UNIVERSITY OF FLORIDA, GAINESVILLE  MAY 2-3, 1989
Sponsored by the Dairy Science Department, Florida Cooperative Extension Service and the Agricultural Experiment Station of the Institute of Food and Agricultural Sciences with the Cooperation of State Dairy Organizations.
The Truman J. Smith family received the Dairy Family Award. Picture (L to R) are [standing] Pat Cockrell, Florida Farm Bureau Federation and presenter of the award, Troy and Wendy Smith, Kent Eppley, Erica Smith, Thurman and Becky Hatter, Pam and Warren Lowery. Seated (L to R) are Peggy and Kenneth Smith, Truman and Janie Smith, and Ruth Brown. See details in proceedings.

Miss Sarita Henderson, representing DFI and the Florida Dairy Princess, presented the Outstanding Senior Award to Meline Kulhanjian, graduating senior in the Dairy Science Department.

Cover Photo: Dairy Herd Management Awards were presented to (left to right) Estal Mattox Dairy, Perret's Dairy (Michael Perret) and Fieser Dairy (Gerald Feiser). Mr. Charles Thompson, president, N. FL Farm Credit Service, presented the awards. See details in proceedings.
The Robert K. Butler family received the Olympian Award. Pictured here [L to R] are Roger and Zoe Butler with Ryan, Robert Jr. and Pam with Ben, Katie and Will, Robert K. and Mildred, and Ron and Deborah Butler with Jacob, Jarrod and Justin. Award sponsored by Florida Bankers Association. See details in proceedings.

Mr. Don Bennink (L), president of PDCA presented the Outstanding Service Extension Award to Mr. David Solger, county extension director in Washington County.
Top three winners in the Honor Roll Quality Milk Contest were (L to R): Small Division (Cohasset Dairy – F.A. and Florida McMillian), Medium Division (Shenandoah Dairy – Sarita, Jennie, Carol and Jim Henderson), and Large Division (Sloane Ray Dairy – Sloane Melear Hesler and Clint Bass).

Mr. Bruce Buckler (left) incoming president, PDCA, presents the Special Recognition Plaque to Mr. Don Bennink, North Florida Holsteins.
May 6, 1989

TO: FLORIDA DAIRYMEN AND ALLIED INDUSTRIES

RE: TWENTY-SIXTH ANNUAL FLORIDA DAIRY PRODUCTION CONFERENCE

The 26th Annual Florida Dairy Production Conference brought together authoritative speakers on topics of major current interest. Thanks is extended to the speakers for their excellent presentations.

Special appreciation is extended to the Dairy Advisory Committee and Florida dairymen. Thanks is given to US Sugar Corporation and Monsanto Company for their support and sponsorship of the milk and coffee breaks.

Special thanks is given to the Dairy Division of the State Department of Agriculture and Consumer Services, the Farm Credit Services of Florida, the Florida Farm Bureau Federation, Florida Bankers Association, PDCA, State DHIA Board, and Dairy Farmers Incorporated for their support and participation in the awards program Tuesday evening, May 3.

Special appreciation is extended to North Florida Farm Credit Service for their sponsorship of the lunch on Wednesday at their facilities in Hague. The smoked steaks served were most delicious and were a real treat prior to the tour of the Dairy Research Unit.

In these proceedings is a list of those attending the conference. Also, the sponsors and those having commercial booths at the conference are recognized. Additionally, we have included a list of those on the Industry Advisory Committee to the Dairy Science Department.

Thanks to everyone for your help and support.

Roger P. Natzke, Chairman
Dairy Science Department

Barney Harris, Jr., Chairman
Dairy Production Conference (Extension Dairyman)
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PAST AND CURRENT RESEARCH ON DAIRY WASTE MANAGEMENT -- Roger A. Norstedt

PHOSPHORUS LEVELS IN SOILS OF SELECTED LAKE OKEECHOBEE WATERSHED DAIRIES -- Donald A. Graetz

ATTENDERS OF THE TWENTY-SIXTH ANNUAL FLORIDA DAIRY PRODUCTION CONFERENCE
DAIRY SCIENCE DEPARTMENT 1988-89
Roger P. Natzke

"CHANGE"

It is often said that we live in a world of change. When that change occurs and you have no control over it— it can be very threatening. If change occurs and you are in control, it is called progress. Our goal in the Dairy Science Department is to keep the majority of the change we experience in the latter category— progress.

Let's look at the progress for 1988-89.

Faculty

The first obvious area is in new positions. Mr. James Umphrey arrived in December to take on the position of half-time recruitment and half-time 4-H and Youth Development. Initiation of a position like this is a real "change" for us and becomes one of the first in the country. In the last few months, several other Animal Science departments have initiated similar positions. Enrollments in the Colleges of Agriculture continue on the decline. It will take a real recruiting effort at the department level to get the trend to turn around, and James is off to a good start. His work in the 4-H program will definitely help in recruiting.

A concern of many administrators is whether the efforts in the department are swinging too much toward the applied or too much to the basic. This year we struck a perfect balance because, to go along with our recruitment program, we were also able to attract a biotechnologist.

Dr. Frank Simmen will join the faculty on May 15. His wife, Rosalie, also a biotechnologist, accepted a position in the Animal Science Department. Combining the strengths of this team with our existing faculty will allow the basic animal reproduction program to continue to be one of the world leaders and provide further expertise for an already strong and productive basic research program. The Simmens have been on the Ohio State faculty for the last four years. We feel very fortunate to have been able to attract two biotechnologists that have an understanding of and appreciation for farm animals.

Publications

The research faculty had a banner year by publishing a record number of articles in refereed publications. That information will soon start showing up in extension publications and in materials presented at meetings. In addition to increasing the number of publications, they were also effective in competing for grant funds from industry and the Federal Government.
Milk Check-off

The first full year of the check-off brought in a total of $241,308. The majority of the money enters the University through the Florida Foundation SHARE with a smaller portion going through the Grants office. By going different routes, we can maximize the effectiveness of the program. In 1988, the project review committee placed $190,000 into projects, thus leaving a reserve of $51,308. For 1989, it is anticipated that the check-off will accumulate approximately $250,000. At this year’s meeting, the committee awarded grants in the amount of $253,543. Here is a list of the topics:

- Dairy Scholarships for Undergraduates
- Environmental Modifications for Reducing Summer Stress on Florida Dairy Farms
- Teaching Materials for Adult Education (Herdsman’s Seminars and Cow Colleges)
- Automatic Data Collecting System on Vacuum Fluctuation and Water Temperature
- Recruitment Coordinator position/one third support
- Development of Videotape for Training Bulk Milk Haulers
- The Effect of Microbial Inoculant and/or Supplemental Sugars on the Fermentation and Aerobic Stability of Bermudagrass Ensiled at Two Moisture Levels
- Dietary Electrolyte Balance Effect on Performance During Lactation and Metabolism of Calcium During the Dry Period
- Improved Breeding Management in Florida Dairy Herds
- Insulin-like Growth Factors-I and Postnatal Growth of Calves
- 4-H Dairy Science Youth Programs--support for the judging teams and quiz bowl
- The Seasonal Demand and Supply Imbalance--an in-depth analysis
- Passive Protection of Calves Against Cryptosporidiosis with Colostrum from Cows Immunized with a Host-Protective Cryptosporidium Parvum Antigen
- Establishment and Milk-producing value of Mott Dwarf Elephantgrass
- Partial Support of Visiting Sabbatical Scientist Dr. David Wolfenson from Hebrew University of Jerusalem, Dept. of Animal Science
- Automated Pre- and Post-milking Sanitation on Florida Dairies
- Effect of Heat Stress and Bovine Growth Hormone on Leukocyte Function in Cattle
- Alleviating Heat Stress and Associated Infertility in Dairy Cows
- Florida Dairy Business Management Project--a modeling approach.

The results of the first year’s projects are very interesting. Some reports are being presented at this meeting. In addition to giving reports at the Production Conference, we will continue to make reports at FDFA’s regional meetings and prior to the TIDFA board meetings. I just wish I could adequately describe what the check-off has meant to the department and what it will do for
the Florida dairy industry. The number of projects underway has increased dramatically, the faculty have never reached their limit on the number of projects they can handle, facilities are totally utilized, and the faculty is enjoying every minute of it.

Patents

U.S. universities are taking a new look at their roles in patenting of products and procedures. University of Florida is taking the posture of being more involved in aggressively pursuing patents. Our department has entered the picture with two applications being applied for this year.

1) Use of Interferon of the Alpha Family to Enhance Fertility in Mammals

University of Florida
P. J. Hansen
W. W. Thatcher

University of Missouri
R. M. Roberts
K. Imikawa

2) A Novel process for Facilitating Bovine Embryo Transfer and Otherwise Controlling the Estrous Cycle in Mammals

University of Florida
W. W. Thatcher

Raukura Animal Research Station, New Zealand
Keith (Jock) Macmillan

We don't anticipate major economic rewards from the patents, but we do hope that the findings will have an impact in reducing the effect of heat stress on reproduction.

Facilities

One of the spin-offs from accepting commercial grants is that we can use some of the money to upgrade our facilities. This year we completed a free stall barn which provides 100 Calan gates for individual feeding. We now have capacity to individually feed 184 cows. These facilities will be in heavy demand for the type of trials being funded through the check-off grants.

We are still struggling with our waste management problem. It has been difficult to find enough funds to complete the project as drawn by SCS. Hopefully, we can make another step forward this year.

Thanks

A special thanks to all who made this another good year for the department. That includes all the dairymen in Florida who contributed to the milk check-off program; to our advisory committee and the project review
committee who give so unselfishly of their time; to the donors to the bottle fund who completed their $2500 pledges this year; to Woody and Grace Larson, Emory Walker Company, Inc. and McArthur Farms, Inc.; and finally to those dairymen who allowed us to use their facilities and animals to increase the scope of our research.

**Dairies**

- Levy County Dairy
- Parrish Dairy
- North Florida Holsteins
- Larson Dairies
- Frank Denham
- Perrets Dairy
- Meadowmilk Dairy
- Wisteria Dairy
- Fort King Dairy
- Trinity Dairy
- M & M Dairy
- Wiggins Dairy
- Oaklane Dairy
- Hilltop Dairy
- Bart Bongers
- Vernon Blackadar

Not included in the list are those dairymen who allowed us to use their financial data, and those DHI members whose data adds much to our program.

We are pleased with the "changes" which took place this year. There is no question that the changes we observed would fit in the progress category.

Thanks, it's great to have your continued support.
ORGANIZING COMMITTEE

IFAS Faculty

Barney Harris, Jr., Conference Chairman, Dairy Science
Dan W. Webb, Dairy Science
David K. Beede, Dairy Science
Jan K. Shearer, Veterinary Medicine and Dairy Science
Kermit C. Bachman, Dairy Science
<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
</tr>
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<tbody>
<tr>
<td>Bill Bassett</td>
<td>Bassett's Dairy Farm, Rt. 2, Box 17A, Monticello, FL 32344</td>
</tr>
<tr>
<td>William Berman</td>
<td>Davie Dairy, Inc., 3105 NE 128th Ave., Okeechobee, FL 33492</td>
</tr>
<tr>
<td>Bart Bongers</td>
<td>Rt. 1, Box 192, Alachua, FL 32615</td>
</tr>
<tr>
<td>R. L. Dressel</td>
<td>Dressel's Dairy Farm, P. O. Box 398, Avon Park, FL 33852</td>
</tr>
<tr>
<td>Gerald Fieser</td>
<td>Fieser Dairy, 689 S. Kentucky Ave., Orange City, FL 32673</td>
</tr>
<tr>
<td>James Henderson</td>
<td>Sheandoah Dairy, Rt. 8, Box 153, Live Oak, FL 32060</td>
</tr>
<tr>
<td>David Kelbert, DVM</td>
<td>P. O. Box 24811, Jacksonville, FL 32241</td>
</tr>
<tr>
<td>Woody Larson</td>
<td>Larson's Dairy #2, P. O. Box 1242, Okeechobee, FL 33472</td>
</tr>
<tr>
<td>Steve Mattox</td>
<td>Rt. 1, Box 269B, Chipley, FL 32428</td>
</tr>
<tr>
<td>Kenneth Smith</td>
<td>23421 Whitman Rd., Brooksville, FL 33512</td>
</tr>
<tr>
<td>Ron St. Johns</td>
<td>Rt. 1, Box 869-J, Chiefland, FL 32626</td>
</tr>
<tr>
<td>Kelly Walker</td>
<td>Walker Bros. Dairy, P. O. Box 1259, Hilliard, FL 32046</td>
</tr>
<tr>
<td>Carroll L. Ward, Jr.</td>
<td>Laylaine Guernsey Farm, P. O. Box 146, Astatula, FL 32705</td>
</tr>
<tr>
<td>Tommy Watkins</td>
<td>C. R. Melear Dairy, P. O. Box 1647, Avon Park, FL 33825</td>
</tr>
<tr>
<td>Steve Yoder</td>
<td>Blue Bird Farm, Rt. 2, Box 737, Grand Ridge, FL 32046</td>
</tr>
<tr>
<td>Jay Boosinger, Director</td>
<td>Division of Dairy Industry, FL Dept of Ag &amp; Consumer Services, 3125 Connor Blvd., Tallahassee, FL 32301</td>
</tr>
<tr>
<td>David Solger, CED</td>
<td>800 Highway 90 West, Chipley, FL 32428</td>
</tr>
</tbody>
</table>
DAIRY PRODUCTION CONFERENCE
AWARDS BANQUET
1989 AWARDEES

1. DAIRY FAMILY AWARD - For several years, the Florida Farm Bureau Federation has enjoyed the opportunity of presenting a plaque to an outstanding Florida dairy family at the annual Dairy Production Conference. The family recognized annually is selected by a committee representing the Florida Farm Bureau Federation, Dairy Science Department of the University of Florida, Dairy Division of the Florida Department of Agriculture and Consumer Services, and with assistance from the local county Extension agent. The citation was read by Mr. Pat Cockrell.

Some of the criteria used in making the selection include:

1. Contributions made to the dairy industry
2. Longevity in the dairy business (two, three, or four generations, etc.)
3. Record of quality milk production
4. Cooperative attitudes
5. Success in milk production

The dairy family selected this year got its start in the dairy business in Florida at the height of the Depression. The patriarch moved to Miami in 1929 from DeKalb County, Alabama. Like many other young men, he was seeking work. He visited his brother at Farway Dairy near Miami. The owner had no openings but invited the young man to stay in the bunkhouse until he could find work. Truman J. Smith, a man of principles, insisted that he would help around the farm to pay for his board. At the end of the first week, the owner paid him the same as the others—showing Mr. Smith’s potential. He stayed on for several years and worked for several dairies in the Miami area before getting a job as assistant plant manager for Miami Home Milk Producers Association.

Truman Smith married his wife, Janie Dean, in 1935, and the two of them worked for 10 years to save money to buy their own dairy. Their dream came true in 1946, when the couple purchased 100 head of dairy cows in partnership with Smith’s brother-in-law, Hobson Rucks. They rented the building and land for the dairy, which was located in Callahan. In 1948, Mr. Smith bought out his partner. Then in 1949, he sold the cows. He turned down several job offers and spent three months looking for another dairy, before relocating in the Tampa area.

He finally bought 125 head of cows, leasing the building and lands. Two years later, he bought the land and barns in the area that is now Carol Wood Meadows in Tampa. He operated that dairy for 30 years.
In 1977, he bought a piece of property near Brooksville and began moving his dairy to its present location. The Smiths' only son, Ken, was born in 1938, and worked on the family dairy while growing up. With the move north, Ken took more responsibilities in running the family dairy.

At the present location in Brooksville, we see three generations of Smiths farming side by side in the running the family dairy. Ken's son Troy, 22, is active in all phases of the operation. Ken's daughter, Erica, is also involved as bookkeeper for T. J. Smith and Son Dairy. The Smiths milk more than 400 cows at the dairy and have a rolling herd average of more than 17,000 pounds. Mr. Smith not only provided a solid start for his family, he took a young worker, Thurman Hatten, under his wing and invited him in as partner in a second dairy—the 600-head Trinity Dairy. Thurman oversees most of the day-to-day operations at the main dairy, and Warren Lowry manages the Trinity Dairy.

Truman Smith has served in many leadership positions during his career. He was President of Tampa Independent Dairy Farmers, Inc. for five years, President of the American Dairy Association, President of Dairy Farmers, Inc., and President of the Florida Dairy Farmers Federation as well as several industry committees.

Ken is following in the father's footsteps as a member of the Florida Farm Bureau Dairy Advisory Committee. He also serves on the Board of Tampa Independent Dairy Farmers, Inc. and the Hernando County Farm Bureau. He is a former member of the Soil Conservation Board.

2. **DAIRY HERD MANAGEMENT AWARDS** - The awards are sponsored by Farm Credit Services in Florida and are selected from recipients nominated by the County Extension Faculty. Selections are based on changes and progress in milk production and herd management practices. Also, involvement in association, community and Extension programs are given consideration. The 1989 awards were presented by Mr. Charles Thompson, President, North Florida Farm Credit Service.

**Small Herd Division** - submitted by Jack Spears, County Extension Director, Holmes County. The citation was read by Dr. Barney Harris.

Estal and Wanda Mattix, and their two children, A. J. and Josh, owners of Whispering Hope Dairy near Graceville, were the recipients of the 1989 Florida Small Dairy Herd Management award at the 1989 Florida Dairy Production Conference held in Gainesville this week.

Estal and Wanda are third-generation dairy farmers. They moved from Tennessee to Florida in the mid-70's and have been on their own for the past eight years. Whispering Hope Dairy milks 56 cows on 120 acres, and has a rolling herd average of 19,339 pounds milk and 654 pounds fat. While the dairy is small, it houses a feed mill where all rations are
formulated, mixed and fed. About 30% of the Holstein herd is registered, and all animals are bred AI.

Estal presently serves as president of the Jackson DHI Association, is a member of the Holmes County Farm Bureau, and is actively involved in a local Baptist Church. He and his wife Wanda have two sons, ages seven and thirteen.

Medium Herd Division - submitted by Sharon Fox, Volusia County Extension. The citation was read by Dr. Barney Harris.

Fieser Dairy is owned and operated by the Fieser family in Volusia County. Originally from Kansas, Mr. and Mrs. Ralph Fieser and their three children moved to Florida in 1960, and after serving as herdsman for two other dairies for 13 years, purchased the Blowers dairy. Since 1972, they have owned the dairy. It is a family dairy, with all three children, Gerald, Karl, and Susan, frequently involved. Karl has an interest in auto racing, Susan is involved in teaching, and Gerald represents the dairy at various meetings.

The dairy has made considerable progress in recent years. It is located on 350 acres, milks 484 cows, and has a rolling herd average of 16,192 lbs of milk.

The family is very much involved in community and state activities. Gerald is a member of the Virginia-NC Select Sires Board, Dairy Farmers Incorporated, University of Florida Advisory Committee, and Florida Feed Technical Council. Locally, Gerald serves on the Farm Bureau Board, is an Orange City Councilman, and is actively involved in the Volusia County Dairy Show. Also, the dairy serves as a host for tours and events during the year.

Large Herd Division - submitted by Mike Kelly, Multi-county Extension Agent in Duval County. The citation was read by Mr. Mike Kelly.

Perret's Dairy, Inc. of Callahan was named the recipient of the Florida Large Dairy Herd Management Award at the Florida Dairy Production Conference held in Gainesville on May 2-3, 1989.

Perret's Dairy is a third-generation operation which was started in 1917 by G. A. Perret, an immigrant from Switzerland, who began dairying with six Guernsey cows. In 1932, son Don Perret began selling milk door-to-door from the back of a station wagon. Perret's Dairy continued to bottle and distribute milk until 1979.

Today, Perret's Dairy is owned and operated by grandson, Michael Perret. The 800-acre dairy has a herd size of 1350 cows with plans to increase
to 1500 cows. The dairy enjoys a DHIA rolling herd average of 17,669 lbs milk with 3.6% BF.

The success of the dairy operation is attributed to its strong staff of employees. Perret’s Dairy subscribes to a personnel management program which is based on an organizational chart for all positions and a job description for every position. Communication is the key as it flows from management to supervisors to workers and back again through close daily interaction, weekly meetings between management and supervisors and monthly meetings between supervisors and workers. Workers are evaluated monthly based on individual and team performances.

Perret’s dairy is very innovative in the use of computers and other management practices. Heat stress management programs include the use of shade, sprinklers and fans. Feeding and health programs are carefully monitored.

The management of Perret’s Dairy is very supportive of Extension dairy educational programs in Northeast Florida including participation on the Northeast Florida Extension Dairy Advisory Committee and the Duval DHIA Board of Directors. The management of Perret’s Dairy also supports the Florida dairy industry through membership and active participation in Florida Holstein Association, Florida PDCA and Florida Dairy Farmers, Inc.

3. THE OLYMPIAN AWARD - sponsored by the Florida Bankers Association, this award recognizes a dairyman each year that has made significant progress in the dairy industry, is progressive in management concepts and facilities, involved in community and association activities and supportive of Extension programs. Such is the case Butler’s Dairy where Robert K. Butler and the family have been progressive leaders in the dairy industry. The citation was read by Dr. Roger Natzke.

The dairy was founded July 1, 1940, by Bob’s father, Ben W. Butler. In 1948, Robert K. became a partner in the dairy and was married to Mildred Thomas. In 1965, Bob, Mildred and the three sons purchased Ben’s shares of the dairy and constructed a new dairy in Highlands County. Today, Butler’s Dairy, Inc., is two dairies and still very much a family farm.

The three sons, Robert, Ron, and Roger, are now married and all three, as well as their wives, are involved in the operation. In 1973, Ron married Deborah Beasley, Robert, Jr. married Pamela Hendry in 1977, and in 1984, Roger married Zoe Travelyn. The wives, along with Bob, Sr. and Mildred, handle all the records through their computer programs.

The Butlers have always had a keen interest in the Florida Dairy Industry as well as community activities. Bob, Sr. has served on the board of IDF (now FDFA) since it was formed in 1957, the first year as an alternate, and thereafter as a director. He has served on the executive
board since 1959, and now serves as Secretary. He was a charter member of the board of Commercial Bank of Okeechobee, later purchased by Sun Bank. Since United Feed Co-op was formed in 1979, he has served as Secretary-Treasurer. He also serves as director and Treasurer of Producers' Meat Packing Co-op. Bob also served for eight years on the Board of Trustees of Okeechobee General Hospital, and later for three years on the board of H. H. Raulerson Hospital. Governor Graham appointed him to the Resource Management Task Force, and later to the South Florida Water Management Board.

Mildred has served on the Okeechobee County Library Board since 1983, and on the Hospice Board since 1985. She also serves on the Extension Service Advisory Board. Bob, Jr. has served on the UDIA board for ten years and is now serving as President of DFI. He also serves on the University of Florida SHARE Board, as well as the Kissimmee River Advisory Board. Pam stays busy with their three children, Ben, Katie and Will. She serves as a school volunteer and this year headed up the dairy section of the Food Fair. Ron serves on the Farm Bureau Board and the Youth Livestock Committee. He coaches the 4-H Dairy Judging Team and judges local dairy shows. Debbie stays busy with their three sons, Justin, Jarrod and Jacob. She has been going back to college to get her teaching certificate. Roger has had a busy year putting the BMP project in at Barn No. 1. Zoe stays busy with their two-year-old son, Ryan.

All of the Butlers are very much involved in the activities of their local church in Okeechobee.

4. DAIRY SCIENCE SENIOR AWARD - Florida Dairy Princess (1st runner-up) Sarita Henderson presented the Outstanding Dairy Senior Award to Ms. Meline Kulhanjian at the 26th Annual Florida Dairy Production Conference. This award is sponsored by Dairy Farmers, Inc., and recognizes the strong leadership that Meline provided during her undergraduate study in Dairy Science. Meline is completing a dual major in Dairy Science and Food/Resource Economics, and plans to work in agricultural extension. In addition to her Dairy Club activities, Meline has been active in Alpha Zeta honorary fraternity and the Little Sister program at Alpha Gamma Rho Fraternity.

5. PDCA AWARDS - Mr. David Solger, County Extension Director in Washington County received the IFAS Purebred Dairy Cattle Association (PDCA) award at the 26th Annual Florida Dairy Production Conference Awards Banquet. Mr. Solger was cited for his outstanding leadership and services to the Florida dairy industry, especially in the areas of youth work and dairy cattle management, and in the promotion of healthy and quality cows.
Mr. Don Bennink, owner of North Florida Holsteins at Bell, received the industry PDCA award. He was cited for his dedication and hard work with the Florida Holstein Association, the PDCA, and support of the Florida dairy industry. Also, he was recognized for his leadership role with purebred dairy cattle shows and in the promotion of purebred dairy cattle.

**Posthumous awards** - Mr. Herman Boyd and Mr. Earl Van Wagner were honored by the Florida Purebred Dairy Cattle Association for their many contributions to the promotion of purebred dairy cattle and the Florida dairy industry.
6. **TOP DHIA HERD RECOGNITION - 1989 DAIRY PRODUCTION CONFERENCE**

### Division I - Under 500 Cows

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### Division II - Over 500 Cows

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<td>631</td>
<td>20,279</td>
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<tr>
<td>*L A D Dairy Farm</td>
<td>Greenville</td>
<td>837</td>
<td>19,751</td>
<td>697</td>
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<td>*Pine Valley Dairy, Inc.</td>
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<td>672</td>
<td>18,828</td>
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<tr>
<td>*North Florida Holsteins</td>
<td>Bell</td>
<td>1,877</td>
<td>18,670</td>
<td>665</td>
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<tr>
<td>*Aukema Dairy Farms, Inc.</td>
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<td>18,076</td>
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**Fat**

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<td>*L A D Dairy Farm</td>
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<tr>
<td>*North Florida Holsteins</td>
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<td>Farren Dakin Dairy</td>
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<td>Cameron Dakin</td>
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<td>17,281</td>
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Production data from DHI test year ending September 30, 1988.

