normal muscular activity. Excesses of calcium in relation to potassium can result in a muscle existing in the fully contracted state — calcium rigor. By contrast, elevated levels of potassium in relation to calcium tend to have a relaxing effect on the muscle.

Potassium is a component of our principle livestock products — milk, meat, and eggs. Potassium is the most abundant mineral element in milk.

**COMPOSITION OF COW’S MILK**

<table>
<thead>
<tr>
<th></th>
<th>%</th>
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<tbody>
<tr>
<td>Water</td>
<td>87.2</td>
</tr>
<tr>
<td>Protein</td>
<td>3.5</td>
</tr>
<tr>
<td>Fat</td>
<td>3.7</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.9</td>
</tr>
<tr>
<td>Ash</td>
<td>0.71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>0.147</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.102</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.101</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.055</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.053</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.028</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.010</td>
</tr>
<tr>
<td>Iron</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The dairy cow's requirements for calcium and phosphorus are based upon the level of production because of the need for these two elements in producing milk. It is not appreciated by many that the actual need for potassium in milk production is considerably greater than that of either calcium or phosphorus. A dairy cow in high milk production actually excretes large quantities of potassium each day in her milk. For example, a dairy cow producing 40 kg. (88 lbs) of milk/day needs 60 g. of potassium, compared to 40 g. of phosphorus and 48 g. of calcium for her milk production alone. In addition she needs potassium for all other physiological functions. Failure to provide net absorptions of these amounts results in either negative body balance or reduced milk production. Obviously, gross negative mineral balances cannot proceed for any length of time without reduced production or a health crisis. The dairy cow will produce milk of fairly constant potassium content, that is, regardless of the potassium level in her feed, her milk potassium level will remain about the same. The consequence of this is that if the feed level of potassium becomes too low to meet the needs for milk production, the cow will adjust her milk output (lower it) to accommodate the shortage of potassium.
Potassium must be supplied daily in sufficient quantities because it is a very mobile element. There are no appreciable body reserves other than those in the muscle and nerve cells - where it is vital to cellular functions.

Of the magnesium in the animal body, approximately 70% is found in bone, 28% in the cells of the soft tissue, and 1% in the extra-cellular fluids. Magnesium in the skeleton probably has a structural function, as well as, a storage function. As an animal matures, its ability to utilize or have access to the skeletal magnesium diminishes greatly. Adult animals may be able to mobilize only 2% of their bone magnesium to satisfy physiological needs, whereas in young animals 30% of the skeletal magnesium can be mobilized and translocated under conditions of reduced magnesium intake. Once again, the importance of supplying the animal's needs on a daily basis should be stressed - especially for mature livestock.

Magnesium is known to be an activator for many enzymes. Because it is so intimately involved with systems dealing with protein synthesis and energy metabolism, it is probably involved in almost all body processes. Even though much is known about the role of magnesium in many physiological systems, it still is not possible to explain the gross systems of magnesium deficiency based upon this knowledge. Some of the earliest studies on magnesium demonstrated its relaxing effects on the animal. Decreased levels of magnesium enhanced irritability apparently through increased nerve conduction and increased muscular contractility. In fact, the most common characteristic of a magnesium deficiency is hyper-irritability. Magnesium is also one of the body's important electrolytes and in quantity is second only to potassium as an intracellular electrolyte.

Sulfur is an element that is of unquestioned importance in nutrition. The generally accepted belief is that the total sulfur requirement is satisfied by the two sulfur containing amino acids, methionine and cystine. These play a prominent role in protein structure and function. Proteins function as structural components (collagen), as catalysts (enzymes), as carriers of oxygen (hemoglobin), as hormones (insulin), and in many other ways. Sulfur in the sulfate form is an important part of a group of polysaccharide compounds which when combined with specific proteins are classified as mucopolysaccharide. One of the most important of these is chondroitin since it is an essential structural component of cartilage, bone, tendons, and walls of blood vessels.

Metabolic functions of sulfur are due to the sulfur amino acids bound to proteins, free sulfur amino acids, and other sulfur compounds of relatively low molecular weight. In addition to the structural role which sulfur containing amino acids play in proteins, sulphydryl groups are often involved at the active site of an enzyme. It has been estimated that nearly 90% of the specific activity of all enzymes would be inhibited if the sulphydryl groups of those enzymes are destroyed.

Because of its role in protein structure and enzyme activity, sulfur is involved in almost all aspects of metabolism. Sulfur is also involved in the vitamins, thiamin, and biotin. Sulfate sulfur is very important in the detoxification of many substances of metabolic origin prior to their excretion in the urine.
Dr. Conrad and Dr. Bouchard at Ohio State University have conducted an interesting series of experiments on the utilization of sulfur sources by dairy cattle. They tested several sources and levels of sulfur and utilized both a semi-purified concentrate and a corn-soy concentrate.

In one of their experiments using the semi-purified concentrate, a basal diet containing 0.10% sulfur was supplemented with either sodium sulfate or Dyna-Mate (IMC's double salt of potassium and magnesium sulfates) at levels of 0.18% and 0.24% sulfur in the complete diet. The basal sulfur deficient diet decreased dry matter intake, dry matter digestibility, and milk production, and caused the sulfur balance to be negative. Supplementation of the basal diet with Dyna-Mate or sodium sulfate increased dry matter intake, dry matter digestibility and milk production. However, Dyna-Mate was superior to sodium sulfate in maintaining higher nitrogen and sulfur tissue storage for the same sulfur supplement level in the complete diet. When Dyna-Mate was added to a corn-soy concentrate in an amount sufficient to elevate the sulfur concentration of the total diet to 0.20%, the following differences were observed when compared to the unsupplemented diet with 0.12% S:

<table>
<thead>
<tr>
<th></th>
<th>Basal</th>
<th>Basal + DYNA-MATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. M. digest.</td>
<td>67.0%</td>
<td>69.4%</td>
</tr>
<tr>
<td>S retention</td>
<td>1.0 g/day</td>
<td>5.4 g/day</td>
</tr>
<tr>
<td>Apparent S digest.</td>
<td>47.7%</td>
<td>66.6%</td>
</tr>
<tr>
<td>Absorbed N used for milk &amp; tissue</td>
<td>48.5%</td>
<td>52.9%</td>
</tr>
<tr>
<td>N:S ratio</td>
<td>19.0</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Bouchard and Conrad, OARDC, 1973

When compared to the basal diet the addition of Dyna-Mate increased the dry matter digestibility from 67% to 69.4%. This was statistically different at the 95% probability level. The sulfur retention was increased from 1 to 5.4 g/day. The apparent sulfur digestibility was increased from 47.7% to 66.6% (this was statistically significant at the 95% probability level) and the proportion of nitrogen absorbed which was used for milk production and tissue storage was increased from 48.5% to 52.9%. It was concluded by the Ohio workers that the optimum level of sulfur in the complete diet for high producing cows is 0.2%. It should be noted that the N:S ratio of the basal diet was 19.0:1 as compared to 11.4:1 for the supplemented diet.
Because sulfur is so directly related to protein and nitrogen utilization, especially in the ruminant animal, it is not surprising that guidelines would be developed to relate these two items in formulating diets. Even though the sulfur content of the diet may be less than optimum, the effects of sulfur deficiency are less dramatic than the effects of deficiencies of some other elements. If the diet contains a wide ratio of nitrogen to sulfur, the animal adjusts to this ratio by wasting nitrogen. Reduced efficiency of feed protein utilization is the principle effect of sulfur deficiency.

There is fairly general agreement among researchers that the dietary N:S ratio should be approximately 10:1. This is especially true if the diet contains non-protein nitrogen. The nitrogen-sulfur ratios of many feedstuffs including roughages are wider than 10:1. The ratio of total nitrogen recycled through the rumen to the sulfur recycled is of the order of 70-80:1. Therefore, there are clearly circumstances under which the animal cannot profit from the nitrogen recycling mechanism because of a sulfur deficiency. Under these conditions, supplements of non-protein nitrogen without additional sulfur are valueless.

Variation in ingredient composition is always a concern for any nutritionist formulating feeds. Because of variations, it is not practical to formulate to minimum animal requirements. The application of margins of safety for specific nutrients is entirely the nutritionist's responsibility. The margin may vary depending on the ingredients available and if the variation is greater than the margin of safety must be increased.

Several studies on feed ingredients have shown that the levels of the three elements, potassium, magnesium, and sulfur vary to a considerable extent. Although it is necessary to use average values for formulation work it is important to realize that the actual content of the ingredient used may be quite different.

Proper potassium, magnesium, and sulfur levels in the diet have a direct effect on profitability. Many of their functions are interrelating so the improvement of one results in the improvement of another. Milk production, feed intake, feed efficiency, growth, nitrogen utilization, fiber digestibility, reproduction, and stress resistance are influenced by these three elements.

Milk production has been shown to be influenced by all three elements. It is now recognized that elevated levels of magnesium will at least partially correct low fat test milk caused by low fiber diets. The high producing cow has a tremendous requirement for potassium due to milk production. Since milk is produced with a fairly constant composition, limitations of potassium can cause a decrease in milk output. This element is very important on a daily basis in the diet of any dairy cow.

