JOURNAL OF DAIRY SCIENCE

Contents

Vol. XXIII, No. 6, June, 1940

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION

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JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION
Published at
NORTH QUEEN ST. AND MCGOVERN AVE., LANCASTER, PA.

The Journal of Dairy Science is issued monthly. Subscription is by the volume and one volume is issued per year.

Manuscripts should be typewritten and carefully revised before submission to T. S. Sutton, The Ohio State University, Columbus, Ohio. Twenty-five reprints will be furnished gratis to authors. Cost of additional reprints and reprint order blank will be submitted with proof.

The use of material published in the Journal is encouraged and a liberal policy will be followed concerning reproduction of articles with proper notation as to source.

Subscriptions. Price; $6.00 per volume in United States and Canada; $6.50 in all other countries. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume. Renewals should be made promptly to avoid a break in the series. Subscriptions should be sent to R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Subscriptions for the British Isles and British Empire, except for Canada and Australia, should be ordered through our agents: Messrs. Bailliere, Tindall and Cox, 7 and 8 Henrietta Streets, Covent Garden, London, W. C. 2, England. Subscriptions for Australia should be sent to our agent: John H. Bryant, 19 Bridge Street, Sydney, Australia.

Advertising should be mailed direct to the Science Press Printing Company, N. Queen St. and McGovern Ave., Lancaster, Pennsylvania.

Correspondence regarding business policies of the Journal should be addressed to the Secretary-treasurer, R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Post Office Notices of undeliverable copies and changes of address should be sent to R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Entered as second-class matter April 13, 1934 at the postoffice at Lancaster, Pa., under the act of March 3, 1879.

JOURNAL OF DAIRY SCIENCE

VOLUME XXIII JUNE, 1940 NUMBER 6

PROGRAM

THIRTY-FIFTH ANNUAL MEETING

OF THE

AMERICAN DAIRY SCIENCE ASSOCIATION

PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA
JUNE 24–28, 1940

PROGRAM COMMITTEE

F. H. HERZER, Mississippi State College

T. S. SUTTON (*Advisory Member*), Ohio State University

E. V. ELLINGTON (*Advisory Member*), State College of Washington

A. H. KUHLMAN, Oklahoma A. & M. College

R. G. CONNELLY, Virginia A. & M. College

B. E. HORRALL (*Chairman*), Purdue University

AMERICAN DAIRY SCIENCE ASSOCIATION

The Thirty-fifth Annual Meeting

West Lafayette, Indiana, June 24–28, 1940

PURDUE MEMORIAL UNION BUILDING
HEADQUARTERS OF THE MEETINGS

GENERAL PROGRAM

Monday, June 24

9 A.M.–5 P.M.	General Registration and Room Registration, Purdue Memorial Union Building.
2–4 P.M.	Dairy Products Judging Conference for Coaches and Instructors. Smith Hall. K. C. Boxell and R. E. Roberts, in charge.
1–3 P.M.	Open Meeting of Special Committee to Study the Work of the College Feed Conference Board. Purdue Memorial Union Building, Room 350. Paper—"The history of the open formula and the College Feed Conference Board," E. S. Savage, Cornell University.
3–4:30 P.M.	Tour of Dairy Barns. J. H. Hilton, in charge.
8 P.M.	Board of Directors Meeting. Purdue Memorial Union Building, Room 263.
8 P.M.	Family Get-Together. South Cary Hall Lounges.

Tuesday, June 25

ALL SECTIONAL AND COMMITTEE MEETINGS WILL BE HELD IN THE PURDUE MEMORIAL UNION BUILDING. ROOM IS DESIGNATED AFTER EACH MEETING.

8 A.M.–9 P.M.	General Registration and Room Registration.

9:30 A.M.–12 NOON	Opening Session, North Ballroom, Room 287, E. S. Guthrie, presiding. Address of Welcome: E. C. Elliott, President, Purdue University. Response and Address: E. S. Guthrie, President, American Dairy Science Association. The Milkfat Globule Paul F. Sharp, Cornell University.
1:30 P.M.–4 P.M.	Manufacturing Section. Sectional Meeting, Room 340.
1:30 P.M.–4 P.M.	Production and Extension Sections combined. A. H. Kuhlman, presiding, Room 350.
4 P.M.	SECTIONAL COMMITTEE MEETINGS. Committee chairmen secure room assignments at registration desk. Extension Section. Manufacturing Section. Production Section.
8 P.M.	Reception, Rooms 340 and 350.

Wednesday, June 26

8 A.M.–5 P.M.	General Registration and Room Registration.
8 A.M.–9 A.M.	SECTIONAL COMMITTEE MEETINGS. Extension Section. Manufacturing Section. Production Section.
9 A.M.–11:30 A.M.	SECTIONAL MEETINGS. Extension Section, Room 363. Manufacturing Section, Room 340.
8:30 A.M.–11:45 A.M.	Production Section, Room 350.
12 NOON	Complimentary Luncheon, Livestock Pavilion.
1:30 P.M.–4 P.M.	SECTIONAL MEETINGS. Extension Section, Room 363. Manufacturing Section, Room 340.
1:30 P.M.–5 P.M.	Production Section, Room 350.
4 P.M.–5 P.M.	SECTIONAL BUSINESS MEETINGS. (Use same rooms as for Sectional Meetings.)
8 P.M.	Entertainment. Music Hall.

Thursday, June 27

8 A.M.–9 A.M.	SECTIONAL COMMITTEE MEETINGS. Extension Section. Manufacturing Section. Production Section.
9 A.M.–11:30 A.M.	SECTIONAL MEETINGS. Extension Section, Rooms 230–257. Manufacturing Section, Room 340.

8:30 A.M.–12 NOON — Production Section, Room 350.

11:30 A.M.–1 P.M. — Lunch and Picture.

1 P.M.–4 P.M. — SECTIONAL MEETINGS.
Extension Section, Room 363.
Manufacturing Section, Room 340.
Production Section, Room 350.

4 P.M. — GENERAL SESSION, E. S. Guthrie, presiding, North Ballroom.
Program Commemorating the "50th Anniversary of the Babcock Test."
1. Dr. Babcock, the Scientist.
Professor E. B. Hart.
2. Dr. Babcock, the Man.
Dr. Gustav Bohstedt.

6:30 P.M. — Annual Association Banquet. Presentation of Borden Awards.

Friday, June 28

9 A.M.–11 A.M. — GENERAL SESSION, South Ballroom, Room 237.

SECTIONAL PROGRAMS

EXTENSION SECTION

Tuesday, June 25, 1:30–4:00 P.M.

Room 350, Union Building

A. H. KUHLMAN, *Presiding*

Joint Session With Production Section

E1—The nation-wide D.H.I.A. proved sire program. J. F. Kendrick, Bureau of Dairy Industry.

E2—The importance of selective registration to the dairy industry. Lynn Copeland, The American Jersey Cattle Club.

Symposium on Artificial Insemination

Discussion Leader: E. J. PERRY, *Chairman,* Better Sire Committee, New Jersey

P1—Vitamin C for sterile and partially sterile sires. Paul H. Phillips and Henry A. Lardy, University of Wisconsin.

P2—The storage of bull spermatozoa. H. A. Herman and Eric W. Swanson, University of Missouri.

P3—Some observations on the morphological variations in the spermatozoa of dairy bulls. Eric W. Swanson and H. A. Herman, University of Missouri.

P4—Fecundity and certain other characteristics of fresh and stored bovine semen. H. P. Davis, G. W. Trimberger, Gravers K. L. Underbjerg, University of Nebraska.

Discussion Panel

Phillips—Herman—Davis—Bartlett—Hutton

Wednesday, June 26, 9:00–11:30 A.M.

Room 363

R. G. CONNELLY, *Chairman*

E3—Utilization of proved sires and sons of proved sires. Floyd Arnold, Iowa.

E4—An Appraisal of Cooperative Artificial Insemination to Date. Stanley Brownell, Cornell University.

E5—Observations in the care and management of dairy bulls. R. R. Welch, Pennsylvania State College.

E6—Recommended methods of feeding and management for keeping sires fit. E. E. Heizer, University of Wisconsin.

Panel Discussion on Breeding Problems

Leader: Floyd Arnold

Panel Members: Arnold—Cash—Welch—Heizer—Bartlett

Wednesday, June 26, 1:30–4:00 P.M.

Room 363

R. G. CONNELLY, *Chairman*

E7—Report of feeding committee. A. R. Merrill, Chairman, Connecticut State College.

E8—Suggestions for making better use of D.H.I.A. feed records. R. G. Connelly, Virginia Polytechnic Institute.

E9—Accuracy and use of D.H.I.A. feed records. C. G. Cushman, Clemson Agricultural College.

E10—A method for determining feeding levels in D.H.I.A. herds. W. T. Crandall, Cornell University.

E11—Report of testing committee. R. C. Jones, U.S.D.A., Chairman.

Thursday, June 27, 9:00–11:30 A.M.

Rooms 230–257

R. G. CONNELLY, *Chairman*

General Symposium on Extension Methods

E12—Display of extension teaching ideas. E. C. Scheidenhelm, Michigan State College, Chairman.

Michigan—South Dakota—Nebraska—Iowa—Missouri—Wisconsin—Kansas—Texas—West Virginia—South Carolina—Alabama—Tennessee—Indiana.

Panel Discussion on Extension Methods

Leader: E. C. Scheidenhelm

Panel Members: Regan—Hayes—Johnson—Flack

Thursday, June 27, 1:00–4:00 P.M.

Room 363

R. G. CONNELLY, *Chairman*

E13—Report of type classification committee. Jas. W. Linn, Kansas State College, Chairman.

E14—Clinics for Dairy Herd Improvement Association fieldmen. A. J. Cramer, University of Wisconsin.

E15—4H Dairy programs—Requirements and recommendations. Report of Calf Club Committee. H. A. Willman, Cornell University, Chairman.

E16—Report of Quality Committee. H. R. Searles, University of Minnesota, Chairman.

E17—An extension program in quality. J. M. Jensen, Michigan State College.

MANUFACTURING SECTION

Tuesday, June 25, 1:30–4:00 P.M.

Room 340

F. H. HERZER, *Chairman*

Ice Cream

M1—The relation of acidity and total solids contents per gallon to the physical and chemical properties of high serum solids ice cream. C. W. Decker and W. C. Hall, Missouri Agricultural Experiment Station.

M2—Characteristics of base exchange treated skim milk powder in ice cream. J. H. Erb, R. B. Hornberger and J. D. Bowers, Ohio State University.

M3—Fresh and frozen plain, superheated and sweetened condensed skim milk for ice cream. L. K. Crowe, Darrell D. Deane, Harry H. Winn, University of Nebraska.

M4—Replacing cane sugar with variable increments of dextrose sugars and the effect upon the physical and chemical properties of ice cream at different serving temperatures. R. J. Cooley, W. H. E. Reid and W. C. Hall, Missouri Agricultural Experiment Station.

M5—Use of high conversion corn syrup in the manufacture of ice cream and ices. George J. Edman and P. H. Tracy, University of Illinois.

M6—Corn sugar and sirups for frozen desserts. A. C. Dahlberg and E. S. Penczek, New York Agricultural Experiment Station.

M7—Factors affecting the viscosity of ice cream mixes containing sodium-phospho-alginate. John H. Hetrick and J. H. Erb, Ohio State University.

M8—Influence of drawing temperature as a factor affecting the stabilizing action of gelatin and the body and texture of batch and continuous frozen ice cream. R. E. Heyl and P. H. Tracy, University of Illinois.

M9—The application of motion pictures as a medium in showing the influence of several factors upon the stability and meltdown properties of ice cream. W. S. Arbuckle, C. W. Decker and R. J. Cooley, Missouri Agricultural Experiment Station.

M10—A study of the coliform group in ice cream. H. J. Fournelle and H. Macy, University of Minnesota.

M11—Prevention of oxidized flavor in frozen cream by homogenization and high temperature pasteurization. G. C. McFarland and L. H. Burgwald, Ohio State University.

Wednesday, June 26, 9–11:30 A.M.

Room 340

F. H. HERZER, *Chairman*

Market Milk

M12—A survey of the objectionable feed flavors in milk throughout the North American Continent. P. A. Downs, University of Nebraska.

M13—Interrelation of certain metals and metallic ions and the development of oxidized flavor in milk. O. F. Garrett, New Jersey Agricultural Experiment Station.

M14—A comparison of the effects of seven different types of roughages on the color and flavor of milk. O. F. Garrett, R. B. Arnold and G. H. Hartman, New Jersey Agricultural Experiment Station.

M15—Recent studies on oxidized flavor in milk. W. J. Corbett and P. H. Tracy, University of Illinois.

M16—Milk flavor study. H. B. Henderson, Thos. B. Harrison, and C. E. Wylie, University of Tennessee.

M17—The relationship of quality of hay to the development of oxidized flavor in milk. W. Carson Brown, A. H. VanLandingham and Chas. E. Weakley, Jr., West Virginia Agricultural Experiment Station.

M18—The effect of feeding cod-liver oil on the goaty and oxidized flavors, and vitamin C in milk. E. S. Guthrie, Cornell University.

M19—Resistance of thermoduric bacteria to chlorine disinfection. A. C. Maack and M. J. Prucha, University of Illinois.

M20—Is the standard plate count a proper yardstick of quality? M. E. Parker, Beatrice Creamery Company.

M21—Control of sediment in homogenized milk. A. J. Hahn and P. H. Tracy, University of Illinois.

Wednesday, June 26, 1:30–4:00 P.M.

Room 340

F. H. HERZER, *Chairman*

Market Milk and Butter

M22—A study of the effect of added iodine and hydrogen peroxide to milk on the enzymes. Myer Glickstein, W. S. Mueller and J. H. Frandsen, Massachusetts State College.

M23—A study of the time-temperature relationships in the pasteurization of milk as regards creaming, phosphatase and bacterial destruction. R. F. Holland, and A. C. Dahlberg, New York Agricultural Experiment Station.

M24—The relationship of changes in the chemical composition of milk to the development of mastitis. A. H. VanLandingham, Chas. E. Weakley, Jr., and E. N. Moore, West Virginia Agricultural Experiment Station.

M25—The determination of copper in butter. W. F. Epple and B. E. Horrall, Purdue University.

M26—The uniformity of butter composition as related to type of churn. S. L. Tuckey and P. H. Tracy, University of Illinois.

M27—Changes in the bacterial flora of butter. C. A. Wilson and M. J. Prucha, University of Illinois.

M28—Some preliminary observations on the effectiveness of propionates as mold inhibitors on dairy products. J. D. Ingle, Swift & Company.

M29—Propionic acid and its calcium and sodium salts as inhibitors of mold growth. J. C. Olson and H. Macy, University of Minnesota.

M30—Some of the factors affecting the phosphatase values of butter. W. H. Brown, Purdue University.

M31—Effect of salt on the keeping quality of cream. W. J. Caulfield, F. E. Nelson, and W. H. Martin, Kansas Agricultural Experiment Station.

Thursday, June 27, 9–11:30 A.M.

Room 340

F. H. HERZER, *Chairman*

Cheese

M32—The chemical and bacteriological changes in brick cheese during manufacture. J. C. Garey, E. M. Foster and W. C. Frazier, University of Wisconsin.

M33—The control of abnormal bacterial fermentations in the manufacture of Swiss cheese. Lloyd A. Burkey, Morrison Rogosa and Robert R. Farrar, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

M34—The effect of heat-treatment of milk on the activity of Swiss cheese starters. M. E. Tyler and H. H. Weiser, Ohio State University.

M35—Standardization of fat in Swiss cheese and the relationship of fat to quality. George P. Sanders, Robert R. Farrar, Fred Feutz, and Robert E. Hardell, Bureau of Dairy Industry, U. S. Department of Agriculture.

M36—Improving the quality of Swiss cheese through applied research and technical control. Robert R. Farrar, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

M37—Relation of salt content to bitter flavor development in cheddar cheese. S. L. Tuckey and H. A. Ruehe, University of Illinois.

M38—More accurate determinations of volatile fatty acid and other changes as a means to study cheddar cheese curing. J. C. Marquardt and A. C. Dahlberg, New York Agricultural Experiment Station.

M39—Effect of lipolytic enzymes on the ripening of cheddar cheese. C. B. Lane and B. W. Hammer, Iowa Agricultural Experiment Station.

M40—The purification of rennin. C. L. Hankinson and L. S. Palmer, University of Minnesota.

M41—The effect of standardizing the acidity on the methods and physical and chemical properties of cottage cheese and cultured buttermilk. L. E. Mull and W. H. E. Reid, Missouri Agricultural Experiment Station.

M42—The use of homogenized milk in the manufacture of cottage cheese. D. W. Glover and L. H. Burgwald, Ohio State University.

M43—The effect of temperature upon score value and serving properties of cheese. W. S. Arbuckle, J. E. Edmondson, and L. E. Mull, Missouri Agricultural Experiment Station.