*All or part of herd milked 3X.*
STATE DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES
HONOR ROLL AWARDS FOR 1988

Top Four Honor Roll Awardees were:

a. Small herd division (less than 200 cows) - Cohassett Dairy, Fillmore McMillan, Grand Ridge, Florida, 40 cows

b. Medium herd division (200-499 cows) - Shenandoah Dairy, James E. Henderson, Live Oak, Florida, 225 cows

c. Large herd division (greater than 500 cows) - Sloane Ray Dairy, Raymond C. Melear, Okeechobee, Florida 650 cows

Other herds receiving Honor Roll Certificates:

12 Months

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>City</th>
<th>State</th>
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<tr>
<td>Norman Nickerson</td>
<td>Bellview Dairy, 12835 SE Highway 301</td>
<td>Bellview</td>
<td>FL</td>
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<tr>
<td>Fred Gore</td>
<td>Gore Dairy No. 2, P. O. Box 605</td>
<td>Zephyrhills</td>
<td>FL</td>
<td>34283</td>
</tr>
<tr>
<td>Leon N. Lockhart</td>
<td>Lockharts Dairy, 10020 SW 105th St.</td>
<td>Ocala</td>
<td>FL</td>
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<tr>
<td>Walter Wayne Jerkins</td>
<td>Blue Jay Farm Dairy, 21328 Ayers Rd.</td>
<td>Brooksville</td>
<td>FL</td>
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</tr>
<tr>
<td>John F. Carter, Jr.</td>
<td>Green Oak Dairy, Rt. 1, Box 352</td>
<td>McAlpin</td>
<td>FL</td>
<td>32062</td>
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<tr>
<td>Mrs. Jean McArthur Davis</td>
<td>McArthur Farms, Inc. #4</td>
<td>Okeechobee</td>
<td>FL</td>
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<tr>
<td>Mike Bond</td>
<td>Chrislyn Dairy, Rt. 2, Box 345</td>
<td>Lake City</td>
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<tr>
<td>T. J. Koon</td>
<td>Koon Dairy, Rt. 2, Box 238</td>
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<tr>
<td>J. P. O'Connell</td>
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<tr>
<td>James L. Enrico</td>
<td>Enrico Dairy, Inc., 6001 SE 128th Ave.</td>
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<tr>
<td>Wayne Lee</td>
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<tr>
<td>Riley &amp; Mark O'Steen</td>
<td>O'Steen, Whitey Dairy, Rt. 2, Box 215A</td>
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<tr>
<td>Robert Goolsby</td>
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<tr>
<td>C. Lee Holcomb</td>
<td>Leemin Premium Dairy, 603 Pawn Way</td>
<td>Seffner</td>
<td>FL</td>
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<tr>
<td>Beverly Platt</td>
<td>Platt Farms, P. O. Box 46</td>
<td>Okahumpka</td>
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<td>Robert Goolsby</td>
<td>Goolsby Dairy No. 2, Rt. 4, Box 453</td>
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<tr>
<td>D. W. Lester</td>
<td>Lester, D.W. &amp; Sons, 200 Lester Dairy Road</td>
<td>Land O' Lakes</td>
<td>FL</td>
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<tr>
<td>Ray Melear</td>
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<td>Name</td>
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<tr>
<td>Mike Reagan</td>
<td>Rolling Hills/Pasco Co. 1062 Covington Rd. Dade City 33525</td>
<td>Raymond C. Melear Sloane Ray Dairy 5200 HWY 98 North Okeechobee 33472</td>
<td>Mrs. Earl Van Wagner Van Wagner Dairy Rt. 1, Box 2760 Citra 32627</td>
<td></td>
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<tr>
<td>Neil Rucks</td>
<td>Rucks, Neil Dairy No. 3 1717 Hwy 301 South Zephyrhills 33599</td>
<td>Thomas J. Adams Triple A Dairy, Inc. P.O. Drawer 640 Glen St. Mary 32040</td>
<td>Howard Nickerson White Owl Dairy Rt. 5, Box 149X Live Oak 32060</td>
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### 24 Months

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<th>Name</th>
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<tr>
<td>Bernard Arndt</td>
<td>Arndt Dairy Rt. 1, Box 178 High Springs 32643</td>
<td>Norman Nickerson Lemon Grove Dairy Rt. 2, Box 267N Wauchula 33873</td>
<td>Neil Rucks Rucks, Neal Dairy 1717 HWY 301 South Zephyrhills 33599</td>
</tr>
<tr>
<td>G. E. Toms</td>
<td>Graham Co. No. 3 143400 NW 60th Ave. Moore Haven 33471</td>
<td>Carlton Melear &amp; Son Melear Dairy No. 2 P. O. Box 1647 Avon Park 33825</td>
<td>James E. Henderson Shenandoah Dairy Rt. 8, Box 153 Live Oak 32060</td>
</tr>
<tr>
<td>Donald G. Hanson</td>
<td>Hanson’s Dairy Rt. 2, Box 128A Mayo 32066</td>
<td>R. L. Price, Jr. Price Dairy 1107 Webb St. Graceville 32440</td>
<td>Charles Williams V &amp; W Dairy P. O. Box 1057 Avon Park 33825</td>
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### 36 Months

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<th>Name</th>
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<tr>
<td>Frank Butterworth</td>
<td>Butterworth’s Dairy P. O. Box 114 Bonifay 32425</td>
<td>Mrs. Jean McArthur Davis McArthur Farms No. 5 1550 NW 208th St. Okeechobee 34972</td>
<td>Jay Swiers Pine Lane Dairy Rt. 1, Box 40 High Springs 32643</td>
</tr>
<tr>
<td>F.A. &amp; Florida McMillan</td>
<td>Cohassett Dairy Rt. 1, Box 7 Grand Ridge 32442</td>
<td>Wayne Oelfke Oelfke Dairy Farm Rt. 1, Box 88 High Springs 32643</td>
<td>Pride Inc. Apalachee Correctional Inst. P. O. Box 699 Sneads 32460</td>
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48 Months
G. E. Toms
Grahams Company
P. O. Box 41
143400 NW 60th Ave.
Moore Haven 33471

60 Months
I. O. & Everett Kerby
Kerby Dairy
Rt. 3, Box 61
Mayo 32066

84 Months
James L. Legg
Turnpike Dairy
P. O. Box 385
Palm City 34990-0385

144 Months
Wallace Eicher
Eicher's Dairy
Rt. 1, Box 175
McDavid 32568

168 Months
Mrs. Max Brantley
Brantley's Dairy
3825 Turtle Mound Rd.
Melbourne 32905

George White
River Dairy
2642 Flowing Well Rd.
DeLand 32720
SPONSORING ORGANIZATIONS

Milk and Coffee Breaks:
US Sugar Corporation
Monsanto Company

Wednesday Lunches:
North Florida Farm Credit Service

COMPANIES HAVING EXHIBIT TABLES

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<tr>
<th>Company</th>
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<tr>
<td>Alltech, Inc.</td>
<td>Dr. James D. Chapman</td>
</tr>
<tr>
<td></td>
<td>1443 Craddock Way</td>
</tr>
<tr>
<td></td>
<td>Macon, GA 31210</td>
</tr>
<tr>
<td>American Breeders Service</td>
<td>Mr. Dirk Vlot</td>
</tr>
<tr>
<td></td>
<td>4040 Chelsea Lane</td>
</tr>
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<td></td>
<td>Lakeland, FL 33809</td>
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<tr>
<td>American Cyanamid Company</td>
<td>Tommy Martin</td>
</tr>
<tr>
<td></td>
<td>104 Lake Otis Road SE</td>
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<tr>
<td>Balanced Energy Co.</td>
<td>Charlene Speakman</td>
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<td>P. O. Box 946, 2041 Lincolnway Blvd.</td>
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<tr>
<td>Carolina By-products</td>
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<td>Chr. Hansens Laboratory, Inc.</td>
<td>Jane Allman</td>
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<tr>
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<td>9015 W. Maple Street</td>
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<td>Milwaukee, WI 53214</td>
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<td>Church &amp; Dwight</td>
<td>Randy Cawood</td>
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<td>Rt. 2, Box 144A</td>
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<td>Abbeville, SC 29620</td>
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<td>Controls &amp; Weighing Systems, Inc.</td>
<td>Betty Caruthers</td>
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<td>Dairy Equipment Company</td>
<td>Lee Jarrett</td>
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<td>Dairyland Milking Parlours, Inc.</td>
<td>Doug Zarling</td>
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<td>Omro, WI 54963</td>
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<td>Dekalb-Pfizer Genetics</td>
<td>Willbur Webb</td>
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<td>Tifton, GA 31794</td>
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<td>Donovan Enterprises, Inc.</td>
<td>Alfred Sweeney</td>
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<td>2951 SE Dominica Terr.</td>
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<td>Stuart, FL 33497</td>
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Federated Genetics
George M. Manter
4138 Piper Drive
Jacksonville, FL 32207

Fogleman Welding & Fabrication
Works, Inc.
Boyd C. Fogleman
2170 Herron Road
Whitsett, NC 27377

Franklin Laboratories
Richard Devereaux
3011 NW 142 Ave.
Gainesville, FL 32609

Furst McNess Co.
James E. Troncin
120 E. Clark St.
Freeport, IL 61032

Germania Dairy Automation
Dave Luzader
Rt. 1, Box 125C
Chappell Hill, TN 37034

H & H Equipment Sales, Inc.
Carl Harper
P. O. Box 468
Alma, GA 31510-0468

Haas Chemical Co., Inc.
George A. Haas, Jr.
111 S Beltline Hwy, Suite 208
Mobile, AL 36606

Kentucky Dept. of Agriculture
Barney Hornback
#63 Wilkinson Blvd.
Frankfort, KY 40601

Lakeland Cash Feed Co.
Rod Peeples
P. O. Box 24868
Lakeland, FL 33802-4868

Landmark Genetics, Inc.
Les Anderson
2203 Woodbine Drive
Tallahassee, FL 32308

Life Services
Tommy Lynn
P. O. Box 5568
Ocala, FL 32678

M & M Supply Company of Florida
Roger Abbott
P. O. Box 248
Thonotosassa, FL 33592

M.R.B., Inc.
Jim Waits
P. O. Box 1347
Zephyrhills, FL 34283

Meadowlake Farms
Troy Orwig
R. R. #1
Vermont, IL 61484

Moorman Mfg. Co.
Kent Egbert
1000 N. 30th
Quincy, IL 62301

MSD AGVET, Div. of Merck & Co.,
Nancy Patterson
6055 Primacy Parkway Suite 404
Memphis, TN 38119

Noba, Inc.
Linda Weygardt
P. O. Box 607
Tiffin, OH 44883

North Florida Farm Credit Service
Charles Thompson, Don Dean
P. O. Box 909
Alachua, FL 32615-0909
Paul Mueller Company  
Frank Bird  
P. O. Box 56  
Winterville, GA  30683

Pine Point Construction Co., Inc.  
Edwin H. Pedrick  
1001 East Screven St.  
Quitman, GA  31643

Pioneer HI Bred - Microbial Genetics  
Daryl D. Hammer  
200 Caldwell  
Campobello, SC  29322

Project Management Associates, Inc. and Don Themm Enterprises  
Don Themm  
6121 Hwy 98 N  
Lakeland, FL  33809

Smith Cattle Guard Co.  
Tom Jones  
P. O. Box 1356  
Leesburg, FL  32749-1356

TUCO/Upjohn  
Tom Holloway  
2626 Handley Blvd.  
Lakeland, FL  33803

US Sugar Corporation  
Mr. W. M. Gober  
P. O. Drawer 1207  
Clewiston, FL  33440

VA/NC Select Sires  
Danny Yant  
1428 Rosecrans Lane  
Green Cove Springs, FL  32043

Westfalia Systemat  
Richard H. Larson  
1862 Brummel Drive  
Elk Grove Village, IL  60007
PROGRAM PARTICIPANTS—1989 DAIRY PRODUCTION CONFERENCE

D. K. Beede, associate professor, Dairy Science Department, University of Florida, Gainesville.

D. R. Bray, Extension Agent II, Dairy Science Department, University of Florida, Gainesville.

R. Collier, Dairy Research Director, Monsanto Company, Chesterfield, MO.

C. E. Coppock, Professor of Dairy Science, Texas A & M University, College Station, TX.

W. A. Darling, Director of Environmental Programs, Dairy Farmers, Inc., Orlando.

O. Forker, Professor of Ag Economics, Cornell University, Ithaca, NY, and Adjunct Professor, Food and Resource Economics Department, University of Florida, Gainesville.

R. Giesy, Area Extension Dairy Specialist, Dairy Science Department, University of Florida, Seffner.

D. Graetz, Associate Professor, Soil Science Department, University of Florida, Gainesville.

B. Harris, Jr., Extension Dairyman, Dairy Science Department, University of Florida, Gainesville.

G. Hartnell, Dairy Clinical Research, Monsanto Company, Chesterfield, MO.

R. Harvey, Deputy Director, Division of Water Facilities, State Department of Environmental Regulations, Tallahassee.

R. P. Natzke, Professor and Chairman, Dairy Science Department, University of Florida, Gainesville.

R. Norstedt, Professor, Agricultural Engineering Department, University of Florida, Gainesville.

C. R. Staples, Assistant Professor, Dairy Science Department, University of Florida, Gainesville.

W. W. Thatcher, Professor, Dairy Science Department, University of Florida, Gainesville.

J. E. Umphrey, Extension Dairy Youth Specialist, Dairy Science Department, University of Florida, Gainesville.

D. W. Webb, Extension Dairyman, Dairy Science Department, University of Florida, Gainesville.


G. L. Zachariah, Vice President for Agricultural Affairs, University of Florida, Gainesville.
MEASURING THE IMPACT OF MILK PROMOTION DOLLARS

Olan D. Forker
Professor of Agricultural Economics,
Cornell University, Ithaca, NY and
Adjunct Professor, Food and Resource Economics Department
University of Florida, Gainesville, FL

Have the dairy promotion organizations been measuring the impact of milk promotion dollars? Yes! Is it being done now? Yes! Is enough being done? No!

The New York Milk Promotion Board has been supporting economic studies designed to measure the impact of their fluid milk promotion dollars on sales since 1972. That is when the industry obtained legislation for a mandatory, no refund, check-off. From the beginning the dairy farmer board of directors insisted on an ongoing process of evaluation. Ideally they wanted return on investment type measurements. We at Cornell entered into an agreement to do as much as we could to provide answers; with an understanding that we could and would publish the research results regardless of the outcome, positive or negative. This condition, of course, made many in the generic milk promotion business very nervous.

The early work yielded very positive results. As a result much of the local opposition disappeared.

In this presentation I wish to address three questions. What kind of studies are being done? Who is doing them? And, what kind of answers are they getting? Then I will close with some generalizations and a statement as to why I think not enough is being done.

WHAT KINDS OF STUDIES ARE BEING DONE?

Two approaches are being used: Tracking studies and economic analysis.

The tracking studies are designed to measure changes in consumer awareness and consumer attitudes—awareness to the dairy advertisements attitudes toward dairy products. These studies are essential in the management of any advertising and promotion program. If they are continuous, they provide management a quick reading on how well their promotion efforts are being received by the viewing and reading consumer. However, they do not provide a basis for measuring return on investment.

The second approach, economic analysis, gets to the question of return on investment. Through the proper kind of economic analysis one can measure the net effect of advertising on sales. This in turn can be used to estimate returns. And if properly done, the results will be useful in deciding how much money to put behind different kinds of programs.
WHO IS DOING THE WORK?

Tracking studies have been supported by the dairy promotion organizations for several years. Nobody would think of spending millions of dollars on advertising without the information that tracking studies provide. In the past UDIA, the California Milk Advisory Board and other dairy organizations all supported different kinds of market research studies. Now that work is consolidated at the national level and funded by the National Dairy Board.

Economic analysis has been supported by the New York State Milk Promotion Board since 1972. But, that research covers only the advertising programs in the New York markets.

In the late 1970's, the United Dairy Industry Association hired Stan Thompson of Michigan State University to develop an economic model of the ADA fluid milk advertising program. Stan Thompson was a graduate student of mine who had helped develop the first studies of the New York promotion programs. Stan and the UDIA selected 10 markets in the United States to include in that analysis.

In 1984, Ron Ward here at Florida took over that work. Then the next year, the National Dairy Board took over. They hired Arthur D. Little their first year. But in their second year, they entered into a contract with the University of Florida. Ron Ward, with the help of Bruce Dixon from the University of Arkansas, has been updating the study annually since 1987.

The Ward/Dixon economic model is very sophisticated and efficient. It provides the dairy industry with an excellent measure of the impact of the fluid milk advertising dollar on sales in 12 markets that represent about 42 percent of total US volume.

Some work has been done on measuring the impact of the cheese advertising dollars on sales. At Cornell, we did a study of cheese advertising in the New York City market. The UDIA had Wharton Econometrics do a study. A.D.Little did one study for the National Dairy Board. The Economic Research Service in the USDA has a model of cheese advertising that provides some insight. They all yield positive results, but their value is limited because of lack of data to use in measuring changes in away from home consumption.

At Cornell we have just completed a study which begins to gain some insight into the relationship between fluid milk advertising and cheese advertising.

The Ontario Milk Marketing Board has been supporting economic analysis of their fluid milk and butter promotion programs for about 3 years now. That work has been done using faculty from the University of Guelph in Ontario and Henry Kinnucan from Auburn. Henry worked with me at Cornell on the New York studies until about 1983 when he joined the faculty at Auburn.
RESULTS

So what are the results?

First, all of the studies have shown a positive impact on sales. Second, the return on investment has been positive in almost every case, but not all. Third, it is reasonable to expect that different studies done in different markets over different time periods will yield different results. And they do.

IMPACT ON SALES

One way to measure the impact on sales is to develop what is called a long run advertising elasticity. This is a measure of the percent increase in sales associated with a one percent increase in advertising expenditure. They range from 0.3 to 0.005. A study of the California fluid milk advertising program for the period 1970-73 indicated a 0.3 percent increase in sales from a 1 percent increase in advertising expenditure. That is the largest number anyone has gotten.

The second largest elasticity observed comes from a Cornell study of fluid milk advertising in the Buffalo, New York market covering January 1978-June 1981. This yielded an elasticity of 0.121. Other studies have yielded a range of elasticities from 0.051 (New York City, January 1971 to June 1980) to 0.005 (Syracuse, NY).

Different results of this magnitude can come about in several ways. First, different markets might respond differently because of different kinds of consumers.

Second, the size of the market makes a difference in media costs. For example, because of population density differences, it is much less costly to reach 100,000 viewers in New York City than in Syracuse, NY.

Third, the competitiveness of the market for advertisers makes a difference. For example, it costs more to reach the same number of viewers in Boston than it does in NYC.

Fourth, the law of diminishing returns applies to advertising just like it does to the application of fertilizers to a crop. The effectiveness of each additional dollar increases at an increasing rate up to some level of expenditure, then increases at a decreasing rate, but then it might begin to decrease. But, just like a fertilizer response curve, the effectiveness and shape depend on the quality of the environment and the quality of the input. The markets are the environment. The advertisements, good and bad, are the inputs.

Generic milk advertising expenditures were relatively modest prior to the 1970’s. The results then indicated that the response was on the early part of an upward sloping curve. The studies of the 1980’s with much higher levels of expenditure indicate that the measurement is much higher on the curve; perhaps nearing the top; and, perhaps, even over the economic optimum in some markets. It is worth noting that the rate of return on investment decreases as you move to higher levels of expenditure.
Of course, this is a very useful information. If in fact you know what the response function is, you can determine the optimum level of advertising expenditure.

**Cumulative Effect**

Most fluid milk studies indicate a substantial carryover effect, sometimes referred to as a lag effect, or a cumulative effect. Almost every study indicates a lag between the time the expenditure is made and the time of greatest impact. All of the studies indicate that the greatest impact comes about two to three months after the initial advertising and the impact of that advertising is completely gone by the end of five or six months. This is evidence that if it pays at all it pays to continue to advertise.

**Return on Investment**

Return on investment estimates are available from some of the studies. I am going to report some of them, but I suggest that they be used with caution.

One of our models of the New York City market indicated a $6.00 return on investment. This covered the period January 1971-June 1980. The advertising expenditure level was at 7 to 8 cents per capita.

Our Buffalo study indicated a return of $16-20 per advertising dollar invested. Expenditure levels per capita were higher than in NYC. But Buffalo is a unique market.

Studies over the same time period indicated relatively modest returns on investment in the other upstate markets. The Albany study indicated a return of $1.50 for each dollar spent. The Syracuse study indicated only a $0.50 return on each dollar invested.

We calculated an optimum level for the New York markets. The optimum for NYC was 10 cents per-capita. The optimum for Albany was 3 cents and 1.5 cents for Syracuse. The actual level of advertising expenditures in all markets was about 7 cents per-capita.

Later studies of the NYC program showed more modest returns primarily because advertising expenditures had gotten to much higher levels. For example, by 1984 per capita expenditure in New York City had gotten to 15 cents and at that level the return on investment was $1.50 for each dollar spent. In fact, the optimum level in that study would have been about 35 percent less than what was actually being expended at that time.

The more recent studies of Ward and Dixon for the National Dairy Board yield some interesting numbers. For the period December 1978 to September 1984, $90 million dollars was spent on fluid milk advertising in the 12 markets being studied. This is an annual rate of $15.4 million. On average, $1 of advertising yielded 43 pounds of additional milk sales.

For the period September 1984 to September 1987, $105 million was spent on fluid milk advertising. This is an annual rate of $35 million. On average, $1 of advertising yielded an increase in sales of 57 pounds of milk.
The study further indicates that the advertising level pre 1984 caused a 3.2 percent increase in sales over what would have occurred without advertising.

For the post 1984 period, the actual advertising level caused a 6.5 percent increase in sales over what would have occurred without advertising.

The difference between pre 1984 levels and the post 1984 levels of advertising expenditures yields an increase of 2.5 percent.

The annual update indicates that since the industry began advertising at higher levels following the Dairy Promotion Act of 1983, there has been a continual improvement in the effectiveness of each dollar spent.

OTHER FACTORS

Factors other than advertising also affect sales of a commodity. Each of the studies that I have mentioned takes into account the impact of those other factors. The advertising responses discussed above are net of the influence of those other factors.

In all of the studies the only other economic variables identified as having any significant impact on sales, are the price of milk itself, purchasing power of the consumers and their demographic characteristics. In just a few of the studies, the price of cola or the price of orange juice, competing beverages, showed up as being important. The higher the price of the competing beverages, the lower the consumption of fluid milk, or the lower their prices the higher the consumption of fluid milk.

MORE ECONOMIC ANALYSIS NEEDED

All of the studies so far indicate positive results. So why do I think it necessary to support more economic analysis?

First, the fluid milk advertising is the only portion of the generic milk promotion program that has been anywhere near adequately researched. The dairy industry collects and invests annually about $200 million. About $70 million (35 percent) is spent on fluid milk advertising. So to date the industry has a meaningful level of economic understanding on only one third of their investment.

Second, the industry will not be able to determine whether investing 35 percent in fluid milk advertising is the correct allocation until the industry has response estimates for the other programs, that is, cheese advertising, butter advertising, nutrition education and the several other programs that are being supported. When advertising response functions are known for each program, the Boards will be able to make more informed allocation decisions among program activities.

Third, the economic analysis needs to be continuous and cover different segments of the total market that the industry is trying to influence. It is apparent from the completed studies that the effectiveness of the advertising effort changes over time. Current information is necessary to make appropriate
temporal adjustments in program funding. It is also apparent that different geographical markets respond differently. Knowledge of these differences is necessary if these differences are to be exploited to the dairy farmers advantage. The use of different media might also give different economic results. Economic studies to determine these differences would help with decisions about media allocations.

A NATIONAL MULTI-PRODUCT STUDY

Ideally, for optimum utilization of the funds available, a person would like to have a separate response measure for each advertising, promotion, education and research effort of the dairy promotion organizations. The ideal is not possible. But we could come a lot closer than we are now.

We have just completed a study at Cornell that goes one step farther. It measures the impact of all fluid milk advertising and all cheese advertising on the total US volume of milk used for fluid and for manufacturing purposes. It measures the impact on the M-W price and the federal order price levels. It also measures the milk production response resulting from the more favorable prices. With this information, separate return measures for the cheese advertising effort and the fluid advertising efforts can be determined. This makes it possible to estimate the best allocation between fluid and cheese advertising. It also provides a basis for deciding whether the national 15 cent assessment is the optimum.

This particular study indicates reasonable but somewhat more positive responses from fluid milk advertising than the previous studies. But more important it indicates a very positive response from the cheese advertising effort.

SUMMARY

In summarizing, let me make some general observations.

First, two approaches are used to measure the impact of advertising. Tracking studies are essential in monitoring the manner in which consumers respond to the advertisements that are developed. They are essential in the diagnosis of the various programs so that better programs can be designed for the future.

Economic analyses are essential to obtain any estimate of economic benefits or any estimate of a return on investment. Only through some form of economic analysis can we obtain a measure of the net effect of advertising on sales, net of the influence of other factors such as changes in relative prices and changes in consumer purchasing power.

Second, it is clear from the research that has been done so far that the advertising expenditures can and do have a positive impact on sales. But it is also clear that the effectiveness changes as the levels of expenditure are increased. It is clear that effectiveness is influenced by different economic and demographic conditions in the market place and by different type program efforts.
Third, economic analyses that cover all different program efforts, all products being advertised, and all markets are necessary. That much economic insight is necessary if the Boards of Directors of the programs and the program managers are to make the allocation and investment decisions that will maximize returns to dairy farmers over the long pull. It is important to recognize though that the optimum level is a continually moving target and, therefore, a system of economic analyses needs to be put in place to continuously update the programs' impacts.

Why has more economic analysis not been done? Data limitations are the main reason. A major investment of time and effort is required on the part of the promotion organizations to develop some sort of a consistent way of measuring and recording the advertising effort. It is also necessary to develop some way of recording in a consistent and continuous manner a more thorough breakdown of sales. Only then can more detailed, more sophisticated, more accurate measurements be made.

There is a tendency to not want to allocate funds for this kind of effort, partly because it is expensive business, and partly because people do not want to know the answer. Knowing the answer might require substantial deviations from the current way of doing business. It might also suggest an optimal program inconsistent with the current policy of having the promotion dollar follow the milk to market.

CLOSING STATEMENT

Let me close on a positive note. First, I think you, as dairymen, should feel good about your promotion program. The research indicates that the fluid milk advertising effort is yielding positive returns. The modest amount of research on cheese advertising indicates a likely positive return. Sound economic analyses of the other program components will provide information for sound decisions, decisions that will make the most effective use of your advertising dollars. The dairy promotion business has come a long way in 4 years.

To make sure that the promotion business continues to improve, I encourage you to keep asking the important, crucial and perhaps embarrassing questions. Are we getting a reasonable return on our investment?
Getting Ready for Bovine Somatotropin

C. E. Coppock
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The Texas Agricultural Experiment Station

Introduction

One may be certain that future technology will bring developments incomprehensible today. Yet, it is unlikely that any will refute or even modify the laws of thermodynamics. In other words, we'll have to pay for increased milk yields with corresponding nutrients including energy. Yet the synthesis of milk from feed ingredients will become much more efficient regardless of how we choose to define that word. With high genetic merit for milk pervasive in our dairy cow population, continued advances in the engineering of milking systems, more effective control of mammary infections, and dramatic advances in repartitioning agents, all these have combined to focus attention on nutritional constraints to higher, but economic yields of milk. Although the effects of most future technology on nutrition programs are not directly predictable now, the effects of exogenous bovine somatotropin (BST) are well established because of the large amount of research already published concerning the responses of cows given this product. Therefore, in contrast to most previous technologies, it is possible to prepare for the arrival of this technology even before it becomes available. The central theme of this paper is that preparation for the arrival of BST can pay off as soon as that preparation begins; it can pay off even if BST is never approved; it can pay off for those who choose not to use BST.

My objectives in this paper are to note briefly how cows respond to BST and then describe the way these responses should direct one's preparation for the arrival of this new technology.

How Do Cows Respond to BST?

To deal with the effect of a new technology, one should know how the new technology works. Assuming the new technology has a positive effect on production, how is that increase in yield brought about? How does the cow respond to this new technology? 1) Increased genetic merit may occur with new technology such as embryo splitting, embryo sexing, and semen sexing as well as use of genetically superior sires. This technology will cause greater production accompanied by greater intake of feed. 2) Other technology may result in a greater consumption of feed energy. An example of this is in the use of high fat ingredients and rumen inert fat products. 3) Other technology may increase the digestibility of feed. An example of old technology to increase digestibility of forage is early cutting—a technology just as relevant today and for the foreseeable future. 4) Other technology might decrease the heat used in metabolizing nutrients for milk synthesis. Supplemental fats do this in pigs, and probably the same effect occurs in cows. 5) Another technology, 3X milking, directs more feed energy toward milk synthesis with a small increase in feed intake. But how do cows respond to BST?
The most obvious response of cows given BST is a sharp increase in milk yield. Studies of total energy balance with respiration chambers at USDA-Beltsville (Tyrrell et al., 1982) revealed that neither digestive nor metabolic efficiency was changed significantly when lactating cows were injected with BST. So the explanation for the increased yields is that BST enables the mammary gland to command a high priority for nutrients from both the diet, and in early lactation, from body reserves (Figure 1). The small depression in feed eaten seen in the short-term studies was of concern because with no change in digestive or metabolic efficiency, the increase in milk yield could not be sustained unless feed intake also increased.

Responses observed in long-term studies show that the large increases (16 to 36%) in milk energy seen in short trials were sustained, but increases in feed intake of 3 to 15% also became evident. In several studies, however, the increased feed intake was not enough to provide the energy for the increase in milk energy produced. This means that many of the cows probably finished the long-term studies with lower body energy reserves than when they began, or lower reserves than the control cows in the same study. This point can be seen in data from Minnesota (Soderholm et al., 1986). At 25 mg/day of BST, the increase in feed (4.84 lb) provided enough energy for 11.9 lb of 3.5% FCM, but 19.1 lb were obtained. Fortunately, these workers measured body fat, body condition score, and body weights which permit verification of the assumptions based upon milk and feed energy increases. Body weights did not differ significantly, but both body fat and body condition score were significantly lower for cows that received BST. Dairymen are astute evaluators of body condition and know that cows who have not regained body condition by the end of lactation, must do so to continue another lactation successfully. But body condition can be restored during lactation when cows receive BST as shown in one complete lactation study at Cornell (Bauman et al., 1985). Moreover, this feature is largely under managerial control in the form of the decision point at which cows are moved from high to medium to low dietary nutrient densities. This decision should be based primarily on restoration of body condition. To summarize the responses of lactating cows to BST: a) in early lactation, BST increases the nutrient flow from body reserves to milk synthesis; b) it increases feed intake, but only after a lag of 3-4 weeks; and c) it increases heat production.

Now that we understand how cows respond to BST, one might ask, which systems of dairy cattle management will be affected? How can one strengthen those systems in preparation for BST?

**Integrated Systems in Dairy Cattle Management**

Several years ago entomologists developed a strategem for dealing with insect pests, a comprehensive program they called "Integrated Pest Management Systems (IPMS)". According to Webster's New Collegiate Dictionary, "integrate" means, "to form, coordinate, or blend into a functioning or unified whole: unite". More recently, reproductive physiologists adopted the concept as in "Integrated Reproductive Management Systems (IRMS)". At the dairy short course in Texas in 1987, Dr. David
Beede (1987) introduced to us the concept of Integrated Environmental Management Systems (IEMS). In this paper I will introduce the concept of "Integrated Nutritional Management Systems (INMS)", which I define, in the context of dairy cattle, as the process of integrating the a) procurement, b) ingredient evaluation, c) inventory-storage, processing, e) formulation, f) feeding system, and g) on-the-farm delivery of diets, that will sustain high yields economically in dairy cattle production.