One of the first observable effects of a slight deficiency of potassium, magnesium, or sulfur is a depression in feed intake. Feed intake, of course, is very important to efficient production since without proper feed intake
all other functions suffer. Potassium and sulfate have both been observed to influence feed efficiency. Similar observations have been made with regards to growth.

Sulfur has a very important bearing upon nitrogen utilization, especially the efficiency with which the nitrogen is utilized. The elements, potassium and magnesium, due to their metabolic involvements in this process, are indirectly related and effect the efficiency also.

Fiber or cellulose digestibility has been demonstrated to be effected by sulfur levels, and again, this can have very important practical benefits both in the case of milk production and feed efficiency or growth.

All three elements, of course, are necessary for the reproductive system to function normally. This aspect of the animal production system must be operating efficiently if profitability is going to be realized.

The following Table presents recommendations for total ration levels of magnesium, potassium, and sulfur to meet nutritional needs from Cornell, Penn State, NRC and IMC:

<table>
<thead>
<tr>
<th></th>
<th>Cornell</th>
<th>Penn State</th>
<th>NRC</th>
<th>IMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.8-1.1</td>
<td>0.8</td>
<td>0.7</td>
<td>0.8-1.0</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

I could have picked several others, but use these to illustrate the general agreement in recommendations. Dr. Crowley of Wisconsin has indicated that the magnesium value for dairy cattle should be formulated at 0.25-0.30 to allow for ingredient variations.

In summary, we have discussed the functions of potassium, magnesium, and sulfur in dairy nutrition. Evidence has been presented that they do have direct effects on profitable animal production. Today's feeding practices that create greater crowding of our livestock, reduced use of roughage in ruminant feeds, increased use of NPN sources, changes in ingredient quality, and use of lower quality ingredients due to increased feed costs, all place greater stress on your nutritional knowledge and the application of that knowledge to feed production. The pressures of the profit and loss statement in today's agri-business makes it essential to use every tool at your disposal to produce nutritionally balanced, profitable feeds.
EPA's New Guidelines in Dairy Waste Management

L. B. Baldwin

The Environmental Protection Agency (EPA) has recently issued guidelines for control of "feedlot" wastes under the direction of an Act of Congress, October, 1972. On that date, Congress amended the Federal Water Pollution Control Act and established national goals for the virtual elimination of pollutant discharge to surface waters by 1985. The program is called the National Pollutant Discharge Elimination System (NPDES). It calls for increasingly stringent reduction of pollutant discharge, with an interim level to be reached by July 1977, and another by July 1983.

The Florida Department of Pollution Control has been studying the establishment of rules to protect Florida surface waters. While still in draft stages, the rules indicate that State guidelines will also sharply reduce or completely eliminate discharge of pollutants to most of the State's waterways. Despite recent trends - realization of the energy shortage; the kinks in regulatory red tape; executive impoundment of funds; and the inadequacy of some hastily contrived rules - it appears certain that the discharge of large quantities of pollutants will be prohibited. Both Federal and State programs are directed to this end.

The Federal program, NPDES, has developed guidelines for pollutant discharge by various industries, and instigated a permit system to inventory and control approved discharges. Permits will not be issued until dischargers meet the guidelines. For the dairy production industry, the guidelines require limiting discharge to the overflow of the waste management system brought about by intense rainfall. At all other times, wastes are to be confined by the property and spread on the soil or otherwise disposed of. Specifically, by July 1977, feedlots (this includes dairy farms) are to confine all wastes except those that occur as a result of runoff from a storm exceeding once in ten year average frequency and 24-hour duration. By 1983, the waste management system is to be built to contain all runoff up to a storm of once in 25 year frequency and 24-hour duration. All new installations are to meet the 1983 Standard immediately.

Dairies in Florida have been under State guidelines concerning animal waste management for about 4 years. These guidelines require the retention of wastes on the property. Although the 10 year and 25 year storm requirements of NPDES may require upgrading of some existing waste management systems, it is not likely that major expense will be involved. Most Florida dairies have met State guidelines.

The NPDES permit system requires that all dairies having 700 or more mature cows (milking and dry) apply for a permit. By law, this was to be done

2Published in Federal Register, February 14, 1974, Volume 39, No. 32, Feedlots, Point Source Category.
by April, 1973. Actually, neither the permit forms nor the final guidelines were available at that time. EPA now requests that all applications be in by August 1, 1974, in order that they may process them by their deadline, December 31, 1974.\(^1\) Permit application forms may be obtained by writing:

Mr. Raymond D. Cozart  
Coordinator, Administration Staff  
Water Enforcement Branch  
EPA, Region IV  
1421 Peachtree Street, N.E.  
Atlanta, Ga. 30309

Agricultural short form B, for feedlots should be requested.

Upon return of the completed form to EPA, receipt will be acknowledged. This fulfills the producers' obligation to apply for a permit. The application is then routed to the State EPA coordinator and the State's Department of Pollution Control. If the waste management system meets Federal and State guidelines, a permit will be issued.

There are several ways by which dairy wastes can be contained and spread on the land. The most common system in Florida uses lagoons, due to the fact that this is an economical facility for handling large volumes of waste water. Information about the design and construction of lagoons can be obtained from county Extension agents and from the Soil Conservation Service.

The NPDES permit system currently involves only discharge from "point sources". This is simply a definable source of pollutants with an identifiable discharge point, or points. The milking, holding, cow wash, and feeding areas of a dairy are considered a point source. Pastures are not point sources, but are being studied along with other crop producing areas as non-point sources of pollution. Overland runoff and seepage are examples of non-point discharge and are difficult to evaluate as to quantity and quality. We are concerned that the EPA's approach to non-point discharges be realistic and not detrimental to agricultural productivity. The Institute of Food and Agricultural Sciences is keeping up with developments regarding non-point sources and will make inputs to EPA as appropriate.

In summary, dairy producers having over 700 mature cows should apply for an NPDES permit by August 1, 1974. Waste management systems that Extension has been recommending should meet the requirements for a permit in most cases.

\(^1\)From correspondence with EPA
POTENTIAL APPLICATION OF PROSTAGLANDIN F$_{2\alpha}$ (PGF$_{2\alpha}$) IN CATTLE FOR OVULATION CONTROL

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Dairy Science Department
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Detection of estrus and the proper timing of insemination are major reproductive management problems facing dairymen. Large herd size and subtropical environmental conditions undoubtedly increase these problems for Florida dairymen. Any system which improves estrus detection will greatly improve reproductive management. This can be partially accomplished by estrus and ovulation control. However, we will never really be successful in regulating the estrous cycle to breed cows in groups when we want until a full understanding of the hormonal relationships controlling the estrous cycle are established. The first experiment to be presented was designed to characterize the transitory hormonal changes of progestins, estradiol and LH which culminate in spontaneous ovulation. Such knowledge is essential in developing an ovulatory control system.

Six animals were fitted with indwelling jugular catheters on day 14 (day 0 = day of last estrus) of the estrous cycle. Blood samples were collected daily on days -6 through -4 prior to heat, every 6 hr on days -3 and -2, and every 2 hr from day -1 to the time of ovulation. Animals were observed for estrus after every blood sample was collected and palpated per rectum to determine the time of ovulation. Plasma progestins, estradiol and LH were measured by radioimmunoassay, and the results are illustrated by the regression lines in figure 1. Associated with the regression of the corpus luteum (CL) was a decrease in plasma progestins (secreted by the CL) from a concentration of 5.7 ng/ml at day -6 to 0.068 ng/ml at the onset of estrus. Progestins remained at this low level until after ovulation. Plasma estradiol remained at approximately 2 pg/ml until day -4 at which time it began to rise. A substantial increase in E$_2$ did not occur until after the CL had begun regression. Estradiol remained elevated from 24 to 48 hr prior to the onset of estrus and declined precipitously during the period of estrus. The low level of progesterone and elevated level of estradiol prior to the onset of estrus appear to cause a massive surge of plasma LH close to the onset of estrus. This peak of LH is responsible for ovulation that occurred 22 hr after the peak of LH (Table 1).

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Table 1. Intervals between certain physiological and behavioral events in the bovine at estrus.

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>MEAN HOUR</th>
<th>S.D.</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak LH to Ovulation</td>
<td>22.25</td>
<td>3.53</td>
<td>6</td>
</tr>
<tr>
<td>Onset of Estrus to Peak LH</td>
<td>2.83</td>
<td>1.27</td>
<td>6</td>
</tr>
<tr>
<td>Duration of Estrus</td>
<td>10.00</td>
<td>1.52</td>
<td>5</td>
</tr>
</tbody>
</table>

*a S.D. = standard deviation
*b n = number of animals measured

In the past few years a compound called prostaglandin F₂₀α (PGF₂₀α) has been attracting much attention in the field of reproductive physiology. Research in sheep indicates that the uterus produces a luteolytic factor (PGF₂₀α) and data from Cornell University indicate that a similar luteolytic compound might be produced by the cow uterus. PGF₂₀α causes CL regression in many species when injected. We designed the following experiment to determine if PGF₂₀α would induce CL regression (decreased progestins), follicle growth (increased estradiol), estrus (LH surge) and ovulation. If these events can be induced and appear to be normal, then PGF₂₀α may be a very useful tool for control of ovulation. Seven heifers were treated with PGF₂₀α (either 30 mg Intramuscular or 10 mg Intra uterine). Heifers were fitted with indwelling jugular catheters and blood samples were collected at 2 hr intervals from 6 hr prior to PGF₂₀α administration until ovulation. Plasma progestins, estradiol and LH were measured and this data is illustrated in figure 2.