Thursday, June 27, 1–4 P.M.

Room 340

F. H. HERZER, *Chairman*

By-Products, Bacteriology, Testing

M44—Economic barriers affecting the dairy industry. H. A. Ruehe, University of Illinois.

M45—The effect of cocoa upon the digestibility of milk proteins. L. D. Lipman and W. S. Mueller, Massachusetts State College.

M46—The acid hydrolysis of lactose and the preparation of hydrolyzed lactose sirup. G. A. Ramsdell and B. H. Webb, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

M47—Some properties of different combinations of whey and other materials which dry satisfactorily on the atmospheric drum drier. E. L. Jack and A. J. Wasson, University of California.

M48—A more precise method for estimating fat in the Babcock Test. E. O. Herreid, Vermont Agricultural Experiment Station.

M49—The effect of specific gravity and coefficient of expansion of butterfat on the accuracy of the Babcock Test. R. Jenness, Vermont Agricultural Experiment Station.

M50—Observations on the distribution of *Pseudomonas fragi.* H. B. Morrison and B. W. Hammer, Kentucky and Iowa Agricultural Experiment Stations.

M51—The serological integrity of *Streptococcus lactis.* J. M. Sherman, Karl L. Smiley, and Charles F. Niven, Jr., Cornell University.

PRODUCTION SECTION

Tuesday, June 25, 1:30–4:00 P.M.

Room 350

Joint Session with Extension Section

A. H. KUHLMAN, *Presiding*

E1—The nation-wide D.H.I.A. proved sire program. J. F. Kendrick, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

E2—The importance of selective registration to the dairy industry. Lynn Copeland, The American Jersey Cattle Club.

Symposium on Artificial Insemination

Discussion Leader: E. J. PERRY, *Chairman,* Better Sire Committee, New Jersey

P1—Vitamin C for sterile and partially sterile sires. Paul H. Phillips and Henry A. Lardy, University of Wisconsin.

P2—The storage of bull spermatozoa. H. A. Herman and Eric W. Swanson, University of Missouri.

P3—Some observations on the morphological variations in the spermatozoa of dairy bulls. Eric W. Swanson and H. A. Herman, University of Missouri.

P4—Fecundity and certain other characteristics of fresh and stored bovine semen. H. P. Davis, G. W. Trimberger, Gravers K. L. Underbjerg, University of Nebraska.

Discussion Panel

Phillips—Herman—Davis—Bartlett—Perry

Wednesday, June 26, 8:30–11:45 A.M.

A. H. KUHLMAN, *Chairman*
Room 350
Milk Secretion

P5—Outlines and subject matter in teaching dairy husbandry courses. E. N. Hansen, Iowa State College.

P6—An assay method for Thyrolactin. W. W. Heathman and C. W. Turner, Missouri Agricultural Experiment Station.

P7—Thyrolactin, a new source of thyroxine for dairy cattle. C. W. Turner, Missouri Agricultural Experiment Station.

P8—The effect of thyroxine injections on the physiological processes of dairy cattle. Victor Hurst, R. P. Reece and J. W. Bartlett, New Jersey Agricultural Experiment Station.

P9—The ejection of milk from the mammary gland. Fordyce Ely and W. E. Petersen, Kentucky and Minnesota Agricultural Experiment Stations.

P10—Effect of post-hypophyseal extract on lactation in hypophysectomized post-gravid rats. Eliseo T. Gomez, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P11—The fat metabolism of the mammary gland of the cow. J. C. Shaw and W. E. Petersen, University of Minnesota.

P12—Some factors influencing the completeness of milking. Kenneth Miller and W. E. Petersen, University of Minnesota.

P13—The effect of dinitrophenol administration on milk and milk fat. G. C. Graf, L. M. Ludwick and W. E. Petersen, University of Minnesota.

P14—The pH of the bovine mammary gland. Philip L. Kelly, Arkansas Agricultural Experiment Station.

P15—The hormone control of mammary duct growth. A. A. Lewis, Missouri Agricultural Experiment Station.

P16—The mammogenic lobule-alveolar factor of the anterior pituitary. John P. Mixner, Missouri Agricultural Experiment Station.

P17—The effect of nembutal anesthesia on the rate of milk secretion, the respiratory quotient, and uptake of milk precursors by the lactating mammary gland. E. P. Reineke, Missouri Agricultural Experiment Station.

P18—A modification of the Allen blood fat procedure. J. C. Shaw, University of Connecticut.

Wednesday, June 26, 1:30–5:00 P.M.

Room 350

A. H. KUHLMAN, *Chairman*

Breeding, Disease, Calf Feeding

P19—A study of some methods for the prediction of butterfat percentage in herds of Ayrshire cattle. G. A. Bowling and D. N. Putnam, West Virginia Agricultural Experiment Station.

P20—The use of cellular antigens in the blood of cattle for determining parentage. L. C. Ferguson and M. R. Irwin, University of Wisconsin.

P21—Effects of inbreeding in dairy cattle. G. E. Dickerson, Wisconsin Agricultural Experiment Station.

P22—Results of twenty years work on proving bulls at the Huntley, Montana, field station. R. R. Graves, J. R. Dawson, and D. V. Kopland, Bureau of Dairy Industry, U. S. Department of Agriculture.

P23—Average useful life-span, and causes of losses of dairy bulls. R. B. Becker and P. T. Dix Arnold, Florida Agricultural Experiment Station.

P24—The inheritance of the solids-not-fat percentage in dairy cattle. H. C. Moore and K. S. Morrow, New Hampshire Experiment Station.

P25—Some factors affecting breeding efficiency in dairy cattle. R. E. Erb, J. W. Wilbur and J. H. Hilton, Purdue University.

P26—Early recognition of the freemartin condition in heifers twin-born with bulls. W. W. Swett, C. A. Matthews and R. R. Graves, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P27—Some factors relating to bloat in cattle. Dwight Espe and C. Y. Cannon, Iowa State College.

P28—Extreme rarity of cancerous growths in the cow's udder. W. W. Swett, C. A. Matthews and R. R. Graves, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P29—Heavy corn feeding as a contributory factor to the development of mastitis. Earl N. Moore and H. O. Henderson, West Virginia Agricultural Experiment Station.

P30—Short-wave diathermy treatment of bovine mastitis. C. W. McIntyre, A. C. Ragsdale, and E. R. Garrison, Missouri Agricultural Experiment Station.

P31—Purified diet studies with calves. P. E. Johnson, J. K. Loosli, and L. A. Maynard, Cornell University.

P32—Changes in pH and in bacterial count of milks sham fed to a dairy calf. George H. Wise, G. W. Anderson and J. C. Jones, South Carolina Agricultural Experiment Station.

Thursday, June 27, 8:30–12:00 A.M.

Room 350

A. H. KUHLMAN, *Chairman*

Nutrition

P33—Studies with barn air-cured alfalfa hay. C. E. Wylie, S. A. Hinton, and J. A. Schaller, University of Tennessee and Tennessee Valley Authority.

P34—Dried grapefruit pulp for milk production. P. T. Dix Arnold, R. B. Becker and W. M. Neal, Florida Agricultural Experiment Station.

P35—The value of the qualitative color test in the study of ketosis. C. W. Duncan and C. F. Huffman, Michigan Agricultural Experiment Station.

P36—Blood sugar and carbon dioxide combining power of plasma in relation to ketosis in dairy cattle. J. F. Sykes, C. W. Duncan and C. F. Huffman, Michigan State College.

P37—The relationship of fat content in the dairy ration to milk and butterfat production. C. F. Monroe and W. E. Krauss, Ohio Agricultural Experiment Station.

P38—Alfalfa hay cut at three stages of maturity; its yield, chemical composition and feeding value for milk production. J. R. Dawson, D. V. Kopland, and R. R. Graves, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P39—Cystine as a possible deficiency in a ration of alfalfa hay for milk production. C. F. Huffman and C. W. Duncan, Michigan Agricultural Experiment Station.

P40—The feeding value of rye stillage for dairy cows. K. L. Turk and M. H. Berry, Maryland Agricultural Experiment Station.

P41—Fermentation studies on alfalfa silage prepared by the phosphoric acid and molasses methods. H. D. McAuliffe, R. W. Stone and S. I. Bechdèl, The Pennsylvania State College.

P42—The losses resulting from the ensiling of legumes and grasses with varying amounts of phosphoric acid. O. L. Lepard and E. S. Savage, Cornell University.

P43—Effect of depth of corn in the silo on weight of corn silage. Joseph B. Shepherd, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P44—Broomcorn silage for dairy cattle. K. E. Harshbarger and W. B. Nevens, University of Illinois.

P45—Comparison of *Lespedeza Sericea* silage, alfalfa silage, and corn silage for dairy cows. S. A. Hinton and C. E. Wylie, University of Tennessee.

P46—Composition and nutrient value of sugarcane as fresh forage, shocked fodder and silage. W. M. Neal, Florida Agricultural Experiment Station.

Thursday, June 27, 1:00–4:00 P.M.
Room 350

A. H. KUHLMAN, *Chairman*

Minerals and Vitamins

P47—Is timothy hay adequate in calcium for optimum growth of dairy heifers? H. T. Converse, Edward A. Kane, and Edward B. Meigs, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P48—The effect of rations deficient in phosphorus and protein on ovulation, estrus and reproduction in dairy heifers. L. S. Palmer, T. W. Gullickson, W. L. Boyd, C. P. Fitch and J. W. Nelson, University of Minnesota.

P49—The effect of avitaminosis-A upon vitamin C in the bovine. W. A. King, P. H. Phillips, M. E. Nesbit, I. W. Rupel and G. Bohstedt, University of Wisconsin.

P50—Vitamin C in the nutrition of dairy cattle. G. C. Wallis, South Dakota Agricultural Experiment Station.

P51—Blood-plasma magnesium in relation to the vitamin D deficiency of mature dairy cattle. G. C. Wallis, South Dakota Agricultural Experiment Station.

P52—Vitamin E potency of certain feedstuffs. L. S. Palmer, J. W. Nelson and T. W. Gullickson (with the assistance of B. B. Migicovsky and W. W. Kielley), University of Minnesota.

P53—Carotene content of corn silage. Edward A. Kane, Herbert G. Wiseman, Leo A. Shinn, and C. A. Cary, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

P54—Changes in the amounts of carotene and vitamin A and in the composition of milk fat in artificially induced mastitis. P. G. Miller, E. J. Lease and G. W. Anderson, South Carolina Agricultural Experiment Station.

P55—The effects of vitamin A deficiency on the young male bovine. T. S. Sutton, W. E. Krauss and S. L. Hansard, Ohio Agricultural Experiment Station and Ohio State University.

P56—Cerebrospinal fluid pressure and vitamin A deficiency. L. A. Moore and J. F. Sykes, Michigan Agricultural Experiment Station.

P57—The effect of carotene consumption on the milk yield of Jersey cows. O. C. Copeland, Texas Agricultural Experiment Station.

P58—The vitamin A requirements of dairy cows for the production of butter of high vitamin A value. II. Relative efficiency of carotene (dehydrated alfalfa hay) and vitamin A. J. W. Wilbur, J. H. Hilton and S. M. Hauge, Purdue University.

ABSTRACTS OF PAPERS

MANUFACTURING SECTION

M1. The Relation of Acidity and Total Solids Contents per Gallon to the Physical and Chemical Properties of High Serum Solids Ice Cream.* C. W. DECKER AND W. C. HALL, Missouri Agricultural Experiment Station.

This investigation included a study of the relation of the acidity, total solids per gallon, and variable increments of serum solids in the mix to the flavor, body, crystalline structure, dipping qualities and chemical properties of high serum solids ice cream.

Consumer preference of ice creams containing 13.50 per cent and 15.00 per cent serum solids content with the acidity adjusted to 0.24, 0.18, 0.12 and 0.08 per cent showed that the flavor of the low acid ice cream was preferred at the lower temperatures and the flavor of the higher acidity ice cream was preferred at the higher temperatures. As the per cent acidity decreased from 0.24 to 0.08 per cent, the crystal size decreased to a certain extent and then slightly increased again at the lowest acidity.

At the higher acidity and lower pH, the weight per "disher" was greatest and the stability was progressively greater as the acidity decreased in the 13.50 per cent serum solids ice cream. However, this was not as noticeable in the 15.00 per cent serum solids ice cream. There appeared to be a relationship between the acidity and pH and the viscosity and freezing properties of the mix.

The weight per gallon of ice cream was varied from 1.65 to 2.06 pounds. Consumer observations indicate that the flavor and body was more desirable in the medium weight per gallon ice creams, and dipping studies show that as the total solids per gallon decreased, the "disher" size increased at the lower temperatures. However, the reverse was true at higher dipping temperatures, and as the weight of total solids per gallon increased the stability decreased.

The results of this study indicate that the acidity, weight of total solids per gallon and per cent serum solids content has a pronounced effect upon the physical and chemical properties of the finished ice cream.

M2. Characteristics of Base Exchange Treated Skimmilk Powder in Ice Cream. J. H. ERB, R. B. HORNBERGER AND J. D. BOWERS, Ohio State University.

Base-exchange treated spray-process skimmilk powder was used in varying amounts to supply serum solids in ice cream mixes, and these were

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station Journal Series No. 627.

compared with mixes of the same composition containing serum solids from regular spray-process skimmilk powder and skimmilk. In producing the special milk powder the skimmilk was not acidified before being sent through the zeolite so that the final reaction of the dried milk was pH 7.16. The titratable acidity on the reconstituted basis was .06 per cent. In later work it was found that skimmilk, acidified so that the final pH of the powder was 6.5 before being sent through the zeolite, responded similarly to the unacidified.

The most significant difference in the use of the base-exchange powder in ice cream mixes was the more rapid whipping in batch freezers of mixes containing this product. The rapidity of whipping varied with the amount of base exchange powder used, but a quantity as small as 10 per cent of the total amount of serum solids content showed more rapid whipping. The mixes containing the zeolite treated solids were of lower viscosity than the control mixes.

Ice cream containing base exchange treated powder melted slightly more rapidly than ice cream of the same composition containing regular powder. The rapidity of melt down was in proportion to the amount of base exchange product used.

Figures will be given showing the distribution of minerals in the zeolite treated milk.

M3. Fresh and Frozen Plain, Superheated and Sweetened Condensed Skimmilk for Ice Cream.* L. K. CROWE, DARRELL D. DEANE AND HARRY H. WINN, University of Nebraska.

A study was made of some characteristics of a commercial milk supply in relation to the manufacture and storage of condensed skimmilk for use in ice cream as well as the suitability of stored frozen condensed milk of three types as a source of added serum solids in ice cream.

Chemical analysis of the whole milk supply did not reveal a significant correlation between the characteristics studied and the degree of stability of the protein fraction of the plain condensed skimmilk manufactured from it and held at 0° F. for four weeks.

Plain and sweetened condensed skimmilks after being held frozen for periods up to three months were satisfactory sources of serum solids for ice cream. The protein in superheated condensed skimmilk showed precipitation after one month's storage at 0° F. and precipitation increased rapidly with longer storage periods.

There were no significant differences in protein stability, pH, titratable acidity and viscosity of ice cream mixes made with the three types of fresh and stored frozen condensed skimmilk.

* The data presented in this paper are from a study made by the junior authors under the supervision of the senior author in partial fulfillment of the work required for the degree of Master of Science.

Ice cream mixes made with fresh plain condensed skimmilk whipped to 100 per cent overrun slightly faster and to a slightly higher maximum overrun than when fresh superheated or fresh sweetened condensed milk was used. Superheated and sweetened condensed skimmilk mixes were equal in time to reach 100 per cent overrun but the former did not reach as high maximum overrun. Freezing and storing condensed skimmilk for 3 months at 0° F. reduced the time to reach 100 per cent overrun in the mixes in which it was used.

There was no appreciable difference in flavor score of the mixes containing either of the three types of condensed milk when used fresh or after storage.

Ice cream made with fresh or stored frozen superheated condensed skimmilk was more resistant to melting and gave less foam on melting than ice cream made with plain and sweetened condensed skimmilk.

M4. Replacing Cane Sugar with Variable Increments of Dextrose Sugars and the Effect upon the Physical and Chemical Properties of Ice Cream at Different Serving Temperatures.* R. J. COOLEY, W. H. E. REID AND W. C. HALL, Missouri Agricultural Experiment Station.

The object of this investigation was to obtain technical data relating to replacing cane sugar with variable increments of dextrose sugar and its effect upon the ice cream mixes and the resulting ice cream.

The partial replacement of cane sugar in ice cream by corn sugar seems to be a desirable manufacturing procedure when the approximate replacement is 25 per cent. The replacement in this investigation ranged from 16.7 per cent to 44.4 per cent in mixes varying in total sugar content from 12 to 18 per cent.