**Procurement.** In this category, I include, a) writing specifications, b) forward contracting, c) hedging, d) delivery, and e) quality control (QC) of incoming ingredients. The importance of sound financial advice concerning forward contracting, hedging and purchasing in quantity, is crucial. Smaller dairies may combine to purchase in carload lots, but the minimum tonnage which one should be able to receive at once would be one large bulk truck load. But purchasing directly from producers or through a broker, may place the quality control responsibility on the purchaser, the dairyman. Without previous experience, this may result in the acceptance of inferior grades of commodities. Lane (1986) recently made some appropriate suggestions for QC at the farm when receiving commodities: a) always have someone meet the truckload of incoming product; b) before unloading, sample and inspect the commodity noting its appearance, smell, taste, touch, tag, take a sample, and split the sample with the driver; c) keep a daily log noting the day of delivery, the source, the guarantee, the trucker and the observations made in b) including a sample identification code; d) use your scales or an independent one nearby; e) run a moisture test as soon as possible; f) have any nutrient analyses run by an independent lab with a copy sent by the lab to the seller. The specifications and guarantees for a purchase contract are usually written by a purchasing agent or other officers of a feed company. Examples of these specifications and guarantees will be very helpful to those with little experience in this subject.

**Ingredient evaluation.** This concept includes much more than a laboratory test as noted under b) in the previous paragraph. But, it is essential to find the services of a feed testing laboratory that is both accurate and fast. Not only will one need to test purchased ingredients, but also it is essential to confirm the formulations that are prepared on the dairy, especially, the final total mixed ration (TMR).

**Inventory costs and storage losses.** These are important components of the INMS. These may be overlooked, but to obtain total costs, these must be included.

**Processing.** Many commodities (sometimes called by-products) need no processing, but feed grains should be rolled or fractured. Whole linted cottonseed needs no processing because less than 1% of the whole seeds passed through the cow (Coppock et al., 1985). But in the same study, more than 11% of whole acid-delinted seeds passed through the cow undigested.

**Formulation.** All formulation should begin with intensive and comprehensive forage and feed testing. The case for forage testing has been presented on many occasions. Recently, it was emphasized by Bertrand.
and Ely (1987), who showed that in crude protein (CP) percentage, forages from ten Georgia farms ranged from 5.1 to 13.5% for corn silage, 5.8 to 12.6% for sorghum silage, and 15.4 to 25.3% for alfalfa. Great variation and uncertainty are the reasons book value cannot be used for precise formulations. One should expect greater nutrient variation in many of the by-products than in feed grains.

In formulation one should consider predicted dry matter intake, net energy for lactation (NE\textsubscript{L}), crude protein, plus a specific fraction of undegraded and degraded protein, one of the newer fiber fractions, ADF or NDF, fat, 7 macro and 7 micro elements, vitamins A, D and E, niacin, buffering capacity, and in some cases, water composition. It is very likely that a nutritional constraint that limits production in a herd before use of BST, will be more devastating following use of BST.

Comprehensive formulation based upon detailed forage and feed testing with the intended nutrient profile confirmed in the final mixture will do much to avoid dietary deficiencies. These deficiencies will eventually depress production, but earlier they may increase heat production. Reid (1972) identified protein, phosphorus, and possibly sodium, magnesium, cobalt, and copper as being in this group. Earlier, Kleiber (1945) noted that most mineral elements and vitamin E deficiencies increase the metabolic rate which lowers energy efficiency.

Dry cow care and management should include a careful monitor of body condition so that reserves can be replenished if this has not been done during late lactation when it is more efficient. Only if the prepartum cow has been prepared for the stress of a new lactation can she respond to the demand high yields will make upon her. The cow in negative energy flow (NEF) requires special consideration in formulation because the large reserve of energy is probably unmatched by any other nutrients with the possible exception of calcium. In effect, the cow in NEF needs a diet enriched in all nutrients, relative to the cow who can eat enough feed to meet her energy requirements. Supplemental fat or ingredients with high fat should be a component of diets of cows in NEF which allows greater energy consumption without the adverse effects of excess starch and too little fiber. The study of Schneider and others (1987) showed that cows that received both BST and calcium salts of long chain fatty acids produced more during 4-wk postpartum than cows receiving only 1 of the 2 treatments. Use of BST appears to make cows of all genetic abilities better cows that produce more and that require correspondingly more nutrients.

In addition, to increasing energy density, a special feature of added fats is their reduction in heat increment. Early work at Penn State showed that with equicaloric diets, increasing fat decreased heat increment, making more calories available for production but also reducing heat stress in hot weather. This work was done with rats and it is not certain it applies to ruminants. However, Moody (1962) observed lower body temperatures in cows fed whole cottonseed (WCS) during heat stress in Arizona. More recently, Kronfeld et al. (1980) fed protected tallow to Holsteins 2 to 16 wk postpartum which provided 25% of the ME as fat. Protected tallow increased milk fat yield 12.4% and calculations of
improved metabolic efficiency favored cows fed protected tallow with a peak of 87.5%. Chalupa (1982) noted that higher metabolic efficiencies with long chain fatty acids reflect the higher efficiencies with which ruminants are able to use these acids compared to the volatile fatty acids.

An increased efficiency suggests added fat would be more valuable in hot weather than in cold weather. Feeding whole cottonseed (WCS) increases the transfer of dietary long chain fatty acids to milk fat (Smith et al., 1981) and the calcium soaps of long chain fatty acids have been shown to provide beneficial effects of increased dietary energy density without adverse effects on rumen digestibility. Because WCS appears to be a slow release (in the rumen) of oil, one could predict that WCS and calcium soaps have additive effects on the nutrition of the lactating cow.

Feeding Systems. The complete ration or total mixed ration (TMR) fed ad libitum has much to commend it as a system to feed dairy cows. Specifically, it’s easy to transfer cows from the low energy prepartum diet to the postpartum high energy diet with a minimum probability of digestive upsets. Dilution of the concentrate with forage and ad libitum feeding results in many small meals through the day with a stable rumen fermentation even with high starch ingredients. For those dairymen who feed concentrate separate from forage, the computer-controlled concentrate feeders have much to offer. They distribute the concentrate in small amounts and allow a monitor of the amount and pattern of consumption. For those who pasture the milking herd and the TMR is not feasible, the computer-controlled feeder is especially beneficial. But it contains within its application, one significant limitation; the prediction of the forage eaten by an individual cow is not known, so neither is the contribution of the forage or the total nutrient intake precisely defined.

On-the-Farm Delivery. There are also economies to be made in transportation and feed handling on the farm. A survey of corral feeding and energy used for feed distribution by 175 herds in Tulare County, California in the summer of 1980 (Schultz, 1981) shows large herd sizes, all fed some hay, and the larger herds were fed more on-the-farm grain mixtures (Table 1). The average daily fuel and labor cost per 100 milking cows shows a fuel cost advantage for separate feeding in 3 smaller herd categories but a lower fuel cost for total mixed rations in larger herd categories. Dairies of similar size were often greatly divergent with respect to amount of fuel and labor needed to feed their herds. Some were adept at locating feed ingredients at efficient points, in matching equipment size to specific needs, and at conserving energy through innovation and attention to details.

Chilled Drinking Water. Our work with chilled drinking water for lactating dairy cows under heat stress has been consistent (Lanham et al., 1986; Baker et al., 1988; and Wilks et al., 1989) in showing reduced respiration rates and body temperatures, increased feed dry matter intakes, and greater milk yields. However, the cost effectiveness of this technology has not been clearly evident to us. We used a refrigeration system provided by agricultural engineers which had been built to chill meat in previous research. Our calculations showed that the economic
return using this small unit would be marginal with the production responses that we had achieved. Recent conversations, however, with a representative of a major milk cooling equipment company revealed that his calculations showed that one pound of milk would pay for chilling water 20°F for lactating cows in the summer. If this is the case, this technology has wide application, especially in the southern and eastern states. Although evaporative cooling systems have been designed and shown to be economically effective in low humidity areas, especially in Arizona, we have assumed that evaporative cooling would be much less effective in areas of high humidity. Chilled drinking water is effective independent of relative humidity. Although we have not addressed these areas in our research, over long periods of time, reproductive efficiency, mastitis, and longevity may also receive benefits from chilled drinking water. It is clear now, that dairymen who are fortunate to have cold well water should not bring that cold water up to an open trough where it will warm up, but they should keep it shaded, or better, use one of the newer insulated tanks to keep it cold until the cows drink it.

Management Diagnostics

Analysis and evaluation of herd management constraints which currently limit milk yields will be valuable to increase the probability of success with BST. For instance, use of BST under conditions where the diet is qualitatively incomplete might induce a more severe manifestation of the nutrient deficiency than is seen without BST. A Georgia study evaluated management practices used by 2712 southern dairy farmers and showed that those who used forage testing and ration balancing had herd averages 693 lb/cow/yr greater than those who did not (Ely and Smith, 1986). A demonstration project on nutrition and forage quality in Maryland showed that participants saved an average of $0.20/cow/day in feed costs and a production response was achieved in 20 of 28 herds (Cassell and Vough, 1987). Herd managers who do not test their forages and practice feed programming will be less likely to see the potential possible with BST.

Summary and Conclusions

BST causes cows to give more milk, to eat more feed, and to produce more heat. Management systems which encompass nutrition and environment will be directly affected. Improvement in these systems will help to insure the success of BST use. But improvement in these systems can be profitable without BST.

Why not use the impending arrival of BST as the impetus, the incentive, the motivation to make those changes in your management that you intended to make last year, but just didn’t get around to it?

Does it really matter whether BST is approved in September, October, or November, or January, February, or March. Today is May. Now is the time to begin the preparation that will make BST pay for you.
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1 from Shultz (1981).
With BST

Tissue Energy

Early Lactation

\( \triangleright E \text{ due to } \triangleright \text{Tissue E} \)

Intake Energy (IE) \rightarrow Milk Synthesis \rightarrow Reproduction \rightarrow Growth \rightarrow Maintenance

\( \triangleright IE \text{ due to BST} \)
WILL DAIRY COWS RESPOND TO BST IN THE TROPICS AND SUBTROPICS?

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SUMMARY

Cows administered BST in warm environments clearly respond with increased milk yield, water and feed intake, and heat production without adversely affecting rectal temperature or altering heat balance. BST treated cows under heat stress dissipate the increase heat load through increased respiratory and skin vaporization. The data clearly supports the homeorhetic role of BST. Even under heat stress, BST coordinates the physiological functions of the animal to support the increased production. Thus, heat intolerance appears not to be a consequence of BST use and assuming good feed, water and environmental management, the evidence suggests that BST can be used successfully in tropical and subtropical conditions.

INTRODUCTION

The efficiency of the dairy cow plays a major role in the profitability of the dairy enterprise. Bovine somatotropin (BST) increases lactation efficiency by increasing milk yield in dairy cows. As cows produce more milk, a greater proportion of the feed utilized for milk production, a valued commodity, and a lesser proportion for maintenance. These facts are well documented for short and long term studies with differing breeds and under various management programs and environmental conditions. Collectively, among the studies conducted by the four companies pursuing the marketing of BST, thousands of lactating dairy cattle have been administered the protein with no reports of catastrophic metabolic diseases despite the large increase in milk output. In fact, Cole et al., 1988 demonstrated that no difference in the incidence of health maladies among non-treated cows and cows receiving 1X (600 mg), 3X or 5X concurrent injections of sometribove (ST) biweekly from 60 d postpartum to dry off. Vicini et al., 1988 administered the equivalent of 2 year’s worth of formulated BST (ST) s.c. into pregnant lactating dairy cows on day 0 and 7 of a 14-day study. The health of all cows was generally excellent. This demonstration of the safety of BST is even more impressive when one considers the fact that feed intake responses to BST lag the milk response by generally four to six weeks. How the animal is able to accomplish the large milk responses without negatively affecting its other functions is indeed a fascinating story that is still under investigation.

MODE OF ACTION

Research results continue to support the conclusion that BST is acting through established metabolic pathways in the dairy cow to produce the increase in milk production. Although the data has not provided clear definition of the metabolic pathways involved with milk response, a broad description of those actions can be made. BST is 1) pleiotropic in that it affects multiple tissues and has multiple biological effects; and 2) homeorhetic in that it coordinates metabolism to partition nutrients preferentially to the mammary gland for milk synthesis during lactation.
without negative consequences on the rest of the body (Bauman and Curnie, 1980). Tyrrell et al., 1982 were the first to demonstrate through calorimetry studies that BST did not affect partial efficiency, which is metabolic efficiency of energy utilization in lactating dairy cows. BST does not alter the maintenance requirements but dilutes the maintenance cost by increasing milk output. In addition, no significant effect of BST on digestive efficiency or rumen function have been observed. Since feed intake lags the milk response by four to six weeks after treatment initiation, the increased nutrients needed for milk synthesis are derived primarily from body stores. This shift in deriving additional nutrients from body stores to support the increased milk yield is identical to what occurs in early lactation in the high producing cow.

BST, in effect, drives the milk production to a new peak utilizing the same metabolic processes for achieving peak milk production in early lactation. To sustain this level of elevated response, the cow must increase feed intake before body reserves are depleted. This means managing the BST treated cow like any high producing cow. Managing the cow to optimize feed intake and to have her at the proper body condition will be similar to the management strategies already employed for obtaining maximum performance and sustaining good body condition in cows milked three times per day.

HEAT STRESS CONCERN

Environmental tolerance of lactating dairy cows administered BST has been a concern. Tyrrell et al., 1982 showed that BST increased heat production of lactating dairy cattle but the increase in heat production is accounted for by the energy requirement for the increase in milk produced. A BST treated animal produces no more heat at a given level of production than an untreated animal at the same production level. Thus, one would expect a BST treated cow to deal with heat stress just like an nontreated cow at a similar production level. However, Kronfeld 1987 indicated that since somatotropin cows produce more heat than untreated cows a potential heat tolerance problem may arise. This assumes that under heat stress conditions, the BST treated cow will not be able to dissipate the additional heat load resulting in an elevation of body temperature. The following discussion will prove that this assumption is erroneous and that cows will respond with increased milk yields from BST administration.

RESULTS FROM STUDIES CONDUCTED IN WARM ENVIRONMENTS

Several short and long term studies have now been conducted examining the effect of BST production responses of lactating dairy cattle in Florida, Missouri, Southern California and Arizona. Results of these studies are presented Table 1. The experiments by Zoa-Mboe et al., 1986, Staples et al., 1988 and Mollet et al., 1986 resulted in much lower milk responses due to daily BST treatment than the other studies. In the short term experiments, the duration of treatment may not have been long enough to see the maximum effect. Zoa-Mboe et al., 1986 and Staples et al., 1988 observed elevated respiration rates and rectal temperatures in all treatment groups indicating that the cows were suffering from heat stress. However, no significant BST effect on these parameters was observed. Mollet et al., 1986 attributed the variable response of BST treatment to a period of high ambient temperature and humidity with a concurrent reduction in feed intake.
Clearly, in the long term studies BST significantly increased milk output (Table 1). Milk composition was unaffected. Chalupa et al., 1988 found that primiparous and multiparous cows responded similarly to BST treatment. These research workers concluded that under commercial conditions in Southern California, BST increased milk yield with no adverse effect upon health and reproduction. Collectively, the results indicate a significant milk production response to BST in hot environments and similar to those reported in more temperate climates.

In an effort to better define the effects of heat stress on the cow's capability to respond to BST, Missouri workers housed cows under controlled environmental climatic conditions. Mohammed and Johnson, 1985, housed six Holstein cows (90 to 120 d postpartum) in climatic rooms for four treatment periods. Five days were assigned for each treatment of thermoneutrality at 64.9°F and 75% relative humidity (RH), heat stress (84°F and 53% RH), heat stress and BST administration (16.6 mg/d), followed again by heat stress without BST (84°F and 55% RH). Each period was preceded by at least three days of adjustment. The results are shown in Table 2. Heat stress resulted in significant reductions milk yield, milk fat % and heat production with a significant increase in rectal temperature. Cows administered BST under heat stress increased milk output, milk fat % and heat production as compared to controls. No effect of BST was observed on rectal temperature or water intake during the five days.

Johnson et al., 1988 further examined the milk production and heat balance of BST treated cows under controlled summer conditions. Twelve lactating Holstein cows were given daily injections, (6, saline; 6, sometribove) for a 30 day period under seasonal heat (72-95°F, and 60-65% RH) and then placed in a climatology laboratory. The climatic conditions were set for thermoneutrality, (TN: 52-72°F, 30-50% RH) and then for ten days under heat stress (H: 77-95°F, 50-65% RH). Cows in the TN environment never exceeded the temperature humidity index of 72, which is the upper critical point for milk yield in Holstein cows. Cows in the seasonal and controlled heat stress environments spent about 14 hours each day above the critical point. The results are shown in Table 3. Milk production was increased 16 lbs under heat conditions, which was similar to the response under TN conditions, even though milk production dropped 10 lbs/day for both groups when under heat stress. Heat production, feed intake and water intakes were also increased in sometribove treated animals when subjected to both environments. However, respiratory and skin vaporization heat loss were also increased. The net effect of the increased heat loss was no net gain in rectal temperature as shown in Table 3. Despite a 16 lb/day increase in milk yield during the heat, the treated cows displayed no impairment of their ability to maintain rectal temperature or its increased feed intake. Clearly, sometribove treatment is not adversely affecting feed intake, milk production or health under heat stress conditions in this study. If anything, the treated cows appear to be more heat tolerant than the contemporary control if we define heat tolerance as the ability to dissipate a heat load or even the ability to sustain milk production under heat stress conditions. This short term study is corroborated by the long term studies shown in Table 1. Huber et al. 1988 also demonstrated significantly increased milk yields with no adverse effects on health with 30 Holstein cows treated with sometribove (500 mg once each 14 days for 36 weeks starting 60 days postpartum) under Arizona environmental conditions (Table 4). No other significant effects were observed.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Treatment Length (Wk)</th>
<th>N</th>
<th>Dose (mg/d)</th>
<th>Milk Response (lbs/d)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elvinger et al., 1987 (Florida)</td>
<td>39</td>
<td>9</td>
<td>6.25</td>
<td>9.7</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td>12.5</td>
<td>11.9</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td>25</td>
<td>18.1</td>
<td>39</td>
</tr>
<tr>
<td>Hutchison et al., 1986 (Mississippi)</td>
<td>27</td>
<td>6</td>
<td>13.5</td>
<td>18</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>27</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>40.5</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Mollet et al., 1986 (Missouri)</td>
<td>27</td>
<td>6</td>
<td>13.5</td>
<td></td>
<td>12.6</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>27</td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>40.5</td>
<td></td>
<td>4.4</td>
</tr>
<tr>
<td>Chalupa et al., 1988 (California)</td>
<td>29</td>
<td>30</td>
<td>10.3</td>
<td>8.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td>20.6</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td>30.9</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>Zoe-MBoe et al., 1986 (Florida)</td>
<td>4</td>
<td>13</td>
<td>25</td>
<td>3.1</td>
<td>5.5</td>
</tr>
<tr>
<td>Staples et al., 1988 (Florida)</td>
<td>1.4</td>
<td>5</td>
<td>37</td>
<td>6.4</td>
<td>17.5</td>
</tr>
</tbody>
</table>
Table 2

Effect of Bovine Somatotropin Administered Daily for Five Days in Lactating Cows in Missouri

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TN</td>
</tr>
<tr>
<td>Milk, lbs/d</td>
<td>51.7</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>3.51</td>
</tr>
<tr>
<td>Rectal temperature, °F</td>
<td>101.8</td>
</tr>
<tr>
<td>Heat production, kw/h</td>
<td>.90</td>
</tr>
<tr>
<td>Water intake, gal/d</td>
<td>17.1</td>
</tr>
</tbody>
</table>

*Means in the same row with different superscripts differ (P<.05).

TN = Thermoneutral, H = heat stress, RH = relative humidity.

TN at 64.9°F, 75%RH; H1, H + BST and H2 at 84°F, 55% RH.

Mohammed and Johnson, 1985.
Table 4
Lactational Performance of Dairy Cows in Arizona Treated With a Prolonged-Release Formulation of Methionyl Bovine Somatotropin (Sometribove) for 36 Weeks in Arizona

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>Sometribove</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, lbs/d</td>
<td>60.1*</td>
<td>65.1*</td>
<td>5.0; 8.4%</td>
</tr>
<tr>
<td>3.5% FCM, lbs/d</td>
<td>58.5*</td>
<td>63.4*</td>
<td>4.9; 8.3%</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>3.40</td>
<td>3.43</td>
<td>0.03; 0.9%</td>
</tr>
<tr>
<td>Milk protein, %</td>
<td>3.08</td>
<td>3.10</td>
<td>0.02; 0.6%</td>
</tr>
<tr>
<td>Dry matter intake, lbs/d</td>
<td>49.3</td>
<td>51.5</td>
<td>2.2; 4.5%</td>
</tr>
<tr>
<td>Energy balance, Mcal/d</td>
<td>8.6</td>
<td>8.6</td>
<td>---- ----</td>
</tr>
<tr>
<td>Services/conception</td>
<td>2.0</td>
<td>2.1</td>
<td>0.1; 5%</td>
</tr>
</tbody>
</table>

* Values with differing superscripts are significantly different (P<.05).

Huber et al., 1988
CONCLUSION

Cows administered BST in warm environments clearly respond with increased milk yield, water and feed intake, and heat production without adversely affecting rectal temperature or altering heat balance. BST treated cows under heat stress dissipate the increase heat load through increased respiratory and skin vaporization. The data clearly supports the homeorhetic role of BST. Even under heat stress, BST coordinates the physiological functions of the animal to support the increased production. Thus, heat intolerance appears not to be a consequence of BST use and assuming good feed, water and environmental management, the evidence suggests that BST can be used successfully in the tropics and subtropics.
REFERENCES


FLORIDA ON-FARM EXPERIENCE WITH BST
Roger P. Natzke, Mary Russell and Francois Elvinger

Research trials conducted at Land Grant Universities across the U.S. have demonstrated that BST will increase milk production 15 to 40% during the portion of lactation in which it is used. In spite of all that research several unanswered questions remain for Florida dairymen.

1. Will we get equal response when we turn BST over to dairymen and use it in a commercial setting?
2. Will BST be effective in cows during heat stress?
3. Will cows that have been heat stressed be able to respond?
4. Can a dairyman initiate treatment on an entire herd at once without regard to lactation stage?

With those questions in mind the Monsanto Company asked the Dairy Science Department to cooperate in a study on two Florida farms, one in North Florida and one in South Florida. The design included starting the trial in early July with cows in three different stages of lactation at the start of the treatments - 57 to 100 days, 101 to 140 days and 141 to 180 days. Half of the animals were in first lactation and half in second or greater. Half of the animals were treated and half served as control. Treatment of these animals was to continue through January 1989. In the North Florida herd a second group of animals was started in October and continued through January 1989. Some general characteristics of the herds.

South Florida herd

800 cows
milked 2x
cows fed in feeding barn
portable shades in pastures
fans in the holding area
54 cows on trial in July

North Florida herd

1500 cows
milked 3x
fans and sprinklers in feeding barns
cows had access to exercise lot
fans and sprinklers in holding area
72 cows on trial in July plus 72 added in October

The results of the study are similar to what is expected when the product is approved for sale. The data revealed excellent response in one herd and limited response in the other.
Table 1. Effect of BST on 3.5% FCM on two Florida herds

<table>
<thead>
<tr>
<th>Herd</th>
<th>Summer</th>
<th></th>
<th>Fall</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>lbs</td>
<td>Average</td>
<td>lbs</td>
</tr>
<tr>
<td>North</td>
<td>63.3</td>
<td>12.6</td>
<td>58.3</td>
<td>16.7</td>
</tr>
<tr>
<td>Florida</td>
<td>75.9</td>
<td></td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>54.7</td>
<td>3.1</td>
<td>58.3</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>57.8</td>
<td>5.7</td>
<td>58.3</td>
<td></td>
</tr>
</tbody>
</table>

The cows in the South Florida herd were at a lower production level (5.47 lbs.) at the start, compared to the North Florida herd and only averaged 3.1 lbs. of milk more for the duration of the trial. The North Florida cows started in July produced an average of 12.6 lbs. per day more than the controls. The cows that started in the fall produced 16.7 lbs. more than the controls. These excellent responses indicate that BST can be beneficial to dairymen and can be utilized in all seasons as long as the proper management conditions exist.

Effect of Parity

The effect of parity could only be studied in the North Florida herd as insufficient first lactation animals were available in the South Florida herd. The percentage change in production was nearly identical for first lactation and second or greater lactation cows. The response was consistent for cows beginning treatment in summer and those started in the fall. Thus it appears that all age animals will respond similarly.

Stage of Lactation

The results of the effect of stage of lactation was less clear cut. For the animals that began treatment in July the early lactation animals showed the greatest increase in both lbs. of milk and percentage increase. In the group of cows which began treatment in the fall, cows in later lactation showed a greater lbs. of milk and percentage increase. A possible explanation is that the early lactation animals that started treatment in the fall, actually calved in the middle of the heat stress period and didn’t have enough reserve to respond at a greater rate. When the data is combined for all animals it appears that the percentage increase in production will be similar for cows in all stages of lactation.

The body condition of the cows was scored every other week to determine the effect of treatment on body condition. During the course of the trial the condition scores of the treatment and control cows remained nearly equal. Another way of saying it is that changes in score were similar to those seen is a result of lactation. Cows on BST did not become excessively thin. It should be noted that all cows, even those which were as much as 300 days in lactation remained in the high feeding group.

Somatic cell counts of the treated and control cows were very low in the 100,000 to 200,000 cells per ml range. There was no significant change in cell level due to treatment.
Summary

While this was a study in two herds only, the study did demonstrate that there will be differences in response between herds. In this case, the herd with the best heat stress control procedures showed the greatest response to BST treatment.

The results show that Florida dairymen can expect a response to BST treatment even if it is initiated during the heat stress period. Cows started on treatment after going through heat stress will also respond.

Dairymen can expect that the percentage increase in first lactation and older animals will be similar.

There may have been differences in response by cows in differing stages of lactation due to season. However, since all cows responded it would appear that a dairymen could initiate treatment at any time in all animals which are beyond 60 days in lactation and expect a positive response.

More work is needed to determine why some herds respond better than others to BST. This information will insure that as many Florida dairymen as possible can benefit if they elect to use the product.
Solubility of Magnesium from Feed Grade Sources in an
In Vitro Ruminal + Abomasal System

D. K. Beede, E. M. Hirchert, D. S. Lough,
W. K. Sanchez and C. Wang

Summary and Conclusions

1. In order for magnesium (Mg) from a supplemental source to be bioavailable to the dairy cow it must be solubilized into the liquid matrix of the digesta and it must be absorbed from the digestive tract. For many supplemental sources solubilization may be the primary factor limiting the amount of bioavailable Mg.

2. In our studies, an in vitro [ruminal + abomasal] system was used to test the solubility of Mg from feed grade sources. Solubility of Mg, as a percentage of the total Mg in the sample source, ranged from 81.0% [Magnesium Phosphate-Sweden] to 37.2% [SuperMag-Greek] and averaged 59.1% for the 11 sources evaluated.

3. The percentage soluble Mg in the total dry weight of commonly used magnesium oxide sources ranged from 40.1% [Feedox-U.S.A.] to 19.7% [SuperMag-Greek]. Three sources, Magnesium Phosphate-Sweden, Rumen-Mate-U.S.A. and Min-Ad-U.S.A., had relatively lower total soluble Mg primarily because they contained less total Mg in their whole dry weight. These three sources are not used principally in dairy rations as sources of supplemental Mg, but provide other nutrients [calcium, phosphorus, sodium, potassium, sulfur and microminerals] and other potential nutritional attributes (i.e., buffering and alkalizing).

4. Sources used primarily to provide supplemental Mg should be bid and purchased by dairymen, and feed and premix manufacturers on a Mg solubility basis.

5. Prudence should be exercised to ascertain the origin of the product in question. Over time a particular supplemental source may have the same

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*The research reported was supported partially by Magnesitas de Rubian, Madrid, Spain. Naming or studying specific commercial products, but not others, does not constitute either endorsement or disapproval by the authors, Dairy Science Department, Institute of Food and Agricultural Sciences, or the University of Florida.

Authors are Associate Professor, Biologist I, Postdoctoral Research Fellow and Graduate Research Assistants, respectively, Dairy Science Department, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

commercial or label name, but may be from a different origin; therefore, the Mg solubility of a particular brand may change over time.

6. Because of the variation in Mg solubility among sources it is impossible and foolhardy to recommend a single specific concentration for total Mg in lactation rations. The appropriate concentration to maximize lactational performance will depend on the supplemental source used.

Introduction

Bioavailability of magnesium (Mg) from inorganic feed supplements is a function of 1) solubilization or release of the Mg into the liquid phase of the digesta and 2) the absorbability of the solubilized Mg from the digestive tract. Solubility of Mg may vary depending on origin of the supplemental source. Furthermore, solubility is not equal to bioavailability. However, if the Mg in a supplemental source is not solubilized in the digestive tract liquid phase, most likely it will not be absorbed and will not be available to the dairy cow.