Six of seven heifers expressed an induced estrus and ovulated after receiving PGF₂₀α. By 7 hr after PGF₂₀α administration, plasma progestins declined 50% thus confirming that CL regression was induced. The induced hormonal changes in figure 2 synchronized to the peak of LH and reflects the same relative changes associated with spontaneous heats and ovulation of experiment I (Figure 1). Results from the second experiment indicate there are no major alterations of expected hormonal interrelationships between progestins, estradiol and LH approaching a PGF₂₀α induced estrous and ovulation. Other laboratories have reported similar findings. The intervals from PGF₂₀α administration to estrus, peak LH and ovulation were: 74.9, 78.8 and 99.5 hr, respectively (Table 2). The interval between the peak of LH to ovulation and duration of estrus was comparable to that observed with the spontaneous ovulations of experiment I (Table 1).

At this point it was felt that PGF₂₀α may provide a means of synchronizing ovulation with one treatment. However, the traditional progestational compounds used for estrous synchronization have resulted in lowered fertility at the synchronized estrus. Thus it was essential to determine if fertility at the PGF₂₀α induced ovulation was normal. A cooperative regional study was
Table 2. Intervals (hr) between PGF$_{2\alpha}$ injection and certain physiological events in the bovine.

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>$\bar{X}$ (n=6)$^a$</th>
<th>S.D.$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGF$_{2\alpha}$ to Onset of Estrus</td>
<td>74.9</td>
<td>21.1</td>
</tr>
<tr>
<td>PGF$_{2\alpha}$ to Peak of LH</td>
<td>78.8</td>
<td>20.8</td>
</tr>
<tr>
<td>PGF$_{2\alpha}$ to Ovulation</td>
<td>99.5</td>
<td>19.2</td>
</tr>
<tr>
<td>Onset of Estrus to Ovulation</td>
<td>24.6</td>
<td>4.8</td>
</tr>
<tr>
<td>Peak LH to Ovulation</td>
<td>20.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Length of Estrus</td>
<td>11.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Onset of Estrus to Peak LH</td>
<td>3.9</td>
<td>3.1</td>
</tr>
</tbody>
</table>

$^a$ n = number of animals measured  
$^b$ S.D. = standard deviation

Conducted between the University of Florida, Upjohn Co., Michigan State University and Louisiana State University involving 386 animals. The University of Florida component of the study was conducted in cooperation with Bassett's Dairy, Monticello, Florida. Cattle were assigned randomly to one of three treatment groups at each of the four locations. At the initiation of the experiment, ovaries of all animals were palpated to determine the presence of a CL. Treatment I animals served as controls and were artificially inseminated approximately 12 hr after onset of estrus. Animals assigned to Treatments II and III were injected with 30 mg of PGF$_{2\alpha}$-Tham Salt if a CL was detected. Animals without a CL were injected one week later. Animals in Treatment II were inseminated as those in Treatment I, whereas Treatment III cattle were inseminated twice, at 72 and 90 hr after PGF$_{2\alpha}$ injection, without regard to time of estrus.

Cattle in Treatments II and III were considered to have responded to PGF$_{2\alpha}$ if they returned to estrus between days 1 to 7 following PGF$_{2\alpha}$ injection. Using this definition 58 and 72% of the animals responded to PGF$_{2\alpha}$ in Treatments II and III, respectively. However, if the rate of estrus detection for Treatment I (82.5%) can be considered a reliable measure of percent animals expressing estrus or capable of being detected, then 73 and 88% responded to PGF$_{2\alpha}$ for Treatments II and III, respectively. These data suggest that additional methods should be investigated for administering PGF$_{2\alpha}$ to cattle in order to obtain a greater rate of response. Of the heats induced within a 7 day period, 52% were observed on day 3 and 90% were detected between days 2, 3 and 4.

All animals were diagnosed for pregnancy by rectal palpation at 35 to 60 days after artificial insemination. The overall fertility and fertility for each region is expressed in Table 3.
Table 3. Fertility following PGF$_{2\alpha}$.

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>LOCATION</th>
<th>Michigan</th>
<th>Florida</th>
<th>Louisiana</th>
<th>Upjohn</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>62.5 (24)$^c$</td>
<td>54.5 (33)</td>
<td>48.2 (56)</td>
<td>55.5 (9)</td>
<td>53.3 (122)</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>90.5 (21)</td>
<td>31.8 (22)</td>
<td>38.9 (18)</td>
<td>37.5 (8)</td>
<td>52.2 (69)</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>78.9 (19)</td>
<td>33.3 (30)</td>
<td>65.0 (20)</td>
<td>58.9 (17)</td>
<td>55.8 (86)</td>
</tr>
</tbody>
</table>

$^a$Treatments I and II Fertility = (number of cattle pregnant 35 to 60 days after AI) divided by (number of cattle AI). Treatment III Fertility = (number of cattle pregnant 35 to 60 days after AI) divided by (number of cattle responding to PGF$_{2\alpha}$).

$^b$Michigan State University, University of Florida, Louisiana State University, The Upjohn Company.

$^c$Number of animals in parenthesis.

There was no evidence of a treatment by area interaction so the data were pooled for the four regions: Fertility for Treatments I, II and III were 53.2, 52.2 and 55.8%, respectively. Thus, fertility was similar to controls when cattle were inseminated at the synchronized estrus following PGF$_{2\alpha}$; fertility was similar to controls when cattle were inseminated at predefined intervals following PGF$_{2\alpha}$. An additional way to express the fertility data is percent conceived of animals assigned to each treatment groups. These were 42, 30 and 42% for Treatments I, II and III, respectively; such values reflect degree of estrous detection (Treatments I and II), response to PGF$_{2\alpha}$ (Treatments II and III) and conception rates (Treatments I, II and III).

These results indicate that the prostaglandin F$_{2\alpha}$ drug may provide dairymen with the first practical ovulatory control treatment that results in normal fertility. Such a compound could markedly improve reproductive management schemes in dairy heifer and cow operations. Animals between days 1 and 5 of the estrous cycle are non-responsive to PGF$_{2\alpha}$ and therefore such animals cannot be synchronized. Additional research is needed to sensitize cattle to the drug at this time or devise appropriate management schemes to minimize the problem.

Use of PGF$_{2\alpha}$ on the farm will depend on its price and whether the drug receives clearance for use from the Food and Drug Administration. Drug residue studies are now under investigation. Fortunately PGF$_{2\alpha}$ is very rapidly metabolized and should not present a major problem. The amount of drug required will depend on route of administration and availability of more potent PGF$_{2\alpha}$ drug analogues.
REFERENCES


FIGURE 1. ALTERATIONS OF PROGESTINS, ESTRADIOL, AND LH APPROACHING ESTRUS AND OVULATION IN THE BOVINE
FIGURE 2. ALTERATIONS IN PROGESTINS, ESTRADIOL AND LH AFTER PROSTAGLANDIN F$_{2}$$\alpha$ INJECTION
THE TOTAL ASPECTS OF POULTRY LITTER AND COW WASTES AS FEED INGREDIENTS

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Virginia Polytechnic Institute and State University
Blacksburg, Va. 24061

Approximately 2 billion tons of farm animal wastes are produced each year in the United States. Since a large portion of the wastes are from animals which are managed under intensive systems, these must be disposed of. In the past, animal wastes have been used mainly as fertilizer, but economic studies indicate that the plant nutrient content of these wastes, in many cases, is not sufficient to justify the cost of handling. Wastes from different species of animals appear to have nutritional value for certain phases of animal production. Possibly, a more economically feasible approach to disposal of the wastes would be recycling by feeding, at least a portion of the wastes.

Nutritional Value of Poultry Wastes

Poultry wastes are usually high in nitrogen (crude protein content). The crude protein content of broiler litter and cage layer manure has averaged 28% or higher. It is apparent that poultry wastes vary considerably in crude protein content, which would preclude the use of standard values. However, lots of wastes could be analyzed as is commonly done for forages, which may also vary considerably. It appears that 40% or more of the total nitrogen in broiler litter and layer manure is in the form of protein. The remainder is in the form of non-protein nitrogen, the main constituent of which would be uric acid. Other non-protein nitrogen fractions are ammonia, urea and creatine. Cattle are able to utilize all of these non-protein nitrogen sources quite efficiently.