Motion and still pictures were used in studying the stability and meltdown qualities. Microphotographs and macrophotographs were used to show the crystalline and air cell structure of the different ice creams. Regardless of the amount of cane sugar replaced by dextrose or cerelose up to 18 per cent total sugar and 44.4 per cent replacement, there appeared to be no marked variation between all sucrose mixes.

Consumer preference studies on fifteen different mixes were conducted in cooperation with over 400 individual men and women. Fourteen classes of four to five samples of ice cream per class were given relative placings and specific criticisms by these representative consumer judges. Tabulations have been made on 3,465 samples of ice cream for flavor, body, and texture. The serving temperatures used were 4, 8, 12 and 16° F. respectively.

It appeared that a replacement of 25 to 35 per cent dextrose or cerelose

* Missouri Agr. Experiment Station, Journal Series No. 628.

for an equal weight of sucrose in ice creams was acceptable and, in some instances, preferred by the average consumer of ice cream.

M5. Use of High Conversion Corn Sirup in the Manufacture of Ice Cream and Ices. GEORGE J. EDMAN AND P. H. TRACY, University of Illinois.

The introduction of a new type of corn sirup (known commercially as Sweetose) with an increased dextrose equivalent and reduced dextrin content as compared with the regular type of corn sirup, has made it desirable to determine the possibilities of the use of this product as a sweetening agent in the manufacture of ice cream, water ices, and sherbets.

Studies have been made of the effect of the use of the sirup upon the physical properties of the mix and ice cream. In the same way the merits of the sirup in ices have been determined.

It has been found possible to replace as much as $33\frac{1}{3}$ per cent of the sucrose in ice cream and 50 per cent of the sucrose in water ices and sherbets without any undesirable effects. The sweetening value assigned to the high conversion sirup was two-third that of sucrose. The superior body effect resulting from the use of the sirup was thought to be due to the higher total solids content resulting as well as the effect of the dextrins and the slightly greater depressing effect upon the freezing point that the sirup has as compared with sucrose.

No deleterious flavor effects were observed, and in some cases the added flavors were intensified by the sirup.

While the corn sirup lowered the freezing point of the mix (one-third replacement) as compared with the sucrose control mix, the effect was no greater than in the case of a mix containing dextrose (one-fifth replacement).

Corn sirup was found to be soluble in water solutions frozen and stored at $-15°$ F. This property of the sirup was found to be a decided advantage in preventing surface crustation in water ices.

M6. Corn Sugar and Sirups for Frozen Desserts. A. C. DAHLBERG AND E. S. PENCZEK, New York Agricultural Experiment Station.

In this study three types of corn sweeteners were compared with sucrose, namely a new type of liquid corn sirup, d. e. 64.5, a new dry corn sirup, d. e. 42.5 and corn sugar. These sweeteners were compared in water solutions, in ice cream, and in ices.

There are differences in the flavor, pH, relative sweetness, and freezing point depression of these corn sweeteners. Only one of the three products had a "sirup flavor" in concentrations used in ice cream. The pH values of both sirups were below that of the ice cream mix. Both corn

sirups, on a dry basis, depressed the freezing point of water about the same as sucrose whereas corn sugar showed a greater depression.

In the ice cream mix it was found that 25 per cent of the sucrose could be replaced with corn sweeteners as larger amounts produced soft ice cream. All of the corn sweeteners reduced the freezing points of the mixes more than sucrose when used in quantities sufficient to give comparable sweetness. However, the dry corn sirup was used in reduced quantities and it produced a mix with a high freezing point and an ice cream slightly firmer than sucrose ice cream.

The use of corn sweeteners had no material effect upon the acidity, pH, viscosity, surface tension, fat clumping and whipping properties of the mixes.

The various corn sweeteners varied somewhat in their effect upon the flavor of ice cream. The ice cream with liquid corn sirup possessed a slightly fresher, fuller flavor than sucrose ice cream. The dry corn sirup ice cream was a trifle flat in flavor due chiefly to too low a sweetening value indicating clearly the need for additional sugar. In most instances the liquid corn sirup ice cream possessed slightly superior keeping qualities. The body and texture of the ice cream was improved slightly by both sirups.

The hardness of ice cream was decreased and the rate of melting increased most for corn sugar and to a lesser degree for the corn sirups. However, in the concentrations used this effect was commercially insignificant.

The development of sandiness was not greatly affected by the sugars yet there was a tendency for the dry corn sirup to slightly retard its development.

In all cases the use of corn sweeteners eliminated the development of sucrose crystallization in ices. These corn products are essential in sherbets and ices to manufacture a commercial product of satisfactory keeping quality.

M7. Factors Affecting the Viscosity of Ice Cream Mixes Containing Sodium-Phospho-Alginate. JOHN H. HETRICK AND J. H. ERB, Ohio State University.

The ice cream stabilizer, sodium-phospho-alginate, commercially known as Dariloid, increases the viscosity of ice cream mix appreciably when used in the amount necessary for proper stabilization. The quantity used in ice cream ranges from .25 per cent to .30 per cent. The high viscosity of mixes containing this algin is one of the main factors limiting its use.

A number of factors have been studied which have an effect on the viscosity. When a small amount of di-sodium phosphate or sodium citrate

was added to the mix before incorporation of .25 per cent algin the viscosity of the mix was increased over the control containing no added salt. The pH of the mix previous to incorporating the algin was very important from the standpoint of viscosity. In a range from pH 6.2 to pH 7.2 the viscosity increased in proportion to the increase in pH.

Pasteurization temperatures have an influence on the viscosity of mixes stabilized with sodium-phospho-alginate just opposite to those stabilized with gelatin. Temperatures were studied from 160° F. to 180° F. The higher temperatures in the case of the algin mixes produced a greater immediate viscosity and this viscosity was retained on aging. The ice cream made from mixes pasteurized at 180° F. showed greater melting resistance and slightly better body and texture than mixes containing the same amount of algin but pasteurized at 160° F. It was also found that the longer the time the algin mixes were held at the pasteurizing temperature the greater was the final viscosity of the mix.

M8. Influence of Drawing Temperature as a Factor Affecting the Stabilizing Action of Gelatin and the Body and Texture of Batch and Continuous Frozen Ice Cream. R. E. HEYL AND P. H. TRACY, University of Illinois.

In a series of experiments dealing with the stabilizing power of gelatin in ice cream, it was observed that identical mixes when frozen in a counter freezer, a horizontal batch freezer, and in a continuous type of freezer showed little correlation in body score of the resulting ice creams.

When drawing temperatures were compared, the ice creams with the lowest drawing temperatures were found to have the highest body and texture scores, and a study was undertaken to determine the relation of drawing temperatures to the body and texture of ice cream.

Ice cream mixes (12 per cent fat, 11 per cent serum solids, 15 per cent sugar) containing 0.28 per cent, 0.30 per cent, and 0.35 per cent of 225 Bloom porkskin gelatin (pH 4.5) were prepared and frozen in a continuous freezer to 24.4° F., 23.8° F., and 22.1° F. at 100 per cent overrun when drawn. When these samples were judged, it was found that the body and texture scores varied inversely with the drawing temperatures. The ice cream drawn at 22.1° F. had a smoother body than any samples drawn at higher temperatures.

Since the freezing point of an ice cream mix and its whipping ability directly influence the temperature at which it can be drawn from the freezer, the study was extended to include ice cream frozen in a counter freezer, and in a horizontal 40-quart batch freezer. Ice cream frozen in these types of freezers could not be drawn at 100 per cent overrun at as low temperatures as in the continuous type freezer.

In all cases, ice creams that were drawn at the same temperatures regardless of the type of freezer, compared favorably with each other from the standpoint of body, when analyzed by organoleptic tests.

Overfreezing on the continuous freezer or drawing ice creams at temperatures too low, when the quantity of gelatin present was sufficient for higher drawing temperatures, tended to produce ice creams with sticky or gummy bodies.

The results suggest that due consideration should be given to possible variations in drawing temperature of the ice cream in attempting to arrive at the optimum amount of stabilizer that should be used in the mix.

M9. The Application of Motion Pictures as a Medium in Showing the Influence of Several Factors upon the Stability and Meltdown Properties of Ice Cream.* W. S. ARBUCKLE, C. W. DECKER AND R. J. COOLEY, Missouri Agricultural Experiment Station.

Studies have been made by the use of motion picture photography in showing the relation of several factors in the composition and manufacturing procedure upon the stability of vanilla ice cream.

The investigation includes the effect of variable acidity in medium and high serum solids content mixes, the effect of overrun or weight per gallon of ice cream, the different sources of serum solids and of replacing variable increments of sucrose with dextrose and cerelose in medium and low fat content mixes upon the stability and melt down properties.

The pictures illustrate the effectiveness of motion pictures in presenting complete detailed information of educational and investigational value.

M10. A Study of the Coliform Group in Ice Cream. H. J. FOURNELLE AND H. MACY, University of Minnesota.

A study is being made of the numbers and types of the coliform group in ice cream. Factory-packaged samples obtained from ice cream manufacturers have been vanilla, chocolate, strawberry, sherbet (or ice), and a chocolate-covered confection known as "cheerio." Scoop, or dipper, samples have been obtained from drug store fountains, confectioneries, ice cream shops, etc.

Brilliant green-lactose-bile broth has been used for presumptive tests. An estimation of the numbers is made by using the dilution method of Halvorson and Ziegler (Jour. Bact., **25**: 101–121, 1933). For factory-packed ice cream, six dilutions are made with 10 tubes inoculated in each dilution. The lowest dilution, consisting of 10 ml. of the sample, is inoculated into 100 ml. of brilliant green-lactose-bile medium. The other dilutions, 1 ml. to 0.0001 ml., inclusive, are inoculated into 10 ml. quantities of the medium. After 48 hours incubation at 37° C. all tubes are ex-

* Paper No. 629 in the Missouri Agricultural Experiment Station Journal Series.

amined for gas production. Halvorson and Ziegler's tables giving the most probable number of bacteria per ml. are used for interpreting data. The range of dilutions of inocula of scoop samples is between 1 ml. and 0.000,001 ml., inclusive, where 10 tubes are used for each dilution. Direct plate counts are also made on violet red-bile agar.

A comparison is being made between buffered and unbuffered brilliant green-lactose-bile broth to determine which medium is the more suitable for sherbets and ices. Five tubes each of buffered and unbuffered medium are used in each dilution.

Eosin-methylene blue agar plates are streaked from tubes of brilliant green-lactose broth of the lowest and highest dilutions showing gas after 24 and 48 hours. Representative typical and atypical coliform colonies and non-coliform colonies are picked and transferred to nutrient agar slants.

All cultures are purified before planting into differential media. For purification light suspensions are made in sterile distilled water from agar slants and inocula from this are streaked on eosin-methylene blue agar. After incubation, representative colonies of different types are picked and transferred to nutrient agar slants. This process is repeated so that three E. M. B. plates are streaked and colonies transferred to three agar slants.

Gram and flagella stains and determination of motility are made from nutrient agar slant cultures that have incubated 18–22 hours at 37° C. The method of study of bacterial flagellation recommended by Conn and Wolfe (Jour. Bact. **36**: 517–520. 1938) is being used.

The following tests and reactions are used for identification of the types isolated: fermentation of lactose, dextrose, sucrose, salicin, dulcitol, and glycerol; formation of indol from 1 per cent tryptone broth; utilization of citrate as sole source of carbon; methyl red and Voges-Proskauer reactions; reduction of nitrate; hydrogen sulphide production; gelatin liquefaction, and action on litmus milk.

Identification of cultures is made according to Bergey's Manual of Determinative Bacteriology, 5th Edition.

The probable numbers of the coliform types in the samples studied range from less than one per ten milliliters to 1160 per milliliter. The following types have been isolated, *Escherichia coli, E. coli* var. *acidilactici, E. coli* var. *neapolitana, E. freundii, Aerobacter aerogenes, Aerobacter cloacea,* and a variety of other Gram negative rods that were isolated from eosin-methylene blue plates.

M11. Prevention of Oxidized Flavor in Frozen Cream by Homogenization and High Temperature Pasteurization. G. C. McFarland and L. H. Burgwald, Ohio State University.

Due to the lack of balance between production and utilization of milk over the yearly period, some means of storing surplus is necessary. One

method used is that of storing cream in the frozen state; however, considerable trouble from oxidized flavor is encountered.

Three trials were run using high temperature pasteurized cream; the cream being pasteurized at 172° F. for one minute and for five minutes. In one of these trials highly susceptible cream was used. The cream used was separated from milk which had been pasteurized at 145° F. for 30 minutes. Copper was added to the cream in the form of copper sulfate in amounts from 0.5 to 2.5 p.p.m. just before pasteurization at 172° F. Eight minutes were required to bring the temperature from 45° F. to 172° F. The cream was stored in waxed paper cartons at temperatures ranging between minus ten and zero degrees F.

Three homogenized trials were also run in which the copper was added after pasteurization at 145° F. for 30 minutes, but before homogenization at 2300 to 2500 pounds pressure. The temperature at time of homogenization was 130° F. Highly susceptible cream was also used in one of these trials. The cream was stored in waxed paper cartons the same as for the other cream.

In one trial, cream pasteurized at 172° F. for one minute and five minutes did not go oxidized after five months storage. In another trial, those samples contaminated with 2.0 and 2.5 p.p.m. copper and pasteurized at 172° F. for one minute showed a trace of oxidized flavor in four months. None was found in any of the samples pasteurized at 172° F. for five minutes. In the trial with susceptible cream, the copper contaminated samples pasteurized at 172° F. for one minute went oxidized in one and one-half months; however, the intensity was much less than that of the control samples. No oxidized flavor developed in the samples pasteurized at 172° F. for five minutes in this trial by the end of two months.

In all of the trials, the copper-contaminated control samples developed the flavor in one and one-half months or less.

Although an objectionable cooked flavor was present in the cream pasteurized at 172° F. at first, it diminished enough to be unobjectionable after one month's storage.

Results obtained seem to indicate that high temperature pasteurization at 172° F. for five minutes was sufficient to prevent the formation of oxidized flavor in frozen cream.

In one trial, the homogenized samples contaminated with 2.0 and 3.0 p.p.m. of copper developed the flavor in the sixth month. In another trial, none of the homogenized cream developed the flavor after four months, and in the trial with susceptible cream, none of the homogenized samples had gone oxidized after two months storage. All the copper-contaminated unhomogenized control developed the flavor in one and one-half months or less.

Homogenization seems to be effective in preventing the development of the oxidized flavor.

In a trial to note the effect of pancreatic enzyme as a preventive, copper-contaminated samples containing 2.0, 5.0, and 10.0 p.p.m. of pancreatic enzyme have been in storage two months with no development of oxidized flavor. All of the copper-contaminated controls have developed the flavor in one and one-half months or less.

M12. A Survey of the Objectionable Feed Flavors in Milk Throughout the North American Continent. P. A. DOWNS, University of Nebraska.

A survey of the North American continent by states and provinces has been made in an endeavor to ascertain the seriousness of feed and weed flavors in milk and milk products. The results indicate that it is a serious problem in the majority of the territories. Feed flavors are reported as objectionable in widely distributed areas while weeds are reported as being the cause of trouble more extensively in the Middle West and South. Silage contributes in a great many cases, followed by pasture such as rye and sweet clover with alfalfa hay being reported as a cause of flavor in many states. Onion probably is the most common source of trouble in the weed class followed by ragweed and bitter weed. French weed is reported as being a serious problem in the Great Plains area and the Canadian Middle West. In those states where the problem is serious many experimental projects are in progress. Rather a limited file of references are available in the various states, and circulars, bulletins, and printed material available vary with the importance of the problem in the particular state. The educational program in various states that are seriously affected covers the use of the newspaper, radio, extension service, group meetings, 4-H Club, and in some states vocational agriculture high schools.

From the results obtained it is apparent that the problem is serious in the North American continent as a whole, being spread from coast to coast and from Canada to the Gulf of Mexico in one form or another. It is believed that more attention should be given this problem and that greater effort should be made to impress the producer with the importance of feed management for the dairy herd.

M13. Interrelation of Certain Metals and Metallic Ions and the Development of Oxidized Flavor in Milk. O. F. GARRETT, New Jersey Agricultural Experiment Station.

While studying the accelerative action of cupric and ferrous ions on the development of oxidized flavor in milk, it was observed that in one case, where equal molar proportions of both ions were added to a sample of milk, the accelerative effect was not so great as that of either one of the ions when added alone. This led to further studies of the interaction of various other metals and their ions when placed in milk.

In these studies copper sulfate was added in various molar concentrations to milk immediately following which various molar concentrations of other metallic salts were added. The results are summarized as follows:

When divalent manganese was added in molar concentration equal or greater than copper the development of the oxidized flavor was either greatly retarded or completely inhibited for periods up to 96 hours.

In two samples of milk which spontaneously developed the oxidized flavor no such flavor appeared in the milk containing divalent manganese but no copper.