There are various inherent characteristics about supplemental Mg sources which may influence the solubility and consequently the bioavailability of their Mg (Beede and Lough, 1988). Probably the most important factor is particle size of the material. Researchers in Scotland (Wilson, 1981; Hemingway, 1985) demonstrated that bioavailability under a variety of feeding conditions with cattle and sheep was higher always for sources of magnesium oxide (MgO) with smaller average particle size. Also, it was found that sources of different origin, but having similar average particle size or a similar distribution of particle sizes had different bioavailabilities. A practical problem is that as particle size decreases some materials are dustier. These sources are often shunned by feed mill operators because of their adverse handling properties. However, they may have the highest bioavailable Mg contents. Dustiness may represent an acceptability problem to the cow if the supplemental Mg source is provided in a loose supplement or concentrate fed separately from the forage portion of the ration. However, dustiness is not a problem generally in total mixed rations.

The country of origin or mining site within a country (i.e., origin of the mother ore) and processing method are factors affecting solubility and bioavailability. There is considerable variation in geological origin and hardness, as well as particle size of sources. Characterization of the solubility of sources from different origins has not been done. Temperature of calcination (i.e., heating or burning, which is part of the process to produce some commercial calcined magnasites or magnesium oxides from native magnesium carbonates) affects solubility and bioavailability. In an extensive series of studies Wilson (1981) and coworkers found that the optimum temperature of calcination was in the range of 1472 to 2021°F. Bioavailability of Mg was less for materials burned below 1472°F or above 2021°F.
Several lactation experiments (O’Connor et al., 1988; Teh et al., 1985; Beede and Lough, 1988) demonstrated significant lactational responses of 5 to 10% (3 to 7 pounds extra 4% FCM per cow per day) by increasing total Mg concentrations to .38 to .48% of ration dry matter compared with current NRC (1988, Update 1989) recommendations (.2 to .25% of ration dry matter). However, other studies have not shown positive responses. One of the possible explanations for differences in response may be the source used in a particular study and thus, the solubility or bioavailability of the Mg in the supplemental source.

Therefore, the objectives of our studies were to characterize and rank the solubilities of 11 sources of supplemental Mg. The commercial name, origin and sampling source of the materials evaluated are described in Table 1. Eight of these sources were commercially available MgO. Three products were not primarily MgO but were used in the U.S.A. or Europe as mineral supplements for ruminants; they contained less total Mg than the MgO materials and also generally were used to provide other nutrients (i.e., other macro and trace minerals) or digestive tract or dietary buffering.

**Experimental**

The laboratory studies were done utilizing an *in vitro* system [ruminal + abomasal] designed to simulate some of the important features of the dairy cow’s digestive tract. The rumen is the first compartment for potential solubilization and absorption of Mg. Additionally, the low pH of the abomasal fluid may facilitate additional solubilization and that soluble Mg may be absorbed in the digestive tract after the abomasum (i.e., especially in the small intestine).

About 100 mg of each Mg source were weighed separately into test tubes. Just prior to the experiment, a substrate composed of maltose, cellulobiose, casein hydrolysate, L-lysine and urea, and an artificial saliva buffer (without added Mg) were added to the tubes. Live ruminal fluid from a ruminal fistulated cow fed a diet containing 50% concentrate and 50% alfalfa was collected, strained and transported to the lab under anaerobic conditions. The ruminal fluid was added to the tubes and the total mixture was incubated at 102.2°F for intervals of 0, 6, 12, 24, 36, and 48 h. Tubes were hand swirled at these time intervals also. At the end of each incubation interval some of the tubes were removed and a portion of the liquid phase was retained for subsequent analysis of solubilized Mg. The pH of the ruminal system ranged from 6.95 to 6.30 over the course of the incubation. This was to simulate the normal range in ruminal pH.

After sampling the liquid phase in the ruminal stage of the system the remaining contents of the tubes were subjected to a simulated abomasal environment by adding a hydrochloric acid and pepsin solution and mixing every 15 min for 1 h. Typically, the pH of liquid was less than 2. At the end of 1 h a portion of the liquid phase was sampled for determination of solubilized Mg.
Results and Discussion

Table 2 shows the percentages of the total Mg from the supplemental sources which were detected in the liquid phase of the in vitro system, after incubation in the ruminal stage (averaged from 12 to 48 h), the abomasal stage, and the sum of the ruminal + abomasal stages. Listing of sources is arranged according to relative Mg solubility in the ruminal + abomasal system. Relative solubility was calculated as: Mg solubility of a specific source divided by the average Mg solubility of all 11 sources evaluated.

Percentage of the total Mg in the supplemental MgO sources which was solubilized in the ruminal stage averaged 13.9% and ranged from 6.5% (SuperMag-Greek) to 22.6% (MagOx-U.S.A.). Among these same sources, solubility of the total Mg in the abomasal stage ranged from 30.7% (SuperMag-Greek) to 53.9% (FeedOx-U.S.A.) and averaged 45.2% for all sources in the study. Obviously, solubility of Mg from all sources was considerably greater in the abomasal stage than in the ruminal stage. This likely was due to the much lower pH of the abomasal incubation. The pH of the ruminal system was intentionally maintained within a optimal range which would sustain normal ruminal function for a lactating dairy cow. This pH range (6.95 to 6.3) may be higher than that occurring at certain times of the day in some dairy cows fed high concentrate rations with a lot of highly fermentable carbohydrates. Some sources with lower than average ruminal Mg solubility in our studies (i.e., Magnesium Phosphate-Sweden, Chinese pink MgO, Min-Ad-U.S.A., MagFeed-Greek and SuperMag-Greek) may have higher Mg solubilities in a ruminal system with lower pH. However, the general relative ranking among the sources would not vary greatly.

The total (ruminal + abomasal stages) percentage of soluble Mg averaged 59.0% and ranged from 81.0% (Magnesium Phosphate-Sweden) to 37.2% for SuperMag-Greek. Among the MgO sources, the percentage of the total Mg which was solubilized was about twice as high for FeedOx-U.S.A. and MagOx-U.S.A. as it was for MagFeed-Greek and SuperMag-Greek. Magnesium solubility of other sources fell between these bounds. This in vitro system gave very similar results for different samples of common origin. For example, FeedOx-U.S.A. and MagOx-U.S.A. were from a common origin but were distributed through different routes as were the two sources originating from Greece. Their Mg solubilities and position in the relative ranking were quite similar (Table 2).

Knowing the percentage of the total Mg in a source which will solubilize is only part of the consideration in purchasing a supplemental source to provide soluble Mg. The total Mg content of a particular source must be considered as well. Total soluble Mg in the whole weight of the source equals ([total Mg concentration of the source] X [solubility of Mg of the source in the ruminal plus abomasal system]). This calculation yields the percentage total soluble Mg of the whole weight of the sample source. Because these sources are typically bought on a whole weight basis, establishing a relative ranking on this basis will aid in making an informed purchasing decision. Table 3 shows the percentage total
soluble Mg and relative ranking on that basis of the supplemental sources evaluated in our studies.

Among the MgO sources FeedOx-U.S.A. and MagOx-U.S.A. had the highest percentages of total soluble Mg, about 40%. MagFeed-Greek and MagOx-Greek had the lowest soluble Mg, 21.7 and 19.7%, respectively. Therefore, on this basis some sources ranked about twice as high as other sources. Suggesting that either the low ranking sources had only half as much value as the high ranking sources in providing soluble Mg or that the high ranking sources had twice as much value as the low ranking sources. The other MgO sources studied, Chinese pink, CoMag-Turkish, BayMag-Canada, and Magal-Spanish, had relative rankings of 0.81, 0.79, 0.68, 0.63, compared with FeedOx-U.S.A. (Table 3).

The other three supplements in our studies, Magnesium Phosphate-Sweden, Rumen-Mate-U.S.A., and Min-Ad-U.S.A. had lower relative rankings than the MgO sources. This was primarily because they had lower concentrations of total Mg in their whole dry weight (see Tables 1 and 3). These sources are not included in diets primarily to provide supplemental or soluble Mg. They have other nutritional claims and attributes such as sources of calcium, phosphorous, sodium, potassium, sulfur and microminerals and as dietary buffers and alkalizers. These other nutritional attributes may justify inclusion of these products in rations, if they are priced appropriately based on their nutritional merits.

References


<table>
<thead>
<tr>
<th>Lab #</th>
<th>Name/Origin</th>
<th>Sampling Source</th>
<th>Percent Total Mg (label)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MagFeed-Greek American Minerals, Inc. 301 Pigeon Point Rd. New Castle, DE 19720</td>
<td>Batkins Feed &amp; Grain Co. 104 N Oak St. Batkins, OH 45306</td>
<td>53.0</td>
</tr>
<tr>
<td>3.</td>
<td>CoMag-Turkish Istanbul, Turkey</td>
<td>U.S. Terra Corp. 1050 S. Fed. Hwy. Delray Beach, FL 33444</td>
<td>53.0</td>
</tr>
<tr>
<td>4.</td>
<td>Magox-U.S.A. Basic Chemicals Combustion Engineering, Inc. 7887 Hub Parkway Cleveland, OH 44125</td>
<td>Harvest Brands, Inc. P. O. Box 46 Pittsburg, KS 66762</td>
<td>54.0</td>
</tr>
<tr>
<td>5.</td>
<td>Chinese Pink Granule Peoples Republic of China</td>
<td>Sampled from the ship &quot;Irish Sea&quot; by Mr. Ted Huntsman</td>
<td>54.0</td>
</tr>
<tr>
<td>6.</td>
<td>BayMag-Canada BayMag Plant 200, 1144-29 Ave., NE Calgary, Alberta T2E 7Pi</td>
<td>Ragland Mills, Inc. Rt. 8, Box 168 Neosho, MO 64850</td>
<td>58.0</td>
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<tr>
<td>7.</td>
<td>Magnesium Phosphate-Sweden Boliden Kemi AB Box 902 S-251 09 Helsingborg Sweden</td>
<td>Boliden Kemi AB Helsingborg, Sweden</td>
<td>24.0</td>
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<tr>
<td>8.</td>
<td>Feedox-U.S.A. Southeastern Minerals P. O. Box 1866 Bainbridge, GA 31717</td>
<td>UF Dairy Research Unit Hague, FL</td>
<td>54.0</td>
</tr>
<tr>
<td>9.</td>
<td>Magal-Spanish formerly: Magnesitas de Rubian Montalban N.3 Madrid 14, Spain currently: ERT North America, Inc. 1 Walter Street White Plains, NY 10601</td>
<td>High Springs Milling High Springs, FL</td>
<td>52.0</td>
</tr>
<tr>
<td>11.</td>
<td>Rumen-Mate - U.S.A. Pitman-Moore, Inc. 421 East Hawley St. Mundelein, IL 60060</td>
<td>High Springs Milling High Springs, FL</td>
<td>16.6</td>
</tr>
</tbody>
</table>
TABLE 2. Percentage of total magnesium in supplemental source solubilized in \textit{in vitro} ruminal + abomasal system, and relative Mg solubility.

<table>
<thead>
<tr>
<th>Source (Lab #)</th>
<th>Percent of Total Magnesium of Source Solubilized In:</th>
<th>Relative Mg Solubility\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ruminal Stage</td>
<td>Abomasal Stage</td>
</tr>
<tr>
<td>Average</td>
<td>13.9</td>
<td>45.2</td>
</tr>
<tr>
<td>Magnesium Phosphate (#7)</td>
<td>11.2</td>
<td>69.8</td>
</tr>
<tr>
<td>Rumen-Mate (#11)</td>
<td>27.9</td>
<td>47.3</td>
</tr>
<tr>
<td>Feedox (#8)</td>
<td>20.4</td>
<td>53.9</td>
</tr>
<tr>
<td>MagOx (#4)</td>
<td>22.6</td>
<td>51.1</td>
</tr>
<tr>
<td>Chinese (#5)</td>
<td>11.7</td>
<td>48.2</td>
</tr>
<tr>
<td>Turkish (#3)</td>
<td>14.6</td>
<td>45.1</td>
</tr>
<tr>
<td>Min-Ad (#10)</td>
<td>1.4</td>
<td>50.8</td>
</tr>
<tr>
<td>Spanish (#9)</td>
<td>14.5</td>
<td>33.8</td>
</tr>
<tr>
<td>BayMag (#6)</td>
<td>14.2</td>
<td>33.2</td>
</tr>
<tr>
<td>Greek (#1)</td>
<td>7.6</td>
<td>33.4</td>
</tr>
<tr>
<td>Greek (#2)</td>
<td>6.5</td>
<td>30.7</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Relative Mg solubility = Mg solubility of a specific source divided by average Mg solubility of all 11 sources evaluated.
TABLE 3. Relative ranking by total soluble magnesium in sources tested. Total soluble magnesium in source = magnesium concentration of source X solubility of Mg of source in ruminal + abomasal system.

<table>
<thead>
<tr>
<th>Source (Lab #)</th>
<th>% Total Mg of Source</th>
<th>% Soluble Mg in Source</th>
<th>% Total Soluble Mg of Source</th>
<th>Relative Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeedOx (#8)</td>
<td>54.0</td>
<td>.743</td>
<td>40.1</td>
<td>1.00</td>
</tr>
<tr>
<td>MagOx (#4)</td>
<td>54.0</td>
<td>.737</td>
<td>39.8</td>
<td>.99</td>
</tr>
<tr>
<td>Chinese (#5)</td>
<td>54.0</td>
<td>.599</td>
<td>32.3</td>
<td>.81</td>
</tr>
<tr>
<td>Turkish (#3)</td>
<td>53.0</td>
<td>.597</td>
<td>31.6</td>
<td>.79</td>
</tr>
<tr>
<td>BayMag (#6)</td>
<td>58.0</td>
<td>.472</td>
<td>27.4</td>
<td>.68</td>
</tr>
<tr>
<td>Spanish (#9)</td>
<td>52.0</td>
<td>.483</td>
<td>25.1</td>
<td>.63</td>
</tr>
<tr>
<td>Greek (#1)</td>
<td>53.0</td>
<td>.410</td>
<td>21.7</td>
<td>.54</td>
</tr>
<tr>
<td>Greek (#2)</td>
<td>53.0</td>
<td>.372</td>
<td>19.7</td>
<td>.49</td>
</tr>
<tr>
<td>Magnesium Phosphate (#7)</td>
<td>24.0</td>
<td>.810</td>
<td>19.4</td>
<td>.48</td>
</tr>
<tr>
<td>Rumen-Mate (#11)</td>
<td>16.6</td>
<td>.752</td>
<td>12.5</td>
<td>.31</td>
</tr>
<tr>
<td>Min-Ad (#10)</td>
<td>14.0</td>
<td>.522</td>
<td>7.3</td>
<td>.18</td>
</tr>
</tbody>
</table>

aPercentage total soluble Mg of whole weight of source.

bRelative ranking compared with the source (FeedOx, #8) containing the largest quantity of soluble magnesium as determined by the ruminal + abomasal evaluation system.
HEAT STRESS RESEARCH ON EMBRYO SURVIVAL:
CONCEPTS RELATED TO SUPEROVULATION, EMBRYO TRANSFER AND HEAT STRESS

by

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Introduction

A major constraint to reproductive efficiency in subtropical, tropical and arid environments is seasonal periods of heat stress. During the last four years, we have implemented the techniques of superovulation and embryo transfer as tools to study at what stage heat stress causes embryo death and whether embryo transfer of normal embryos can bypass the early detrimental effects of heat stress. Prior research in our laboratory has examined the effects of heat stress on the endocrinology of the estrous cycle, and development of management systems to reduce heat stress on the cow so that fertility can be maintained during the summer months. Heat stress under conditions of our Florida environment does not prevent animals from having normal estrous cycles. Temperature measurements of the uterus indicate that as uterine temperature approaches 40°C pregnancy does not occur and embryos are apparently loss. To further develop systems to improve fertility, we need to know specifically how elevated body temperature interferes with embryo development, what stages of embryo development are most sensitive to heat stress, and whether this new knowledge can be applied to improve fertility during the summer months. The purpose of this presentation is to update our dairy producers on our research with the early embryo that was supported by a USDA-CSRS Competitive Research Grant for a 4-year period (1984-1988). The grant contributed to the support of a graduate student, Dr. D. James Putney, and some of the research also was conducted on Florida dairy farms. The authors are deeply appreciative of the cooperation provided by the dairy industry to support our various on-farm research efforts.

Early Embryo Development

Reproductive efficiency is depressed when lactating dairy cows are maintained under environmental conditions of high ambient temperature and relative humidity, resulting in conception rates as low as 10 to 15 percent during stressful months of the year. Heifers do not have these clear summer time drops in fertility because they are not lactating and
can tolerate the summer temperature and humidity without a major increase in body temperature. For our experimental purposes, we can use heifers if we expose them to sufficiently high temperatures within an environmental chamber that elevates their body temperature to a level that you find during the summer months in a lactating dairy cow. Holstein heifers (n=16) were used to determine whether heat stress prior to ovulation increases the incidence of embryonic abnormalities in dairy cattle [2]. Heifers were superovulated with (FSH-P; 32 mg total), beginning on Days 10 or 11 of the estrous cycle. Prostaglandin Fα (Lutalyse; 60 mg total) was administered on Day 3 of FSH-P treatment. Heifers were maintained at either thermoneutrality (24°C) or under hyperthermic conditions (exposure to 42°C for 10 h) beginning at the onset of estrus. After the short 10-hour heat stress, the treated heifers were cooled off so that their body temperatures were normal and then inseminated artificially at 15 and 20 h after the onset of estrus. Heifers were continuously maintained under environmental conditions of thermonutrality for 7 days as provided by environmental shade structures. On Day 7 post estrus, embryos were recovered nonsurgically and evaluated morphologically for stage of development and quality. The distribution of embryos classified as normal, retarded and/or abnormal, or as unfertilized ova differed (P<0.001) between heat stress and thermonutral treatments (Table 1). Only 12.0% of 25 embryos recovered from stressed heifers were normal compared to 68.4% of 19 embryos from thermoneutral heifers. Stressed heifers had a higher (P<0.001) incidence of retarded and/or abnormal embryos with degenerate blastomeres. We were able to use a fluorescent stain (4'-6'-Diamidino-2-Phenylindol) that permits us to identify dead cells. Cells that fluoresce are dead cells and the viability of embryos can be classified as: healthy with negative or no staining; partial staining in which some of the cells in the embryo are dead and the embryo is probably in the process of undergoing degeneration and death; positive staining in which all cells of the embryo are dead and the embryo is considered dead. An appreciably higher level of embryo cell death occurred in the heat-stressed group (Table 2). Responses indicated that thermal stress during the preovulatory period increases the incidence of retarded and/or abnormal embryos in superovulated heifers. This is a very important observation in that it means the ovum within the follicle of the ovary on the day of estrus is extremely sensitive to heat stress. This is the time that the oocyte undergoes final maturation following the LH surge at the onset of estrus and is being prepared for subsequent fertilization following ovulation. THE IMPORTANT POINT FOR THE DAIRY PRODUCER IS THAT THE DAY OF HEAT IS EXTREMELY SIGNIFICANT AND COWS NEED TO BE KEPT COOL. OTHERWISE, SUBSEQUENT EMBRYO DEVELOPMENT FOLLOWING FERTILIZATION WILL BE ALMOST COMPLETELY BLOCKED AND EMBRYOS WILL DIE.

A second experiment with Holstein heifers (n=14) was conducted to determine whether thermal stress increases the incidence of embryonic abnormalities when heat stress was imposed from the time of ovulation (day after insemination) until day 7 of embryo development [1]. Heifers were acclimated to environmental chambers at 20°C for 9 days and superovulated with Follicle Stimulating Hormone (FSH-P; 40 mg total), beginning on Days 9 to 11 of the estrus cycle. Prostaglandin Fα (Lutalyse; 60 mg total) was administered on Day 3 of FSH-P treatment. At estrus, heifers were inseminated artificially and then maintained either at thermal neutrality (20°C) or under hyperthermic conditions (16 h at 30°C and 8 h at 42°C per
Table 1. Distribution* of normal and retarded-abnormal embryos and unfertilized ova recovered from thermoneutral and heat-stressed heifers on Day 0.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Normal</th>
<th>Retarded abnormal</th>
<th>Unfertilized ova</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermoneutral:</td>
<td>n 13</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>% 68.4</td>
<td>21.1</td>
<td>10.5</td>
</tr>
<tr>
<td>Heat stress:</td>
<td>n 3</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>% 12.0</td>
<td>68.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

* X²=15.05; P<0.001 distribution of embryos different between treatments.

Table 2. Distribution of 4′-6′-diamidino-2-phenylindol (DAPI)a fluorescence reaction of embryos classified by light microscopy into developmental and quality groups and as effected by environmental temperature on Day 0.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Negative % (n)</th>
<th>Partial % (n)</th>
<th>Positive % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>16</td>
<td>100.0 (16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retarded-abnormal</td>
<td>21</td>
<td>47.6 (10)</td>
<td>52.4 (11)</td>
<td></td>
</tr>
<tr>
<td>Unfertilized ova</td>
<td>7</td>
<td>100.0 (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good to excellent</td>
<td>10</td>
<td>100.0 (10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor to fair</td>
<td>27</td>
<td>22.2 (6)</td>
<td>37.0 (10)</td>
<td>40.7 (11)</td>
</tr>
</tbody>
</table>

a The DAPI staining is characterized by a brilliant yellow-colored fluorescence of single nuclei (partial fluorescence) or of all nuclei (positive fluorescence) within an embryo.

** X² = 15.05; P<0.001 distribution of fluorescence reaction different among developmental groups.

** X² = 31.53; P<0.001 distribution of fluorescence reaction of embryos different between quality groups.

** X² = 17.04; P<0.01 distribution of fluorescence reaction of embryos different between treatments.
day) for an additional 7-day period beginning at 30 h after onset of estrus. Respiratory rates and rectal temperatures were monitored throughout the treatment period. On Day 7 post estrus, embryos were recovered nonsurgically and evaluated by light microscopy as to their morphological stage of development and quality. Heifers maintained under hyperthermic conditions had higher (P<0.01) rectal temperatures and respiration rates compared to heifers at thermoneutrality. The distribution of embryos classified as normal, abnormal, retarded and unfertilized ova differed (P<0.001) between heat stress and control treatments (Table 3). Stressed heifers had a higher incidence of abnormal and retarded embryos with degenerate nonviable blastomeres (vital fluorescent staining: 4'-6'-Diamidino-2-Phenylindol; Table 4). Responses indicated that thermal stress (from 30 h post onset of estrus) increased the incidence of abnormal or retarded embryos in superovulated heifers.

Table 3. Distribution\(^a\) of normal, abnormal or retarded embryos and unfertilized ova collected from thermoneutral and heat-stressed heifers (Days 1 to 7).

<table>
<thead>
<tr>
<th>Embryo category</th>
<th>Normal</th>
<th>Abnormal</th>
<th>Retarded</th>
<th>Unfertilized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermoneutral:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 68</td>
<td>35</td>
<td>9</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>%</td>
<td>51.47</td>
<td>13.24</td>
<td>16.18</td>
<td>19.12</td>
</tr>
<tr>
<td>Heat stress:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 82</td>
<td>17</td>
<td>22</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>%</td>
<td>20.73</td>
<td>26.83</td>
<td>34.15</td>
<td>18.29</td>
</tr>
</tbody>
</table>

\(^a\)χ^2=18.09; P<0.001 distribution of embryos different between treatments.

It is obvious that embryos during this period were sensitive to heat stress but the magnitude of the effect was the same as the single 10-hour stress on the day of estrus before ovulation. These results suggest that the embryo becomes somewhat more resistant to heat stress as it ages or becomes more developmentally mature. NEVERLESS, THE 7-DAY PERIOD FOLLOWING FERTILIZATION IS A TIME WHEN CATTLE NEED TO BE PROTECTED FROM HEAT STRESS TO MAINTAIN FERTILITY.

Since embryos that are less than 7 days of age are sensitive to controlled heat stresses imposed on the mother in vivo, we examined whether environmental temperatures were associated with both quality of embryos from donors and pregnancy rates of recipients in cattle managed under conditions associated with a COMMERCIAL EMBRYO TRANSFER UNIT IN TEXAS [3]. Transfer records on embryo donor (n=3,908; beef 99%, dairy 1%) and recipient (n=19,936; beef 92%, dairy 8%) cattle, collected for 4
Table 4. Distribution of 4',6'-diamidino-2-phenylindol (DAPA) fluorescence reaction of embryos classified by light microscopy into four developmental groups as influenced by environmental temperature (Days 1 to 7).

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>DAPI Reaction % (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td>Normal</td>
<td>19</td>
<td>68.4 (13)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>12</td>
<td>16.7 (2)</td>
</tr>
<tr>
<td>Retarded</td>
<td>8</td>
<td>----------</td>
</tr>
<tr>
<td>Unfertilized</td>
<td>12</td>
<td>----------</td>
</tr>
<tr>
<td>Thermoneutral</td>
<td>24</td>
<td>45.8 (11)</td>
</tr>
<tr>
<td>Heat stress</td>
<td>27</td>
<td>14.8 (4)</td>
</tr>
</tbody>
</table>

\[ \text{a} \] DAPI stains dead nuclei of the embryo with a yellow fluorescence.

\[ \text{b} \chi^2 = 70.110; P<0.001 \] distribution of fluorescence reaction different among embryo groups.

\[ \text{c} \chi^2 = 6.11; P<0.005 \] distribution of fluorescence reaction different between treatments.

years, were analyzed for environmental effects. Embryos (n=42,428) were recovered on Days 5 to 8 post estrus from superovulated donors (FSH-P). Numbers of ova, fertilized embryos and embryos of transferable quality were recorded. Transferable embryos were classified as to stage of development and morphological quality. Embryos (n=19,936) were transferred nonsurgically. These responses were analyzed statistically to determine if environmental temperatures were associated with either quality of the embryos following superovulation of donor cattle and conception rates of recipient animals that received these embryos. Fluctuations in mean daily maximum temperature (1 to 43°C), for Days 0 to 7 of embryo development, had no effect on distribution of embryos classified as good (48%), fair (40%) and poor (12%). Temperature did not affect percentage of donors flushed with recoverable ova (89%), mean number of ova (12.2 ± 0.3), fertilization rate (76%) or percent transferable embryos (57%). Recipient pregnancy rate (56%) was unaffected by mean daily maximum temperature for days 0 to 10 post transfer. Interactions between temperature and breed type (dairy vs beef), parity (cow vs heifer), or lactational status (lactating vs dry) on pregnancy rate were not detected. Although heat stress of donors induces embryonic abnormalities (i.e., Experiments one and two described above) present data indicate that elevated environmental temperature does not adversely affect reproductive responses of donors in a COMMERCIAL TRANSFER UNIT. Furthermore, pregnancy rates of recipients were unaffected by temperature.
Of course, a commercial embryo transfer unit is in the business to generate pregnancies following embryo transfer and the management systems are likely to partially protect the donor and recipient cattle from the stresses of the environment. However, embryo transfer may provide an alternative to artificial insemination to circumvent heat stress-induced infertility in cattle. The potential for on-farm embryo collection, screening and transfer of only good quality embryos is a modern day reality. An evaluation of pregnancy rates to embryo transfer, as compared to artificial insemination during summer months, warrants investigation.

Several physiological strategies should be combined with environmental modification. In dairy systems, utilization of frozen semen from proven bulls is essential for improving genetic merit. Furthermore, heat stress effects on the bull are avoided by use of artificial insemination in which semen can be collected and frozen during cooler times of the year. Prostaglandin F₂α works effectively to regress the CL in heat stressed cattle [4], and effective synchronization system should be implemented with environmental management systems. Parts of the herd could be synchronized and bred to avoid the heat stress season. Alternatively, groups of cows could be synchronized during hot weather to intensify accuracy of heat detection, and these synchronized groups managed under shade management systems for a limited time (e.g., 20 to 40 days) to maximize conception rates. It is anticipated that, with continued technological advancements, frozen embryos will be utilized successfully (with a normal rate of fertility) for embryo transfer in cattle. Furthermore, on farm non-surgical embryo transfers may develop into a routine reproductive manipulation as artificial insemination is today. Hypothetically, these techniques may offer a means of bypassing the early pre- and post-ovulatory periods of thermal sensitivity. For example, excellent quality embryos that are frozen could be transferred into recipients at Day 7 when the embryo appears to be less sensitive to heat stress. Alternatively, embryos could be collected from heat stressed donors, screened for quality and development, and only good quality embryos transferred to recipients that are not as sensitive to heat stress (e.g., non-lactating recipients).