Researchers from Virginia, Pennsylvania, Michigan State, Florida and USDA have found that nitrogen in poultry wastes is utilized quite efficiently. In addition, poultry wastes may be important sources of energy for ruminants. For example, in studies at Virginia Tech it was found that the digestibility of energy for broiler litter, calculated by difference, was 64% in sheep. On the average the litter contained 1108 kcal. of digestible energy per pound and 59.8% TDN, on a dry basis. These values compare quite favorably with those for roughage such as alfalfa hay. The ash content of poultry wastes is fairly high. In a sampling of broiler litter from different parts of Virginia the ash content was 31%. Laying house litter has been shown to contain 8-34% ash, dry basis. The high ash content would result in a lowering of the energy value of poultry wastes. However, some components of the ash would be quite valuable. Poultry wastes are good sources of calcium and phosphorus.

The digestibility of dry matter and organic matter of poultry wastes has been shown to be substantial. In early studies at Virginia Tech we
found that the digestibility of broiler litter dry matter, calculated by difference, was about 60%. Florida researchers reported that 81% of the organic matter in citrus pulp litter was digested. Workers from Maine reported that the apparent digestibility of energy in laying house poultry litter was 59%. Digestibility of dry matter of caged broiler manure was reported to be 54%. The digestibility of dry matter of caged layer manure has varied from 39 to 57%. Digestibility of organic matter in caged broiler and layer manure has been 61 to 67%.

We have ensiled broiler litter with corn forage, which resulted in sharp increases in crude protein content of the silage. The materials ensiled very well when 15 to 30% of litter, on a dry basis, was mixed with corn forage prior to ensiling. Including litter in silage resulted in increased dry matter intake and nitrogen retention in sheep and had no marked effect on the apparent digestibility of dry matter.

Researchers at the University of Arkansas were the first to report concerning the effects of feeding poultry litter to ruminants. They found that the performance of gestating–lactating ewes fed a ration containing ground chicken litter was similar to that of ewes fed a ration containing soybean meal. They also reported that when energy intake was equalized, rate of gain of fattening steers was similar to that of cattle fed cottonseed meal. Researchers from Georgia found that the rate of gain of steers fed a fattening ration containing 30% corn cob broiler litter was similar to that of control steers.

In the early 1960's, in experiments in Virginia, we observed similar rate of gain for steers fed a fattening mixture containing 25% peanut hull or wood shaving broiler litter as for steers fed a control mixture; all cattle were fed 2.2 lb. of long hay, in addition. Feed efficiency was highest for the cattle fed the peanut hull litter and lowest for those fed the control ration. In later research we found that feeding broiler litter with four base materials – peanut hulls, corn cobs, grass hay and soybean hulls, resulted in similar performance in fattening cattle. Performance was higher in steers when mixtures contained 25% litter, compared to 40%.

In periods of drought in Australia wood shaving broiler litter has been used, in addition to wheat. In Arkansas beef cows and calves were successfully wintered on tall fescue pastures supplemented with a mixture of 20% corn grain and 80% oat straw broiler litter, with no harmful effects.

Performance and carcass quality of cattle fed rations supplemented with autoclaved or dried caged layer manure were similar to those of cattle fed soybean meal. Cornell University researchers reported that feeding 5 to 9 lb. of air dried caged layer manure had no adverse effect on milk production. At Michigan State, including 10% dehydrated poultry wastes in the grain mixture of dairy cows did not affect milk production.

Dried poultry wastes have been found to be low in protein and energy value for layers, although feeding at levels up to 25% of the diet
did not affect egg production. It appears that only a portion of the waste from layers could be recycled and the remainder would have to be handled by some other waste management system.

**Nutritional Value of Cattle Wastes**

Feeding cattle manure to laying hens had no significant effect on egg production or fertility of the eggs. In early research by Anthony of Auburn University it was found that feeding of a ration consisting of 60 parts of basal feed and 40 parts of washed cow manure resulted in average daily gains of over 3 lb. per day in steers. These same researchers fed fresh manure in rations containing concentrate alone or in combination with silage. They found that including of the manure resulted in sharp depressions in the dry matter digestibility and daily gain by cattle fed this mixture. The cattle consumed the manure containing rations readily with no visible harmful effects. Anthony found that fresh feedlot manure was a valuable ration component when it was either autoclaved or washed. This researcher explored the feasibility of mixing cattle manure with hay and ensiling the mixture to produce a product termed wastelage. Proportions of 57 parts manure and 43 parts of ground hay were used. Feeding a ration formulated to contain 40% wastelage and corn to steers produced rate of gain and feed efficiency as high or higher than steers fed conventionally formulated high-concentrate rations. Anthony also reported that wastelage would produce satisfactory performance in breeding ewes and beef cows, when supplemented with Vitamin A. Colorado researchers have reported promising results from feeding a washed, fermented solid fraction prepared from feedlot manure.

It appears that digestibility of cattle manure by ruminants is considerably lower than for poultry wastes. Researchers from U.S.D.A. and Michigan State have reported dry matter digestibility of 22 to 29% for dairy cattle manure. In recent work at Virginia Tech, it was found that including 40% dairy cattle manure in barley or corn silage at ensiling time resulted in marked depressions in dry matter digestibility of the silage. We have recently completed studies in which fecal waste from steers fed a ration containing 50% roughage was included in the ration at the level of 20%. It was found that the fecal waste had a dry matter digestibility of only approximately 16%. On the other hand researchers from Oklahoma have reported dry matter digestibilities of feedlot wastes in sheep to be between 42 and 56%.

The daily cattle wastes and the wastes which we have been working with were from cattle fed considerably higher roughage levels, presumably, than the feedlot wastes fed by the Oklahoma workers. Thus, it appears that with cattle fed fairly high roughage levels the digestibility would not be very high. One of the characteristics of the fecal wastes from cattle fed high roughage levels is a high cell wall and lignin content which would result in rather low digestibility values. Perhaps treatment of the wastes with materials such as sodium hydroxide, calcium hypochlorite and sodium chlorite would improve the utilization of the waste. In fact, U.S.D.A. researchers have found that dry matter
digestibility was improved considerably by treating dairy cattle wastes with these chemicals.

The Effect of Feeding Wastes on Quality of Product

Feeding of animal wastes have not been shown to impart undesirable flavors to the meat, milk or the eggs. In Virginia we have tested the effect of feeding different levels of poultry litter on the taste of the meat. In no case did we find that the litter had any adverse effect on taste of the product. Similar results were found by researchers at Penn State from feeding caged layer manure. Researchers at Cornell and Michigan State likewise found that feeding of poultry wastes to dairy cows did not have any harmful effects on the taste of the milk. Michigan State workers found that the taste of eggs was not affected by the feeding of processed caged layer manure to layers.

Effect of Feeding Animal Wastes on Animal Health

The feeding of wastes is not sanctioned by the Food and Drug Administration due to potential hazards from possible disease organisms and drug residues in wastes. There have been no disease problems reported from including poultry and cattle wastes in practical rations for cattle and sheep. Copper toxicity was observed in Virginia experiments in ewes fed poultry litter containing high levels of copper. The high copper levels resulted from feeding high levels of copper sulfate to the chicks. The copper problem would not likely be severe in cattle as they are not as sensitive as sheep to dietary copper. In fact, we have fed cows rations containing 80% broiler litter containing 200 parts per million of copper alone and in combination with supplementary copper equal to the amount supplied by the litter without any harmful effects. A higher incidence of abortion was reported in Pennsylvania in cows fed a ration containing poultry litter and grazed on pastures fertilized with litter. The litter was found to contain estrogenic activity and the authors suggested the abortions were due to a hormone imbalance. However, it should be emphasized that it was not proven that the feeding of litter or the use of litter as a fertilizer were responsible for the abortions.

Processing of Wastes

One of the reasons the use of wastes is not sanctioned as feedstuff is the potential hazards from disease organisms. Of course, the wastes may contain different classes of bacteria, molds and yeasts. It has been found that the pathogens found in the poultry litter are destroyed by heat treatment.

We have found that poultry litter can be pasteurized to meet the same standards as pasteurized milk by heating at 300°F for 20 minutes at a thickness of 1/4 in. We have found that the combination of chemical and heat treatment may be quite effective in pasteurizing litter. Heat processing of litter was shown to result in marked reductions in crude protein content but acidifying the litter with sulfuric acid prior to heating resulted in a reduction of nitrogen loss.
Possibly, ensiling or stacking the material would produce sufficient heat by thermophilic bacteria for pasteurization. In fact, we have found that ensiling of broiler litter with a minimum of 30% moisture would result in destruction of the coliform organisms. It appears that there is not a serious hazard from disease organisms from feeding of animal wastes since the wastes can be rendered free of pathogens by appropriate processing.

Drug Residues

Another deterrent to the use of animal wastes as feedstuffs is the potential hazards from drug residues. This would be an especially serious problem in feeding of poultry litter. Pennsylvania and Virginia researchers found that there were no substantial levels of pesticide residues in edible tissues of cattle which had been fed wastes from cage layers or broiler litter.