The addition of ferrous iron to samples of milk containing added copper greatly retarded but usually did not completely eliminate the development of the oxidized flavor.

The addition of divalent manganese to samples of milk containing ferrous iron either greatly retarded or completely inhibited the development of oxidized flavor up to 72 hours.

The addition of trivalent aluminum or of ferric iron to samples of milk which contained copper did not retard the development of the oxidized flavor.

When pieces of manganese metal were placed in milk containing various concentrations of copper sulfate or ferrous sulfate the development of the oxidized flavor was greatly retarded.

When strips of copper metal were placed in milk containing divalent manganese or pieces of manganese metal the development of the oxidized flavor was greatly retarded.

Divalent manganese added to milk containing copper after the development of the oxidized flavor had begun checked further development of the flavor.

The addition of divalent manganese to milk containing copper had no effect on the oxidation rate of reduced ascorbic acid nor on the magnitude of the oxidation-reduction potential.

M14. A Comparison of the Effects of Seven Different Types of Roughages on the Color and Flavor of Milk. O. F. GARRETT, R. B. ARNOLD AND G. H. HARTMAN, New Jersey Agricultural Experiment Station.

In the first experiment a comparison was made between silage made from immature alfalfa preserved with molasses and green spring pasture. The color of the milk showed most of its increase during the first 4 weeks of feeding the silage but the maximum level was not reached until appproximately 10 weeks had passed. The maximum color of the milk produced on the alfalfa silage (6.3 lactochrometer units) was almost equal to that produced after 3 weeks on green pasture (6.4 lactochrometer units).

The flavor score of the milk produced on the alfalfa silage reached a maximum (above 22) in about 4 weeks and maintained this level until the cows were put on pasture when there was a slight but definite drop due to the appearance of "feed" flavors.

In a second experiment a comparison was made of the effects of feeding molasses grass silage, phosphoric acid grass silage and corn silage on the color and flavor of milk. Three groups of cows were fed continuously on the three types of roughages for a period of 18 weeks. The following average values were obtained at the beginning of the experiment; color, 5.2 lactochrometer units; fresh milk score, 20.8; milk score after 72 hours, 19.3; oxidation score after 72 hours with copper, 3.6. Similarly, the averages for the experimental period on the three roughages were: molasses silage 6.3, 22.1, 21.1 and 1.6; phosphoric acid silage 6.1, 21.9, 20.9 and 1.5; corn silage 5.2, 20.6, 19.4 and 3.4. The grass silage preserved by either method was definitely superior to corn silage for producing milk of high yellow color and good flavor stability but no significant differences occurred in the effects of the two grass silages.

In a third experiment the effects on color and flavor of milk produced on molasses grass silage, beet pulp, and molasses-impregnated citrus pulp were studied. One group of cows was fed in 4-week periods, respectively, beet pulp, citrus pulp and grass silage. A second group was fed, respectively, grass silage, citrus pulp and beet pulp.

The average color in lactochrometer units for the three roughages was as follows: beet pulp, 4.9; citrus pulp, 4.8; grass silage 5.6. Similarly, the average flavor scores for the fresh milk were: beet pulp, 20.5; citrus pulp, 20.6; grass silage, 21.7; flavor scores after 72 hours were: beet pulp, 19.4; citrus pulp, 19.5; grass silage, 20.9; oxidation scores after 72 hours with copper were: beet pulp, 4.1; citrus pulp, 3.8; grass silage, 2.3.

Beet pulp and citrus pulp, impregnated with molasses, appear to be inferior to grass silage in producing milk of high color and good flavor. No significant difference with respect to these two factors was noted between beet pulp and citrus pulp.

M15. Recent Studies on Oxidized Flavor in Milk. W. J. CORBETT AND P. H. TRACY, University of Illinois.

Various investigators have suggested that the degree of saturation of the milk fat was related to the oxidation of the fat and occurrence of oxidized flavor. The saturation of the fat was varied by feeding one group of 3 cows cocoanut oil and another group of 3 cows corn oil. The oils were fed for a period of 12 days, omitted for 10 days, and then the groups were reversed and again fed corn and cocoanut oil for a period of 12 days. The cocoanut oil lowered the iodine number approximately 4 per cent and the corn oil increased the iodine number approximately 15 per cent. Each group of

cows contained one animal that gave milk which developed the oxidized flavor "spontaneously," and two cows whose milk developed the oxidized flavor in the presence of copper, one cow's milk being more resistant to copper than the other. All samples of milk were pasteurized in glass immediately after milking and divided into several lots. Copper sulphate was added to some of the milk samples. Changing the degree of saturation of the fat had no effect on the development or occurrence of the oxidized flavors.

Studies of the anti-oxidative effect of tyrosine and the more soluble tyrosine esters have shown them to be very effective anti-oxidants in milk when added at the rate of .02 per cent–.03 per cent.

M16. Milk Flavor Study. H. B. HENDERSON, THOS. B. HARRISON AND C. E. WYLIE, University of Tennessee.

For two years investigations have been conducted at the Tennessee Station relative to the preservation and feeding of legume silage. This year a project has been conducted in conjunction with this work to determine what effect feeding various rations to dairy cows might have upon the flavor of milk. Data relative to the flavor score, flavor criticisms and susceptibility of the milk to the development of oxidized flavor have been obtained.

Four groups of cows were used in this project. Groups I, II, and III were fed rations comparing alfalfa, corn, and sericea silages. Group IV, which was composed of all the cows on official test in the University herd, received a much heavier ration than either of the other three groups.

A comparison of flavor scores of milk from individual cows over a period of several months during the winter of 1939–1940 would indicate that although the feed consumed by cows does have some effect upon the flavor of the milk, as is evidenced by the presence of a feed flavor in the milk, this effect varies considerably between cows. Marked variations were consistently noted in the flavor score of milk from individual cows receiving identical rations. It was also noted that individual cows in a particular group produced milk that varied considerably in flavor score from one scoring period to the next, and no one cow was found to produce milk having a consistently high or low score. From the data collected to date, it would appear that other factors may have at least as much effect upon the flavor of the milk as the feed the cows consume.

Samples of milk from individual cows were tested for their susceptibility to the development of oxidized flavor by the addition of copper to the milk. Group IV was the only one of the four groups of cows used in this experiment which produced milk susceptible to the development of this flavor to such an extent that it would be considered serious. Practically every cow in the entire herd, at one time or another during the time this investigation was conducted, produced milk that developed at least traces of oxidized

flavor, but each individual cow in Group IV consistently produced milk that was very susceptible to the development of this flavor. There was some variation in the degree of concentration of the flavor developed in the milk from the individual cows in the group, but every cow in this group consistently produced milk which was definitely susceptible to the development of the oxidized flavor.

M17. The Relationship of Quality of Hay to the Development of Oxidized Flavor in Milk. W. CARSON BROWN, A. H. VANLANDIGHAM AND CHAS. E. WEAKLEY, JR., West Virginia Agricultural Experiment Station.

Both carotene and ascorbic acid supplements in the feed have been shown to render milk non-susceptible to oxidized flavor. Since the carotene content of hay is a widely variable factor, it seemed advisable to determine the relationship between hay quality and oxidized flavor.

Eight Jersey cows were selected whose milk developed metal-induced oxidized flavor on the normal herd ration. Throughout the entire experiment carotene, ascorbic acid, and flavor determinations were made each week. The flavor determinations were made by adding none, 0.5, 1.0, and 1.5 p.p.m. of copper to pasteurized milk prior to storage for 3 days at 35 to 40° F. At the end of the storage period the samples were scored by 3 persons familiar with the flavor. After 5 weeks on a preliminary herd ration, all the animals were changed to a low-carotene ration. This ration consisted of 8 pounds brown leafy alfalfa hay (0.58 mg. of carotene per 100 grams) and 12 pounds of beet pulp per day as roughage, with a grain mixture of 100 pounds ground oats, 100 pounds wheat bran, 15 pounds cottonseed meal, 3 pounds salt, and 2 pounds steamed bone meal fed according to production. After 4 weeks on the low-carotene ration the cows were divided into 2 groups producing milk about the same intensity of flavor. Group I was given the same ration as before except that the alfalfa was increased to 12 pounds per day while the cows in Group II were changed so that they received 12 pounds of bright, green alfalfa (4.30 mg. of carotene per 100 grams). After 5 weeks on this ration the cows in Group II had their ration supplemented by 2 pounds of alfalfa leaf meal (0.49 mg. of carotene per 100 grams) per day. Special care was taken to select hay of equal leafiness in both types of hay.

At the start and during the period of carotene depletion there did not appear to be any direct relationship between the carotene content of the milk and the intensity of the oxidized flavor developed. Even when the carotene content of the milk was reduced to about one-third of the quantity present at the start of the experiment, the oxidized flavor was not increased in intensity. However, the feeding of bright green alfalfa hay and alfalfa leaf meal resulted in an increased carotene content in the milk and a de-

crease in the intensity of the oxidized flavor developed. The level of the carotene in the milk after feeding the bright alfalfa was about the same as at the beginning of the experiment at which time the milk was susceptible to oxidized flavor. Even with the carotene content of the milk reduced to an extremely low level, no spontaneous development of oxidized flavor occurred. In general it appears that as the carotene content of the milk decreases the ascorbic acid increases. This relationship was rather general and daily fluctuations tended to obscure it.

From these results it would appear that there is no relationship between metal-induced oxidized flavor and the carotene content of the milk. Earlier work has shown that there is a relationship between carotene and ascorbic acid in the feed and oxidized flavor. Therefore it appears that susceptibility of milk to oxidized flavor is the result of a metabolic process involving carotene and ascorbic acid prior to the secretion of the milk, or the susceptibility is related to other substances accompanying these products in the feed.

M18. The Effect of Feeding Cod-Liver Oil on the Goaty and Oxidized Flavors, and Vitamin C in Milk. E. S. GUTHRIE, Cornell University.

This is the second report on the study of the effect of feeding cod-liver oil on the goaty and oxidized flavors, and vitamin C in milk. Last year four cows were fed cod liver oil for 59 days. This second report covers the feeding of cod-liver oil to six cows over a period of 164 days.

The cod-liver oil was administered in the first series of experiments by drenching. In the second set, the one this year, it was mixed in the feed of cows 3, 4, 5, and 6 during all of the oil feeding period. In case of cows 1 and 2 the oil was given both by feeding and drenching.

When it was found that the vitamin C would not climb to a high peak if the cod-liver oil was mixed with the feed, two of the least valuable cows were drenched. Cow 1 in this experiment was also No. 1 in the study of last year. She was the cow that responded most in the production of vitamin C in that first study.

The goaty flavor developed in the milk of only one animal in the group this year, whereas last year it was apparent in the milk of three of the four cows. This year, the goaty flavor appeared during the latter part of a feeding period and the first few days of the following rest period. This was also true in the three examples of last year. The vitamin C on the other hand was below average when the milk was goaty this year, whereas last year this flavor was noticeable when the vitamin C was present in abundance. It seems that there is no correlation between the presence of the goaty flavor and the amount of vitamin C.

There is an indication that cod-liver oil in the ration is a cause of the oxidized flavors.

When cod-liver oil was given at the rates of 0.5 ml. per kilogram weight of the cow the vitamin C remained constant. In case the cod-liver oil was administered by drenching at the same rate an increase of vitamin C was perceptible. Larger doses of cod-liver oil made distinct increases in Cow 1, reaching a high peak of 67 milligrams per liter of Vitamin C in the milk, when the average under normal conditions was about 27 milligrams per liter.

M19. Resistance of Thermoduric Bacteria to Chlorine Disinfection. A. C. MAACK AND M. J. PRUCHA, University of Illinois.

Occasionally difficulty is encountered in meeting the requirements for bacterial count in pasteurized milk because of the presence of thermoduric bacteria. The question has been raised as to the resistance of these organisms to chlorine disinfectants. The present study is an attempt to find the answer to that question.

The heat resistant organisms were found to be resistant to chlorine disinfection also. For example; one organism, non-spore forming, that required a temperature of 143° F. for 3½ hours to kill all of the bacterial cells also required chlorine strengths of 100 p.p.m. for 2 minutes or 20 p.p.m. for 5 minutes for its destruction.

It has been demonstrated that one of the main sources of these organisms are the utensils. Their resistance to chlorine disinfectants as well as to heat, may partly explain why they are present in milk in such large numbers as to be a problem in the dairy industry.

M20. Is the Standard Plate Count a Proper Yardstick of Quality? M. E. PARKER, Beatrice Creamery Company.

Today the standard plate count and possibly the number of coliform bacteria appear to occupy the center of the stage in the certification of sanitary quality of milk and its products. While we have come to accept certain numerical values as indicative of a proper sanitary quality, there is good reason to wonder if too much emphasis is not being placed on the quantitative significance of bacterial counts—particularly with respect to the pasteurized products. No one will deny that a "ceiling" for the total bacterial count in raw milk has practical value. The establishment of a "floor" for low counts in the raw or pasteurized milks, however, does not appear to be feasible. A good example of the false security possible in low bacterial counts is the widespread experiences with cappy or oxidized flavors in many a Grade A milk supply (both raw and pasteurized) during recent years.

Qualitative methods should prove valuable as they would tend to remove any elements of doubt regarding the true significance of practices which might otherwise be controversial. Mere bacterial numbers as enumerated

by the standard plate count are objectionable because of the variety of standards prevailing today which probably will be confusing no end with the projected changes in incubating temperatures and culture medium, not to mention the inherent inaccuracies of any cultural method of bacterial enumeration. Therefore, our plea is to pause and reflect. Consider quality control procedures objectively. Perhaps a good way to measure such intangibles as are involved in the quality control of dairy products—and we mean "quality control" in its broadest sense—is to apply qualitative methods in order to evaluate properly "quality." After all, John Ruskin was right when he said: "Quality is never an accident. It is always the result of intelligent effort."

M21. Control of Sediment in Homogenized Milk. A. J. HAHN AND P. H. TRACY, University of Illinois.

Sediment sometimes appears in the bottom of the bottle of homogenized milk twenty-four to forty-eight hours after bottling. This sediment generally contains leucocytes, epithelial cells, cell debris, protein material and dirt.

There is considerable variation in the cell content of milk from individual herds. Variations from a minimum of 203,840 cells per ml. to a maximum of 3,296,475 cells per ml. were observed, while the average count was 991,608 cells per ml. Samples from the same herds were again tested a week later with the result that the cell counts varied from a minimum of 121,030 cells per ml. to a maximum of 2,395,120 cells per ml. with an average of 890,295 cells per ml.

The extent of sedimentation in milk is related to the creaming ability of milk. When the creaming ability of milk was impaired or destroyed, either by homogenization or excessive heat treatment, the degree of sedimentation in that milk increased.

The degree of sedimentation in homogenized milk was increased by destabilizing the protein using calcium salts.

A chemical analysis, on a dry matter basis, of the sediment in homogenized milk showed that as the homogenization pressure increased there was also an increase in the percentage of protein contained in the sediment. The percentage of ash decreased with an increase in homogenizing pressure, while the percentage of ether soluble material underwent no changes.

From the standpoint of removing cells from milk, single clarification either using a clarifier unit or a separator unit and remixing the milk reduced the cell content on an average of 61.7 per cent and 51 per cent respectively. Filtration did not remove cells from milk appreciably. There did not seem to be any definite amount of cells removed from milk by clarification at any one time as data indicated variations throughout the entire clarifying period. The efficiency of cell removal by clarification increases with an increase in temperature.

Clarifying two or more times increases the extent of cell removal over a single clarification. Clarification after homogenization was more efficient than clarification before homogenization.

Pumping milk at slow speeds through an airtight clarifier results in greater clarification efficiency than pumping at the higher speeds.

Increasing the storage temperature of homogenized milk from 40° to 60° F. increased the degree of sedimentation of that milk. Placing the samples on a delivery truck for four hours where they could receive mild agitation did not increase the degree of sedimentation after 48 hours although the rate of sedimentation was increased to some degree.

M22. A Study of the Effect of Added Iodine and Hydrogen Peroxide to Milk on the Enzymes. MYER GLICKSTEIN, W. S. MUELLER AND J. H. FRANDSEN, Massachusetts State College.

A study of the effect of added iodine (both organic and inorganic) and hydrogen peroxide to milk was made in an effort to determine the possibilities of stimulating or inhibiting actions.

It was found that iodine and hydrogen peroxide in concentrations of as high as 100 p.p.m. in milk affects differently the activities of the enzymes studied.

Organic iodine stimulates catalase and peroxidase activities to a marked extent; inorganic iodine and hydrogen peroxide to a lesser degree. Lipase is adversely affected by the reagents used, with inorganic iodine showing the most drastic action.

Both types of iodine and hydrogen peroxide have a definite stimulating effect on gastric rennin, the action being most marked with organic iodine. Excessive use of these reagents produced inhibiting effects on the enzyme. Inorganic iodine has a paralyzing action on steapsin, whereas organic iodine and hydrogen peroxide have no significant effect on this lipolytic enzyme.