We recently examined whether embryo transfer could be used under routine conditions to bypass early heat stress effects on the embryo. Lactating Holstein dairy cows were managed on two commercial dairies (NORTH FLORIDA HOLSTEINS, BELLS, FLORIDA; RICHARDSON'S DAIRY, SANDERSON, FLORIDA) during summer heat stress periods to determine if pregnancy rate to embryo transfer (n=113) was higher compared to contemporary control cows (n=524) that were artificially inseminated (AI) [5]. Holstein heifers (n=55) were superovulated with FSH-P (32 mg total), beginning on Day 10 of the estrous cycle, and administered prostaglandin F₂α (Lutalyse; 50 mg total) on Day 3 of FSH-P treatment. Heifers were inseminated artificially during estrus and subsequently managed under shade systems available at the farms to minimize summer heat stress. On Day 7 post-estrus, embryos were recovered, and good quality embryos transferred nonsurgically to estrus-synchronized lactating Holstein cows (n=113). Lactating control cows were managed under routine conditions of exposure to summer heat stress ambient temperatures and relative humidity. Pregnancy was determined by milk progesterone concentrations at Day 21 and per rectum at 45 to 60 days post-estrus (Table 5). Pregnancy rates of
cows presented for AI (Day 21, 18.0%; Days 45 to 60, 13.5%) were typical for lactating cows inseminated during periods of summer heat stress in Florida. Pregnancy rate of embryo recipient cows was higher (P<0.001) than that of cows presented for AI (Day 21, 47.6%; Days 45 to 60, 29.2%). Summer heat stress had no adverse effect on heifer superovulatory response but increased (P<0.05) the incidence of retarded embryos (less than 16 cells) and embryos graded as fair to poor quality. Increased pregnancy rate of recipient lactating cows indicates that the early bovine embryo (Days 1 to 7 post estrus) is extremely sensitive to maternal heat stress. Embryo transfer may bypass this period of extreme embryonic sensitivity and provide an alternative to AI to partially circumvent heat stress-induced infertility in cattle. It is also clear that even though pregnancy rates are higher for the embryo transfer group, there are still additional embryo losses between Day 21 and Day 40. This is an additional area of current research investigation, and the probability of increasing embryo survival during this latter period is higher. The embryo is more developmentally mature and controlling growth rates of the embryo is more likely since we can treat the cow to delay regression or maintain the corpus luteum which will allow embryos more time to grow and reduce embryo mortality.

Table 5. Pregnancy rates of embryo recipients and artificially inseminated lactating cows at North Florida Holsteins and Richardson’s dairies.

<table>
<thead>
<tr>
<th>Group</th>
<th>(N)</th>
<th>Pregnancy rate**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day 21&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Embryo transfer</td>
<td>113</td>
<td>47.6</td>
</tr>
<tr>
<td>Artificial insemination</td>
<td>524</td>
<td>18.0</td>
</tr>
</tbody>
</table>

<sup>a</sup> By milk progesterone  
<sup>b</sup> By rectal palpation  
** P < .01.

The application of embryo transfer and superovulation has been essential to our understanding of heat stress effects in dairy cattle. It is dramatically clear from the present results that management of dairy cattle on the day of estrus (even prior to insemination and fertilization) is important to minimize heat stress on fertility. Furthermore, as the embryo develops from fertilization to Day 7, it also is sensitive to daily re-occurring heat stress. Awareness of this sensitivity will permit producers to better manage their cattle to improve fertility. Embryo transfer of Day 7 embryos will reduce losses to heat stress but not totally alleviate the problem. This suggests that conceptus development after Day 7 is also sensitive to heat stress but not as devastating as the earlier periods.

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References


COOLING PONDS AND MILK QUALITY

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The effects of heat stress on reducing milk production has been studied for many years (3). It has been perceived that heat stress is only a problem in the Sunbelt states. The weather conditions of 1988 has demonstrated that heat stress can be a big problem in the non-Sunbelt states also.

One method used in Florida to reduce heat stress on dairy cattle is the use of cooling ponds. Effects of cooling ponds and mastitis was presented at the 1987 National Mastitis Council Meeting (4). Much interest was generated from that presentation. This presentation will discuss the effects of cooling ponds on reduction of heat stress, types of ponds, pond water quality, the future of ponds and their effect on milk quality in the state.

Cooling Ponds On Reduction Of Temperature

In the summer of 1986, an experiment was carried out on a North Florida dairy who was using man-made cooling ponds (1). Ten early lactation Holstein cows were fitted with radio transmitters which transmitted inner ear temperatures every 5 minutes to a radio receiver and data logger. Data was collected over a 4 day period in mid-August. The cows activities were also monitored during this time, entering and exiting the ponds, eating, drinking and laying.

The cooling ponds lowered the cows temperature by 1-2°F depending on the time of day they entered the cooling ponds. The average length per stay in the pond was 18 minutes for events from midnight to noon and 12 minutes per visit from noon to midnight. It is obvious that cooling ponds cool cows.

Types Of cooling Ponds

Man-made ponds are dug earthen ponds of various dimensions, depending upon the number of cows in that particular lot. They usually have running water in and a exit or drain pipe or overflow. Usually the ponds drain or overflow is from the top of the pond.

Cement ponds are also being built. These ponds are draining from the bottom and can be used to flush an existing barn or loafing area. Bottom drainage will hopefully remove some of the solids from the pond.
The drainage water from many ponds end up in the lagoon or lagoon type low spot from which water can be irrigated to pasture land.

Natural ponds are varied in size and water supply in and out may depend on rainfall, springs or from a well. They may be depressions in the ground with running water through them or filthy mud holes.

**Pond Water Quality**

In 1987, samples were taken from a dairy's man-made earthen ponds. The ponds were sampled weekly from May 19, 1987 to September 28, 1987. Six to ten ponds were sampled each week. Some ponds were void of cows and were not sampled.

Total bacteria counts (TBC), vary greatly from week to week. This may be due to no water entering the ponds, etc. There does not seem to be any great increase in total bacteria counts (Figure 1) or Coliform counts as time progressed (Figure 2).

The total bacteria count averaged 3,133,700 CFU/ml for all ponds for the 20 weeks. The coliform counts averaged 14,340 CFU/ml for the same period (Figure 2).

**1987 Pond Samples**

Total Bacterial Counts

TBC (In million CFU/ml) (Thousands)

Week of Sampling
What Areas Of Research Should Receive Emphasis

This question was asked to get the dairymen’s input to what we should concentrate our efforts on to reduce environmental stress. Eighty-one dairymen or 38% of the respondents indicated cooling ponds should be studies.

As you can see, cooling ponds in Florida are not some passing fancy, but dairymen are using them and more dairymen are going to use them to help relieve environmental stress.

Cooling Ponds And Their Effect On Milk Quality

In a previous study on a dairy in Florida with man-made cooling ponds, it was reported that cows exposed to cooling ponds did not experience more clinical mastitis than cows who did not have access to cooling ponds. In fact cows exposed to ponds during the trial period were only half as likely to develop a case of clinical mastitis as cows not exposed to cooling ponds (Table 1).

<table>
<thead>
<tr>
<th>Group</th>
<th># Cows</th>
<th># (%) Cows Clinical</th>
<th># Qtrs</th>
<th># (%) QtrS Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponds</td>
<td>817</td>
<td>79 (9.8)a</td>
<td>3268</td>
<td>95 (2.9)a</td>
</tr>
<tr>
<td>No Ponds</td>
<td>375</td>
<td>70 (18.6)b</td>
<td>1500</td>
<td>96 (6.4)b</td>
</tr>
</tbody>
</table>

- a differs from b (p < .01)

This same dairy has been providing us with their clinical mastitis records for the past several years. The total number of clinical mastitis cases (Figure 3) was high in the first quarter of the year and then declined sharply about the time hot weather came and the cows started using the ponds. The incidence stayed low even in the last quarter of the year when the ponds were not in use. This can be explained many ways. The first quarter of the year was an extremely wet period. The cows were quite dirty and the cow wash system was available to one-half of the herd. This may explain some of the variation, even though one-half of the herd never had a cow wash. Another confounding variable is that this herd switched to Clorox for pre- and post- teat dipping in April of this year. It had previously pre- and post-dipped with a Chlorhexidine product. From this we could conclude that the Clorox was the cause in reduction of clinical mastitis. Since there were no controls in this study, I will conclude nothing except that the ponds did not increase clinical mastitis.
A natural question that may be asked is why do any research on cooling pond? There can't be more than a couple of dairies in the world that have them anyway.

Environmental Stress Survey

In February of 1988, an Environmental Stress Survey (2) was mailed to every dairy in the state of Florida. 347 surveys were sent out, 15 never reached the dairies. 212 (64%) surveys were completed and returned. The reason for this survey was to obtain base line data presently used on Florida dairies to reduce environmental stress. This data will be used to develop future research and extension efforts in this area.

Methods Presently Used To Provide Relief From Environmental Stress

This section of the survey was to determine what dairymen are now using to relieve environmental stress. Seventeen percent of the respondents indicated that they used natural ponds and 15% indicated that they used man-made cooling ponds. At the present time 68 dairies in Florida are using cooling ponds.

Future Plans to Reduce Environmental Stress

The question was asked of the dairymen, what they planned to do in the next 2 years to reduce environmental stress. 24 dairymen or 11% of the respondents indicated that they were going to build cooling ponds.
Clinical Mastitis Organisms

This herd was on a lactation treatment study during the summer of 1987 (Table 2). A total of 40 cows were sampled and treated. There were no unusual organisms treated. These 40 cows were in no way all the cows treated for clinical mastitis during the period the cows had access to the ponds, but the results are encouraging.

TABLE 2. Clinical Mastitis Organisms - 40 clinicals

<table>
<thead>
<tr>
<th>Organism</th>
<th>Staph. aureus</th>
<th>Staph. species</th>
<th>Strep. ag.</th>
<th>Strep. dys.</th>
<th>Strep. uberis</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Other Gram</td>
<td>E. Coli. Neg.</td>
<td>C. Pyo. C. Bovis</td>
<td>Nocardia</td>
<td>No Growth</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

DHIA Somatic Cell Counts

In Table 3, data from DHIA for this herd is listed. Several observations can be made from this data. The first being that milk production did not drop in the summer months as is usually the case in Florida in the summer. This is the reason that the owner has the cooling ponds. The second observation is that the DHIA somatic cell count did become elevated during the summer months but not by a great
degree. It should also be noted that average days in milk also increased during this period. In this herd somatic cells did not increase greatly during the hot weather and milk production did not decrease.

TABLE 3. DHIA Information - 1987

<table>
<thead>
<tr>
<th>Month</th>
<th># Milking Cows</th>
<th>Ave. Days In Milk</th>
<th>RHA</th>
<th>Ave. SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1597</td>
<td>134</td>
<td>17472</td>
<td>2.9</td>
</tr>
<tr>
<td>2</td>
<td>1634</td>
<td>149</td>
<td>17436</td>
<td>2.9</td>
</tr>
<tr>
<td>3</td>
<td>1582</td>
<td>165</td>
<td>17489</td>
<td>2.7</td>
</tr>
<tr>
<td>4</td>
<td>1524</td>
<td>190</td>
<td>17622</td>
<td>3.2</td>
</tr>
<tr>
<td>5</td>
<td>1541</td>
<td>198</td>
<td>17621</td>
<td>2.9</td>
</tr>
<tr>
<td>6</td>
<td>1561</td>
<td>194</td>
<td>17644</td>
<td>3.0</td>
</tr>
<tr>
<td>7</td>
<td>1480</td>
<td>197</td>
<td>17717</td>
<td>3.2</td>
</tr>
<tr>
<td>8</td>
<td>1383</td>
<td>184</td>
<td>17730</td>
<td>3.4</td>
</tr>
<tr>
<td>9</td>
<td>1410</td>
<td>166</td>
<td>17648</td>
<td>3.6</td>
</tr>
<tr>
<td>10</td>
<td>1424</td>
<td>143</td>
<td>17734</td>
<td>3.4</td>
</tr>
<tr>
<td>11</td>
<td>1595</td>
<td>129</td>
<td>17804</td>
<td>3.1</td>
</tr>
<tr>
<td>12</td>
<td>1711</td>
<td>125</td>
<td>17874</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Statewide Effects Of Ponds On Milk Quality

Regulatory samples for all the herds in Florida were obtained from the Division of Dairy Industry for the year of 1987 were analyzed for the effects of no ponds, man-made ponds and natural ponds. The numbers presented are least squares estimates of SPC (Standard Plate Counts) and DMSCC for each month. They are not biased by different numbers of dairies with no ponds, natural or man-made ponds. Since dairies from the environmental stress survey indicated if their milking cows had access to cooling ponds we analyzed the data by herds whose milking cows had access to ponds.

Figure 4 illustrates the L.S. means for SPC the year for all herds in Florida, with the trend of higher L.S. means SPC during the summer months.
Figure 5 is a graph by months of L.S. means SPC for herds with no ponds and natural and man-made pond herds. The man-made pond herds were lowest for most of the year except for November which was higher.
From Table 4, the L.S. means for the year for standard plate count (SPC) for herds with milking cows with access to pond's herds with man-made ponds had the lowest SPC, L.S. mean 18,151 for the milking cows compared with a L.S. mean SPC for natural ponds of 36,322 for milking cows. Herds with no ponds had a L.S. mean SPC of 38,635 for milking cows.

<table>
<thead>
<tr>
<th>Herd</th>
<th>No Ponds</th>
<th>Natural</th>
<th>Man made</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC</td>
<td>38635</td>
<td>36322</td>
<td>18151</td>
</tr>
</tbody>
</table>

Table 5 presents the L.S. means for the year for somatic cell count (DMSCC). Again, the man-made ponds were the lowest with a L.S. mean of 395,497 for the milking cows. Herds with no ponds had L.S. means DMSCC of 460,056 for milking cows. The herds with natural ponds had the highest L.S. means for DMSCC, 524,412 for the milking cows. Herds with man-made ponds had the lowest DMSCC and the herds with the natural pond had the highest DMSCC.

<table>
<thead>
<tr>
<th>Herd</th>
<th>No Ponds</th>
<th>Natural</th>
<th>Man made</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMSCC</td>
<td>460,056</td>
<td>524,412</td>
<td>395,497</td>
</tr>
</tbody>
</table>

Figure 6 illustrates the L.S. means for somatic cell counts for all herds in Florida, showing an increase in DMSCC during the summer months.
Milking Cows
DMSCC - All Herds

Figure 7 graphs by months the L.S. means DMSCC for herds with no ponds, natural pond and man-made ponds. Like SPC the DMSCC was lowest for man-made ponds and highest for natural ponds.

Milking Cows
DMSCC by Pond Type
It seems obvious from the data for milking cows with access to man-made cooling ponds had lower SPC and DMSCC counts than other herds in the state and that herds with natural ponds were higher in both categories. It could be argued that those who built man-made ponds are better managers and thus have higher milk quality or that natural ponds are mud holes. We presented the data, you can draw whatever conclusions you wish.

Summary

From the data we have collected on cooling ponds we can conclude that cooling ponds are effective in cooling cows. There are 32 percent of the dairies in Florida with cooling ponds and more will be built. Man-made cooling ponds don’t seem to increase clinical mastitis and herds with man-made cooling ponds have higher quality milk as measured by standard plate count and somatic cell count. Herds with natural cooling ponds have decreased milk quality than herds with man-made ponds or herds with no cooling ponds.

References


HAY-FEEDING METHODS AND HAY TYPE ON LACTATING DAIRY COW PERFORMANCE

C.R. Staples, M.C. Lucy, W.W. Thatcher, D. Hissem, and D.S. Lough

INTRODUCTION

Many dairymen in Florida like to get some hay into their lactating cow diets primarily to maintain milk fat percentages. Methods of doing so vary from dairy to dairy. Some dairymen offer hay in large, round bales while others chop it and mix it in the ration. Some incorporate estimated daily intakes of hay from large, round bales into the ration while others ignore the nutrients provided in the hay when formulating the ration. The question as to the profitability of whether to feed a very high quality hay (e.g., alfalfa) or the best possible locally-grown hay (e.g., bermudagrass) is currently of great interest. With this in mind, the following objectives were set:

1. to evaluate currently used methods of hay feeding with their respective methods of ration balancing, and
2. to compare the feeding of limited amounts of alfalfa hay or cubes to bermudagrass for cows in early lactation.

EXPERIMENTAL METHODS

Forty Holstein cows in at least their second lactation, were assigned randomly at calving to one of five dietary treatments. The five diets were the following:

1. Long bermudagrass hay (BHL1) fed separately from a totally mixed ration (TMR). The TMR was formulated to be deficient in nutrients as provided by 7 pounds of hay (as-fed). Therefore the cow must consume approximately 7 pounds of hay daily to receive a balanced diet. This treatment represents that situation where dairymen allow cows the opportunity to balance their own rations by selecting to eat hay or TMR based on their preference.

2. Long bermudagrass hay fed separately from a TMR (BHL2). The TMR was balanced for all nutrients. Consumption of any hay resulted in a dietary dilution of crude protein and energy and a dietary concentration of fiber. This treatment represents that situation where dairymen maintain large, round bales of hay for cows housed on pastures already provided with ad libitum amounts of properly formulated TMR.
3. Chopped bermudagrass hay mixed into TMR at 14% of diet (BHC).
4. Chopped alfalfa hay mixed into TMR at 14% of diet (AHC).
5. Alfalfa cubes mixed into TMR at 14% of diet (AC).

For treatments 3, 4, and 5, the manager is dictating how much hay the cow will consume rather than allowing the cow to "decide."

The TMR was corn silage based and offered ad libitum. Bermudagrass hay was weighed into nylon nets having large openings between strands and only placed next to TMR of cows designated to receive long hay. This allowed actual measurement of individual cow intake of the hay. All cows received their treatments for the first 77 days of lactation. Dry matter intakes and milk yields were measured daily. Milk compositions and body weights were measured weekly. The milk yield during the first 60 days of each cow's previous lactation was used as a covariate adjustment for milk production and dry matter intake data of this experiment.

RESULTS

Table 1 contains the nutrient composition of the forages fed. The bermudagrass was very high quality having a crude protein (CP) content of 15.9% and a neutral detergent fiber (NDF) content of only 68.5%. While the mean CP content of the alfalfa hay was a respectable 19.1%, the net energy of lactation (NEL) was mediocre, only .58 Mcal/lb, due to its high fiber content. The alfalfa cubes were of excellent quality, averaging 19.9% CP and .66 Mcal NEL/lb. The ingredient composition of the five diets are in Table 2.

Certain feedstuffs were kept as constant as possible. Dried distillers grains and soybean meal were fed at a 2:1 ratio in all dietary treatments. Whole

<table>
<thead>
<tr>
<th>TABLE 1. Chemical composition of bermudagrass hay, alfalfa hay, and alfalfa cubes fed to lactating dairy cows.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Crude protein</td>
</tr>
<tr>
<td>Neutral detergent fiber</td>
</tr>
<tr>
<td>Acid detergent fiber</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Phosphorus</td>
</tr>
<tr>
<td>Net energy of lactation,</td>
</tr>
<tr>
<td>Mcal/lb</td>
</tr>
<tr>
<td>Ingredient</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Bermudagrass hay</td>
</tr>
<tr>
<td>Alfalfa hay</td>
</tr>
<tr>
<td>Alfalfa cubes</td>
</tr>
<tr>
<td>Corn silage</td>
</tr>
<tr>
<td>Ground corn</td>
</tr>
<tr>
<td>Dried distillers grains</td>
</tr>
<tr>
<td>Soybean meal</td>
</tr>
<tr>
<td>Calcium carbonate</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
</tr>
<tr>
<td>Trace mineral salt</td>
</tr>
<tr>
<td>Magnesium oxide</td>
</tr>
<tr>
<td>Potassium chloride</td>
</tr>
<tr>
<td>Vitamins A and D</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Cottonseed was included at a constant concentration resulting in a daily intake of 6 pounds per head. Corn and corn silage were adjusted to balance the diets to equal energy basis. Diets were formulated to .776 Mcal/ib, 18% CP, 22.9 to 25.7% acid detergent fiber (ADF), .80% calcium, .50% phosphorus, .32% magnesium, and 1.38% potassium.

Because cows on treatments BHL1 and BHL2 had the opportunity to selectively consume amounts of TMR and long hay at their discretion, the ingredient composition of the diet consumed differed from that which was formulated. Table 3 shows the ingredient composition of the diets as the cows consumed them. Treatments BHC, AH, and AC remained unchanged as the cows were only offered ingredients as TMR's. Cows which needed to consume hay in order to have a properly balanced diet (BHL1), ate about 60% of that needed. Cows which received a well balanced diet (BHL2) and needed no hay, ate nearly 9% of their diet as hay. Cows receiving diet AC also were selective in that alfalfa cubes rolled away from the other feed ingredients upon feeding. Cows tended to prefer the TMR to the cubes. As a result, cubes made up only 11% of the diet rather than the planned 14.7%.
TABLE 3. Ingredient composition of experimental diets as influenced by cow’s selection.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>BHL1</th>
<th>BHL2</th>
<th>BHC</th>
<th>AHC</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermudagrass hay</td>
<td>8.39</td>
<td>8.64</td>
<td>14.69</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14.69</td>
<td>-</td>
</tr>
<tr>
<td>Alfalfa cubes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.06</td>
</tr>
<tr>
<td>Corn silage</td>
<td>29.86</td>
<td>41.11</td>
<td>27.81</td>
<td>31.62</td>
<td>38.06</td>
</tr>
<tr>
<td>Ground corn</td>
<td>18.71</td>
<td>9.14</td>
<td>17.42</td>
<td>15.80</td>
<td>12.04</td>
</tr>
<tr>
<td>Dried distillers grains</td>
<td>15.59</td>
<td>16.00</td>
<td>14.51</td>
<td>13.34</td>
<td>13.66</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>7.8</td>
<td>7.96</td>
<td>7.28</td>
<td>6.70</td>
<td>6.82</td>
</tr>
<tr>
<td>Whole cottonseed</td>
<td>15.78</td>
<td>13.42</td>
<td>14.69</td>
<td>14.69</td>
<td>15.32</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>1.39</td>
<td>.6</td>
<td>1.30</td>
<td>.97</td>
<td>.68</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>.51</td>
<td>1.15</td>
<td>.48</td>
<td>.51</td>
<td>.63</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>1.07</td>
<td>.91</td>
<td>1.00</td>
<td>1.00</td>
<td>1.04</td>
</tr>
<tr>
<td>Trace mineral salt</td>
<td>.49</td>
<td>.42</td>
<td>.46</td>
<td>.46</td>
<td>.48</td>
</tr>
<tr>
<td>Magnesium oxide</td>
<td>.11</td>
<td>.09</td>
<td>.10</td>
<td>.10</td>
<td>.05</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>.27</td>
<td>.46</td>
<td>.25</td>
<td>.11</td>
<td>.15</td>
</tr>
<tr>
<td>Vitamins A and D</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Intakes of TMR’s, long hay, and alfalfa cubes by cows on each of the five treatments are shown in Table 4. Intakes ranged from 40.5 to 46.5 lb/day with no statistical difference among treatments. Dry matter intakes expressed as a percent of body weights ranged from 3.25 to 3.69%. Although no differences were observed, cows tended to consume the alfalfa hay diet to a greater extent than the other diets.

When long hay was fed separately (BHL1 and BLH2), cows consumed about the same amount of hay, 3.5 to 3.9 lb of DM/day, regardless of the make-up of their diet. This indicates that cows will consume some hay if it is made available to them regardless of nutrient needs. In other words, they have little nutritional savvy. Cows on diet BHL1 needed to consume 6.3 lb/day but only consumed 3.9 lb/day. Thus they consumed a diet much higher in energy than needed. By consuming 3.5 lb of hay/day, cows on diet BLH2 were substituting a lower quality feed (bermudagrass hay) for higher quality feedstuffs (TMR).

Ration balancing is very difficult when cows are given hay ad libitum in addition to a TMR ad libitum because wide variation from cow to cow in hay intake occurs. Average hay intake by each cow on diets BHL1 and BHL2 is shown in Tables 5a,b. The variability in voluntary hay intake among cows
TABLE 4. Dry matter intakes of dietary treatments by lactating dairy cows.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TMR (lb/d)</th>
<th>Hay or Cubes (lb/d)</th>
<th>Total DMI (lb/d)</th>
<th>Total DMI (% BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Berm.--Unbalanced (BHL1)</td>
<td>42.6</td>
<td>3.9</td>
<td>46.5</td>
<td>3.45</td>
</tr>
<tr>
<td>Long Berm.--Balanced (BHL2)</td>
<td>37.0</td>
<td>3.5</td>
<td>40.5</td>
<td>3.30</td>
</tr>
<tr>
<td>Chopped Bermudagrass (BHC)</td>
<td>41.2</td>
<td>-</td>
<td>41.2</td>
<td>3.25</td>
</tr>
<tr>
<td>Chopped Alfalfa Hay (AHC)</td>
<td>42.9</td>
<td>-</td>
<td>42.9</td>
<td>3.69</td>
</tr>
<tr>
<td>Alfalfa Cubes (AC)</td>
<td>36.2</td>
<td>4.5</td>
<td>40.7</td>
<td>3.30</td>
</tr>
</tbody>
</table>

needing more fiber in their diet was less than that of cows already receiving a fiber-adequate diet (coefficient of variability of 13 vs. 34%). Therefore, this difficulty of ration balancing is reduced when fiber in the field is needed to help balance the diet. Providing large, round bales of hay to cows already receiving a balanced diet is questionable.

Figure 1 shows changes in the voluntary intake of bermudagrass hay and alfalfa cubes over the 11 weeks of lactation. During week 1, cows needing fiber were eating about 2.5 times more hay than those not needing fiber. After week 1, intake of hay was similar between treatments BHL1 and BHL2. Cows appeared to adjust to the alfalfa cubes in their diets in that cube consumption increased from 2.7 pounds at week 1 to 4.9 pounds by week 6. But cube intake never increased to the desired amount of 6.3 lb/day.

Average yield of milk during the first 11 weeks of lactation ranged from 56.2 to 65.0 lbs/day (Table 6). Yields were not different from one another (P>0.05). Cows appeared to be depressed in milk fat as milk fat percentages ranged from 3.00 to 3.20. Cows receiving the least fiber (BHL1) had the lowest milk fat percent while those consuming the most NDF (BHC) had the highest milk fat percent. Yield of 4% fat-corrected milk (FCM) was not different among treatments. Cows receiving alfalfa in their diets tended to produce more FCM. Efficiency of production (lb of FCM/ lb of DM intake) tended to be better when all feedstuffs were fed as TMR's rather than when hay was fed separately.

Apparent profitability of each dietary treatment is shown in Table 7. Because DM intakes and milk yields were not different among treatments, profitability differences are not given with a high degree of confidence. Milk was priced at $14/cwt with $.17 per .1% change from 3.5% milk fat differential. Feed prices ($/ton, as-is) were corn at 118, distillers dried grains at 160, soybean meal at 280, whole cottonseed at 170, bermudagrass hay at 90, alfalfa hay at 165, and alfalfa cubes at 160. Corn silage was priced at $35/wet ton. Diets fed as TMR's showed the highest income over feed costs with alfalfa diets appearing the most profitable.
SUMMARY

- Cows voluntarily ate the same amount of long bermudagrass hay regardless of fiber status of their diet. Cows will eat long hay if offered to them so no long hay should be provided to cows if those cows are fed a well balanced diet ad libitum.

- Formulating the correct amount of forage into the TMR rather than allowing voluntary consumption of forage tended to improve 1) efficiency of production and 2) income over feed costs.

- Diets containing alfalfa hay or cubes appeared to be more profitable than diets containing bermudagrass hay. Feed costs were lower for diet containing chopped bermudagrass hay but milk income also was lower.

<table>
<thead>
<tr>
<th>Cow</th>
<th>Hay Intake (lb/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>3.9</td>
</tr>
<tr>
<td>1038</td>
<td>4.1</td>
</tr>
<tr>
<td>1112</td>
<td>3.1</td>
</tr>
<tr>
<td>1154</td>
<td>3.7</td>
</tr>
<tr>
<td>1165</td>
<td>3.5</td>
</tr>
<tr>
<td>1198</td>
<td>4.0</td>
</tr>
<tr>
<td>1340</td>
<td>3.9</td>
</tr>
<tr>
<td>9648</td>
<td>4.6</td>
</tr>
<tr>
<td>Mean</td>
<td>3.9±.5</td>
</tr>
</tbody>
</table>

Coefficient of variability = .5/3.9 = 13%

<table>
<thead>
<tr>
<th>Cow</th>
<th>Hay Intake (lb/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1145</td>
<td>3.1</td>
</tr>
<tr>
<td>1323</td>
<td>1.7</td>
</tr>
<tr>
<td>1367</td>
<td>2.8</td>
</tr>
<tr>
<td>3593</td>
<td>5.0</td>
</tr>
<tr>
<td>3620</td>
<td>4.1</td>
</tr>
<tr>
<td>9073</td>
<td>4.0</td>
</tr>
<tr>
<td>Mean</td>
<td>3.5±1.2</td>
</tr>
</tbody>
</table>

Coefficient of variability = 1.2/3.5 = 34%
### TABLE 6. Lactation performance of dairy cows fed bermudagrass or alfalfa in different management systems.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Milk Yield (lb/day)</th>
<th>Fat (%)</th>
<th>4% FCM (lb/day)</th>
<th>Efficiency (FCM/DMI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Berm.—Unbalanced (BHL1)</td>
<td>64.2</td>
<td>3.00</td>
<td>52.1</td>
<td>1.18</td>
</tr>
<tr>
<td>Long Berm.—Balanced (BHL2)</td>
<td>56.2</td>
<td>3.15</td>
<td>47.2</td>
<td>1.14</td>
</tr>
<tr>
<td>Chopped Bermudagrass (BHC)</td>
<td>59.8</td>
<td>3.20</td>
<td>50.4</td>
<td>1.28</td>
</tr>
<tr>
<td>Chopped Alfalfa Hay (AHC)</td>
<td>64.7</td>
<td>3.14</td>
<td>522.7</td>
<td>1.30</td>
</tr>
<tr>
<td>Alfalfa Cubes (AC)</td>
<td>65.0</td>
<td>3.15</td>
<td>53.7</td>
<td>1.41</td>
</tr>
</tbody>
</table>

### TABLE 7. Apparent profitability of dietary treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Milk Income ($/cow/d)</th>
<th>Feed Costs ($/cow/d)</th>
<th>IOFC (^1) ($/cow/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Berm.—Unbalanced (BHL1)</td>
<td>8.44</td>
<td>3.62</td>
<td>4.82</td>
</tr>
<tr>
<td>Long Berm.—Balanced (BHL2)</td>
<td>7.53</td>
<td>3.11</td>
<td>4.42</td>
</tr>
<tr>
<td>Chopped Bermudagrass (BHC)</td>
<td>8.07</td>
<td>3.11</td>
<td>4.96</td>
</tr>
<tr>
<td>Chopped Alfalfa Hay (AHC)</td>
<td>8.66</td>
<td>3.48</td>
<td>5.18</td>
</tr>
<tr>
<td>Alfalfa Cubes (AC)</td>
<td>8.71</td>
<td>3.24</td>
<td>5.47</td>
</tr>
</tbody>
</table>

\(^1\)Income over feed costs.
VOLUNTARY INTAKE OF HAY OR CUBES BY COW FED ADEQUATE OR INADEQUATE FIBER DIETS

FORAGE INTAKE, LB/DAY

WEEK OF LACTATION

DIET

BHL1  BHL2  ALFALFA CUBES
COST AND RETURNS FROM SELECTED FLORIDA DAIRY FARMS

Daniel W. Webb
Dairy Science Department
University of Florida
Gainesville, FL

The costs and profitability of dairying in Florida have been estimated in various ways. U.S.D.A. makes routine estimates for use in formulating agricultural outlooks. The last Dairy Business Analysis Summary was published in 1969. It included data from 21 farms in peninsular Florida and showed total costs of $7.31 per hundred pounds with net return of $0.35.