Workers from Virginia, Maine and FDA reported that broiler litter may contain certain levels of medicinal drugs which were included in poultry diets. Workers from Maine reported no detectable levels of amprolium and arsenic in tissues of lambs fed litter containing these. In Virginia we have not found any substantial levels of amprolium, nicarbazin or chlortetracycline in muscle, kidney, fat and liver from steers which have been fed up to 50% broiler litter for 121 or 198 days, with a 5-day withdrawal. Arsenic has been consistently increased in the liver by feeding broiler litter but the levels were below the normally accepted safe levels.

Summary and Conclusions

It appears that animal wastes have substantial nutritional value. Some wastes seem to be of higher nutritional value for cattle than others. Wastes such as poultry litter and caged layer manure are especially high in crude protein and the nitrogen is efficiently utilized by the cattle. The energy of the poultry wastes also appears to be quite efficiently utilized. It appears that the nutritional value of cattle wastes is lower than that of poultry wastes, when fed to cattle. However, the value of the cattle wastes would probably depend on the roughage level in the ration.

The wastes can be rendered free of pathogenic organisms with heat treatment, a combination of chemical and heat treatments or perhaps by stacking or ensiling.

Palatable rations can be formulated including animal wastes, provided the levels are not excessive. Also, modification of the rations to include more palatable ingredients may improve the palatability of the ration. The feeding of animal wastes does not adversely affect the taste of the meat, milk or eggs.

The only harmful effect from recycling of animal wastes by feeding which was documented was copper toxicity in sheep fed high levels of copper. This would not appear to be a serious problem in cattle since they are not as sensitive to copper.
It appears that there is not a serious problem with pesticide residues in waste or in meat from animals fed the waste. Although there is no data available it is not likely that this would be a serious problem from contamination of the milk either. The medicinal drug residue problem in animals fed poultry waste does not appear to be serious for meat production but more conclusive information is needed on this aspect. Prior to using of poultry wastes in dairy cows, research is needed to study the effect of feeding the waste containing the medicinal drugs on possible secretion of these drugs in the milk.

Utilization of wastes is a more practical approach than simply disposal. Use of animal wastes as feedstuffs would reduce the total amount of solid waste pollution. It appears that there is sufficient information so that some wastes can be recycled at this time without presenting a hazard to animal or human health. However, this practice is not sanctioned by the Food and Drug Administration at present.
Liquid Supplements for Dairy Cattle

L. W. Whitlow, S. P. Marshall* and H. H. Van Horn

Discovery of a practical feeding method that caused rumen by-pass of certain nutrients would be a useful tool in cattle nutrition. A by-pass method would enable feeding high-producing cows extra protein without degradation in the rumen. If oral by-pass feeding of sugars could be practiced the resulting increase in glucose supply for metabolism should have a preventive effect on ketosis. Likewise, the productive value of energy from glucose would be greater than when it is converted into organic acids.

Work in Australia with calves and heifers demonstrated that following glucose infusion into the abomasum blood glucose values rose but that infusions into the rumen did not cause a change in blood glucose values. In 1972, workers at Louisiana State University reported that lactating cows fed silage, hay and concentrate showed a significant increase in blood plasma glucose when given liquid supplement from a lick-wheel. Heifers fed sorghum silage plus liquid supplement from a lick-wheel had significantly higher average plasma glucose values than those fed a supplemental concentrate mixture. The data suggested that liquid supplement taken from the lick-wheel may have by-passed the rumen and absorbed sugars caused a rise in plasma glucose. Thus, research was initiated to determine the passage route into the stomach of liquid feeds taken from a lick-wheel feeder by cattle.

Heifers fitted with rumen and abomasal fistulas were placed on a control ration of silage and concentrate mixture fed at maintenance levels. In the first experiment, treatments were either one pound daily of molasses from a lick-wheel, one pound daily of liquid supplement from a lick-wheel or one pound daily of the liquid supplement infused directly into the rumen through the cannula. A water-soluble chromium chelate was dissolved into test rations of the liquid feeds as a marker so that the amount could be quantitated in the reticulorumen ingesta taken 30 minutes after feeding or infusion. Reticulorumen ingesta ammonia levels also were determined. Blood plasma glucose was assayed on samples taken four hours after supplementation.

Percentage of the chromium chelate administered that was recovered in the reticulorumen ingesta did not differ significantly for the three treatments. Reticulorumen ammonia levels were higher when the liquid supplement was infused into the rumen than when it was consumed from the lick-wheel. There were no significant differences in mean plasma glucose values at four hours after the different treatments. These data indicate there was little, if any, rumen by-pass of molasses or liquid supplement take from the lick-wheel feeder.

In a second experiment, one pound of molasses, Pro-Lix or United States Sugar Corporation 20% crude protein liquid supplement was infused through the cannula into the abomasum and plasma glucose values determined at intervals during the ensuing four hours. Least square predicted values for plasma glucose were higher for the United States Sugar Corporation 20% crude protein liquid than for molasses infusion.

* Presented by S.P. Marshall
EFFECTIVE COW TRAFFIC AND GROUPING PATTERNS AT ROBERTS DAIRY

Art Graden, Manager
Roberts Dairy

Roberts Dairy is located three miles west of Palatka just North of Hwy 100. The 1200 cow dairy has one double-12 herringbone milking parlor with 24 milking units, two holding areas, (one with cow-washers and one for cow movement to the parlor), and a shaded lane leading to the holding area. The parlor and feeding barn have been constructed within the past five years.

Storage and mixing facilities for bulk feed are available and used at Roberts Dairy. A number of 25 to 30 ton storage tanks are used to store ingredients prior to mixing and prior to feeding a complete feed. Permanent pasture is available during the year and some hay is fed to the cows all during the year. The hay is produced at Roberts Dairy.

The feeding barn has two fairly wide feeding troughs that allows cows to eat from either side. The feed is fed mechanically through a badger feeding system. All cows are separated according to level of milk production and regrouped each month according to the following scheme:

<table>
<thead>
<tr>
<th>Herd No.</th>
<th>Pounds of Milk</th>
<th>Type of Breeding</th>
<th>Time in Feed Barn</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Slow Milkers</td>
<td>AI</td>
<td>45 Minutes</td>
</tr>
<tr>
<td>3</td>
<td>Under 35 Lbs</td>
<td>Natural</td>
<td>15 Minutes</td>
</tr>
<tr>
<td>2</td>
<td>35 - 50 Lbs</td>
<td>AI</td>
<td>30 Minutes</td>
</tr>
<tr>
<td>1</td>
<td>Over 50 Lbs</td>
<td>AI</td>
<td>45 - 60 Minutes</td>
</tr>
<tr>
<td>0</td>
<td>Fresh Under 60 Days</td>
<td>None</td>
<td>45 - 60 Minutes</td>
</tr>
</tbody>
</table>

Management at the dairy is happy with the grouping system employed at the dairy a few years ago. While the system of feeding offers the greatest advantage through greater feed control and more flexibility in feeding high producing cows extra feed, it also aids in the execution of other management practices. As noted in the above table, certain groups
of cows are bred with AI while Natural service is used for the lower pro-
ducing cows and only heat records are recorded on fresh cows. The grouping
system used at Roberts dairy offers advantages in identification and
handling as well as breeding.

The importance of well designed lanes and corrals for excellent cow
traffic movement cannot be overemphasized. The movement of cows to and from
the parlor and to the eating area requires a minimum amount of labor. A
crowd gate is not used at Roberts dairy but is sometimes useful in getting
the cows in the parlor. Automatic washers are used to clean the cows since
the cows are frequently muddy and become a burden for the milkers to clean.
All ramps and lanes are well sloped to prevent the accumulation of water
puddles. Men escapes (about 11 inches clear) spaced throughout the design
aid in cutting out cows in heat, sick cows, and increases movement of cows.
An area in the old milking barn is provided for the hospital herd to
avoid getting antibiotics and other residues in milk.
Environmental and Management Factors
Which Affect Conception Rate

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INTRODUCTION

Many factors affecting conception rates in dairy cattle have been documented. Several years ago, Salisbury and VanDemark reviewed 34 studies which appeared in the scientific literature between 1929 and 1956. They concluded that overall conception rates were lowest in summer and highest in spring regardless of whether the data were collected in the Northern temperate regions or Southern subtropical regions of the U.S. Additional research by other scientists has detected effects on conception rates of such climate factors as temperature, humidity, solar radiation, atmospheric pressure, rainfall and day length. Variation in fertility also is associated with age of cow, inseminator, service number, service sire and breed.

Difficulties become apparent in evaluating effects of specific climate measurements because more often than not they are highly correlated with each other. Differences in fertility among months or seasons, for example, reflect combined effects of a large number of climate factors plus variations in many possible nutritional and management variables. The exact means by which climate effects alter conception are not known precisely. For example, increased heat loads, due to solar radiation or high ambient temperatures, at estrus or following insemination tend to increase body temperature, which may affect conception. Ulberg at North Carolina State University showed that an increase in rectal temperature of 1°C (1.8°F) 12 hours after insemination was associated with a decline in pregnancy rate in cattle from 61 to 45%
Likewise, we have shown here at Florida that increases in uterine temperature of .5°C (.9°F) on the day of or day after insemination were associated with declines in conception of 13 and 7%.