Inorganic iodine has a definite retarding action on the proteolytic enzymes, pepsin and trypsin. The action of organic iodine is less marked and that of hydrogen peroxide is negligible.

In general, it can be said that where there was a definite stimulation of enzymatic activity, organic iodine and, to a lesser degree, hydrogen peroxide were mainly responsible. In instances where inhibition took place, inorganic iodine was chiefly responsible and organic iodine and hydrogen peroxide had a materally reduced action, if any at all.

M23. A Study of the Time-Temperature Relationships in the Pasteurization of Milk as Regards Creaming, Phosphatase and Bacterial Destruction. R. F. HOLLAND AND A. C. DAHLBERG, New York Agricultural Experiment Station.

New and more rapid methods of heating, and the increasing use of high temperature–short hold pasteurization have created a need for a careful

study of the time and temperature relationships in the pasteurization of milk.

This investigation covers the temperature range 140° to 175° F. employing heating periods of only 2 to 10 seconds. The maximum holding periods which may be used without destruction of the creaming ability of the milk have been determined at each 5° interval over this range; also the minimum periods for the destruction of phosphatase and *Escherichia coli.*

The milk was brought to pasteurizing temperature in a thin walled tinned copper container $12 \times 20 \times 1$ cms. in size held in a hot water bath. After the proper temperature was attained this container was transferred to a constant temperature bath for holding.

Cream layer volume was determined by placing 100 ml. of the milk in graduated cylinders in ice water and observing the depth of the layer 4 hours and 24 hours after pasteurization. Phosphatase tests were run by the Gilcreas and Davis modification of the Kay and Graham method and by the Neave modification of the Gilcreas-Davis test.

The milk was inoculated with a resistant strain of *Escherichia coli* before pasteurization and the surviving organisms determined by plating on violet red bile agar. Five formate-ricinoleate gas tubes were inoculated with 1 ml. of milk from each sample as a check on the plates.

When the results of these determinations were plotted on semi-logarithmic paper with time on the vertical axis on the logarithmic scale and temperature on the horizontal axis on the arithmetic scale, the points were found to fall on a straight line in each case.

The maximum times at which milk may be held without reduction of creaming ability varied from 80 minutes at 140° F. to 2.5 seconds at 170° F.

Bacterial destruction followed the creaming line exactly between 140° F. and 155° F. and then dropped slightly below at the higher temperatures.

The line for phosphatase destruction denoting proper pasteurization fell below the creaming line and ran parallel to it until a temperature of 165° F. was attained when it dropped off sharply.

M24. The Relationship of Changes in the Chemical Composition of Milk to the Development of Mastitis. A. H. VANLANDINGHAM, CHAS. E. WEAKLEY, JR. AND E. N. MOORE, West Virginia Agricultural Experiment Station.

Since mastitis does not develop simultaneously in all quarters of the udder, and since negative quarters in affected udders secrete what seems to be milk of normal composition, a study has been made of the normal variation in the chemical composition of milk from individual quarters of the same udder. It appeared that a study of this kind might be of considerable value in diagnosing chronic mastitis in individual quarters of the same udder.

Approximately 250 udder examinations on 40 pure-bred Holstein cows have been made. The percentage of chloride, lactose, total nitrogen, and non-casein nitrogen was determined on samples of foremilk from individual quarters. The chloride-lactose number and the casein number were calculated.

Physical examination and the following diagnostic tests on samples of foremilk were made in conjunction with the chemical studies: strip cup, brom thymol blue, Hotis test, chloride (colorimetric), microscopic examination of incubated milk, leucocyte count, and blood agar plate.

The foremilk from individual quarters free from mastitis was found to contain an average of 0.124 per cent chloride, and 4.79 per cent lactose. The average chloride-lactose number was 2.61 and the casein number 77.6.

The mean difference between quarters in normal udders free from mastitis was for chloride content 0.007 per cent, lactose 0.115 per cent, chloride-lactose number 0.184, and casein number 1.00.

In order to detect incipient stages of chronic mastitis by changes in the chemical composition of the milk from individual quarters, the quarter with the lowest per cent chloride and chloride lactose number or the highest per cent lactose or casein number is considered normal. For a significant difference between normal quarters and affected quarters there must be a difference of at least 0.02 per cent chloride, 0.36 per cent lactose, 0.60 for chloride lactose number, and 2.90 for casein number. This difference, for significance, is equal to the mean difference between normal quarters, plus two times the standard deviation of normal quarter differences.

Diagnosis of mastitis based upon quarter differences tends to eliminate difficulty due to changes in the chemical composition of milk from time to time as well as changes associated with advanced stages of lactation.

Individual quarters invariably showed bacteriological changes in the foremilk before a change in the chemical composition of the milk was apparent.

M25. The Determination of Copper in Butter. W. F. EPPLE AND B. E. HORRALL, Purdue University.

A review of the literature on the determination of copper in dairy products revealed that no one method was entirely satisfactory. This study has proven that for the determination of minute quantities of copper in dairy products, the colorimetric method using the neutral wedge photometer, was most satisfactory. The method as finally adopted is a combination and modification of the Williams[1] wet ashing method and the colorimetric method of Clifford and Wichmann.[2]

Method. To 50 gms. of butter in a 250 ml. beaker, 15 ml. C.P. nitric acid was added and slowly digested on a steam bath until both layers were clear.

[1] J. Dairy Research, **3**, 1931.

[2] J. A. O. A. C., **19**, No. 1, 1936; **22**, No. 2, 1939.

The covered beaker was then cooled in a refrigerator until the fat layer congealed. The congealed fat layer was punctured and the nitric acid layer drained into a 500 ml. Kjeldahl flask. The fat was washed by adding 50 ml. of glass distilled water, heated until the fat melted with occasional swirling of beaker, then cooled and the water layer added to the nitric acid in the Kjeldahl flask. This procedure was repeated three times. Ten ml. of concentrated sulfuric acid were added to this mixture and slowly heated on a Kjeldahl digestion apparatus until the contents assumed a black frothy consistency, after which the flask was removed from the rack and allowed to cool. Then four to five drops (about 0.2 ml.) perchloric acid (70 per cent) were added with caution. After the decomposition of organic matter, the heat was increased to volatilize the excess acid and this continued until about three ml. remained. After cooling, the residue was transferred to a 250 ml. separatory funnel with small portions of hot distilled water and neutralized with ammonium hydroxide using litmus paper (any great excess was avoided). Ten ml. of 15 per cent solution of citric acid were added and the whole diluted to 90 ml. When at room temperature, 10 ml. of 0.1 per cent sodium-diethyl-dithio-carbamate solution were added and the contents well shaken. To this mixture, 20 ml. of redistilled carbon-tetra-chloride were added and the mixture shaken vigorously until complete extraction of the color by the solvent was obtained.

The carbon-tetra-chloride was filtered into the standard tube and the color measured with the use of a neutral wedge photometer. The light filter used was a Wratten No. 62 Hg. Green (530 mμ) mounted in B glass. The tube was 150 mm. in length and 12 mm. in diameter.

Results. The data show that a high percentage of recovery is possible when known concentrations of copper are carried through the entire method.

The method permits the use of a large sample without the possibility of reagent contamination.

The photometer used is sensitive through a color range of 5 to 50 p.p.m. of copper.

M26. The Uniformity of Butter Composition as Related to Type of Churn. S. L. TUCKEY AND P. H. TRACY, University of Illinois.

The production of butter of uniform composition is one of the essentials of good plant management. One of the important factors in the production of butter of uniform composition is the type and construction of the churn.

Even though churning load, churning temperature, butter granule size, wash water temperature, and other important factors may be properly controlled, it will be impossible for the operator to produce butter of uniform composition if the churn is of such construction that it permits excess water to remain at one end or the center of the churn.

For this analytical study butter samples were obtained from several types of churns under commercial operating conditions. For comparison,

four samples were secured from each end and from the center of each churn. In this experiment over 200 samples were analyzed by the Kohman method.

Our data serve to stress the importance that each operator know the characteristics of his particular churn since no particular type or make of churn was found to produce butter of uniform composition consistently. New workerless churns were found in which the butter taken from the two ends varied over 1 per cent in composition. Also workerless churns were found that produced butter of uniform composition; samples taken from the two ends showing a variation of only 0.1 per cent. These statements may be applied also to worker type churns. Some worker churns which had been remodeled to act as workerless churns produced butter of greater uniformity than that produced before the rollers were removed.

M27. Changes in the Bacterial Flora of Butter. C. A. WILSON AND M. J. PRUCHA, University of Illinois.

Bacterial deterioration of butter is still largely an unsolved problem of the dairy industry, although it has been the subject of a considerable amount of research.

The following study, consisting of observations of the changes in the bacterial flora was made in an effort to throw additional light on the subject.

Butter samples were made from sour, neutralized cream which had been processed by three different methods of pasteurization. Studies were made on the raw cream, pasteurized cream, fresh butter, and butter stored for 3 weeks at 65° F. and for 4, 8, and 12 weeks at 40° F.

The method of study consisted of making agar plates of suitable dilutions. Usually the plates that had about 50 colonies were selected and all the colonies were picked and inoculated into sterile litmus milk. The microbial flora was divided according to the reaction in the litmus milk after two weeks of incubation at 90° F. into the following groups:

1. Fast acid formers—milk clabbered.
2. Slow acid formers—milk not clabbered.
3. Alkali formers.
4. Sweet curd formers.
5. Peptonizers.
6. Inert—no visible reaction.

The microbial flora in the raw cream consisted chiefly of the rapid acid producing coagulating organisms. After pasteurization, the rapid acid organisms decreased but the flora was still predominantly acid forming. The slow acid formers became more numerous on percentage basis. The percentage of acid formers in the raw and pasteurized cream tended to remain quite constant.

In the freshly made butter, the percentage of the acid formers decreased and the percentage of the alkali-formers, of the peptonizers and of the inert increased.

Three weeks storage of the butter at 65° F. resulted in an almost complete elimination of the acid forming organisms. The microbial flora consisted mostly of the alkali-formers and of the inert types.

The flora of the butter stored at 40° F. tended to remain of the same kind as that of the fresh butter.

No marked differences were observed between the bacterial flora of the cream pasteurized by the three different methods or between the butter made from these creams.

M28. Some Preliminary Observations on the Effectiveness of Propionates as Mold Inhibitors on Dairy Products. J. D. INGLE, Swift & Company Chemical Laboratories.

Several series of tests were run on fresh cut blocks of natural cheese wrapped in tinfoil, moisture-proof cellophane, or pliofilm. The samples were either dipped in propionate solutions or the wrappers sponged with the solutions. The results indicated that sponging the wrappers has little effect in holding down surface mold. Samples dipped in 8 per cent propionic acid held up about twice as long before showing visible mold as compared to the controls. Eight per cent calcium and 8 per cent sodium propionate treated samples were somewhat better than the controls but did not approach the 8 per cent propionic acid in effectiveness.

Tests made indicate that small percentages of sodium or calcium propionate incorporated into processed cream cheese are only slightly effective in holding down surface mold. The most effective method of holding down surface mold on cold packed cream cheese was found to be that of waxing the wrappers with a wax containing propionic acid.

Tests made on unsalted butter stored at 60° F. and 100 per cent humidity indicated that wrappers containing either 6 per cent calcium propionate or 12 per cent sodium propionate greatly inhibited the growth of mold on the surface of the butter. Wetting the propionate impregnated wrappers before wrapping gave better results than using the dried impregnated wrappers.

There seemed to be little difference in effect between the parchments treated with sodium and calcium propionates.

M29. Propionic Acid and Its Calcium and Sodium Salts as Inhibitors of Mold Growth. J. C. OLSON AND H. MACY, University of Minnesota.

A study has been made to determine the effectiveness of propionic acid, calcium propionate and sodium propionate in inhibiting the growth of various species of mold on the surface of butter and in culture media.

It has been found that it requires less calcium propionate by weight, than sodium propionate to inhibit the development of molds on media and on the

surface of butter wrapped with parchment treated with solutions of the propionates. Further, it requires a much lower concentration by weight of propionic acid to bring about the same degree of inhibition.

The final pH of media containing either of the salts is an extremely important factor in restraining mold growth, for example, with a two per cent concentration of sodium propionate in potato dextrose agar, the reaction was approximately at pH 7.00 and relatively rapid and abundant mold growth occurred. When the medium was brought to pH 6.1 by the addition of lactic acid no growth occurred in five days.

Some difference in the tolerance of several genera of molds to propionic acid and its sodium and calcium salts has been noted. Of those studied, Penicillium species showed the greatest tolerance.

In an attempt to determine the agent actively responsible for the inhibitory effect of the salts and the acid, several observations have been made. In potato dextrose agar to which had been added sufficient propionic acid to give a 0.009 M concentration the growth of *Hormodendrum cladosporioides* was relatively abundant; when 0.4 gm. of sodium propionate was added to 100 ml. of such acidulated medium, growth was completely checked, but when 0.4 gm. of sodium propionate alone was added to 100 ml. of potato dextrose agar containing no propionic acid there was abundant growth. This observation and other experimental results point to the possibility that the undissociated propionic acid is responsible for the growth inhibition.

M30. Some of the Factors Affecting the Phosphatase Values of Butter.

W. H. Brown, Purdue University.

The application of the phosphatase test to sour cream butter presents a more complex problem in the interpretation of the results than the application of the test to sweet products. Studies were made to determine some of the reasons for inaccuracies that may occur which are not directly due to the technique of the test. The methods used were those developed by Scharer.

The concentration of the phosphatase enzyme in cream has been recognized. There is a further concentration of the enzyme in butter during the buttermaking process. This fact may give rise to a positive phosphatase value for butter, if the suggested milk standards are used, even though the cream gave a negative test.

An increase of the phosphatase value of butter from a negative to a positive test during a storage period of 10 days at 60° F. has been encountered in approximately 10 per cent of the samples analyzed. This increase in phosphatase value also occurred at temperatures considerably lower than 60° F. However, the values obtained on butter samples held at 0° F. remained constant for three years. The possibility that this increase might be due to the production of the phosphatase enzyme by micro-organisms has

been investigated. Many micro-organisms were isolated which are capable of producing the enzyme in milk and cream, but none of these organisms produced the enzyme in butter. By increasing the incubation period in determining the phosphatase value of fresh samples, it was possible to predict, in many cases, those samples which changed from negative to positive during storage.

Slow cooling of the cream after marginal pasteurization has been found to affect the phosphatase reaction of the cream and butter.

It was found that the enzyme phosphatase is not acid tolerant. As the development of acidity in raw cream increases, the destruction of the phosphatase enzyme increases.

M31. Effect of Salt on the Keeping Quality of Cream. W. J. CAULFIELD, F. E. NELSON AND W. H. MARTIN, Kansas Agricultural Experiment Station.

In each of a series of four trials, four samples of 30 per cent cream to which salt in quantities equal to 0, 7, 10, 13 and 16 per cent of the weight of the fat-free serum was added, were held at 60, 70, 82, and 90° F. for 10-day periods. Changes in acidity, formol titration and grade were followed, observations being made at 1, 2, 3, 4, 5, 6, 8 and 10 day periods. Changes in the bacterial flora of two samples were followed by direct microscopic observations. All control samples deteriorated rapidly, and at 80 and 90° F. became unlawful within five days. At 60° F., 7 per cent salt kept the cream from going below first grade in all samples, but at higher temperatures this concentration was not sufficient to keep the cream from becoming second grade or lower. Salt in 10 per cent concentration kept the cream from changing from sweet to first grade at 60 and 70° F. but was considerably less effective at 82 and 90° F. where much second grade cream resulted when this salt concentration was used. Salt in 13 and 16 per cent concentrations kept the cream sweet through a five day period at all temperatures, with the exception of two samples, and through the 10 day period at 60 and 70° F. with but one exception. At 82° F. these two salt concentrations kept all samples from becoming second grade, but at 90° F. second grade cream was obtained in about half of the samples. The data from acidity and formol titrations and the bacteriological observations corroborate the results of the organoleptic grading.

In each of a series of four other trials, the addition of 13 per cent salt on a serum basis to the cream after holding at 70° F. for 3, 4, 5, and 6 day intervals did not prevent further deterioration during the remainder of a 10 day storage period.

In three additional trials, creams to which 13 per cent salt on a serum basis was added and control lots of the same creams without salt were held at 70° F. for 10 days. The resulting creams were then neutralized if neces-

sary, pasteurized at 150° F. for 30 minutes and churned, unsalted butter being made. After storage the control creams were all low second grade, while the creams to which salt had been added were all on the border line between sweet and first grade. Acidity and formol titrations and bacteriological results again corroborated the organoleptic findings. The fresh butter from the creams to which salt had been added graded 92, 92, and 92.5, while the butters from the control creams graded 87, 90, and 90 respectively. No change in score occurred after storage at −10° F. for 60 days, indicating no greater tendency for chemical change in the butters from the salted creams.