Dairying in Florida can be partitioned into three logical enterprises:

1. **The milking operation** - includes facilities, labor, adult cattle and management for the production of milk.
2. **Feed acquisition** - refers to production, contracting or purchase of feed ingredients with required land, equipment and storage facilities.
3. **Replacement rearing** - includes feeding, care and management of young female cattle from birth to first-calving.

Each of these enterprises requires considerable capital and unique management skills. These needs are magnified when applied to the scale of large Florida dairy farms; and consequently, many farms do not attempt to do all three. Some herds only milk, selling all calves, purchasing all feed and replacement cattle. Others milk and raise replacements, but purchase all feed.

Feed represents 40% - 60% of on-farm milk production costs in Florida. This great spread results from varying levels of production, different strategies of feed acquisition and varying production efficiencies. Some farms can produce silage and other crops efficiently. Others purchase ingredients with forward contracts and blend rations on the farm. Still others purchase all feed which is delivered daily, ready to place in the feed bunk.

With an annual cow turnover rate near 35%, replacing dairy cows in Florida is expensive! Such items as "cow depreciation" or "purchased replacements" figure prominently in most dairy income statements. Recent reviews of several dairies' statements showed **cow replacement** to be a major cost of Florida milk production. Costs range from $225 to $300 per cow milked or $1.75 to $2.35 per hundred pounds of milk produced.
Financial statements from 26 cooperating dairy farms have been reviewed for this study. Seventeen of the dairies had data which was complete and consistent enough for summary. Income and expenses are summarized in Tables 1 and 2. Cost and returns for a dairy based upon the 17 herds summarized are presented in Table 3. Of the herds studied, nine provided the information related to assets and liabilities which are presented in Table 4. Table 5 shows a summary of the herds studied.

In consideration of data available, several observations can be made.

1. Dairy farming is not a high profit business;
2. Debt management is key;
3. Dairymen need to use accrual accounting method in order to assess profit and loss, accurately;
4. Depreciation method is important;
5. Many accountants are tax-oriented; and,
6. Much effort is needed to provide information for accurate determination of Florida dairy farm profitability.

TABLE 1: INCOME

<table>
<thead>
<tr>
<th></th>
<th>per</th>
<th>per</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cow</td>
<td>cwt.</td>
</tr>
<tr>
<td>Milk Sales</td>
<td>$2,130</td>
<td>$15.27</td>
</tr>
<tr>
<td>Butcher Cow Sales</td>
<td>138</td>
<td>.99</td>
</tr>
<tr>
<td>Calf Sales</td>
<td>22</td>
<td>.15</td>
</tr>
<tr>
<td>Crop Sales</td>
<td>0</td>
<td>.00</td>
</tr>
<tr>
<td>Rent, Int. Divd.</td>
<td>18</td>
<td>.13</td>
</tr>
<tr>
<td>Other Farm Income</td>
<td>17</td>
<td>.12</td>
</tr>
<tr>
<td>Total Cash Receipts</td>
<td>$2,324</td>
<td>$16.66</td>
</tr>
<tr>
<td>Change in Inventory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed &amp; Crops</td>
<td>1</td>
<td>.01</td>
</tr>
<tr>
<td>Livestock</td>
<td>7</td>
<td>.05</td>
</tr>
<tr>
<td>Total Farm Income</td>
<td>$2,332</td>
<td>$16.72</td>
</tr>
<tr>
<td>Expense Category</td>
<td>per cow</td>
<td>per cwt.</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Payroll</td>
<td>$301</td>
<td>$2.15</td>
</tr>
<tr>
<td>Purchased Feed</td>
<td>893</td>
<td>6.40</td>
</tr>
<tr>
<td>Crop Expense</td>
<td>36</td>
<td>.26</td>
</tr>
<tr>
<td>Power &amp; Machinery</td>
<td>41</td>
<td>.29</td>
</tr>
<tr>
<td><strong>Total Feed Cost</strong></td>
<td><strong>$970</strong></td>
<td><strong>$6.95</strong></td>
</tr>
<tr>
<td>Breeding</td>
<td>16</td>
<td>.11</td>
</tr>
<tr>
<td>Vet &amp; Medicine</td>
<td>42</td>
<td>.30</td>
</tr>
<tr>
<td>Marketing &amp; Adv.</td>
<td>46</td>
<td>.33</td>
</tr>
<tr>
<td>Milk Hauling</td>
<td>85</td>
<td>.61</td>
</tr>
<tr>
<td>Livestock Pur. &amp; Lease</td>
<td>198</td>
<td>1.42</td>
</tr>
<tr>
<td>Dairy Supplies</td>
<td>38</td>
<td>.27</td>
</tr>
<tr>
<td>DHIA</td>
<td>4</td>
<td>.03</td>
</tr>
<tr>
<td>Interest</td>
<td>74</td>
<td>.53</td>
</tr>
<tr>
<td>Taxes &amp; Insurance</td>
<td>97</td>
<td>.69</td>
</tr>
<tr>
<td>Utilities</td>
<td>34</td>
<td>.24</td>
</tr>
<tr>
<td>Repair - Bldg. &amp; Facil.</td>
<td>61</td>
<td>.43</td>
</tr>
<tr>
<td>Other Fuel</td>
<td>9</td>
<td>.06</td>
</tr>
<tr>
<td>Rent</td>
<td>20</td>
<td>.14</td>
</tr>
<tr>
<td>Consulting</td>
<td>5</td>
<td>.04</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>44</td>
<td>.32</td>
</tr>
<tr>
<td>Corporate Overhead</td>
<td>31</td>
<td>.22</td>
</tr>
<tr>
<td><strong>Total Operating Cost</strong></td>
<td><strong>$2,072</strong></td>
<td><strong>$14.85</strong></td>
</tr>
<tr>
<td></td>
<td>Per Cow</td>
<td>Per CWT Milk</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td><strong>Total Cash Receipts</strong></td>
<td>$2,324</td>
<td>$16.66</td>
</tr>
<tr>
<td><strong>Other Income</strong></td>
<td>8</td>
<td>.06</td>
</tr>
<tr>
<td><strong>Total Income</strong></td>
<td>$2,332</td>
<td>$16.72</td>
</tr>
</tbody>
</table>

| **Feed Cost**                  | $ 970   | $ 6.95       |
| **Payroll**                    | 301     | 2.15         |
| **Livestock Expense**          | 435     | 3.12         |
| **Interest, Taxes, Insurance** | 171     | 1.22         |
| **General Farm Expense**       | 196     | 1.40         |
| **Total Operating Cost**       | $2,072  | $14.85       |

| **Depreciation**               |         |              |
| **Machinery**                  | $ 46    | $ .33        |
| **Building & Improvements**    | 39      | .28          |
| **Livestock**                  | 33      | .24          |
| **Total Cost**                 | $2,190  | $15.70       |

**NET FARM INCOME**             | $ 142   | $ 1.02       |
### TABLE 4: BALANCE SHEET - SUMMARY

<table>
<thead>
<tr>
<th>Assets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>$302,910</td>
</tr>
<tr>
<td>Other</td>
<td>$1,100,283</td>
</tr>
<tr>
<td>Fixed</td>
<td>$1,896,563</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$3,299,756</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>$257,312</td>
</tr>
<tr>
<td>Intermediate</td>
<td>$90,808</td>
</tr>
<tr>
<td>Long</td>
<td>$1,264,686</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$1,612,806</strong></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Worth</td>
<td>$1,686,950</td>
</tr>
<tr>
<td>Total Assets Per Cow</td>
<td>$3,019</td>
</tr>
<tr>
<td>Debt Per Cow</td>
<td>$1,476</td>
</tr>
<tr>
<td>Net Worth Per Cow</td>
<td>$1,543</td>
</tr>
</tbody>
</table>

### TABLE 5: SUMMARY OF SURVEYED HERDS

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-COST OF PRODUCTION</td>
<td>$15.70/CWT</td>
</tr>
<tr>
<td>-CAPITAL INVESTMENT</td>
<td>$2,435/COW</td>
</tr>
<tr>
<td>-DEBT LOAD</td>
<td>$1,019/COW</td>
</tr>
<tr>
<td>-HERD SIZE</td>
<td>1,253 COWS</td>
</tr>
<tr>
<td>-PRODUCTION LEVEL</td>
<td>13,879 LBS./COW</td>
</tr>
</tbody>
</table>
REDUCING THE LIKELIHOOD OF ENVIRONMENTAL PROBLEMS

W. Arthur Darling
Dairy Farmers, Inc.
Orlando, Florida

First, eight dairy farms have contacted the Department of Agriculture saying they wished to participate in the joint Florida Department of Agriculture/South Florida Water Management District program to cease milking operations in the Lake Okeechobee Drainage Basin. Second, the Florida Audubon Society has challenged the Lake Okeechobee SWIM Plan because it leaves dairy farmers under the Department of Environmental Regulation. That review challenge will go to the Land and Water Adjudicatory Commission which consists of the Governor and Cabinet. Third, after six months of objections, meetings and counteroffers, the Governing Board of the Southwest Florida Water Management District took just 45 minutes to change its rules whereby mandatory metering will be implemented on large agricultural water users in that District. And finally, a prominent state senator has received numerous letters and phone calls about a proposed dairy in the Suwannee River Water Management District and asked state agencies how they are responding. And, it all happened in the last two weeks.

Florida is a powerhouse state in our nation. One movie studio opened this weekend in Orlando and another one will open before the end of the year. Business people have recognized what many local and state officials are reluctant to admit. Florida can no longer conduct itself as it did 20 years ago when we had less than half of today's population.

The attitudes of our basically urban-oriented population confound us. "Where do they think food comes from?" we ask. They might respond "Where do you think clean water comes from?" Our nest is getting smaller every day and our opportunities to fowl our nest are expanding every day.

If we do not want more government oversight and regulation, then we must earn the right to not get it. Some things that you can and should consider to move our industry out of the environmental limelight are:

A. Become your brothers' keeper. Suwannee County dairy farmers meet informally for dinner from time-to-time. It offers fellowship and a chance to discuss conditions. No man (or dairy) is an island. As we now know in the Okeechobee area, one poorly managed lagoon ruins it for an entire sub-basin. Neighbor support and a little chiding can prove important in environmental awareness.

B. Get a water permit and meter your usage. Whether we like it or not, fighting over available water sources is growing every day.
Your historic right to water is greatly strengthened by the possession of a valid Consumptive Use Permit. You should even consider the installation of in-line flowmeters and monthly tabulations of your usage. It is a further protection of your historic right to the water. On a SWFWMD Consumptive Use Permit, you will now have to document it if you are asking for more water than they can calculate that you need. "I don't know" is no longer a politically advantageous position for agriculture.

C. Install Monitoring Wells. Monitoring wells, properly designed, installed and routinely sampled, provide an historic record of oversight and responsibility that can more than pay for themselves in any future challenges. They may also pinpoint problems before they can cause an offsite complication. Showing such records to an investigating officer is far better than "I'm not polluting!" The former is proof, the latter is a meaningless claim.

D. Have Valid Engineering Plans and then follow up with an annual review. Any business that carries the environmental impact of a commercial dairy farm should have an up-to-date engineering plan for its waste management and have the engineers conduct an annual on-site review.

This way, not only is the likelihood of a problem greatly diminished, nuisance complaints from an irate neighbor are easily handled with documentation. Cost is not a valid excuse for not having a plan since unlike most businesses, you can call on the USDA Soil Conservation Service to design a Conservation Plan for your farm at no cost to you. If you do not wish to use the SCS, private agricultural engineers are available. You would not build a parlor without a blueprint, you should not be operating your farm without an engineered waste management system.

I would urge you to read, and perhaps file for future reference, the environmental column in the May issue of Southeastern Dairy Review on what to do if a regulatory agency receives a complaint about your dairy. Dairy farming can survive in the heady commercial climate of 1989 Florida, but only if we plan and manage for it environmentally as well as economically.

###
ENVIRONMENTAL REGULATION AND DAIRY FARMS
DER's PERSPECTIVE

Richard M. Harvey
Deputy Director
Division of Water Facilities
Department of Environmental Regulation
Tallahassee, Florida

Until very recently, the Department of Environmental Regulation did not routinely require permits for typical dairy operations around the State of Florida, and it is not our intent to do so in the future. Approximately two years ago the Florida Environmental Regulation Commission approved modifications to our Industrial Waste Treatment Rule (Chapter 17-6) which required industrial waste permits for dairies located in the Lake Okeechobee Drainage Basin. The purpose of the rule modification (which is now generally known as the Department's "Dairy Rule") is clearly stated in section 17-6.330, Florida Administrative Code (F.A.C.). "The discharge of untreated wastewater and runoff from dairy farms may reasonably be expected to be a source of pollution to waters of the state. The purpose of sections 17-6.330 through 17-6.337, F.A.C., is to control pollution of waters of the state due to the discharge of wastewater and runoff from dairy farms in the Lake Okeechobee Drainage Basin to surface and ground water." This rule only applies to existing and new dairies in the Lake Okeechobee Drainage Basin. Regulation of dairy farms in other drainage basins is covered elsewhere in Chapters 17-6 and in 17-28, F.A.C., which deals with ground water protection.

The "Dairy Rule" requires that wastewater and runoff discharged from dairies not cause or contribute to violations of water quality standards. To comply with that requirement approximately 45 to 50 dairies are required to implement specific management practices designed to collect and recycle their wastewaters through land application. These dairies are also required to apply for and obtain Industrial Waste construction and operation permits from the Department. For a more detailed description of the rule requirements, I have included a copy of the industrial waste rule as an appendix to this paper.

Outside of the Lake Okeechobee area we have not generally permitted dairy operations. In fact, typical agricultural field activities were, and still are, exempt from permitting unless we have reason to believe the activities represent a threat to either ground or surface water resources. By field activities we mean pastures, croplands, ditches, canals, etc. Livestock waste lagoons are also exempt if discharges to surface waters from these lagoons only occur in response to major (25 years, 24 hour) storm-events. If discharges are more frequent than that, both a state and a federal discharge permit may be required if the dairy is determined to be a "concentrated animal feeding operation." With respect to dairies, a concentrated animal feeding operation is one with 700 or more mature cows (whether milked or dry).

Regardless of herd size or whether or not a dairy discharges to surface waters, if a dairy operation causes or even threatens to cause ground water quality standards violations or otherwise threatens to impair the designated use of contiguous waters, we can require the dairy owner to obtain a permit. For example, certain areas of the state, such as North-Central Florida are particularly vulnerable to ground water contamination from high intensity agricultural activities such as dairy farming. In these areas a farmer may be
required to provide us with detailed information regarding his operational practices, specifically what he does with his wastewater and manure, and provide us with reasonable assurances that these practices will not adversely impact the areas' water resources. If adequate reasonable assurances are provided, then we may choose to either exempt the dairy or require a permit. In most cases we will probably exempt the dairy with some requirements such as ground water monitoring.

If ground water contamination is discovered, and if that contamination reaches drinking water wells, then the dairy farmer may be held responsible for cleaning up that ground water and/or providing alternative drinking water supplies to the affected families, and that can be very expensive.

To help us identify dairies which may pose a threat to the quality of either ground or surface waters, Secretary Twachtman recently sent letters to the Executive Directors of each water management district requesting their assistance. In those letters (a copy of which is attached) he states that it is not our intent to require permits for each dairy in the state. Our objective is to inform and educate dairy farmers about our concerns and to work closely with them to correct existing or to avoid future problems. That will basically be our approach statewide, except for those dairies covered by the dairy rule. We hope the dairy farmers and dairy industry will cooperate and assist us in our efforts to protect Florida's valuable water resources.
March 31, 1989

Mr. Donald O. Morgan  
Executive Director  
Suwannee River Water Management District  
Route 3, Box 64  
Live Oak, Florida 32060

Dear Don:

This letter is to ask for your assistance in the identification of existing or proposed new dairies in your district which may pose a threat to the quality of either ground or surface water.

When you review surface water management permits, we will appreciate it if those permits could be provided to the water management district coordinators. They in turn will work with the respective district offices. As I am sure you are aware, our rules exempt most agricultural practices from the requirement to obtain a permit unless those activities threaten to violate ground or surface water quality standards. While we do not intend to require permits for each dairy in the state, some parts of the state are particularly vulnerable to ground water contamination from high-intensity agricultural activities, such as dairy farming, and some permits may be necessary in those areas. In other areas, these same activities may pose more of a threat to surface water.

Our objective is to inform and educate dairy farmers about our concerns and to work closely with them to correct existing or to avoid future problems. Where possible, we hope you can help us in these efforts. Similar assistance will also be requested from the Soil Conservation Service, the University of Florida Institute of Food and Agricultural Sciences, and the various dairy farmer associations around the state.

We recently have been informed that several Chambers of Commerce are actively involved in the recruitment of new dairies to their areas. We have offered to meet with those organizations to explain the complications and our interest in providing assistance to dairy farmers.
We hope that through these combined efforts we can continue to have a viable dairy industry in the State of Florida, while at the same time protecting the water resources. If you have any questions, please have your staff call Richard Harvey in our Water Facilities Division in Tallahassee at (904) 487-1855.

Sincerely,

Dale Twachtmann
Secretary

DT/ab
cc: Ernie Frey
Mr. Douglas Barr  
Acting Executive Director  
Northwest Florida Water Management District  
Route 1, Box 3100  
Havana, Florida 32333  
cc: Bob Kriegel

Mr. Henry Dean  
Executive Director  
St. Johns River Water Management District  
Post Office Box 1429  
Palatka, Florida 32077  
cc: Alex Alexander

Mr. John R. Wodraska  
Executive Director  
South Florida Water Management District  
Post Office Box 24680  
3301 Gun Club Road  
West Palm Beach, Florida 33416-4680  
cc: Phil Edwards  
Scott Benyon

Mr. Peter G. Hubbell  
Executive Director  
Southwest Florida Water Management District  
2379 Broad Street  
Brooksville, Florida 33512  
cc: Richard Garrity

Mr. Donald O. Morgan  
Executive Director  
Suwannee River Water Management District  
Route 3, Box 64  
Live Oak, Florida 32060  
cc: Ernie Frey
(g) The submission, by the owner, manager, or operator of a domestic wastewater facility, or agent or employee thereof, of misleading, false, or inaccurate information or operational reports to the department, either knowingly or through neglect.

(h) Land application of effluent which results in direct effluent contact with crops intended directly for human consumption unless preapplication treatment levels meet, at a minimum, the requirements for slow-rate land application in public access areas (i.e., Section 17-6.040(4Kq) and unless the permittee affirmatively demonstrated to the department that processing of the crops will inactivate (or remove) pathogens and that all precautions necessary to protect public health will be taken. Any operating permit which may be issued shall identify the crop and stipulate the conditions under which land application may be practiced.

(i) The operation of land application effluent discharge equipment when authorized persons (other than operators who have taken precautionary measures to minimize contact with the effluent) are known to be within the wetted area (where there is a reasonable possibility of direct contact with the effluent) unless preapplication treatment levels meet the requirements for slow-rate land application in public access areas (i.e., Section 17-6.040(4Kq)).

(j) The operation of land application projects such that wastewater effluents, including effluent from spray irrigation and aerosol drift, reach within 100 feet of outdoor public eating, drinking, or bathing facilities.

(k) The grazing of dairy cattle whose milk is intended for human consumption on pastures onto which effluent has been applied until 15 days after application.

(l) No owner or permiitee of a wastewater treatment plant shall knowingly allow or encourage any operator in his employ to violate any rule, regulation, or law related to treatment plant operation.

Specific Authority: 403.061, 403.087, F.S.
Law Implemented: 403.021, 403.061, 403.062, 403.085, 403.086, 403.087, 403.088, 403.121, 403.131, 403.161, F.S.
History: New 1-1-82, Amended 5-31-82, 1-29-84, 5-8-85.

PART II
INDUSTRIAL WASTE TREATMENT REQUIREMENTS

17-6.20 is renumbered as 17-6.500.
Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.804, 403.805, F.S.
Law Implemented: 403.021, 403.061, 403.086, 403.087, 403.088, 403.091, 403.121, 403.141, 403.161, 403.182, 403.502, 403.704, 403.708, F.S.
History: New 3-1-79, Renumbered 1-1-82.

17-6.30 is renumbered as 17-6.640.
Specific Authority: 403.061(7), F.S.
Law Implemented: 403.061, 403.085, 403.086, 403.087, F.S.
History: New 6-23-80, Renumbered 1-1-82.

17-6.300 Effluent Limitations.

The following effluent limitations apply to plants and installations which discharge industrial wastes into waters of the state.

(1) Effluent Limitations Based on the Availability of Technology.

(a) Section 301 of Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972, (FWPCA) requires all existing point source discharges of pollutants to meet uniform technology-based effluent limitations as a minimum. Two levels of effluent limitations are established.

2. The first level is defined as "best practical control technology currently available" (BPT). FWPCA Section 301(b)(1)(A), 33 U.S.C.A. Section 1311(b)(1)(A). By no later than July 1, 1977, dischargers are required to apply BPT as defined by specific effluent limitations issued by the Administrator of the United States Environmental Protection Agency (EPA) pursuant to Section 304(b)(1).

3. The second level is defined as "best available technology economically achievable" (BAT). FWPCA Section 301(b)(2)(A), 33 U.S.C.A. Section 1311(b)(2)(A). By July 1, 1993, dischargers are required to apply BAT, as defined by effluent limitations issued by the Administrator pursuant to Section 304(b)(2).

4. Section 306 requires the Administrator to establish effluent limitations containing performance standards for new sources. For this purpose, "new sources" are defined as any source the construction of which commenced after the publication of proposed regulations prescribing standards for such sources. FWPCA Section 306(a)(2), 33 U.S.C.A. Section 1316(a)(2). After the effective date of new sources standards, it is a violation of the Federal Water Pollution Control Act to operate any new source in violation of such standards. FWPCA Section 306(e).

5. Section 307(a) requires and authorizes the Administrator to establish and promulgate effluent limitations for toxic pollutants, which may include a prohibition of the discharge of such pollutants or combination of such pollutants. After the effective date of such effluent standards, it is a violation of the FWPCA to operate any source in violation of such standard or prohibition.
| DER 1988 | WASTEWATER FACILITIES | 17-6 |
|----------------------------------------------------------|----------------|
| **EFFLUENT LIMITATIONS, GUIDELINES AND STANDARDS**      | **U.S. CODE OF FEDERAL REGULATIONS** |
| 5. Effluent Guidelines and Standards for Sugar Processing | 40 CFR 409 (Effective 9-8-80) |
| 7. Cement Manufacturing                                | 40 CFR 411 (Effective 8-29-79) |
| 8. Effluent Guidelines and Standards for Feedlots       | 40 CFR 412 (Effective 6-16-76) |
| (See 17-6.300(1)(f), F.A.C.)                           |                  |
| 9. Effluent Guidelines and Standards for Electroplating  | 40 CFR 413 (Effective 9-4-84) |
| 10. Effluent Guidelines and Standards for Organic Chemicals | 40 CFR 414 (Effective 5-12-76) |
| 11. Inorganic Chemicals                                 | 40 CFR 415 (Effective 9-25-84) |
| 12. Plastics and Synthetics                             | 40 CFR 416 (Effective 7-1-78) |
| 13. Effluent Guidelines and Standards for Soaps and Detergents | 40 CFR 417 (Effective 6-16-76) |
| 14. Effluent Guidelines and Standards for Fertilizer Manufacturing | 40 CFR 418 (Effective 6-2-80) |
| 15. Effluent Guidelines and Standards for Petroleum Refining | 40 CFR 419 (Effective 8-12-85) |
| 16. Iron and Steel Manufacturing                       | 40 CFR 420 (Effective 6-22-84) |
| 18. Phosphate Manufacturing                             | 40 CFR 422 (Effective 2-17-82) |
| Effluent Guidelines and Standards                       |                  |
| 19. Effluent Guidelines and Standards for Steam Electric Power Generating | 40 CFR 423 (Effective 7-8-83) |

6. Section 307(b) requires and authorizes the Administrator to establish and promulgate pretreatment standards for introduction of pollutants into publicly owned sewage treatment facilities which are not susceptible to treatment by such facilities or which would interfere with the operation of such treatment works.

(b) The objective of the FWPCA is to restore and maintain the chemical, physical and biological integrity of the nation's waters, and the Act established, as a national goal, that the discharge of pollutants into the navigable waters be eliminated by 1985, Section 101(a), FWPCA.

c) The FWPCA preserves to each state the power to adopt or enforce any effluent standard or limitation respecting discharge of pollution or control or abatement of pollution which is stricter or more stringent than the comparable federal effluent limitation or standard, Section 510, FWPCA.

d) Pursuant to the above sections of the FWPCA, the EPA has promulgated and prescribed effluent guidelines and standards (limitations) for new and existing point sources which discharge pollutants. Dischargers are required to comply with these regulations and NPDES permits issued pursuant to Section 402 of the Act must be conditioned upon requirements of Section 301 and 306 (as well as certain other requirements).

e) The Department has reviewed and evaluated the EPA effluent guidelines and standards which have been published as final regulations in the United States Code of Federal Regulations, and are in full force and effect on the date of adoption of this section. With respect to each particular class or category of sources as hereinafter listed, the following EPA Effluent Guidelines and Standards, as they are contained in the United States Code of Federal Regulations are in effect on the date indicated, are incorporated herein, and adopted by the Department, except where expressly supplemented or modified by the Environmental Regulation Commission, and are incorporated by reference as though fully set forth herein:

**EFFLUENT LIMITATIONS; GUIDELINES AND STANDARDS**

1. Environmental Protection Agency General Provisions for Effluent Guidelines and Standards
   - 40 CFR 401 (Effective 6-4-82)

2. Effluent Guidelines and Standards for Dairy Products
   - 40 CFR 405 (Effective 2-17-82)

3. Effluent Guidelines and Standards for Canned and Preserved Fruits and Vegetables
   - Citrus Products Subcategory
     - 40 CFR 407 Subpart C (Effective 6-16-76)

4. Effluent Guidelines and Standards for Canned and Preserved Seafood
   - 40 CFR 408 Subpart A
     - 40 CFR 408 (Effective 5-19-80)

17-6.300(1)(a) -- 17-6.300(1)(e)
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EFFLUENT LIMITATIONS: GUIDELINES AND STANDARDS

U.S. CODE OF FEDERAL REGULATIONS

51. Electrical and Electronic Components

40 CFR 469 (Effective 1-31-85)

52. Nonferrous Metals Forming and Metal Powders

40 CFR 471 (Effective 10-7-85)

(f) Copies of the above effluent limitations as published in the United States Code of Federal Regulations may be obtained by writing the United States Environmental Protection Agency, Washington, D.C.