Objectives of the present study were to delineate further effects of several environmental and management factors upon conception rates which would be applicable to the Florida dairyman.

MATERIALS AND METHODS

We analyzed breeding records of dairy cattle at the Dairy Research Unit herd from January 1, 1960 through December 31, 1971. Information obtained included breed, service date, service number (up to 5 normal inseminations), lactation number (0 through 9), sire and inseminator. Daily maximum and minimum temperatures, minimum relative humidity, wind movement and rainfall

1Research Assistant, Geneticist and Assistant Professor, respectively.
data were obtained from the Agronomy Department. Solar radiation, which was measured on campus, and atmospheric pressures for Gainesville, were obtained from records provided by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Asheville, N. C. Conception was based on pregnancy diagnosis made 40 to 54 days post-insemination or records of confirmed parturitions. Feeding programs in the herd were designed to meet growth and production requirements amply.

RESULTS AND DISCUSSION

Means for the climate measurements are shown in Table 1. Since climate data were not available for all days in the 12 year period, insemination numbers for the different analyses varied from 3586 to 5062.

Table 1. Averages of Climate Measurements

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>AVERAGE</th>
<th>MEASUREMENT</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MXT&lt;sup&gt;a&lt;/sup&gt;</td>
<td>75.9 F</td>
<td>Wind</td>
<td>42.8 mi/day</td>
</tr>
<tr>
<td>MNT&lt;sup&gt;b&lt;/sup&gt;</td>
<td>52.0 F</td>
<td>Solar Radiation&lt;sup&gt;h&lt;/sup&gt; (SR-0)</td>
<td>362.5 Langley's&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td>AVGTD</td>
<td>64.2 F</td>
<td>Solar Radiation (SR-1)</td>
<td>364.5 Langley's</td>
</tr>
<tr>
<td>DIFTE</td>
<td>23.9 F</td>
<td>MXAP&lt;sup&gt;k&lt;/sup&gt; 0</td>
<td>761.16 mm Hg</td>
</tr>
<tr>
<td>MXT</td>
<td>75.9 F</td>
<td>MNAP&lt;sup&gt;k&lt;/sup&gt; 0</td>
<td>758.04 mm Hg</td>
</tr>
<tr>
<td>MNT</td>
<td>51.8 F</td>
<td>DIFAP&lt;sup&gt;e&lt;/sup&gt; 0</td>
<td>3.58 mm Hg</td>
</tr>
<tr>
<td>AVGT</td>
<td>64.0 F</td>
<td>MXAP</td>
<td>761.54 mm Hg</td>
</tr>
<tr>
<td>DIFT</td>
<td>24.1 F</td>
<td>MNAP</td>
<td>758.05 mm Hg</td>
</tr>
<tr>
<td>RH&lt;sup&gt;f&lt;/sup&gt;</td>
<td>45.8%</td>
<td>DIFAP</td>
<td>3.51 mm Hg</td>
</tr>
<tr>
<td>RH</td>
<td>45.3%</td>
<td>PPT&lt;sup&gt;m&lt;/sup&gt; 0</td>
<td>.11 inch</td>
</tr>
<tr>
<td>WIND&lt;sup&gt;g&lt;/sup&gt;</td>
<td>42.8 mi/day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>MXT = Average maximum daily temperature  
<sup>b</sup>Day of insemination (0), and day after insemination (1)  
<sup>c</sup>MNT = Average minimum daily temperature  
<sup>d</sup>AVGT = Average mean daily temperature  
<sup>e</sup>DIFT = Average difference between daily MST and MNT  
<sup>f</sup>RH = Average minimum relative humidity  
<sup>g</sup>Wind = Average wind movement per day  
<sup>h</sup>Solar Radiation = Average daily solar radiation  
<sup>i</sup>Langley = 1gm calorie per square centimeter  
<sup>j</sup>MXAP = Average maximum daily atmospheric pressure  
<sup>k</sup>MNAP = Average minimum daily atmospheric pressure  
<sup>l</sup>DIFAP = Average difference between daily MXAP and MNAP  
<sup>m</sup>PPT = Average daily rainfall

From these 21 variables, 6 were discarded as being the unimportant; the 15 remaining were analyzed in order to rank the importance of their effects on conception. Table 2 shows their rankings. Our analyses also included breed, month, year, inseminator, service number and lactation number. The most important climate measurement, MXT 1, had a curvilinear relationship to fertility when all the other climate measurements were excluded from the statistical model. Figure 1 shows that as MXT 1 increased from 21.1° C (70° F)
to 35° C (95° F) conception rates declined from 40 to 31%. These results confirm a 1 year study completed here earlier which indicated that ambient temperatures the day after insemination were related more closely to conception than the same measurements the day of insemination.

Table 2. Ranking of 15 most important climate measurements

<table>
<thead>
<tr>
<th>RANK¹</th>
<th>MEASUREMENT</th>
<th>RANK</th>
<th>MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MXT 1</td>
<td>9</td>
<td>MNAP 1</td>
</tr>
<tr>
<td>2</td>
<td>PPT 0</td>
<td>10</td>
<td>WIND 1</td>
</tr>
<tr>
<td>3</td>
<td>MNT 0</td>
<td>11</td>
<td>SR 1</td>
</tr>
<tr>
<td>4</td>
<td>SR 0</td>
<td>12</td>
<td>RH 1</td>
</tr>
<tr>
<td>5</td>
<td>MNT 1</td>
<td>13</td>
<td>MXAP 0</td>
</tr>
<tr>
<td>6</td>
<td>WIND 0</td>
<td>14</td>
<td>MXAP 1</td>
</tr>
<tr>
<td>7</td>
<td>MNAP 0</td>
<td>15</td>
<td>MXT 0</td>
</tr>
<tr>
<td>8</td>
<td>RH 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹See Table 1 for description of measurements. MXT 1 (maximum temperature the day after insemination) was the most closely related to conception of the 15 listed.

\[ \hat{Y} = 0.2434 + 0.0149X - 0.0003658X^2 \]
\[ X = ^\circ C \]

Figure 1
In the present study PPT 0 was negatively related to fertility. Gainesville seasonal precipitation patterns are such that we have the greatest rainfall from June to September (17.0 cm or 6.7 inch/month) compared to 6.44 cm (2.5 inches/month) for November to February, so that with the greatest amount of rainfall we are also in the hottest months of the year. Solar radiation had significant effects on conception. Its curvilinear effect is seen in Figure 2. As solar radiation increased above 300 Langleyes/day, conception dropped from 39.5% to 26.0% at 800 Langleyes.

The possibility that extremes in temperature or atmospheric pressure on the day of or day after insemination were related to conception was also tested. In no analyses were their effects significant. This suggests that the effects of ranges in temperature and atmospheric pressure would be expected to be about the same regardless of the range in that variable for that particular day.

Table 3 shows distributions of insemination and least-squares estimates of effects on conception for breed, lactation number, service number and year. Breeds were significantly different (P < 0.01) due mainly to the superiority of Jerseys; Guernseys were second highest with little variation among the other three breeds. Advancing age of cow, as measured by lactation number, was associated with a decline in conception rate. Highest conception rates occurred with heifers (47.6%) followed by cows in lactation 1 to 4 (averaging 42.7%) and older cows (31.9%).

In contrast to most studies, no decline in conception rate occurred with advancing service number. The unweighted mean for services 1 and 2 was 36.6%, compared to 38.6% for services 3 to 5. Year effects were significant with evidence of a slight increase in conception rates with time, averaging 35.8% for 1960 to 1965 and 39.7% for 1966 to 1971. Month effects were found to be significant when climate measurements were not included in the statistical analysis. In no case could month effects be detected, however, when the climate measurements were included in the statistical analysis. This suggests that month effects may have represented climate to a greater degree than nutritional and management factors.

As expected, there was considerable variability in conception rates of different inseminators. Fourteen men were included in the study, seven of whom performed 230 or more services. Their conception rates ranged from 20.3% to 55.3%.