Unsatisfactory butterfat tests were obtained on the cream to which salt had been added when the usual Babcock procedure was employed. When a modified procedure was used, results which agreed favorably with the calculated butterfat percentages were obtained.

Summary. The results indicate that the deterioration of cream, held without the benefit of adequate cooling, may be retarded by the addition of salt. The amount of salt necessary will depend upon the time and temperature of storage. The addition of salt will not prevent further change in cream which has already undergone appreciable deterioration and thus the method is limited largely to farm use.

M32. The Chemical and Bacteriological Changes in Brick Cheese During Manufacture. J. C. Garey, E. M. Foster and W. C. Frazier, University of Wisconsin.

Changes in the numbers of bacteria in brick cheese were followed by means of cultural and direct microscopic methods.

When *Streptococcus lactis* was the only starter used, no growth of this organism took place in the vat when cooking temperatures were 104° F. or 112° F. At the lower cooking temperature, the numbers of *S. lactis* increased slowly until the fourth to sixth hour after dipping, then multiplication became very rapid. The maximum numbers of bacteria were attained 20 to 24 hours after dipping. At the higher cooking temperature, the beginning of rapid growth was delayed until the sixth to eighth hour after dipping. Maximum numbers again were reached 20 to 24 hours after dipping. At that time the pH of the cheese varied from 4.9 to 5.1.

When only *Streptococcus thermophilus* was used as starter, growth of this organism began almost immediately, continued rapidly during curd-making (cooked at 104° F.) and in the dipped curd until the third or fourth hour after dipping. Maximum numbers were reached 10 to 12 hours after dipping. At that time the pH varied from 5.2 to 5.35. When the cooking temperature was raised from 104° F. to 112° F. the period of rapid growth was longer and maximum numbers were higher.

When both *S. lactis* and *S. thermophilus* were used (cooking temperature 104° F.) and their proportions varied, a 1:1 ratio (0.5 per cent each) was

found to produce the most desirable type of brick cheese. When this proportion was used, the cessation of growth of *S. thermophilus* and the beginning of rapid growth of *S. lactis* overlapped. This resulted in a steady growth of starter bacteria throughout the making process until the maximum numbers were reached 20 to 24 hours after dipping. At that time the pH was 5.0 to 5.15.

The moisture at two weeks in all of the above cheese ranged from 37.5 to 40.0 per cent.

By means of a washed-curd method, sweet cheese was made with 42 to 44 per cent moisture at two weeks. The washing process removed about 40 per cent of the lactose.

In a study of the development and prevention of "early gas" it was found that 2.5 per cent of starter (0.5 per cent *S. thermophilus* and 2.0 per cent *S. lactis*) would prevent "blowing" when conventional manufacturing methods were used. This was not true with the washed curd methods, where it was found that 3.5 per cent starter (0.5 per cent *S. thermophilus* and 3 per cent *S. lactis*) failed to prevent "blowing." This defect could be prevented in the washed curd process by cooking to 120° F. and using 0.3 per cent *S. thermophilus* and 0.5 per cent *Lactobacillus bulgaricus*. Gassiness in the cheese was also prevented by pasteurization of the milk.

The bacteriological study of the interior of brick cheese during ripening revealed that the *S. lactis* types of bacteria eventually predominated. The *S. thermophilus* types decreased rapidly in numbers even when *S. thermophilus* was added. A few species of lactobacilli, notably *Lactobacillus casei,* appeared in the raw milk cheese after about two to three weeks and gradually increased in numbers thereafter.

M33. The Control of Abnormal Bacterial Fermentations in the Manufacture of Swiss Cheese. LLOYD A. BURKEY, MORRISON ROGOSA AND ROBERT R. FARRAR, Bureau of Dairy Industry, U. S. Department of Agriculture.

A study of bitter flavor and reddish spots in Swiss cheese indicates that these abnormalities are caused by equipment contamination.

Bitter, peppery, and other off-flavors in Swiss cheese were associated with the presence of large numbers of aerobic spore-bearing bacteria. These bacteria were isolated from a sample of bitter cheese which was typical of over one third of the cheese made in one section of the country. The isolated cultures are similar in many respects to *Bacillus vulgatus* and *Bacillus mesentericus*. They are actively caseolytic and produce a distinct bitterness in sterile whole milk but only a slight bitterness in sterile skimmed milk.

Studies made of these cultures under various conditions, including experimental work in laboratory Swiss cheese, show that they are resistant to high temperatures, will grow and attain numbers well over a million per

gram in cured cheese, persist several months in the cheese making equipment, and can be eliminated from this equipment only by severe sterilization methods.

Bitterness in Swiss cheese from this cause is believed to be associated with high moisture. Factors which inhibited the development of the bitter forming bacteria in Swiss cheese were:

(1) The use of an active culture of *Streptococcus thermophilus* with a correspondingly rapid production of acid at the period three hours after dipping.

(2) Adherence to a making process of high cooking temperature (over 53° C.), short foreworking, and a long "stirring out" period.

(3) Addition of salt to the kettle milk and heavy salting during the curing process.

The presence of reddish or brown spots in cured Swiss cheese was found to be caused by the development in the cheese of a contaminating type of propionic acid bacteria persisting in cheese making equipment. In several instances, crevices, roughness, or bad joints in equipment apparently provided places of lodgment for these contaminants.

Suggestions for the prevention of losses caused by these defects are as follows:

(1) Elimination of roughness or places of lodgment for bacteria in all equipment.

(2) Daily thorough cleaning of all equipment.

(3) Occasional sterilization of all equipment by means of prolonged hot water treatment or use of an efficient chemical disinfectant.

(4) The use of pure culture starters of proper activity.

It is believed that laxity in care of cheese making equipment and failure to use active starters of known purity, are responsible for other defects in Swiss cheese associated with abnormal eye formation.

M34. The Effect of Heat-Treatment of Milk on the Activity of Swiss Cheese Starters. M. E. TYLER AND H. H. WEISER, The Ohio State University.

The normal ripening process involved in the manufacture of Swiss cheese depends largely on the biochemical activity of the micro-organisms used in the starter. Under factory conditions, the heat-treatment of the milk used in the preparation of the bulk starter may vary widely and may influence the activity of the starter, assuming that other environmental factors are properly controlled. It was decided, therefore, to study the effect of various heat-treatments of the milk, made immediately prior to inoculation, on the activity of the starter organisms. In this study, 18 strains of streptococci and lactobacilli used in the manufacture of Swiss cheese were employed.

Fresh, raw, whole milk was dispensed in 75 cc. amounts in large, sterile

test tubes, and each tube of milk was heated at a given temperature for a given time interval as follows:

Series I. Samples of milk heated at 80° C. for 1, 2, 3 and 4 hour periods.

Series II. Samples of milk heated at 100° C. for 1, 2, 4 and 5 hour periods.

Series III. Samples of milk heated at 120° C. for 15, 30, 45 and 60 minute periods.

At the end of the heating period the milk was cooled to room temperature and the redox potential was determined, the hydrogen-ion concentration remaining fairly constant. The saturated calomel half-cell, a Model 3C Coleman potentiometer and bright platinum foil electrodes were employed in the determination of the potential. The samples were then inoculated with a Swiss cheese starter culture, amounting to 1 per cent of the volume of each sample. Incubation of these samples was at 37° C. for 24 hours.

The activity of the various starter organisms was determined by titrating the cultures for acidity, using 10 cc. amounts, 0.10 N NaOH, and phenolphthalein as the indicator. The titration was carried out after the starters were incubated at 37° C. for 12 and 24 hours.

It was noted that as the heating period was prolonged at 80° C., 100° C., or 120° C., the Eh curve showed a significant decrease. Milk heated at 80° C. showed very little change in the acid production. When the milk was heated at 100° C. for 2 or 4 hours the maximum amount of acidity was produced by all the cultures studied; a minimum amount of acid was formed in milk heated for 1 hour, while the 5-hour heating period showed considerable variation in the amounts of acid produced by the various organisms. The greatest amount of acid that was formed in the milk heated at 120° C. occurred in the 30 or 45 minute periods, the 15 and 60 minute periods exhibiting a wide range in acid production.

It appears that the use of proper time and temperature of heating the milk employed in the preparation of bulk starters has a favorable influence on the activity of the various starter organisms used in the ripening of Swiss cheese. This may be due to the fact that the Eh of the milk is lowered, thus providing a more satisfactory cultural environment for the micro-organisms concerned.

M35. The Standardization of Fat in Swiss Cheese and the Relationship of Fat to Quality. GEORGE P. SANDERS, ROBERT R. FARRAR, FRED FEUTZ AND ROBERT E. HARDELL,* Bureau of Dairy Industry, U. S. Department of Agriculture.†

1. *Estimation of percentage of fat in dry matter.* For securing results on composition promptly without plugging the cheese, a method has been

* Resigned March, 1940.

† In cooperation with the Departments of Dairy Industry of the University of Wisconsin and the Ohio State University.

devised for preparing pressed samples of kettle curd for analyses. Samples of curd are taken from the kettle, just prior to dipping, by means of strainer-bottom dippers. Two such samples are placed in a perforated-bottom, metal cylinder, a 1000-gram weight is inserted, and excess whey is thus squeezed out. The composition of the sample approximates that of the cheese. Its firm, compact condition, like that of the cheese, permits it to be cut into strips for the fat test. In 355 sets of samples, values of fat in dry matter of pressed curd were within 1 per cent of those found in the corresponding cured cheese in 70 per cent of the cases, and within 2 per cent in 95 per cent of the cases. For efficient standardization it is recommended that, in addition to frequently analyses of pressed curd and cured cheese, fat tests be made of milk samples from every kettle.

2. *Relationship of percentage of fat in dry matter to quality.* Tabulations of analytical and grade data for 632 cheeses, sampled in 39 factories principally in Wisconsin and Ohio, indicate that highest average quality was found in cheese containing 45–46 per cent fat in dry matter, and that cheese in which the values exceeded this range was somewhat superior to that which contained less than 45 per cent fat in dry matter. In controlled comparisons on 30 pairs of laboratory cheese made from high-solids milk, yielding cheese that was rather firm in texture, cheese containing an average of 48 per cent fat in dry matter was superior to that containing less than 45 per cent.

M36. Improving the Quality of Swiss Cheese Through Applied Research and Technical Control. ROBERT R. FARRAR, Bureau of Dairy Industry, U. S. Department of Agriculture.

Improvements were made in the quality of the Swiss cheese produced by a large factory in Idaho during the four summer months of 1939, using the methods recommended by the Bureau of Dairy Industry.

The proportion of low quality or grinder cheese was reduced to 28.6 per cent for the period as compared with 63.3 per cent for the same four months the previous year. During August, the last month of this project, the grinder cheese amounted to 11.6 per cent of the total make as compared with 58.1 per cent the previous year. Under the conditions then prevailing the returns were 33 per cent more for a C grade cheese than for a grinder cheese.

Improvement in the quality of the cheese was effected through (1) the introduction of pure culture starters and improved methods of starter propagation, (2) improvement of the quality of the milk, (3) changes in the manufacturing methods used, including composition control, and (4) improvement in curing-room management.

The improvement in cheese grades effected during late May and during the first several weeks of June can be attributed primarily to starter improvement.

As a result of a milk quality improvement program among the producers the individual methylene blue reduction time was increased from an average of 1.5 hours on May 30 to 5.5 hours on August 10 when general conditions were not as favorable. The temperature of the milk at the intake averaged 7° F. lower on this latter date. An average methylene blue time of 5.5 hours was necessary to obtain a 3-hour reduction time in the kettle milk. Kettle milks having approximately a 3-hour reduction time yielded the highest average quality cheese.

In an attempt to produce the highest average quality cheese the milk was sorted at the intake on the basis of methylene blue time, acidity, and odor; the "poor" milk cheeses graded 78.6 per cent grinders for the 4 months and the "good" milk averaged 19.5 per cent grinders. For the month of August the "poor" milk cheese graded 70.6 per cent grinders as compared with 4.3 per cent for the "good" milk cheese.

The manufacturing methods were changed to meet the changing characteristics of the milk and to produce as nearly as possible a cheese containing less than 40 per cent moisture and at least 45 per cent fat in dry matter. Controlling the acid development at 3 hours after dipping within the range of pH 5.90 to 5.70 was effective in preventing "pressler" cheese.

Changes were made in curing-room management to slow up the rise of the cheese and to provide more salt. The relative humidity of the curing rooms was corrected.

Shrinkage during the usual two-month curing period, through changes in manufacturing methods and curing room humidity, was reduced to a normal figure of 7.59 per cent, as compared with a former extreme of 14 per cent.

Similar improvement in cheese quality was effected at a Pennsylvania Swiss cheese factory where visits of several days duration were made at six-week intervals.

M37. Relation of Salt Content to Bitter Flavor Development in Cheddar Cheese. S. L. TUCKEY AND H. A. RUEHE, University of Illinois.

The flavor of cheddar cheese is the result of the action of several factors, the more important of these being bacterial development, acidity development, moisture content, and salt content. For several years the authors have judged cheese at the Illinois State Fair, and one of the most common defects in these cheese samples was the presence of a bitter flavor. It was also noted that this bitter flavor was not necessarily associated with characteristic acid defects. Cheese made at the College Creamery also frequently developed this characteristic bitter flavor. In an attempt to determine the cause and, if possible, the remedy for this defect, a study was undertaken to determine the relationship between the salt content of cheese and bitter flavor development.

Ten lots of cheese were made using 3000 pounds of 3.5 per cent–3.7 per cent milk in each lot. The procedure was such that the whey was drawn at 0.14 per cent acidity, the curd milled at 0.5 per cent acidity, and salt was added at the rate of 2.6–2.7 pounds per 1000 pounds of milk. The finished cheese had a moisture content of 36–37 per cent. The salting period lasted 60 minutes; however, at regular intervals during this time part of the cheese was taken from the vat and packed in longhorn molds. These samples were used for analyses and judging. Salt determinations were made by the distillation method of Whitmore and Overman. Our results show that:

1. The average salt content of cheese salted for 20 minutes was 1.33 per cent; for 40 minutes was 1.60 per cent; and for 60 minutes was 1.70 per cent.
2. The cheese salted for 20 minutes and 40 minutes developed a lower pH than did the cheese salted for 60 minutes although not low enough to develop acid defects in the body.
3. The cheese salted for 20 minutes developed a bitter flavor, and this flavor was detected often in the cheese salted for 45 minutes, but the flavor was not present in the cheese salted for one hour providing the salt content was 1.7 per cent or more.
4. There is a close correlation between a low salt content of cheddar cheese and a characteristic bitter flavor.

M38. More Accurate Determinations of Volatile Fatty Acid and Other Changes as a Means to Study Cheddar Cheese Curing. J. C. MARQUARDT AND A. C. DAHLBERG, New York Agricultural Experiment Station.

An investigation has been started to develop analytical procedures to follow and interpret changes in the curing of cheddar cheese. It is eventually planned to use these methods to obtain a better understanding of the causative factors for differences in the curing of raw and pasteurized milk cheese, the seasonal variations in curing, and the role of lipase in cheese curing.

The investigation up to the present time has been devoted to the development of suitable procedures for following fat changes in the curing of cheddar cheese. Literature reviews have indicated that methods commonly used are subject to irregularities. It has been established that the amounts of volatile fatty acids obtained by extracting fat by pressure or water-ether solution from the cheese are far greater than those which are obtained directly from the cheese by steam distillation. The studies have also shown the difficulties encountered collecting certain quantities of distillate and expressing for comparative purposes the values obtained with these amounts.

It has been found that salt, moisture, protein, and fat determinations are essential on all cheese and the component parts used in the studies. These are used mainly to augment analyses which follow.

In the studies we have determined the amounts of cheese to use depending upon the age of the cheese for steam distillation so that all of the volatile fatty acids will be obtained in the first 2000 cc. of distillate. Similarly suitable amounts for the extracted fat for steam distillation have been determined. All of these values are finally reduced to comparable terms. It has been possible to perfect methods to show that the amount of volatile fatty acids which can be steam distilled from pressure extracted fats are two or more times greater than those obtained by steam distilling the cheese. Higher values are also obtained when water-ether extracts of the cheese are steam distilled.

The purpose of the study up to the present time has been to develop procedures whereby the fat changes in curing cheese can be more accurately studied.

M39. Effect of Lipolytic Enzymes on the Ripening of Cheddar Cheese. C. B. LANE AND B. W. HAMMER, Iowa Agricultural Experiment Station.

Studies have been continued on the development of flavor in cheddar cheese. Since the relatively high acid numbers obtained on fat from ripened cheese suggest the importance of a limited fat hydrolysis, the effect of lipolytic enzymes on cheese ripening was studied.