(g) In addition, the following regulations which are substantially similar to regulations contained in 40 CFR 124.82 in effect 11/1/78, shall apply to concentrated animal feeding operations:

1. Definitions:
   a. The term "animal feeding operation" means a lot or facility (other than an aquatic animal production facility) where the following conditions are met:
      (i) Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12 month period, and
      (ii) Crops, vegetation, forage growth or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
      (iii) Two or more animal feeding operations under common ownership are deemed to be a single animal feeding operation if they are adjacent to each other or if they utilize a common area or system for the disposal of wastes.
   b. The term "concentrated animal feeding operation" means an animal feeding operation where more animals are confined than are specified in the following categories:
      (i) 1,000 slaughter and feeder cattle,
      (ii) 700 mature dairy cattle (whether milked or dry cows), except that dairy farms located in the Lake Okeechobee Drainage Basin as defined in Rule 17-6.331, F.A.C., shall be regulated pursuant to Rules 17-6.330 through 17-6.337, F.A.C.
      (iii) 2,500 swine weighing over 55 pounds each,
      (iv) 500 horses,
      (v) 10,000 sheep or lambs,
      (vi) 55,000 turkeys,
      (vii) 100,000 laying hens or broilers (if the facility has continuous overflow waste systems),
      (viii) 30,000 laying hens or broilers (if the facility has a liquid manure handling system),
      (ix) 5,000 ducks, or
      (x) 1,000 animals units.
   Provided, however, that no animal feeding operation is a concentrated animal feeding operation as defined above, and thereby subject to the requirement to obtain a discharge permit pursuant to Chapter 403, Florida Statutes, if such animal feeding operation discharges only in the event of a 75 year, 24 hour storm event.

2. Application for Permit.
   a. Any person discharging or proposing to discharge pollutants from a concentrated animal feeding operation, who has not already done so, shall file an application with the department by December 20, 1978.
   b. Each application must be filed on a PERM 14-13 and completed in accordance with the instructions provided in such form.
   c. Case-by-case Designation of Concentrated Animal Feeding Operations. Notwithstanding any other provision of this section, the Secretary or authorized designee may designate as a concentrated animal feeding operation any animal feeding operation not otherwise falling within the definition provided in sub-subparagraph (g) above. In making such designation, the Secretary or authorized designee shall consider the following factors:
      a. The site of the animal feeding operation and the amount of wastes reaching waters of the State;
      b. The location of the animal feeding operation relative to waters of the State;
      c. The means of conveyance of animal wastes and process waste waters into waters of the State;
      d. The slope, vegetation, rainfall, and other factors relative to the likelihood or frequency of discharge of animal wastes and process waste waters into waters of the State;
      e. Other factors relative to the significance of the pollution problem sought to be regulated.
   1. Provided, however, that no animal feeding operation with less than the number of animals set forth in (a)(2) above shall be designated as a concentrated animal feeding operation unless such animal feeding operation meets either of the following conditions:
      (i) Pollutants are discharged into waters of the state through a man-made ditch, flushing system or other similar man-made device; or
      (ii) Pollutants are discharged directly into waters of the state which originate outside of and pass over, across, through the feeding operation or come into direct contact with the animals confined in the operation.
   4. In no case shall a permit application be required from a concentrated animal feeding operation designated pursuant to this section until there has been an onsite inspection of the operation and a determination that the operation should and could be regulated under the permit program. In addition, no application shall be required from an owner or operator of a concentrated animal feeding operation designated pursuant to this section unless such owner or operator is notified in writing of the requirement to apply for a permit, and the basis for imposing such requirement.

17-6.300[1][e] - 17-6.300[1][g]1 b.

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(h) All department permits issued pursuant to Sections 403.087 and 403.088, Florida Statutes, shall, as a minimum, require compliance with the above referenced effluent limitations. In establishing the effluent limitations contained in paragraph (1)(e), which define best practical control technology currently available (BPT) and best available technology economically achievable (BAT), the United States EPA relied on the industry-wide information with respect to specific factors.

(i) In determining BPT, the following factors were considered:

a. Total costs of application of technology in relation to the effluent reduction benefits to be achieved from such application.

b. The age of equipment and facilities involved.

c. The process involved.

d. The engineering aspects of the application of various types of control techniques.

e. Process changes.

f. Non-water quality environmental impact (including energy requirements).

g. Such other factors as the Administrator deemed appropriate.

(j) The following factors were considered in determining BAT:

a. Age of equipment and facilities involved.

b. Process employed.

c. The engineering aspects of the application of various types of control techniques.

d. Process changes.

(e) The cost of achieving such effluent reduction.

f. Non-water quality environmental impact (including energy requirements).

(g) Such other factors as the Administrator of the EPA deemed appropriate.

(k) It is possible that the above factors pertaining to a particular source or category of sources located within the state are fundamentally different from the industry-wide factors considered by the EPA in establishing the limitations. If, based on a preponderance of competent substantial evidence, the department determines that such fundamentally different factors exist in relation to a particular source, it may establish for such source, by order or permit condition, and after notice and public hearing, an effluent limitation which is more or less stringent than the EPA effluent limitation, to the extent dictated by such fundamentally different factors. In no case shall a department permit contain an effluent limitation less stringent than one contained in an NPDES permit issued to a source by the EPA.

(l) All industrial sources which are included in those classes or categories of industry listed in paragraph (1)(e) shall comply with the applicable guidelines, standards and limitations in accordance with the time schedules contained therein. However, no source shall be relieved from complying with any pollution abatement plan or schedule, including a plant or process modification which is contained in any currently valid department permit, order or judicial judgment. However, this does not preclude modification of a department permit, order, or judicial judgment in accordance with applicable rules and regulations.

17.6.300(1)(h) -- 17.6.300(1)(k)
(2) Effluent Limitations Based on Water Quality Considerations.
(a) Pursuant to Section 403.06(111), Florida Statutes, and as required by the Federal Water Pollution Control Act of 1965, Public Law 89-234, 79 Stat. 903, and Section 303 of the FWPCA, the department has adopted water quality standards contained in Chapter 17-3, F.A.C., which have subsequently been approved by the EPA. The standards contain water quality criteria which are applicable to each classification of receiving waters. Section 403.088(3)(b), Florida Statutes, requires the department to deny an application for a permit if it finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them.
(b) Section 301(b)(1)(c) and Section 302 of the FWPCA provide that all discharges of industrial wastes may be required to meet, in addition to technology based effluent limitations, more stringent limitations required to implement applicable state water quality standards established pursuant to the Act. This requirement is enforced and implemented through Section 309 and the National Pollutant Discharge Elimination System established by Section 402 of the Act.
(c) Pursuant to Section 403.087 and Section 403.088, Florida Statutes, no wastes shall be discharged into waters of the state which will violate applicable state water quality standards or reduce the quality of the receiving waters below the criteria established for its respective classification contained in Chapter 17-3, F.A.C.
(d) The effluent limitations based on water quality standards shall be determined by application of accepted scientific methods based upon, but not limited to, a consideration of the following:
1. The condition of the receiving body of water including present and future flow conditions and present and future sources of pollutants.
2. The nature, volume and frequency of the proposed discharge of waste including any possible synergistic effects with other pollutants which may be present in the receiving body of water.
3. For the purposes of this section, the term "TREATMENT" means the use of any device, system, process or method for preventing, abating, reducing, treating, separating, recycling, reclaiming, reusing, recovering, or eliminating pollutants in industrial waste.
Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, 403.805, F.S.
Law Implemented: 403.021, 403.061, 403.086, 403.087, 403.088, 403.091, 403.101, 403.121, 403.141, 403.181, 403.182, 403.502, 403.702, 403.708, F.S.
History: Formerly 28-5-04, 17-3-04, Amended and Renumbered 3-1-79, Amended 1-1-82, 5-31-82, 1-29-84, 12-19-84, 4-30-86, 6-3-87.
17-6.310 Phosphate Mining Waste Treatment Requirements.
The Effluent Guidelines and Standards for Mineral Mining and Processing, 40 United States Code of Federal Regulations, as incorporated in subparagraph 17-6.300(1)(k)(a), apply except as to the following:
(1) Purpose.
(a) The purpose of this rule is to establish effluent guidelines and standards for mining and processing phosphate bearing rock, ore, earth, or any material for phosphate content.
(b) 40 United States Code of Federal Regulation Sections 436.180, 436.181, and 436.182 apply herein, except where the provisions of this rule are more specific.
(2) Definitions:
(a) The definitions set forth in Title 40, United States Code of Federal Regulations, Part 401 and Section 436.181, are adopted by reference, except where in conflict with the definitions in this rule. In addition, the definitions in Section 403.031, Florida Statutes, and the following definitions shall apply to this rule:
(b) "Site" is any area of land, surface or underground, used for or resulting from the extraction of phosphate content from phosphate bearing materials.
(c) "Points of Discharge" mean any outfall structure or location where the effluent from the mining or beneficiation process leaves the treatment system and enters waters of the State. The point of discharge shall be specified in department permits for all discharges from a mining or beneficiation process.
(d) "Sample" means a representative sample of the discharge.
(e) The "1-Day Maximum" means the highest values obtained by the methods specified in this rule for total non-volatile, non-filterable residue (fixed solids) and total non-filterable residue (suspended solids) or total phosphorus (P) of any sample collected as defined in (c) during a 24-hour period.
(f) The "30-Day Average" means the flow-weighted arithmetic mean of all the measured pollutant values obtained during any calendar month and analyzed in accordance with this rule. However, if during any calendar month there are three or less measured pollutant values, then the average shall be computed using the most recent four values.
(g) A "New Pollution Source" means any mine and beneficiation process for which the construction or operation of the industrial wastewater treatment facilities was not permitted before July 20, 1981. Any mine or beneficiation process for which a complete application to construct the industrial wastewater treatment facilities was filed with the department on or before December 31, 1981, shall be deemed as existing.
(h) New pollution sources do not include expansions or modifications of existing sources.
(i) "Total Non-filterable Residue (Total Suspended Solids)" means those solids which are retained by an approved filter and dried to a constant weight at 105° C as described at page 94 of the 14th edition of Standard Methods for the Examination of Water and Wastewater.
"Non-filterable, Non-volatile Residue (Fixed Solids)" means those solids which represent the difference between the total non-filterable residue and the total volatile residue determined in accordance with the test methods specified at page 95 of the 14th edition of Standard Methods for the Examination of Water and Wastewater.
(i) "Total Phosphorus" means the total phosphorus in an unfiltered sample measured in milligrams per liter using the manual or automated ascorbic acid method following persulfate digestion as referenced at pages 476, 481, and 824 of the 14th edition of Standard Methods for the Examination of Water and Wastewater or measured in accordance with a comparable analytical method approved by the United States EPA or the Department.
(j) "Normal Working Level" of an impoundment means that level resulting from the normal height or number of damming boards maintained at the outlet(s) under normal operating conditions.

(3) To correct for losses during the testing and analysis, the analytic results from the above specified tests for non-filterable, non-volatile residue (fixed solids) shall be multiplied by a factor of 1.1 to be reported as total non-volatile, non-filterable residue.

(4) Monitoring requirements for effluent limitations shall be, as a minimum, the collection and analysis of one sample per week for each point of discharge when there is a discharge. When there is no discharge, the sample shall be taken the day of the next discharge.

(5) The following effluent limitations apply to effluent discharges by a pollution source after application of the best practicable control technology currently available (BPT) and the best available technology economically achievable (BTA) or which may be discharged by a new pollution source, unless a more stringent standard is specified in accordance with paragraph (7), measured at the point(s) of discharge as specified in a department permit:

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<thead>
<tr>
<th></th>
<th>1 Day Max.</th>
<th>30 Day</th>
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<tbody>
<tr>
<td>Total non-volatile, non-filterable residue (mg/l)</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>Total non-filterable residue (mg/l)</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Total P* mg/l</td>
<td>5</td>
<td>3</td>
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<tr>
<td>pH</td>
<td>6.0 - 9.0</td>
<td>6.0 - 9.0</td>
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*Total Phosphorus shall be for monitoring and reporting only, except: if monitoring data shows total phosphorus levels exceed 3 mg/l monthly average for more than one 30-day period per calendar year, the discharges, upon written notification by the department, shall prepare and file within 120 days (unless the time is extended by the department) a study consisting of the following: (1) a chronology of at least one year's discharge data; (2) an assessment of the cause and origin of the phosphorus constituent of the discharge, (3) description of the discharger's current maintenance, operation and management practices directly related to the control of phosphorus, (4) an evaluation of the environmental significance of the phosphorus levels; and (5) an identity of reasonable methods to abate, to the extent practicable, the influx of phosphorus into the discharge. Upon receipt of the report the department shall require the applicant to publish a public notice in a newspaper of general circulation in the affected area which states that the report was received and where it is available for public inspection. The department shall evaluate the report and may amend the discharger's permit to reflect additional requirements (subject to administrative and judicial review), including the implementation of cost-effective management practices or technological advances which reduce or eliminate the phosphorus in the discharge to the maximum extent practicable.

1. A management plan prepared by the Soil Conservation Service or a Florida licensed professional engineer that will bring the farm into compliance with the requirements of this rule; and,

2. An application for a construction or operation permit on forms to be provided by the department, which application shall include the ground water monitoring program as required under Rule 17-6.336, F.A.C. Any construction permits issued under this rule shall set a date for completion of construction and compliance with this rule.

(d) A new management plan shall be prepared and submitted to the department should there be any plan to increase the number of animals or change the manner of disposal of the wastes.

(e) All existing dairy farms shall have completed construction in accordance with their permit as soon as practicable but no later than 18 months from the date of issuance of the construction permit.

(2) New Dairy Farms

New dairy farms shall submit an application to the Department for a construction permit together with a management plan prepared by the SCS or a professional engineer licensed to practice in the State of Florida.

Specific Authority: 403.061, 403.087, 403.804, F.S.

Law Implemented: 403.021, 403.062, 403.087, 403.088, F.S.

History: New 6-3-87.
(6) Any overflow caused by precipitation exceeding a 10-year 24-hour precipitation event from facilities designed, constructed, and operated to contain or treat to the applicable limitations the precipitation and runoff resulting from a 10-year 24-hour precipitation event shall not be subject to the effluent limitations of this section. No such overflow shall lower the level of any impoundment below the normal working level of that impoundment or any other impoundment, or below those levels that existed immediately prior to the 10-year 24-hour precipitation event. Provided, however, no source shall be relieved from compliance with Chapter 17-9, Florida Administrative Code.

(7) New pollution sources shall comply with the effluent limitations determined by the department in accordance with this paragraph.

(a) The applicant shall provide the department with the following information in addition to the information required by Chapters 17-1, 17-3, 17-4, and 17-6, Florida Administrative Code:

1. A review of the treatment technologies being applied by similar domestic mining industries, listing the effluent concentration of pollutants, as well as a review of current literature relating to the subject of treating wastes from similar domestic mining industries.

2. A determination of the lowest effluent limitations achievable for the facility by the application of the latest economically feasible technology.

3. The basis for determining the effluent limitations specified in 2. above, and the basis for the determination of the economic feasibility of the technology.

(b) The department shall make the determination of the lowest effluent concentration levels achievable for the facility by the application of the latest economically feasible technology. The limitations determined by the department shall be for the parameters listed in paragraph (5) and any other pollutant reasonably expected to be in the discharge and shall not be less stringent than the concentrations contained in paragraph (5) except as provided in paragraph (7Xc). In making the determination, the department shall give consideration to:

1. All material submitted by the applicant.

2. All scientific, engineering, and technical material, and other material available to the department, including the effluent pollutant levels achieved by similar domestic mining industry or analogous treatment technologies.

3. The social, environmental, and economic impact of the application and implementation of the achievement of the concentrations and discharge levels specified. The consequences of water conservation practices shall be considered.

(c) The effluent limitations determined in accordance with this paragraph shall be specified in terms of a 1-day maximum and 30-day average in the department permit for the facility and shall be the effluent standards for the facility except as provided in paragraph (7Xd).

(d) If, pursuant to this paragraph, the department imposes more stringent effluent limitations than those in paragraph (5) after determining that such more stringent effluent limitations can be attained by the application of innovative technology that has not been demonstrated on an operational plant-scale basis at a phosphate mine, the actual measured concentration of pollutant levels in discharged waste waters shall constitute compliance with the provisions of this chapter and with the effluent limitations contained in the department permit for the source; provided the permittee installs, operates, and maintains the required innovative technology in accordance with good engineering practices, public health and safety are not jeopardized, and the beneficial uses of the receiving waters are not substantially impaired.

(e) Within 15 days after receipt of the application for a construction permit for a facility, which requires a determination in accordance with this paragraph, the department, at the expense of the applicant, shall give notice of the application in the Florida Administrative Weekly and in a newspaper of general circulation in the affected area concerning the determination required by this paragraph. The notice shall contain, as a minimum, the following information: the name of the applicant, the location of the proposed facility, the proposed receiving water, that an application has been received, the date received, the place where the application can be reviewed, and of the determination required by this paragraph.

General Authority: 403.061, F.S.
Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.101, 403.111, 403.121, 403.141, 403.161, 403.182, 403.502, 403.702, F.S.
History: New 7-21-81, Amended 1-29-84, 4-30-85.

17-6.330 Purpose.
The discharge of untreated wastewater and runoff from dairy farms may reasonably be expected to be a source of pollution to waters of the state. The purpose of Rule 17-6.330 through 17-6.337, F.A.C., is to control pollution of waters of the state due to the discharge of wastewater and runoff from dairy farms in the Lake Okeechobee Drainage Basin to surface and ground water.

Specific Authority: 403.061, 403.087, 403.804, F.S.
Law Implemented: 403.021, 403.061, 403.062, 403.087, 403.088, F.S.
History: New 6-3-87.

17-6.331 Definitions.
(i) "Lake Okeechobee Drainage Basin" For the purpose of this rule, the Lake Okeechobee Drainage Basin shall consist of the following sub-drainage basins:

(a) lower Kissimmee River basin below structure 8-85;
(b) Taylor Creek–Nubbin Slough basin;
(c) Fish Eating Creek basin;
(d) Indian Prairie and Harney Pond basins;
(e) C-41A basin;
(f) Nicodemus Slough basin; and.

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(g) drainage areas tributary to the South Florida Water Management District Pump Stations designated as S-121, S-129, S-131, S-133, S-135, S-2, S-3, and S-4. The geographical boundaries of these sub-basins shall be as designated by the South Florida Water Management District in its Technical Publication 81-2, May, 1981.

(2) "Dairy Farm" For the purposes of this rule, a dairy farm is any operation as defined in Rule 5D-1.01(40), F.A.C., and regulated by the Florida Department of Agriculture and Consumer Services.

(3) "25-year, 24-hour Storm Event" means the amount of rainfall within 24 hours that is likely to be exceeded on the average only once in 25 years, as published by the U.S. Weather Bureau in Technical Paper 40 "Rainfall Maps for 24-hour Rainfall Amounts for the Coterminous United States."

(4) "High Intensity Use Area" means all areas of concentrated animal density generally associated with milking barns, feedlots, holding pens, travel lanes and contiguous milk herd pastures where the permanent vegetative cover is equal to or less than 80 percent, under average annual worst-case conditions, as determined by USDA Soil Conservation Service methods. The size of this area is expected to vary on a site-specific basis. It is the intent of this rule that this area shall be minimized through adoption of appropriate site designs and management practices developed in the management plan. It is contemplated that in many cases existing high intensity areas will be reduced in size, thus minimizing the amount of runoff to be collected.

(5) "Management Plan" A management plan shall consist of a site-specific detailed plan, with design calculations, providing for collection, storage and disposal of all wastewater from the milking barn, and of the runoff from the 25-year, 24-hour storm event from all "high intensity" areas within the dairy farm. In addition, the plan shall include provision for implementation of required management practices. Such plan shall be prepared in accordance with the standards of the USDA Soil Conservation Service and shall include detailed instructions for operation and maintenance of wastewater/disposal collection, storage and disposal systems.

Specific Authority: 403.061, 403.067, 403.084, F.S.
Law Implemented: 403.021, 403.061, 403.062, 403.087, 403.088, F.S.
History: New 6-3-87.

17-6.332 Rule Applicability.

Rules 17-6.330 through 17-6.337, F.A.C. shall be applicable to all existing and new dairy farms in the Lake Oklawaha Drainage Area as defined in Rule 17-6.331, F.A.C.

Regulation of dairy farms in other drainage basins under Rules 17-6.330 through 17-6.337, F.A.C. will be proposed upon a determination by the department that such additional regulations are required to insure that water quality standards are met or maintained.

Specific Authority: 403.061, 403.087, 403.084, F.S.
Law Implemented: 403.021, 403.061, 403.062, 403.087, 403.088, F.S.
History: New 6-3-87.

17-6.331(1)(Xg) -- 17-6.332(History)

17-6.333 Rule Requirements.

(1) Discharge of dairy farm wastewater and runoff to waters of the state shall not cause or contribute to a violation of water quality standards.

(2) The system of practices, specified in Rules 17-6.334, 17-6.335, and 17-6.336, F.A.C., for collection and recycling of wastewater by proper land disposal, together with the associated management practices, is established for the purpose of determining compliance with water quality standards. Implementation of these practices will be presumed to provide reasonable assurance that the facility will meet water quality standards in waters of the state.

Specific Authority: 403.061, 403.087, 403.084, F.S.
Law Implemented: 403.021, 403.061, 403.062, 403.087, 403.088, F.S.
History: New 6-3-87.


(1) Fencing

All dairy cattle, including dry cows and heifers, shall be fenced away from all watercourses, or drainage ditches with a drainage area of 100 acres or more, that will transport storm runoff to surface waters. All new and replacement fences shall be located no closer than 25 feet from the top of the side slopes of the drainage or from the stream bank of natural watercourses. The area between the fence and the watercourses or drainage ditches may be used for forage crop production and shall be so managed as to attenuate the loads of nutrients carried to surface waters. Additional fencing may be required by the management plan on the basis of site-specific factors.

(2) Milk Herd Concentration

The high intensity use area shall be so managed as to encourage congregation of the milk herd in the area. Permanent structures, and watering and feeding facilities shall be located in contiguous high-intensity use areas, whenever practicable, to promote maximum waste/runoff collection.

(3) Barn Waste and High Intensity Runoff

All wastes and flushings from milking barns and runoff from high intensity use areas shall be centrally collected for storage and disposal by land application, or treated prior to discharge.

(a) The design of lagoons, storage ponds and other impoundments for barn wastes and runoff from "high intensity use" areas shall be based on total containment of effluents for the longest anticipated period between emptys. The volume should be large enough to store inputs from accumulated manure and wash water, direct rainfall on the pond, and the runoff contributed to the facility for the period minus losses expected due to evaporation. The design will provide for storage of runoff from the USDA Soil Conservation Service procedures. The design and construction of the waste management facilities should conform to the criteria contained in the local SCS Field Office Technical Guide.

17-6.333(1) -- 17-6.334(3Ka)
(b) The storage facilities shall be cleaned periodically to remove accumulated sludge, debris or other solids so that their effective capacity (design volume) to provide adequate storage of wastes and runoff before land application will not be reduced. The bottom of the storage facilities shall be sealed, when necessary, to prevent leakage of the contents to the surrounding ground water.

(4) Land Application

Land application of all wastes (solids, sludge, runoff and wastewater) shall be managed to maximize water quality benefits derived from plant uptake of nutrients.

(a) The nutrient content of all wastes shall be determined at least quarterly before spreading and the wastewater and runoff shall be applied to meet nutrient requirements of the crops. If the nutrient analyses show consistent results, the frequency of the analysis may be reduced. The degree of consistency required and the specific changes in the frequency of analysis shall be specified in the permit.

(b) All sources of nutrients applied shall not exceed the annual nutrient requirements of the grasses or crops in the area.

(c) The water table shall be eighteen (18) inches or deeper below the normal ground surface when wastes are applied to the land.

(d) Irrigation with wastewater and runoff shall be managed so that no irrigation water is discharged to the surface waters of the state.

(e) The frequency and rate of land application shall be managed to avoid secondary environmental problems such as severe odors, insect and pest problems, and other nuisance conditions. If wastes are to be disposed of on property not owned by the permittee, evidence of an appropriate lease or contract shall be provided for inclusion in the management plan.

(5) Alternative to Land Application

As an alternative to land application, the department may consider other methods of treatment and disposal of barn wastewater and runoff from high intensity areas. Limits for such treatment or disposal methods will be based on applicable department rules.

Specific Authority: 403.061, 403.062, 403.087, 403.804, F.S.
Law Implemented: 403.021, 403.061, 403.062, 403.087, 403.088, F.S.
History: New 6-3-87.

17-6.335 Buffer Zones.

(1) All new dairy farms shall maintain the following minimum buffer zones between storage and treatment facilities, or high intensity areas and

- Drinking Water Supply Wells: 300 feet
- Natural Watercourses: 200 feet
- Drainage Ditches: 100 feet

(2) All new dairy farms shall maintain the following buffer zones between land application areas, and

- Drinking Water Supply Wells: 200 feet
- Natural Watercourses: 50 feet
- Drainage Ditches: 50 feet

17-6.334(3)(b) -- 17-6.355(2)

17-6.337(3)(a) -- 17-6.337(1)(kc)
PART III
WATER QUALITY-BASED EFFLUENT LIMITATIONS

17-6.400 Surface Waters.
(a) A water quality-based effluent limit shall be determined by the Department in accordance with this Section and Sections 17-6.401, 402 and 403, F.A.C., and shall be based upon the characteristics of discharge, the receiving water characteristics, and the criteria and standards of Chapters 17-2, 17-4, F.A.C., and this chapter. Requests for zones of mixing and any previously approved zones of mixing will be taken into consideration when determining WQELs. No zone of mixing shall be provided for any parameters for which the applicant fails or declines to provide the necessary characteristics of the discharge.

(2) New Dairy Farms
New dairy farms shall submit an application to the Department for a construction permit together with a management plan prepared by the SCS or a professional engineer licensed to practice in the State of Florida. Specific Authority: 403.061, 403.087, 403.804, F.S.
Law Implemented: 403.021, 403.062, 403.087, 403.088, F.S.
History: New 8-3-87.
3. Instituting an enforcement action for a violation of water quality standards based upon a component or characteristic of a discharge for which no effluent limit has been specified in a permit because the applicant failed or declined to provide, in the application for such permit, information which adequately describes such component or characteristic so as to establish the relationship necessary to establish a water quality-based effluent limit; or


(c) In the case of drainage discharges permitted under paragraph (c) and for which no effluent limitations have been specified in a permit, the department shall not institute enforcement action during the term of the permit, except:
1. Where irreparable harm may occur; or
2. For violations of conditions of a permit.

(2) Effluent limitations based upon water quality standards and the provisions of Section 17-4.244, FAC, shall be determined by application of accepted scientific methods. It is recognized that models and other scientific methods of predicting the concentrations of pollutants result in estimated values of concentrations. Such estimates shall be acceptable for the purpose of determining effluent limitations provided that the most reliable and complete data reasonably available to the department have been applied. Accepted scientific methods shall be based upon, but not limited to,

(a) An analysis of the condition of the receiving body of water including reasonably expected ambient water quality and present and future flow conditions and present and future characteristics of the discharge, under which the cumulative impact of discharge is reasonably expected to be a maximum; and

(b) Consideration of the nature, volume, and frequency of the proposed discharge of waste, including any possible known synergistic effects with other pollutants or substances which may be present in the receiving body of water.

(3) Except in instances where irreparable injury may occur, the department shall not institute enforcement action for a violation of water quality standards against the holder of a permit in force upon the effective date of this rule as long as the permittee complies with effluent limitations contained therein. Upon renewal or modification of an existing permit, the other provisions and requirements of this section shall apply. Specific Authority: 403.061, 403.062, 403.067, 403.064, 403.074, 403.080, 403.085, F.S.
Law Implemented: 403.021, 403.061, 403.066, 403.087, 403.088, 403.061, 403.101, 403.121, 403.141, 403.161, 403.182, 403.502, 403.704, 403.708, F.S.
History: Formerly 17-6.10, Amended and Renumbered 1-1-82, Amended 8-4-86.
PAST AND CURRENT RESEARCH ON DAIRY WASTE MANAGEMENT

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Introduction

Dairy waste management continues to be a problem for Florida dairies. As the human population increases and as dairy milk production increases to meet the needs of the human population, proper management of wastes from Florida dairies can be expected to become even more important. Over the past twenty years, a great deal of research has been conducted in IFAS to address livestock waste management problems. Some of that research has dealt directly with dairy wastes. There has also been research with other wastes and materials which may be applicable to dairy waste problems in the future. This paper will summarize that research and will assess the current needs for research on dairy waste management in Florida.

Background

In the late 1960's, environmental quality became an issue across the United States. It marked the beginning of many of our environmental agencies at federal, state and county levels of government.

In Florida, dairies were the first livestock operations to come under the scrutiny of these new environmental agencies. The primary reason is easily understood. Because dairies were using large volumes of water, their effluents often left the property and became much more visible to the surrounding community.

The response to these problems was at first to use conventional sewage treatment technologies. There were numerous undocumented stories about those efforts. Most of them failed, and a large amount of money was undoubtedly wasted. It was obvious that the management of dairy farm wastes was very different from the management of municipal sewage and industrial wastewaters.

PAST RESEARCH

Spray Irrigation with Dairy Wastewater

The first research project in Florida on dairy waste management was conducted at the Dairy Research Unit (DRU) near Hague, Florida, using a spray irrigation system. The project was begun in 1969, and it was a cooperative effort between the Agricultural Engineering Department, the Dairy Science Department, the Soil Science Department, the Agronomy Department, and the Department of Microbiology.