Summary

From data collected over a 12 year period effects of climate and other management factors upon conception were evaluated. Maximum temperature the day after insemination, rainfall and solar radiation had significant effects on conception. We could detect no differences in conception rate with advancing service number but fertility declined with age of cow and was greatly affected by breed, service sire and inseminator.
<table>
<thead>
<tr>
<th>FACTOR</th>
<th>NO.</th>
<th>%CR</th>
<th>FACTOR</th>
<th>NO.</th>
<th>%CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td></td>
<td></td>
<td>Service Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ayrshire</td>
<td>227</td>
<td>33.8</td>
<td>1</td>
<td>2185</td>
<td>35.7</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>328</td>
<td>34.6</td>
<td>2</td>
<td>1354</td>
<td>37.4</td>
</tr>
<tr>
<td>Guernsey</td>
<td>917</td>
<td>37.0</td>
<td>3</td>
<td>786</td>
<td>38.1</td>
</tr>
<tr>
<td>Holstein</td>
<td>1758</td>
<td>35.5</td>
<td>4</td>
<td>465</td>
<td>39.3</td>
</tr>
<tr>
<td>Jersey</td>
<td>1832</td>
<td>48.4</td>
<td>5</td>
<td>272</td>
<td>38.4</td>
</tr>
<tr>
<td>Lactation Number</td>
<td></td>
<td></td>
<td>Years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1390</td>
<td>47.6</td>
<td>1960</td>
<td>217</td>
<td>34.5</td>
</tr>
<tr>
<td>1</td>
<td>1254</td>
<td>43.8</td>
<td>1961</td>
<td>379</td>
<td>34.7</td>
</tr>
<tr>
<td>2</td>
<td>955</td>
<td>41.5</td>
<td>1962</td>
<td>421</td>
<td>35.4</td>
</tr>
<tr>
<td>3</td>
<td>587</td>
<td>44.5</td>
<td>1963</td>
<td>403</td>
<td>32.0</td>
</tr>
<tr>
<td>4</td>
<td>362</td>
<td>41.0</td>
<td>1964</td>
<td>431</td>
<td>36.4</td>
</tr>
<tr>
<td>5</td>
<td>251</td>
<td>32.7</td>
<td>1965</td>
<td>490</td>
<td>42.0</td>
</tr>
<tr>
<td>6</td>
<td>109</td>
<td>49.0</td>
<td>1966</td>
<td>494</td>
<td>39.2</td>
</tr>
<tr>
<td>7</td>
<td>85</td>
<td>32.1</td>
<td>1967</td>
<td>506</td>
<td>38.9</td>
</tr>
<tr>
<td>8</td>
<td>43</td>
<td>27.8</td>
<td>1968</td>
<td>536</td>
<td>44.0</td>
</tr>
<tr>
<td>9</td>
<td>26</td>
<td>17.8</td>
<td>1969</td>
<td>455</td>
<td>34.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1970</td>
<td>384</td>
<td>41.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1971</td>
<td>346</td>
<td>39.5</td>
</tr>
</tbody>
</table>
COLOSTRUM AND ITS IMPORTANCE TO THE NEWBORN CALF

Dr. B. Harris, Jr.
Department of Dairy Science

The primary function of the mammary gland is two fold in that it provides milk for the nourishment of the young and provides a mechanism for the immunological protection of the otherwise helpless newborn. Its secondary function then is to provide the nutritional needs for millions of people of all ages throughout the world.

Our concern in this paper will be to discuss the secretion of the mammary gland prior to the production of normal milk or the protection the newborn receives by absorbing these gamma globulins or antibodies from the colostrum.

A number of changes occur within the cow as parturition approaches. Some of these prepare for the transition of the calf from the warm, safe environment of its mother's uterus to the germ-infested world in which it must attempt to survive.

The change we are concerned with is the preparation of milk which provides food and nourishment to the young calf. Prior to production of normal milk, the cow further attempts to protect her newborn by providing it with colostrum. Both colostrum and milk are produced by the mammary gland of the mother but the two (colostrum and milk) are uniquely different in composition.

The major food components in milk (protein, fat, and sugar) are each synthesized by secretory cells within the mammary gland. The basic building substances which are used by the mammary gland to synthesize milk proteins, fats, and sugar are transported by the blood to the mammary gland. As the blood passes through the mammary gland, these basic building substances leave the bloodstream and are taken up by the secretory cells in the gland. Each of the secretory cells then takes the basic building substances and constructs milk proteins, milk fat, and milk sugar. Thus, the mammary gland constructs all of the major components present in milk.

Table 1  AVERAGE COMPOSITION OF COLOSTRUM AND NORMAL MILK

<table>
<thead>
<tr>
<th>Component</th>
<th>Colostrum</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>71.7</td>
<td>87.0</td>
</tr>
<tr>
<td>Milk Fat</td>
<td>3.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Casein</td>
<td>4.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Globulin and Albumin</td>
<td>12.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Lactose</td>
<td>2.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Minerals</td>
<td>1.8</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total Solids</strong></td>
<td><strong>25.3</strong></td>
<td><strong>13.0</strong></td>
</tr>
</tbody>
</table>
A major difference between colostrum and milk is the type of protein present as shown in Table 1 above. Colostrum contains large amounts of a protein called immunoglobulin or antibody. Antibodies are produced by animals in response to infection such as IBR, BVD, PI3 or the presence of any number of foreign substances. The foreign substances may be bacteria, viruses, or proteins from unrelated animal species. Collectively, all foreign substances are called antigens. When the body detects a foreign substance, it produces antibodies which can specifically bind the foreign substance and help remove it from the body. Antibodies are specific for a particular antigen and thus an antibody which reacts with bacteria will not react with a virus and vice versa.

The antibody protein is not constructed by the secretory cells of the mammary gland. Antibody molecules are built from basic building substances by special cells located in the spleen and lymph nodes and are then secreted into the bloodstream. As the cow approaches parturition, a message is sent to the mammary gland to prepare for the birth of the calf. Prior to actual birth, the secretory cells begin to develop the machinery necessary for the construction of the various milk components. During this prepartum period, the cells also develop to a high level the ability to transport antibody molecules. As the blood, carrying antibodies, passes through the mammary gland, some of the antibody molecules leave the bloodstream and are picked up by the secretory cells. The secretory cells apparently do not alter the molecules in any way but simply transport them across the cell and deposit the antibodies into the secretion of the mammary gland.

Immediately prepartum, the major function of the secretory cell is to transport completely constructed antibody molecules from the blood to the secretion of the mammary gland. Gamma globulins are concentrated in the udder of the cow prior to parturition and are highly concentrated in the colostrum. The newborn calf derives passive immunity by absorbing these gamma globulins from the colostrum. This ability to absorb whole proteins, however, is limited to the calf's first 24 to 30 hours of life. Thereafter, even if gamma globulin is fed no measurable increase can be detected in the calf's serum gamma globulin. The serum gamma globulin begins to increase naturally when the calf is about 8 weeks of age.

At birth, additional messages, again probably delivered by hormones, are sent to the secretory cells. The message instructs the cells to stop transporting antibody molecules and to concentrate their efforts on construction of normal milk components. Table 2 shows the length of time a cow produces colostrum.

| Table 2 | TRANSITION FROM COLOSTRUM TO NORMAL MILK |
|---|---|---|---|---|---|---|
| TIME AFTER CALVING (HRS) | TOTAL PROTEIN (%) | CASEIN (%) | GLOBULIN AND ALBUMIN (%) | FAT (%) | LACTOSE (%) | ASH (%) | TOTAL SOLIDS (%) |
| 0 | 17.57 | 5.08 | 11.34 | 5.10 | 2.19 | 1.01 | 25.9 |
| 6 | 10.00 | 3.51 | 6.30 | 6.85 | 2.71 | .91 | 20.5 |
| 12 | 6.05 | 3.00 | 2.96 | 3.80 | 3.71 | .89 | 14.5 |
| 24 | 4.52 | 2.76 | 1.48 | 3.40 | 3.98 | .86 | 12.8 |
| 48 | 3.74 | 2.63 | .99 | 3.20 | 4.20 | .83 | 12.0 |
| 72 | 3.86 | 2.70 | .97 | 3.10 | 4.37 | .84 | 12.2 |
Three days post-calving, the transport of antibodies by the secretory cell is minimal and the milk is about normal as shown in Table 2. There are probably at least two explanations for the cessation of antibody transport. First, if the cow continued to transport large quantities of antibodies into the mammary gland, there would be a significant drain on the mother's reserves of antibodies. Since the antibodies in the mother's blood protect her from infection, continued loss through the mammary gland could seriously jeopardize her health. Second, within a few weeks of birth, the calf will synthesize its own antibodies. Until its own antibody-producing system begins to operate, it will be protected by the antibodies received from its mother's colostrum.

The various types of specific antibodies which the mother has in her blood will reflect the variety of infectious agents with which she has come in contact. Thus, from colostrum the calf will receive a wide range of specific antibodies which will protect it from a variety of infectious bacteria and viruses. While the author believes that colostrum feeding should be considered an absolute essential for the newborn calf, dairymen should be aware that feeding colostrum to the calf will not always guarantee that the young calf will be safe from infectious diseases. As pointed out above, the mother's specific antibodies will reflect her environment and not necessarily the environment in which the calf will be raised. Under certain types of housing situations, it is conceivable that the mother may never come in contact with the infectious agents present in the environment in which the young calf is raising. Under these conditions, colostrum will have limited protective ability, no matter how much is consumed by the calf. Instances where this could occur is in the purchase of replacements in other parts of the country and delivered to Florida a few weeks prior to parturition, or by moving a new born calf to a different farm.

The degree of protection afforded the calf will also be influenced by: 1) the amount of colostrum consumed, 2) how soon after birth the colostrum is consumed, 3) the antibody concentration of the colostrum ingested, and 4) the amount of ingested colostrum absorbed from the gut of the calf into the blood. Some protection may also result from the presence of unabsorbed antibodies in the lumen of the intestinal tract.