Lots of cheese were made in which lipolytic enzymes were added to the pasteurized milk used for cheesemaking. Control cheese not containing the enzymes were made from the same original lots of milk. The cheese were examined organoleptically several times during a ripening period of 3 months.

Pancreatin had a rather undesirable effect on the cheese flavor even when added in very small concentrations. A disagreeable rancid condition was regularly produced and persisted during the entire ripening period.

Desiccated, bovine mammary tissue or water extracts of it appeared to have a desirable effect on the cheese ripening. Different lots of tissue varied considerably in lipolytic activity so that it was difficult to determine suitable amounts to employ. Satisfactory results were commonly obtained with 25 to 35 gm. of tissue or the equivalent in extract to 1000 pounds of milk. Cheese made with the tissue or its extract usually developed "cheddar" flavor more rapidly than the control cheese, and the body and texture were often considered more desirable. When a relatively large amount of tissue (100 gm. to 1000 pounds of milk) or when a smaller amount of highly lipolytic tissue was employed, a rancid flavor sometimes developed in the very young cheese, but it disappeared as the cheese aged.

Standardization of extracts of mammary tissue on the basis of lipolytic activity is being attempted.

M40. The Purification of Rennin. C. L. HANKINSON* AND L. S. PALMER, University of Minnesota.

Two liters of Hansen's rennet extract were adjusted to a pH of 4.5 with 7.0 ml. of concentrated HCl. A precipitate formed readily and was centrifuged for 20 minutes at 2000 r.p.m. The supernatant liquid was poured off and the precipitate was dispersed in sufficient 16.7 per cent NaCl solution (20 gm. NaCl per 100 ml. H_2O) to make one liter volume. The pH was adjusted to 6.0, whereupon the precipitate all dissolved. The pH was again adjusted to 4.5 and the suspension centrifuged for 20 minutes. The precipitate was dissolved in 16.7 per cent NaCl at pH 6.0 and made up to 500 ml. volume with the solvent. There was some sediment at this point. This was centrifuged out since previous work had shown it to be relatively inactive. The pH was then adjusted to 4.5 and the suspension centrifuged for 20 minutes. The precipitate was dissolved in the 16.7 per cent NaCl, made up to 250 ml. with solvent and the pH adjusted to 6.1. Again there was considerable sediment which was centrifuged out. Activity determinations were made on the final liquid and on the original rennet extract. The solution was stored in a cold room at 2° C. Portions were dialyzed as needed.

By following the activity per unit weight of dry material in the precipitate and supernatant liquid, it was found that the most active rennin preparation could be obtained by the above procedure. Precipitation at varying pH with varying salt concentrations and different kinds of salt led to this procedure. It was found that the most active rennin material behaved as a globulin, (1) being soluble in dilute salt solution, (2) insoluble in saturated salt solutions, (3) precipitating at the isoelectric point pH 4.6, and (4) precipitating upon electrodialysis. This is in contrast to reports in the literature that rennin is an acid albumin (Fenger, 1923), thioproteose (Tauber and Kleiner, 1932) or some non-protein material (Lüers and Bader, 1927). The reddish brown or coffee-brown color is not associated with the rennin activity as believed by Richardson and Palmer. Most of this colored material is left in the first supernatant liquor at pH 4.5.

This procedure has the further advantage of separating the peptic or proteolytic from the purely rennin active material. Most of the peptic activity is left in the first supernatant liquor at pH 4.5. Thus there may be some association between the pepsin and the reddish brown colored material.

This rennin preparation shows an increase in activity of nearly four times that of the original extract while 92.5 per cent of the proteolytic activity has been removed. It was found possible to store the enzyme in 16.7 per cent NaCl solution at 2° C. with very little loss of activity in three months.

M41. The Effect of Standardizing the Acidity on the Methods and Physical and Chemical Properties of Cottage Cheese and Cul-

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tured Buttermilk.* L. E. MULL AND W. H. E. REID, Missouri Agricultural Experiment Station.

In this investigation, a study was made of the effect of adjusting the acidity at different steps in the manufacturing process upon the physical and chemical properties of cottage cheese and cultured buttermilk.

It was found that cottage cheese curd washed in water containing variable increments of standardizing agent produced a clean, sweet, mild flavored curd. High concentrations of standardizer had a tendency to produce a weak bodied, slick curd, and in some instances a gelatinous material formed around the curd particle.

Adjusting the acidity in the cream used in creaming the curd enhanced the flavor of cottage cheese. The curd, creamed with low acidity cream, maintained a higher pH and a lower acidity throughout the storage period than did curd creamed with normal acidity cream.

Adjusting the acidity in the skim milk before setting, and varying the amount of starter and rennet improved the flavor and body, and reduced the time from setting to cutting of the curd to approximately two and one-half hours.

The use of an excessive amount of standardizer in the storage water resulted in an undesirable flavored curd with an inferior keeping quality.

A clean, full, mellow flavor, and a smooth body of a desirable viscosity was obtained in cultured buttermilk by adjusting the acidity in the milk before setting. There was no indication of wheying-off at the end of a seven-day storage period. Adjusting the acidity in the milk, increasing the amount of starter, and raising the setting temperature produced a high quality cultured buttermilk in approximately five hours.

M42. The Use of Homogenized Milk in the Manufacture of Cottage Cheese. D. W. GLOVER AND L. H. BURGWALD, Ohio State University.

Since the advent of homogenization, dealers selling homogenized milk have been confronted with a problem of utilization of returns. One method for utilizing returns of bottled homogenized milk is to manufacture it into cottage cheese.

Experimental batches of cheese were made using homogenized milks of various butterfat content. The trials were made in groups ranging in number from three to five, each group including one batch from skimmilk for a control. It was found advisable to add calcium chloride to the homogenized milk to increase the coagulability; one cubic centimeter of a saturated solution was added per 100 pounds of milk in the vat. A setting temperature of 70° F. and the acid-rennet method of coagulation was used (1.0 cc. rennet per 1,000 pounds milk). Fat and solids determinations were made using the Mojonnier method.

* Missouri Experiment Station, Journal Series No. 626.

Keeping quality of homogenized milk cheese and creamed curd of equal butterfat content were compared by storing the samples at 45° F.; samples were judged for flavor daily or every two days. In every trial, the same amount of cream was added per 100 pounds of curd, and the butterfat content of the cream was varied to meet the fat requirements. Homogenized milk cheese of a given butterfat content exhibited better keeping qualities at 45° F. than cheese from skimmilk brought up to an equivalent butterfat percentage by adding cream pasteurized at 143° F. for thirty minutes.

Results of preliminary trials in which four, three, and two per cent homogenized milk were used indicated that it is not advisable to use milk exceeding two per cent butterfat content. Cheese resulting from these higher fat content milks were very high in butterfat and were mushy in spite of the low moisture content.

The coagulum may lack the gel-like property exhibited by that of coagulum from skimmilk; consequently, in cutting the curd, it is necessary to exercise care in order that the curd not be broken up into uneven sized particles.

Fat losses in the whey were greater in cases where milk of higher fat content was used. Analyses of whey samples from trials in which milk having two per cent or less butterfat content did not show excessive fat loss in the whey (0.04 to 0.109 per cent).

Solids tests on the whey obtained from various trials show that there is little difference in solids in the whey when using milks of different butterfat content (6.50 to 6.92 per cent).

The average yield of curd increased as the butterfat content of the milk used increased. The butterfat content of the cheese increased as the per cent butterfat in the milk used increased.

The use of homogenized milk for cottage cheese manufacture resulted in a cheese of excellent flavor and texture quality. The flavor and texture scores increased with the percentage of butterfat in the cheese. The butterfat increased the smoothness of texture and richness of flavor.

M43. The Effect of Temperature upon Score Value and Serving Properties of Cheese.* W. S. ARBUCKLE, J. E. EDMONDSON AND L. E. MULL, Missouri Agricultural Experiment Station.

Recent investigations reveal that temperature has a marked effect upon flavor, body, and serving properties of certain dairy products.

Submerged flavors and a resistant body exist at lower temperatures in ice cream and butter, while full, pronounced, volatile flavors, and a less resistant body are prevalent at higher temperatures.

This study deals with the effect of temperature upon the score value and serving properties of high, medium, and low quality cheese. The samples

* Paper No. 630 in the Missouri Agricultural Experiment Station Journal Series.

were scored at 40, 50, 60 and 70° F., and it was found that the low and medium quality cheese received a lower flavor score when judged at higher temperatures. The reverse was true for high quality cheese. As the temperature of scoring was changed from 40 to 70° F., the flavor score varied as much as 2.5 points.

The body score changed considerably at the various temperatures depending upon the type of body studied, and the serving properties became more desirable in most cases at the higher temperatures.

M44. Economic Barriers Affecting the Dairy Industry. H. A. RUEHE, University of Illinois.

During recent years economic barriers affecting the dairy industry have greatly increased. Some of these barriers are the results of laws enacted by Congress, some originate in state, county or municipal legislation, others are directly due to the misuse of legislation created for other purposes, and there are still others that are the result of activities or organized groups carried on for purely selfish motives.

Trade barriers affecting the dairy industry can be classified in four groups:

1. Activities of organized groups.
2. Wage and hour legislation.
3. Misuse of health regulations.
4. Marketing orders operating under the Agricultural Marketing Act of 1937.

There are two types of organized groups whose activities react as barriers to the industry: (1) labor unions, and (2) producer organizations.

In many markets, labor unions control the working personnel in dairy plants. This has a direct effect on students and graduates of dairy institutions. It is gradually becoming more difficult to place men for summer and permanent employment. Furthermore, unions establish wage scales and in many cities they control the methods for marketing milk. These activities in many instances increase the selling prices of milk and cream and, hence, tend to curtail consumption of these products.

Producer organizations in various milk sheds have been effective in curtailing the milk supply by keeping producers out of the market through control of their membership. The health authorities in some cities refuse to inspect the farms of producers not members of certain cooperative groups, and, since the producers must be approved by the inspecting authorities, such producers are eliminated from the benefits of the market.

Wage and hour laws have a direct bearing upon manufacturing and processing costs of plants operating on an interstate basis. Such plants are at a disadvantage when operating in competition with competitors operating on an intrastate basis.

During the last two decades, there has been a progressive evolution of dairy legislation devoted to sanitary requirements. Such legislation has had the support of the dairy industry and the public has benefited greatly by such protection. In the past few years, a misuse of such legislation has created trade barriers which have prevented the free flow of dairy products in commerce.

Various markets are operating under Federal Marketing Orders established under the Agricultural Marketing Act of 1937. The orders, as established in various cities, vary somewhat but their main purpose is to establish milk prices paid to producers. This activity has been effective in establishing high retail prices which in turn has curtailed consumption of dairy products. Some of these orders contain provisions which virtually close the market to new producers, and thus help to limit the supply available to the market.

Dairy educators should study this problem of economic barriers, and they should assist in eliminating such unwholesome factors. Much can be done by encouraging the reciprocal acceptance of equivalent quality standards of inspection by various agencies. Educators must also assist consumers in understanding such economic problems which are affecting the public's economic welfare.

M45. The Effect of Cocoa upon the Digestibility of Milk Proteins. L. D. LIPMAN AND W. S. MUELLER, Massachusetts State College.

Whole milk powder plus a commercial brand of Dutch-process cocoa and whole milk powder plus a commercial brand of American-process cocoa, with and without additional cocoa fat, were fed in comparison with whole milk powder in feeding trials with albino rats. The amount of cocoa added to the diets was approximately 16.5 per cent by weight, which is equivalent to approximately 4 per cent on a fluid milk basis. The digestibility of the milk and cocoa proteins was studied.

The rats were able to digest approximately 85, 69, 71, and 71 per cent of the food proteins when rations containing milk powder, milk powder plus Dutch-process cocoa, milk powder plus American-process cocoa plus 2 per cent cocoa fat were fed, respectively. Subjecting these results to mathematical analysis revealed that the digestibility of milk proteins (85.3 per cent) was reduced 7.8 and 6.0 per cent when the ration contained Dutch, and American-process cocoa, respectively. The addition of 2 per cent cocoa fat to the American-process cocoa-milk rations reduced the digestibility of milk proteins by 5.8 per cent.

The proteins of the American-process cocoa were more completely digested (44.5 per cent) than those of Dutch-process (38.1 per cent), when the ration contained cocoa in amount equivalent to 4 per cent by weight on a fluid milk basis, and cocoa was the only source of protein in the diet. The

digestibility of the proteins in the American-process cocoa was found to be only 41.1 per cent when 2 per cent by weight of cocoa fat was added to the ration.

On the basis that the addition of cocoa to whole milk powder (in quantity equivalent to 4 per cent by weight on a fluid milk basis) does not greatly reduce the digestibility of the milk proteins, we may conclude that the amount of cocoa in average commercial chocolate milk (approximately 1 per cent by weight) has no significant adverse effect upon the digestibility of the milk proteins.

M46. The Acid Hydrolysis of Lactose and the Preparation of Hydrolyzed Lactose Sirup. G. A. RAMSDELL AND B. H. WEBB, Bureau of Dairy Industry, U. S. Department of Agriculture.

A study has been made of the effect of time and temperature of heating and of acid and sugar concentration upon the hydrolysis of lactose. As the temperature of a lactose-water mixture is raised to 150° C. (54½ lbs. gauge pressure) or higher, decreasing amounts of HCl are required to hydrolyze the sugar. The proportion of hydrolytic products other than glucose and galactose increases as the lactose concentration of the aqueous mixture is raised from 10 per cent to 80 per cent. A 10 per cent lactose solution may be almost completely hydrolyzed to glucose and galactose at 150° C. in the presence of a small quantity of HCl, but when a 60 or 80 per cent lactose-in-water mixture is used a marked destruction of the hexoses accompanies the cleavage of the lactose. Hydrochloric acid has been found to be a satisfactory acid, and the quantity required is so small that the flavor of the finished sirup is not adversely affected when the acid has been neutralized.

The determination of lactose, glucose, and galactose in hydrolyzed lactose sirup is complicated by the presence of optically active decomposition products having a reducing action. However, it is believed that a close approximation of the composition of the sirups has been obtained. The analytical procedure involved determining the reducing action of the sirups before and after destroying the glucose with yeast according to the Somogyi technique. The combined hexoses were determined by the use of a modified Barfoed's solution. From these results the sum of the lactose and other reducing decomposition products were obtained by calculation.

A clear, sweet sirup of pleasing taste containing glucose and galactose with small quantities of lactose and with some hexose decomposition products can be made easily by hydrolyzing lactose with acid. Such a sirup which can be prepared to contain 60 to 63 per cent solids will keep well and is suitable for table use or for the manufacture of various sweet goods.

M47. Some Properties of Different Combinations of Whey and Other Materials Which Dry Satisfactorily on the Atmospheric Drum Drier. E. L. JACK AND A. J. WASSON, University of California.

Whey solids have valuable nutritional properties and when they can be

recovered economically they become a supplementary source of income to cheese plants. When whey alone is dried on the double drum atmospheric drier, a gummy mass results that is difficult to remove from the machine and which hardens when cool so that grinding is necessary to put it into useable condition. For the formation of a continuous sheet of dry material it is necessary to add a drying agent to the whey. Various materials have been used, including skimmilk solids, either in liquid or dry form, and cereal products. This study has been concerned with the properties of different combinations of whey and drying agents which yielded a satisfactory sheet when scraped from the drum.

It was found that when liquid skimmilk was used as the drying agent it required about one and one-half parts skimmilk solids to one part whey solids at low acidities to form a satisfactory sheet. This represents about one part milk protein to two parts lactose. As the acidity increases the amount of skimmilk solids required increases also. When condensed skimmilk was used approximately equal parts of skimmilk solids and whey solids in the mixture formed a satisfactory drying combination. Increasing acidity again required that more milk solids be used. Mineral acids gave substantially the same results as developed or added lactic acid. Ground cereal products were also used. Approximately one part cereal product to two parts whey solids gave satisfactory results. Those found to be useable were flour, corn starch, ground oats (sifted), and ground barley (sifted). The amount of cereals required was not much affected by different degrees of acidity. The lactose: nitrogen ratios and the pH relationships have been determined.

M48. A More Precise Method for Estimating Fat in the Babcock Test.
E. O. HERREID, Vermont Agricultural Experiment Station.

Observations indicated that the fat column in the Babcock test was estimated under a variety of conditions with regard to light, alining of bottles, and type of calipers. An effort was made to standardize such conditions so that the test might be estimated on a comparable basis by technicians. It is believed that the equipment described fulfills these requirements.

The apparatus used in the laboratory of the Vermont Agricultural Experiment Station was invented by the late J. Hortvet, chemist in the Dairy and Food Laboratory of the Department of Agriculture, Saint Paul, Minnesota. This apparatus was described in old catalogue C, pages 470–71 of the Central Scientific Company, and is called a Milk Fat Caliper. This equipment is not manufactured at the present time.