The DRU at that time used a sprinkler cow wash system in a new milking parlor. This produced large volumes of wastewater which could
readily run off of the property if not retained. The wastewater from
the milking parlor and cow wash area was collected in a grated gutter.
The wastewater flowed from the gutter into a sand trap and then into a
20,000 gallon underground, concrete storage tank. At the time, there
was sufficient volume to store the wastewater from one day's operation.
The wastewater was pumped through an underground line and through
portable aluminum irrigation pipe to a nearby field with three gun-type
sprinklers. Each gun was capable of covering approximately one acre.
The results from this project are covered in several publications
(Overman et al., 1970; Overman et al., 1971).

A well designed spray irrigation system is an excellent method for
management of dairy wastewaters. However, if it is not operated
properly, it can be a point source of pollution. Nutrient losses are
minimized, and the nutrients can be efficiently utilized in crop
production. However, it is a system which requires a high level of
management. Adequate land area must be available, and the nutrients in
the wastewater must be used in a well-planned nutrient management plan.
This plan should include crop rotations and supplemental fertilization
so that all of the nutrients are utilized to their full potential. Maintenance of equipment is also essential, since breakdown can result
in a point source of pollution.

**Anaerobic Lagoon Systems**

Because the spray irrigation system required such a high level of
management, interest had developed in lagoon systems for handling the
large volumes of wastewater which were being generated by Florida dairy
farms. Soon after the above research on spray irrigation systems for
wastewater was underway, another project was initiated on anaerobic
lagoon systems for handling of dairy farm wastewaters.

At that time, no design criteria existed for lagoons in Florida.
Although lagoons had been used in other states, they had met with
limited success. The cycle of freezing in the winter and thawing in the
spring often resulted in some odor problems. In Florida's climate, it
was known that higher loading rates could be used and that the lagoons
would probably function throughout the year. Also, lagoons in northern
climates often served a major storage function, since less water was
used for flushing. The design criteria for lagoons in Florida would
have to consider the large volumes of water which were used for
flushing.

A careful analysis of information which was available in the
literature on lagoons for both livestock wastes and for municipal sewage
was conducted. Personnel from the Agricultural Engineering Department
and the Soil Conservation Service developed a set of design guidelines
for the construction of anaerobic lagoon systems in Florida. Those
guidelines remain essentially unchanged today. The design guidelines
include both a maximum organic loading rate and a minimum hydraulic
retention time (Baldwin and Nordstedt, 1971).

A research project was initiated on a commercial dairy near
Bradenton, Florida, which involved the construction of the first
designed anaerobic lagoon system for dairy wastes in Florida. It was a
cooperative effort of the Agricultural Engineering Department, the Soil Science Department, and the Bacteriology Department at the University of Florida, the Environmental Engineering Division of the Manatee County Health Department, the Soil Conservation Service, and the Florida Cooperative Extension Service. Experimental facilities were provided by John M. Hood, owner of Hood's Dairy, Inc.

The anaerobic lagoon system which was constructed was a three-stage system -- an anaerobic lagoon and two aerobic lagoons in series. Effluent from the third lagoon was discharged into a seepage irrigation system in a pasture. The system was designed to handle 20 percent of the daily manure production of 800 cows which represented the portion of the day that the cows are on the paved areas from which manure, wash water and rainfall runoff would enter the system. Although most recommendations in the literature called for length to width ratios for the lagoons of no greater than 3:1, the lagoons were constructed with a width of 50 feet and lengths of 640, 700, and 850 feet for the anaerobic and two aerobic lagoons, respectively. The narrow width was chosen because of the common use of the dragline for excavation in Florida, particularly in high water table areas.

Results from this project indicated that the design criteria which had been developed were successful (Nordstedt et al., 1971). The narrow widths of the lagoons and the high length to width ratios worked very well. Nutrient losses in the wastewater passing through the system were quite high. As anticipated, the nutrient content of the effluents was too high to allow for discharge to surface waters. However, the system was designed to be a handling system for the wastewater and not to be a treatment system. It was found that the second lagoon in the series was not predominantly anaerobic or aerobic, but its function in a two stage lagoon system would be for storage of effluent until intermittent dispersal on pasture or cropland.

The choice of a three-stage lagoon system was at the insistence of the regulatory agencies. In fact, it was found that the third lagoon in the series exhibited extensive algal blooms, and the quality of the effluent from the second lagoon was in fact better than the quality of the effluent from the third lagoon.

As a result of this project, the design criteria which had been developed were put into widespread use (Nordstedt and Baldwin, 1973). Most systems since then have been designed as two-stage systems, i.e., an anaerobic lagoon followed by a storage pond. The use of seepage irrigation systems for dispersal of the effluent was employed in many cases, but management of the seepage systems was found to be a problem. If the effluent was permitted to flow continuously into the field, good dispersal was not obtained. This resulted in wet areas at the upper end of the system which caused maintenance problems in the ditches.

It was known at the beginning of the study that sludge would accumulate in the anaerobic lagoons. Thus, sludge accumulation rate and characteristics were monitored in the anaerobic lagoon for a period of fifty-six months. The results showed that there were two distinct layers of sludge, and at the loading rate and retention time in existence that the lagoon would need to have sludge removed every five
years (Nordstedt and Baldwin, 1975a). An analysis of sludge management alternatives was also prepared (Nordstedt and Baldwin, 1975b). As more lagoons required sludge removal, an analysis showed that the value of the nutrients in the sludge was significant (Baldwin and Nordstedt, 1983).

A laboratory study was conducted in conjunction with the field study on anaerobic lagoon systems to investigate the physical and biological sealing mechanisms of anaerobic dairy wastewater ponded over a highly permeable Florida fine sand. The effects of hydraulic head, manure loading rate and inhibited microbial activity were studied. The columns receiving manure experienced a rapid reduction of flow rate. The flow rate was rapidly reduced to 0.12 percent of the original flow rate in the columns receiving the high loading rate of 0.007 lb VS/ft²-day. However, after 113 days of manure loading, the flow rate returned to approximately 30 percent of the original flow rate in one of the two columns receiving the high loading rate.

**Methane Collection from Anaerobic Lagoons**

When prices of fossil fuels began to increase in the 1970's, the level of interest in generating methane from livestock wastes began to increase. Since an anaerobic lagoon is really an anaerobic digester with a very low loading rate, the feasibility of collecting methane from anaerobic lagoons was investigated. Based upon the work of Mahan (1972) which evaluated volatile acid levels and gas production in an anaerobic lagoon, several pilot-scale floating collectors were placed in lagoons. Mahan found that the rates of gas production were the highest in a lagoon near the inlet. The collectors could be placed where the gas production rates were the highest. The gas production rates were high enough that with certain costs of collector construction and energy prices, it would be economically feasible to collect methane from anaerobic lagoons (Nordstedt et al., 1976).

**Anaerobic Digestion**

The use of conventional anaerobic digesters, or stirred tank reactors, requires a higher level of total solids in the waste than in the wastewaters which are generated on most Florida dairies. However, dairies which do not use large quantities of flush water often use storage tanks for long-term storage of the wastes for application to cropland. Research in the Agricultural Engineering Department resulted in a new technique for anaerobic digestion which could utilize existing storage structures and thus lower capital costs for creating an anaerobic digestion system (Hill et al., 1981). The digester was called a continuously expanding reactor (CER). It was operated in a semi-batch mode so that the effluent would periodically be available for spreading on cropland. It was found to produce almost as much methane at ambient temperatures as at 95 °F. It was also very stable and not subject to disruption from shock loadings.

A type of reactor which may be applicable for methane generation from the dilute wastewaters which are generated on Florida dairies is the fixed film reactor. Although dairy wastewaters have not been utilized as feedstock, a great deal of research has been conducted in
IFAS on this type of reactor. The results will be useful whenever the need arises to anaerobically digest those wastewaters.

**Flushing Devices**

Although the drop gate flush tank was being used extensively on Florida dairies, there was a need for other types of flushing devices. Several demonstrations were conducted using small tilt tanks for flushing narrow alleys. Large tilt tanks were also used to flush wide alleys (Baldwin and Nordstedt, 1985). Several single and multiple siphon-type flush tanks were also developed (Baldwin and Nordstedt, 1977).

**Effluent Quality and Irrigation**

In addition to the land application of sludge from anaerobic lagoons for utilization of its nutrients, increasing interest was shown in irrigation of the effluents from anaerobic lagoon systems. Not only was it desirable from the standpoint of forage production, it was a way to utilize the effluents without causing environmental problems. The collection and analysis of effluents from several dairies resulted in recommendations for utilization of the effluents (Baldwin and Nordstedt, 1982).

**CURRENT RESEARCH**

Results of other research on environmental problems related to dairy wastes are elsewhere in these proceedings. Current research on waste handling includes two projects -- one on evaluation of a runoff control system in Okeechobee County, and another on production and characteristics of dairy waste.

**Runoff Control Systems**

A project is underway as part of the Lower Kissimmee River Project in the Rural Clean Water Program (RCWP). One of the best management practices (BMP) which are being implemented as part of the effort to reduce nutrient loadings into Lake Okeechobee is the installation of runoff control systems. This project involves wastewater flow and nutrient tracking through one of these systems.

The system was designed by the Soil Conservation Service using the best available information. However, since this type of system has never been installed on a Florida livestock operation, it is necessary to evaluate how well it functions. With this information in hand, it will be possible to devise improvements in future systems and to provide the data which is essential to proper management of the system.

In the system which is being evaluated, the wastewater from the milking parlor is collected in an anaerobic lagoon. A perimeter ditch around the holding pastures collects runoff which is then pumped into the anaerobic lagoon. The effluent from the anaerobic lagoon is pumped into a secondary lagoon, and then into a large impoundment used for storage of effluent. Irrigation water from the impoundment is pumped to
two pivot irrigation systems. One pivot system is fixed, and the other system is towable between two sites.

A critical part of this system is the performance of the forage program in removing nutrients. Hence, a number of plot studies are being conducted under the permanent pivot irrigation system to evaluate forage varieties, yields, soil fertility, phosphorus uptake, and additional fertilizer requirements.

Samples of effluent are being collected regularly at several points throughout the system, including the pump stations, underneath the pivot irrigation systems, and the tile underdrains. Periodic plant tissue and soil analyses are also being conducted.

Dairy Waste Characteristics

A study in the Dairy Science Department on phosphorus levels in dairy rations has yielded an additional benefit. That benefit is some excellent information on dairy waste characteristics. Engineers and planners have been dependent for a long time on several data tables on livestock waste production and characteristics. Although this data has been suspect for some time, good information was not available to refute it.

Information from the current studies on P levels in rations is being evaluated with respect to waste production and characteristics. Preliminary results indicate that several changes may be justified. Total manure production per 454 kg cow was approximately 20 percent greater than published values (ASAE, 1983). This increase can be attributed to increased feed intake accompanying the increased milk production of dairy cows. An estimation of dry matter excreted per unit dry matter consumed may be a more useful tool than basing manure production on animal liveweight.

SUMMARY

A great deal of research has been conducted in the past twenty years on dairy waste management. As requirements change, more research will be needed. However, implementation of existing information and proper management practices are needed just as much as additional information from research.

Additional research needs at the present time include the following:

1. More information on runoff quantity and quality. In terms of the perimeter ditches around confinement areas, surface flow and subsurface flow should be quantified.

2. Evaluation of solids separation devices as part of recycled water systems and for nutrient removal.

3. Development of nutrient management plans which will quantify nutrient movement through the systems, application rates, nutrient uptake, forage quality, supplemental irrigation requirements, supplemental fertilizer requirements.
References


PHOSPHORUS LEVELS IN SOILS OF SELECTED LAKE OKEECHOBEE WATERSHED DAIRIES

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INTRODUCTION

Lake Okeechobee is the 4th largest lake in the United States with a surface area of 1890 km². Aquatic weed and algae problems are threatening the value of the lake for recreational uses such as fishing and hunting. Recent studies point to phosphorus as the limiting nutrient in the lake. Additional studies indicated that tributary watersheds with large numbers of cattle are primary contributors to the phosphorus loading of the lake. There are 41 dairies with an average of 700 cattle each in the Lake Okeechobee watershed. The State of Florida has passed a "DAIRY RULE" which has made it mandatory for dairy farmers in the watershed to reduce and eliminate, where possible, phosphate runoff from their farms. The South Florida Water Management District concurrently has initiated a series of research projects to aid the farmers in development of alternative management practices in order to respond to the Dairy Rule. Preliminary results of one such project entitled "Biogeochemical Behavior and Transport of Phosphorus in the Lake Okeechobee Basin" are presented herein.

The objective of this study was to determine existing levels of water-soluble, double-acid (0.05 M HCl in 0.025 M H₂SO₄) extractable and total phosphorus in soils of selected dairies in the watershed. The data will be used in an overall modelling effort being undertaken to quantify the fate of phosphorus in the Lake Okeechobee watershed and its potential transport to the lake.

SITE SELECTION

Six sites were selected for intensive soil sampling (Table 1). Four of the sites represented dairies ranging in age from 3 to 32 years. Four components of each dairy were sampled, i.e., intensive, holding, pasture and forage areas (Table 2). Areas next to the barn where cattle are held prior to milking and for some feeding were termed intensive areas. These areas were generally void of vegetation. Holding areas were generally larger areas near the barns and are used for feeding and holding cattle overnight. These areas were generally grass-covered except for around feeding bunks. Pastures were used for grazing and forage areas for forage production. Two areas not affected significantly by

1 Data presented herein were developed as part of a research project entitled "Biogeochemical Behavior and Transport of Phosphorus in the Lake Okeechobee Basin" funded by the South Florida Water Management District and the Institute of Food and Agricultural Sciences, University of Florida.
man's activities, termed native areas, were sampled to represent background conditions. In addition, two beef pastures and one citrus grove were included in the sampling program. Six soil profiles were sampled in each of the components.

SOIL DESCRIPTIONS

Three soil types were represented in the sites selected, i.e., Myakka, Immokalee, and Pomello fine sands (Table 1). All were sandy siliceous, hyperthermic Arenic Haplaquods. The soils are commonly known as flatwood soils. The soils were formed in thick beds of sandy marine deposits. Slopes ranged from 0 to 2%. The water table is at a depth of less than 25 cm for 1 to 4 months during most years and recedes to a depth of 100 cm during dry seasons.

Each soil consists of four primary horizons. The A (surface) horizon was sandy with small amounts of organic matter and generally had a depth of 15 to 20 cm. The E horizon was immediately below the A horizon with a thickness of several centimeters depending on soil type. The Bh horizon, below the E horizon, is a dark colored horizon commonly known as a "hard pan" layer. This horizon is generally thought to have a high retention capacity for phosphorus. The primary difference between the soils is the depth of the spodic horizon (Bh) with this horizon occurring at approximately 40, 75 and 140 cm for the Myakka, Immokalee and Pomello soils, respectively. The Bw horizon occurs below the spodic horizon. Generally only the upper portion of the Bw horizon was sampled. All soils were sampled to a depth of at least 150 cm (1 cm = 2.54 inches).

METHODOLOGY

Water-soluble phosphorus was extracted using a 1:4 soil:water ratio by shaking for 1 hour. Double-acid extractable (0.05 M HCl in 0.025 M H₂SO₄) phosphorus was extracted using a 1:4 soil:double-acid ratio by shaking for 15 minutes. Total phosphorus was determined by digestion with 3 ml concentrated H₂SO₄ containing 1 gm of 9:1 K₂SO₄:CuSO₄ catalyst. Soluble reactive phosphorus was determined in all extracts using the ascorbic acid method.

RESULTS

Selected information on the three forms of soil phosphorus extracted will be presented to show the trends observed in the overall data base. Water-soluble phosphorus represents the amount of phosphorus which is likely to be leached when water movement occurs with in the soil profile. Double-acid extractable phosphorus is used by the IFAS Extension Soil Testing Laboratory as an indicator of plant-available phosphorus. Total phosphorus represents all forms of organic and inorganic phosphorus.

A summary of the data for all sites is given in Table 3. Levels of water-soluble phosphorus in the A horizon of the native areas were less than 1 mg/kg (mg phosphorus/kg soil) compared to an average of 4, 13, 68 and 89 mg/kg in the forage, pasture, holding and intensive areas, respectively. Double-acid extractable phosphorus levels in the A horizon of the native areas were less than 2 mg/kg compared to 10, 31, 575 and 557 mg/kg in the forage, pasture, holding and intensive areas, respectively. A similar trend was observed with total phosphorus levels in the A horizon.
The E horizon is a white, sandy horizon with little phosphorus retention capacity. It contained considerably less of all 3 forms of phosphorus than the A horizon. However, the trend between components was similar to the A horizon. The Bh (spodic) horizon retained higher levels of the 3 forms of phosphorus than the E horizon, however, phosphorus levels in the Bh horizon were considerably lower than in the A horizons. The trend of phosphorus levels between components was again similar to the A and E horizons, i.e., native < forage < pasture < holding < intensive areas. Overall, there did not appear to be a significant amount of phosphorus accumulating below the Bh horizon, i.e., in the Bw horizon. This may be due to either a limited amount of vertical water movement through the Bh horizon or to the ability of the Bh horizon to retain phosphorus.

Beef pastures and a citrus grove contained phosphorus levels slightly above background levels and approximately equal to phosphorus levels in the dairy pasture and forage areas. From the limited amount of sampling of beef pastures and citrus groves, it appears that they should not significantly contribute to phosphorus loading to the streams in the watershed.

Water-soluble phosphorus was generally 5 to 10% of total phosphorus. Double-acid extractable phosphorus was generally 50% or greater of total phosphorus in the intensive areas and 15 to 25% in the forage and pasture areas. Both of these forms of phosphorus may be potential contributors to "leachable" phosphorus.

Phosphorus levels in the intensive areas of the four dairies are shown in Table 4 to illustrate the apparent effect of dairy age on phosphorus accumulation. The 3-year old dairy generally had lower levels of all 3 forms of phosphorus in the A horizon than the 8-, 20- and 32-year old dairies. The two older dairies had similar levels of phosphorus in all horizons. Phosphorus accumulation appeared to reach steady-state levels in the 8-, 20- and 32-year old dairies. However, factors in addition to dairy age, such as differences in cattle stocking rates over the years may be reflected in these numbers.

CONCLUSIONS

Intensive and holding areas of each dairy accumulated substantially greater amounts of phosphorus in all horizons compared to pasture and forage areas. The 3-year old dairy generally had lower levels of phosphorus than the older dairies. Significant amounts of this phosphorus was in the water-soluble and double acid-extractable forms which makes it potentially available for leaching. It appears that beef pastures and citrus groves should not significantly contribute to phosphorus loading to the streams in the watershed.

Florida's "Dairy Rule" states that runoff from intensive areas must be collected and retained on the farm. Some dairymen are constructing perimeter ditches around the intensive areas and pumping the runoff water into a lagoon. The water from the lagoon is then applied to forage areas through center pivot irrigation systems. Based on the levels of phosphorus in the A horizons of the intensive areas, this could have a significant impact on reducing the amount of phosphorus leaving the dairy through drainage. It should also be noted, that as defined herein, both intensive and holding areas contain high levels of phosphorus in the soil and should be considered for inclusion within the perimeter ditch.
TABLE 1. Soil series and dairy age of sampling sites selected for determination of soil phosphorus level.

<table>
<thead>
<tr>
<th>Sampling Site</th>
<th>Soil Series</th>
<th>Dairy Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. F. Rucks Dairy</td>
<td>Myakka</td>
<td>3 yrs</td>
</tr>
<tr>
<td>C and M Dairy</td>
<td>Myakka</td>
<td>8 yrs</td>
</tr>
<tr>
<td>Larsen #6 Dairy</td>
<td>Pomello</td>
<td>20 yrs</td>
</tr>
<tr>
<td>Dry Lake #1 Dairy</td>
<td>Immokalee</td>
<td>32 yrs</td>
</tr>
<tr>
<td>Williamson Ranch</td>
<td>Immokalee</td>
<td></td>
</tr>
<tr>
<td>Bass Ranch</td>
<td>Myakka</td>
<td></td>
</tr>
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</table>

TABLE 2. Components sampled for each sampling location.

<table>
<thead>
<tr>
<th>W. F. Rucks</th>
<th>C and M Dairy</th>
<th>Dry Lake #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive</td>
<td>Intensive</td>
<td>Intensive</td>
</tr>
<tr>
<td>Holding</td>
<td>Holding</td>
<td>Holding</td>
</tr>
<tr>
<td>Pasture</td>
<td>Pasture</td>
<td>Pasture</td>
</tr>
<tr>
<td>Forage</td>
<td>Forage</td>
<td>Forage</td>
</tr>
<tr>
<td>Native</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Larsen #6</th>
<th>Williamson Ranch</th>
<th>Bass Ranch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive</td>
<td>Beef Pasture</td>
<td>Beef Pasture</td>
</tr>
<tr>
<td>Holding</td>
<td>Citrus</td>
<td></td>
</tr>
<tr>
<td>Pasture</td>
<td>Native</td>
<td></td>
</tr>
<tr>
<td>Forage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 3. Soil phosphorus levels averaged over all sampling locations.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Component</th>
<th>WS-P†</th>
<th>DA-P†</th>
<th>TP†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>89</td>
<td>557</td>
<td>1360</td>
</tr>
<tr>
<td>A</td>
<td>Intensive</td>
<td>68</td>
<td>575</td>
<td>1070</td>
</tr>
<tr>
<td></td>
<td>Holding</td>
<td>14</td>
<td>31</td>
<td>235</td>
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<tr>
<td></td>
<td>Pasture</td>
<td>4</td>
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<td></td>
<td>Forage</td>
<td>2</td>
<td>10</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Beef Pasture</td>
<td>2</td>
<td>69</td>
<td>236</td>
</tr>
<tr>
<td></td>
<td>Nature</td>
<td>&lt;1</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>E</td>
<td>Intensive</td>
<td>12</td>
<td>48</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Holding</td>
<td>13</td>
<td>51</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>2</td>
<td>7</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Forage</td>
<td>&lt;1</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Beef Pasture</td>
<td>&lt;1</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Citrus</td>
<td>&lt;1</td>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Native</td>
<td>&lt;1</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Bh</td>
<td>Intensive</td>
<td>19</td>
<td>143</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>Holding</td>
<td>13</td>
<td>74</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>4</td>
<td>65</td>
<td>122</td>
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<tr>
<td></td>
<td>Forage</td>
<td>&lt;1</td>
<td>18</td>
<td>75</td>
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<tr>
<td></td>
<td>Beef Pastures</td>
<td>2</td>
<td>29</td>
<td>111</td>
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<tr>
<td></td>
<td>Citrus</td>
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<td>73</td>
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<td>38</td>
<td>66</td>
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<td>Pasture</td>
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<td>Beef Pasture</td>
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<td>161</td>
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<td></td>
<td>Citrus</td>
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<td>*</td>
<td>*</td>
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<tr>
<td></td>
<td>Nature</td>
<td>&lt;1</td>
<td>7</td>
<td>64</td>
</tr>
</tbody>
</table>

†WS-P, DA-P, and TP = water-soluble, double acid-extractable, and total phosphorus, respectively.

*Horizon not present.
TABLE 4. Soil phosphorus levels for the intensive areas of four Lake Okeechobee dairies compared with the phosphorus level of a native area.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Component</th>
<th>WS-P†</th>
<th>DA-P†</th>
<th>TP†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>mg/kg</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>Rucks (3)*</td>
<td>69</td>
<td>201</td>
<td>364</td>
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<tr>
<td></td>
<td>C&amp;M (8)</td>
<td>110</td>
<td>376</td>
<td>1842</td>
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<tr>
<td></td>
<td>Larsen #6 (20)</td>
<td>87</td>
<td>840</td>
<td>1360</td>
</tr>
<tr>
<td></td>
<td>Dry Lake #1 (32)</td>
<td>89</td>
<td>813</td>
<td>1860</td>
</tr>
<tr>
<td></td>
<td>Native (Rucks)</td>
<td>0.7</td>
<td>1.6</td>
<td>40</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>Rucks</td>
<td>11</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>C&amp;M</td>
<td>20</td>
<td>105</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>Larsen #6</td>
<td>9.0</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Dry Lake #1</td>
<td>7.4</td>
<td>59</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Native (Rucks)</td>
<td>0.1</td>
<td>0.8</td>
<td>11</td>
</tr>
<tr>
<td><strong>Bh</strong></td>
<td>Rucks</td>
<td>4.2</td>
<td>42</td>
<td>113</td>
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<tr>
<td></td>
<td>C&amp;M</td>
<td>28</td>
<td>117</td>
<td>278</td>
</tr>
<tr>
<td></td>
<td>Larsen #6</td>
<td>32</td>
<td>246</td>
<td>263</td>
</tr>
<tr>
<td></td>
<td>Dry Lake #1</td>
<td>12</td>
<td>169</td>
<td>185</td>
</tr>
<tr>
<td></td>
<td>Native (Rucks)</td>
<td>&lt;0.1</td>
<td>4.6</td>
<td>103</td>
</tr>
<tr>
<td><strong>Bw</strong></td>
<td>Rucks</td>
<td>6.2</td>
<td>34</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>C&amp;M</td>
<td>14</td>
<td>75</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Larsen #6</td>
<td>11</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Dry Lake #1</td>
<td>2.3</td>
<td>16</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Native (Rucks)</td>
<td>&lt;0.1</td>
<td>8.4</td>
<td>87</td>
</tr>
</tbody>
</table>

†WS-P, DA-P, and TP = water-soluble, double acid-extractable, and total phosphorus, respectively.

*Dairy age (years).
THOMAS CHARLES
THOMPSON J. CHARLES
THOMPSON NEAL
THORNTON EDWARD
TOMS JERRY E.
TOMS THOMAS N.
TYNER WILLIAM
UMPHREY JAMES
UNDERHILL EDWARD
VAUGHT ROGER
WALKER EMORY
WALLACE JOHN C.
WARD CARROLL
WARD ROBERT
WATKINS THOMAS
WATTS GREG
WEBB DAN W.
WEHNER AL
WHATLEY ERNEST T.
WHITE MURPHY
WHITSON REG
WILCOX CHARLES
WILKINS DAVE
WRIGHT JOE
YANCEY CLYDE
YANT D. SCOTT
ZACHARIAH GERALD
ZIPPERER AL

RT 1, BOX 298
P. O. BOX 909
1022 MCCARTY HALL
1796 NE 54 TRAIL
6843 MAIN ST
P.O. BOX 41
6121 HWY 98 N
UNIVERSITY OF FLORIDA
27695 SW MARTIN HWY
RT. 2, BOX 361
208 SE 5 AVE
3111 50TH AVE E.
P. O. BOX 146
7200 SW 8TH AVE #1
P. O. BOX 1355
SWISS HAVEN DAIRY
UNIVERSITY OF FLORIDA
RT 2, BOX 121-C
RT. 5 BOX 302
344 SE 16TH AVE
1630 25TH AVE
UNIVERSITY OF FLORIDA
RT 1, BOX 2168
P. O. BOX 1057
RT 1, BOX 226
RT 2, BOX 656
1001 MCCARTY HALL
P. O. BOX 805

BRANFORD, FL 32008
ALACHUA, FL 32615
GAINESVILLE, FL 32611
OKKECHOBE, FL 34972
MIAMI LAKES, FL 33014
MOORE HAVEN, FL 33471
LAKELAND, FL 33809
GAINESVILLE, FL 32611
OKKECHOBE, FL 34974
LAKE PARK, GA 31636
OKKECHOBE, FL 34974
BRADENTON, FL 34203
ASTATULA, FL 32705
GAINESVILLE, FL 32607
AVON PARK, FL 33825
PO BOX 300
GAINESVILLE, FL 32611
GREENVILLE, FL 32331
OPELKA, AL 36801
OKKECHOBE, FL 34974
GREENE, CO 80631
GAINESVILLE, FL 32611
OKLAWAHA, FL 32679
AVON PARK, FL 33825
MYAKKA CITY, FL 34251
MARIANNA, FL 32446
GAINESVILLE, FL 32611
ORMOND BEACH, FL 32074

N FL FARM CREDIT SERVICE
UNIVERSITY OF FLORIDA
SYFRETT FEED CO.
THE GRAHAM FARMS
THE GRAHAM FARMS
PROJECT MANAGEMENT ASSOC.
DAIRY SCIENCE DEPT.

CONTINENTAL GRAIN CO.
M & M SUPPLY
CARGILL, INC.
LAYLAINE GUERNSEY FARM
CON AGRA FEED CO.
T K DAIRIES, INC.
PAISLEY FL 32767
DAIRY SCIENCE DEPT.
L A D DAIRY FARM
WILLOW RUN FARM
MURPHY WHITE DAIRY INC.
MIN-AD, INC.
DAIRY SCIENCE DEPT.
OKLAWAHA FARM
V & W FARMS, INC.
DOUBLE C DAIRY
SELECT SIRES
UNIVERSITY OF FLORIDA
SOUTHERN MOLASSES