The mother's colostrum will provide maximum protection provided the following points are taken into consideration:

1. First-milking colostrum is the best source of antibodies.
2. Newborn calves should be permitted to ingest all of the first-milking colostrum they can consume in the first 5 hours after birth.
3. All first-milking colostrum should be fed to calves preferably less than 1 week of age.
4. Following birth, colostral antibodies will be absorbed from the gut of the calf for a period of about 36 hours but at a declining rate.
5. The presence of colostral antibodies in the digestive tract is of marked benefit to a young calf in addition to its effect after absorption into the blood.

6. All milk produced before it is marketable (first six milkings), including colostrum, should be fed to calves at any age prior to weaning in order to save feed costs. Results from a colostrum feeding trial are shown in Table 3.

Table 3  A COMPARISON OF COLOSTRUM WITH WHOLE MILK

<table>
<thead>
<tr>
<th>DIETS</th>
<th>COLOSTRUM</th>
<th>WHOLE MILK</th>
<th>WM + WHEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAILY GAIN</td>
<td>1.03</td>
<td>.95</td>
<td>.97</td>
</tr>
<tr>
<td>TOTAL GAIN - 28 DA.</td>
<td>28.95</td>
<td>26.49</td>
<td>27.10</td>
</tr>
<tr>
<td>DM* INTAKE - &quot; &quot;</td>
<td>11.70</td>
<td>16.50</td>
<td>14.80</td>
</tr>
<tr>
<td>DM INTAKE/LB GAIN</td>
<td>3.17</td>
<td>4.00</td>
<td>3.89</td>
</tr>
</tbody>
</table>

*Dry Matter - Pelleted Starter (80% grain & 20% hay),
All Calves Received 8 Lbs of Liquid Diet Per Day.

While the high antibody content of colostrum makes it a unique mammary gland product, colostrum is also an excellent food source, being especially high in protein and energy. In addition, colostrum has a high content of vitamins and minerals required for the normal health and well-being of the young calf. Dairymen should not underestimate the benefits to good health and nutrition which can be derived from feeding all the colostrum.

Feeding Sour Colostrum to Calves

Many dairymen have successfully raised calves by feeding sour colostrum the last 2 years. The practice is currently being investigated by several Universities. The following are recommendations based on dairymen's experiences.

Procedure

- The extra colostrum collected from the first three to five days is placed in a clean plastic garbage container or clean tinned milk can. Plastic garbage can liners thrown away after each batch can simplify cleaning.

- Colostrum milk from other cows freshening within a few days can be added to the batch. Mix the contents of the container after adding colostrum each time so that the fresh is well blended with the old and fermentation is uniform.

- Start a new container when colostrum milk has not been added daily.

- Fermented batches of colostrum can be mixed together after well fermented.

- Do not add milk from a cow treated for mastitis because the antibiotics can stop fermentation and the milk will not sour properly.

- Store in shade at normal barn temperature.
- Make sure calf drinks at least three to four pounds fresh colostrum milk immediately after birth. This amount is necessary for most calves to absorb adequate antibodies.

- Feed three pounds fresh colostrum per calf twice daily for the first two to five days. Then switch to the stored colostrum.

- Mix the stored colostrum. Feed about a quart (two pounds) of fermented colostrum with a quart of warm water twice a day. If all the milk produced during the first 10 milkings is stored, then three pounds may be fed twice daily because it is less concentrated.

- Wean calves when they are eating 1 to 1.5 pounds of calf starter per day or at 4 to 6 weeks of age.

- If the sour colostrum is gone before the calf can be weaned, then feed whole milk or milk replacer.
RAISING DAIRY CALVES UNDER VARIOUS HOUSING AND MANAGEMENT SYSTEMS

H. N. Van Horn, M. B. Olayiwole, C. J. Wilcox and J. M. Wing
Dairy Science Department, University of Florida

In spite of a tremendous amount of calf research that has been done in this country on calf feeding and management, calf losses can still run quite high at times due to some management deficiency. Housing systems have been studied much less than nutritional factors and so this experiment is designed to compare calf performance in three housing systems and try to see if specifications for milk feeding systems and starter composition should differ with type of housing.

All calves born from July, 1973 through January, 1974 which were not needed in other experiments were assigned to this study until they were 12 weeks of age. The general design for the experiment included three housing systems, two milk feeding programs and four different calf starter formulas, as follows:

<table>
<thead>
<tr>
<th>Housing</th>
<th>Milk feeding</th>
<th>Starters</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Closed barn</td>
<td>(1) Once-day feeding</td>
<td>(1,2,3,4) Four</td>
</tr>
<tr>
<td>(old barn)</td>
<td>(2) Twice-day feeding</td>
<td>starters</td>
</tr>
<tr>
<td>(2) Outside portable pens</td>
<td>(1) Once-day feeding</td>
<td>(1,2,3,4) Four</td>
</tr>
<tr>
<td></td>
<td>(2) Twice-day feeding</td>
<td>starters</td>
</tr>
<tr>
<td>(3) Flush pens</td>
<td>(1) Once-day feeding</td>
<td>(1,2,3,4) Four</td>
</tr>
<tr>
<td></td>
<td>(2) Twice-day feeding</td>
<td>starters</td>
</tr>
</tbody>
</table>

The closed barn contained 4' x 6' pens with concrete floors which required daily bedding. The portable pens were 4' x 10' pens made from 3/4" pipe covered with woven fence wire for the retaining sides and 1/3 of the pen was covered with galvanized tin to give shelter from rain. The Flush Pens were 2' x 4' with slatted floors made from 1" x 2" cypress slats (some pens with 1" side up and some with 2" side up) or expanded metal. The starters fed were:

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Starters No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed hulls</td>
<td></td>
<td>150</td>
<td>150</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Citrus pulp</td>
<td></td>
<td>300</td>
<td>---</td>
<td>300</td>
<td>---</td>
</tr>
<tr>
<td>Gr. shelled corn</td>
<td></td>
<td>240</td>
<td>550</td>
<td>410</td>
<td>720</td>
</tr>
<tr>
<td>Soybean meal (49%)</td>
<td></td>
<td>240</td>
<td>220</td>
<td>220</td>
<td>200</td>
</tr>
<tr>
<td>Molasses</td>
<td></td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Salt, trace min.</td>
<td></td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Biofos</td>
<td></td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Gr. limestone</td>
<td></td>
<td>---</td>
<td>15</td>
<td>---</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

*All rations were fortified, per pound of starter, with: vitamin A--2,500 I.U.; vitamin D--300 I.U.; Aureomycin or Terramycin--10 mg.
The calves were assigned to treatments randomly. Male and female calves of all breeds were placed on the experiment until the latter part of the experiment when we were short of pens and only heifers were saved. A total of 120 calves were placed on the experiment and 4 deaths occurred (2 from scour-s pneumonia complex, 1 from a faulty heart, 1 strangled). The procedures followed were:

1. All calves were fed a 50:50 mixture of frozen colostrum and whole milk (7 lb/day for Jerseys, 9 lb/day for Holsteins and Brown Swiss). These levels were fed for 3 weeks after the calves were placed on experiment and the level cut in half the fourth week. At the end of 28 days the calves were weaned if they were consuming 1 lb of starter daily.

2. Starter and water were offered free-choice at all times. Daily weigh-backs of refusals were made to measure daily starter consumption.

3. Body weights were taken on all calves one day per week.

4. Calves were maintained in individual pens through the day of body weight measurement after 12 weeks of age.

5. The "flush pens" were washed (hosed) daily.

The results are shown in Table 2.

<table>
<thead>
<tr>
<th>Table 2. Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparisons</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Calf Starter 1</td>
</tr>
<tr>
<td>Calf Starter 2</td>
</tr>
<tr>
<td>Calf Starter 3</td>
</tr>
<tr>
<td>Calf Starter 4</td>
</tr>
<tr>
<td>Old Barn</td>
</tr>
<tr>
<td>Portable Pens</td>
</tr>
<tr>
<td>Flush Pens</td>
</tr>
<tr>
<td>Milk Once/day</td>
</tr>
<tr>
<td>Milk Twice/day</td>
</tr>
</tbody>
</table>

1Milk intake is an average over the 84 days of the experiment even though milk was only fed through 28 days of age or until calves were eating 1 lb of starter daily. About 15% of the calves were fed about 1 week longer than 4 weeks.

2Weights are an average for calves of all breeds used at 42 days of age.
The significant results of this experiment seem to be:

1. Housing did not have a significant effect on gains (or health) of the calves. Thus, the flush system has some advantages because need for bedding is removed and feeding and care is easier.

2. The expanded metal floors in the flush pens were much easier to clean but some calves obtained skinned knees and/or hips by 6 weeks or so of age.

3. Feeding milk once per day was equally as good as twice-daily feeding.

4. Calf Starter 2 with 15% cottonseed hulls was superior to the other rations.
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