The original apparatus was illuminated by an electric bulb through an etched glass in the center with a mirror strip on each side; the neck of the bottle being read against the illuminated etched glass and the mirror serv-

ing as a guide to assist in leveling the line of vision at the top and bottom of the fat column with the calibrations on the bottle. Another unique feature of this apparatus is that the fat column is estimated by a mechanical device consisting of two pointers, one adjustable to the lower and the other to the upper extremity of the fat column by means of two knobbed screws.

This apparatus as designed by Hortvet was used, but it became evident that the lighting arrangement could be improved. The combination etched glass and mirror was replaced with white, flashed, opalescent glass thus allowing reading the test against an entire white background. The mirror was unnecessary because the present bottles have a marked line three-fourths the circumference of the neck at each per cent mark to aid in leveling the eye straight across the top and the bottom of the fat column. The original pointers on the mechanical measuring device were too blunt to obtain estimations with ease and accuracy, consequently they were replaced with adjustable needle points held in place by screws. Finally a five inch reading glass was attached that magnified the fat column about two and one-half times.

The time required to read the tests is approximately the same as that with hand calipers when one becomes accustomed to this apparatus. Estimations can be made on milk to 0.025 per cent with ease and precision; however, finer calibrations on the test bottles would be advantageous. A bottle that does not stand level is the only difficulty thus far encountered under practical operations. This equipment will be available for examination.

Acknowledgment is gratefully made to Mr. Henry J. Hoffman, Chief Chemist in laboratories of the Department of Agriculture, Saint Paul, Minnesota, for his courtesy in loaning the Milk Fat Caliper.

M49. The Effect of Specific Gravity and Coefficient of Expansion of Butterfat on the Accuracy of the Babcock Test. R. JENNESS, Vermont Agricultural Experiment Station.

Measurement of specific gravity and coefficient of expansion of pure butterfat and of fat siphoned from the Babcock test column was undertaken in order to determine their exact values and to furnish a basis for evaluation of the accuracy of the Babcock test. The fact that the neck of the Babcock bottle is calibrated on the basis of the assumption that the specific gravity of fat is 0.9 at the temperature of reading makes specific gravity data essential. Coefficient of expansion makes possible estimation of differences in reading to be expected at different temperatures and calculation of changes in specific gravity as temperature changes.

Samples representing the Jersey and Holstein breeds, a University herd composite, and a composite from a nearby cooperative milk plant were collected at weekly intervals throughout 1939. They were tested by the method prescribed by Vermont Regulations (1936), read in quadruplicate

to the nearest 0.05 per cent, and the fat from 24 or 48 bottles siphoned off. The Mojonnier method was used as a standard of comparison. Samples of pure butterfat from the same sources were prepared by churning, melting, filtering, and drying at 135° C. under 20–25 inches of vacuum for 5 minutes.

Specific gravity at 37.5°/37.5° C. was determined using 10 cc. pycnometers with thermometer stoppers and side capillary overflow tubes. Coefficient of expansion in the ranges 30°–40° C., 40°–50° C., 50°–60° C., and 30°–60° C. was measured in 10 cc. expansion tubes having necks containing 0.5 cc. graduated in 0.01 cc. divisions.

Specific gravity values at 37.5°/37.5° C. fell from 0.9150–0.9200 in the first 6 months to a minimum of 0.9110–0.9120 in October and increased to 0.9130–0.9140 in November and December. Specific gravities of purified fat followed a similar trend but were uniformly lower (0.9090–0.9120).

The coefficient of expansion of Babcock column fat averaged 75.58×10^{-5} and that of pure fat averaged 78.34×10^{-5} in the range 30°–60° C. for the period January to June 1939. This represents a theoretical potential decrease of 0.0030 per cent fat per ° C. decrease in temperature for 4 per cent milk.

The calculated error of reading at 135° F. due to deviation of specific gravity of fat from 0.9 varied from 0.015 to 0.050 per cent fat underreading in the first eight months but became negligible in the last four.

A few determinations of specific gravity of fat from cream test columns showed consistently higher results than similar measurements on fat from milk tests, but again the same tendency to reach minimum values in October was exhibited.

M50. Observations on the Distribution of Pseudomonas fragi. H. B. MORRISON AND B. W. HAMMER, Kentucky and Iowa Agricultural Experiment Stations.

The frequency with which *Pseudomonas fragi* causes defects in dairy products makes its distribution of importance. Previous investigations have shown that the organism is often present in raw milk and cream and other dairy products from Iowa and surrounding states. In this study it was isolated from 29 of 176 samples of milk delivered during the cool seasons to an Iowa plant. It was also demonstrated in 16 of 40 samples of milk delivered to a Kentucky milk plant in December but was not found in 17 samples delivered to the same plant in June. It was isolated from 6 of 104 swab cultures from churns and other equipment in 40 Iowa dairy plants and also from 3 of 30 creamery water supplies.

Samples of soil, water, feed and bedding and swab cultures from milking utensils, miscellaneous barn equipment, floors, ledges and the cows themselves were investigated. Seventy-one of 137 such samples obtained on Iowa farms during the winter and spring yielded *Ps. fragi* and 37 of 99

samples obtained on Kentucky farms in the winter yielded it, but it was found in only 2 of 49 samples obtained on Kentucky farms in the summer. Studies on barnyard soil from many of the states indicate that *Ps. fragi* is widely distributed geographically.

With *Ps. fragi* present in the soil, it would be found in materials and on equipment which come in contact with, or are contaminated by, the soil, and in this way it could gain entrance to the milk from water, feed, bedding, utensils, miscellaneous barn equipment, floors, ledges and the cows.

M51. The Serological Integrity of Streptococcus lactis. J. M. SHERMAN, KARL L. SMILEY AND CHARLES F. NIVEN, JR., Cornell University.

The serological grouping method of Lancefield (J. Exp. Med., **57**: 571, 1933), which has proved of such great value in the differentiation of the hemolytic streptococci into more or less species-specific groups, has not been successfully applied to the non-hemolytic streptococci except in those groups which contain both hemolytic and non-hemolytic varieties, such as serological groups B and D. In Group B (*Streptococcus mastitidis* and its varieties) non-hemolytic strains may be serologically identified quite as satisfactorily as those which are hemolytic. Likewise, in group D (the enterococci) are found a number of closely related biological entities, the non-hemolytic *Streptococcus fecalis* and varieties, and the hemolytic *Streptococcus zymogenes* and varieties.

On the other hand, those non-hemolytic species which are generally loosely designated as "viridans streptococci" (*Streptococcus salivarius, Streptococcus bovis, Streptococcus equinus,* etc.) have not as yet been shown to contain group- or species-specific antigens (though there are of course a number of serological *types* within these several species).

It has long been claimed by many bacteriologists that *Streptococcus lactis* is an enterococcus, identical with *Streptococcus fecalis.* In a number of publications from this laboratory it has been shown that *Streptococcus lactis* and *Streptococcus fecalis* may be clearly differentiated on the basis of several physiological tests; we have also shown that *Streptococcus lactis* does not belong to the serological group D, which group includes *Streptococcus fecalis* (Sherman, J. Bact., **35**: 81, 1938). These physiological and serological results have now been completely confirmed by other workers (Graham and Bartley, J. Hygiene, **39**: 538, 1939).

In further confirmation of the serological as well as physiological integrity of *Streptococcus lactis* we have successfully produced species-specific grouping sera against this organism. Such sera give good precipitin reactions with the extracts of all strains of *Streptococcus lactis* which have been tested; but give no reactions with *Streptococcus fecalis* or other enterococci, nor with representatives of the other serological groups (A to H inclusive), nor with viridans streptococci or other non-hemolytic species outside of the so-called "lactic group" of streptococci.

Streptococcus cremoris, a biologically closely related variety, also appears to be serologically closely related to *Streptococcus lactis.* Whether or not these two "lactic" organisms belong to the same serological group is not clear on the basis of our limited data. Most strains of *Streptococcus cremoris* react weakly with anti-lactis group sera. Our few attempts to produce anti-cremoris group sera have failed. This finding of an apparently close serological relationship between *Streptococcus lactis* and *Streptococcus cremoris* appears to be in agreement with the preliminary announcement of work done at the National Institute for Research in Dairying, Reading, England (Annual Report for 1937, p. 37).

PRODUCTION SECTION

P1. Vitamin C for Sterile or Partially Sterile Sires. PAUL H. PHILLIPS AND HENRY A. LARDY, University of Wisconsin.

A series of investigations has been made concerning the effect of the administration of ascorbic acid upon a herd sire. The results indicate to date that (1) the subcutaneous injection of ascorbic acid resulted in the restoration of the fertilizing capacity of certain impotent bulls; (2) potent bull semen normally contained from 1.5–3.5 mg. of ascorbic acid per 100 cc. of fresh semen, values below 1 mg. were associated with impotency, or poor breeding; (3) high ascorbic acid values, 4.0 mg. or more, on the other hand were associated with bulls with an unreliable breeding record; and (4) the ascorbic acid content of fresh semen, freshly drawn blood and longevity of sperm in yolk-buffer provides a fairly accurate estimate of potency or impotency in the bull.

It is apparent that ascorbic acid is intimately involved in the production of virile sperm. The exact nature of its role in this capacity is not known.

P2. The Storage of Dairy Bull Spermatozoa.* H. A. HERMAN AND ERIC W. SWANSON, Missouri Agricultural Experiment Station.

This study is concerned with the storage and preservation of dairy bull semen to be used for artificial breeding. While various dilutors have been proposed and different storage temperatures have been suggested, there still remain many unexplained factors involving the storage of dairy bull semen so as to preserve its fertility. We have attempted to investigate still further the practicability of storing the undiluted semen, collected by means of the artificial vagina, at the usual electric refrigerator temperature of 40° to 50° F. Whenever possible cows have been inseminated with the stored semen and these results correlated with the usual laboratory examinations of the fresh and preserved semen. Practically all studies conducted on bull

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station Journal Series No. 631.

semen have indicated considerable differences in the characteristics of the semen produced at the different ejaculates as well as between individual bulls.

Both diluted and undiluted semen have been used in these investigations. The length of time motility persists under various storage conditions has been carefully followed. It must be recognized, however, that motility alone is a poor index to fertility, and often samples evidencing strong motility are ineffective in settling cows with good breeding histories.

Semen samples representing over 300 separate ejaculates collected from 55 dairy bulls have been stored at 40–50° F. with motility ranging from 20 to 80 per cent maintained after 200 hours. Samples vary widely in this respect. Some samples were very low in motility after six hours of storage. In general the diluted semen of high quality showed no marked increase in survival as compared to the undiluted. Samples which tended to lose motility rapidly were apparently benefitted by the use of dilutors, particularly of the egg-yolk-buffer-type, as shown by higher motility and longer survival than undiluted samples of the same ejaculate. The glucose-buffer type of dilutors seemed to exert no beneficial influence. In many cases the undiluted samples showed greater motility after the same storage period. In the use of stored semen, 20 pregnancies were obtained from 35 inseminations using undiluted semen stored from 4 to 196 hours, with an average storage period of about 48 hours. Using diluted semen at the ratio of 1 part semen to 3 parts dilutor, 13 cows have been settled by 24 inseminations.

In general the second ejaculate, unless bulls were being used regularly, has withstood storage better than the first. Wide variations in the storage capacity of different ejaculates from the same bull, as well as from different bulls, have been observed. These results will be summarized in detail.

P3. Some Observations on the Morphological Variations in the Spermatozoa of Dairy Bulls.* ERIC W. SWANSON AND H. A. HERMAN, Missouri Agricultural Experiment Station.

In efforts to evaluate the semen, and the reproductive abilities of dairy bulls a critical examination of 300 separate ejaculates of 55 bulls has been made. The breeding efficiency of many of these bulls is available and has been compared with their semen picture. Included in the examination were (1) initial motility, (2) daily motility of semen stored at 40° F. undiluted, (3) pH determination initially and after motility had been less than 50 per cent for three days or more, (4) observations on appearance and consistency of fresh semen, (5) concentration per cubic millimeter, volume of semen, and total number of spermatozoa per ejaculate. Examinations were made of the stained spermatozoa at 1075 × magnification for determination of morphological abnormalities. Rose Bengal was used for staining purposes. All semen samples were obtained by use of the artificial vagina.

* Paper No. 632 in the Missouri Agricultural Experiment Station Journal Series.

Wide variations have been observed in the semen collected from the various bulls and there was wide variation in the character of ejaculates obtained from the same bull. It is exceedingly difficult to evaluate the sire through examination of the semen unless several ejaculates collected at various intervals are available.

The percentage of abnormal spermatozoa ranged from 2.1 to 74.8 per cent. All of the bulls of known good breeding efficiency, with the exception of two for which the average was not considered representative of their normal picture, averaged well below 20 per cent abnormal spermatozoa. All of the bulls known to be of poor breeding efficiency produced more than 20 per cent abnormal spermatozoa. Three sires which were practically sterile had more than 60 per cent abnormals, while four known to be of low fertility ranged from 23 to 37 per cent abnormal spermatozoa.

With the exception of semen containing very high percentages of abnormal spermatozoa, 50 per cent or more, there seemed to be no definite correlation between the abnormality count and initial motility or length of survival with good motility. This observation held true for variations in semen from the same bull as well as for that from different bulls.

Morphological variations of the normally ejaculated spermatozoa could not be correlated in any significant manner with concentration, volume, viscosity, or pH of the semen. In cases where it was difficult to obtain the ejaculate, however, an abnormally high pH (7.0 to 7.8) and a high percentage of abnormal spermatozoa of low motility was observed.

Semen from three bulls, examined after a prolonged sexual rest (2 months or more), showed a higher percentage of abnormal spermatozoa than was characteristic for the same sires in regular service. Only after 4 to 6 collections, obtained at 1 to 2 day intervals, did the morphological picture become normal. The increase in abnormalities was largely due to an increase in pyriform heads.

The most common types of abnormal spermatozoa found were tailless, coiled tails of varying degree, and pyriform heads—spermatozoa with tapering or constriction at the posterior portion of the head.

P4. Fecundity and Certain Other Characteristics of Fresh and Stored Bovine Semen.* H. P. DAVIS, G. W. TRIMBERGER AND GRAVERS K. L. UNDERBJERG, University of Nebraska.

During the past four years artificial insemination has been practiced successfully in the University of Nebraska dairy herd. Previously one of us reported that the average number of natural services required per conception was 2.21. This average number was obtained from a study of 1375 conceptions. When the above study was completed about 20 per cent of the cows suffered from trichomoniasis.

* This study supported by grant in aid by the American Dairy Cattle Club.

The immediate objectives of the use of artificial insemination were to determine whether this method would increase the breeding efficiency over natural service and whether it would serve as a means of control of trichomoniasis. Other objectives were to conduct studies that would increase the information on certain phases of reproduction and to determine certain characteristics of semen.

The semen samples were obtained by massage per rectum of the genital organs or by use of an artificial vagina. In 400 attempts by the massage method 378 semen samples with very active motile spermatozoa were obtained. The average volume was 5.7 cc. and the concentration was 429,000 per mm.^{3} The pH value of the semen was usually above 7.00. A total of 107 conceptions resulted from 181 inseminations. The fecundity of the semen obtained by the artificial vagina was likewise studied. A total of 122 conceptions were obtained from 188 inseminations. The above groups include 56 cows which previously had been bred naturally to bulls which were infected with trichomoniasis.

The study of the characteristics of fresh and stored semen and its evaluation in relation to its fecundity revealed certain facts. The characteristics studied included volume, motility, concentration, pH values, morphology of spermatozoa, and fecundity of the semen. A detailed semen analysis by ejaculates of 11 fertile bulls free from disease representing four dairy breeds whose breeding efficiency was supported with pregnancies was included in this study. The mean volume was 4.2 cc.; the motility 74 per cent; the concentration 734,000 spermatozoa per mm.^{3}; and the pH value 6.99. For the determination of the relationship between the four factors, the volume, motility, concentration, and the pH value, each of the factors was correlated with each of the other three factors. When the pH was correlated with the volume and the motility there was a highly significant minus correlation, while when correlated with the concentration there was a highly significant plus correlation. Other correlations were only slightly significant. The percentage of atypical spermatozoa in the semen from the 11 fertile bulls was found to be relatively constant, approximately 18 per cent or less. It was established that there was very little difference between the fecundity of the fresh semen samples of the successive ejaculates. Only the first and second ejaculates were studied. There were 45 conceptions from the semen of the first ejaculate requiring 60 inseminations; 28 from the second requiring 35. Inseminations from undiluted semen samples stored from 24 to 99 hours at 35° and 40° F. resulted in seven conceptions from 13 inseminations; samples stored at 50° F. resulted in four conceptions from 15 inseminations.

P5. Outlines and Subject Matter in Teaching Dairy Husbandry Courses.
E. N. HANSEN, Iowa State College.

A type of outline has been prepared as a helpful guide in teaching such

lecture-laboratory subjects as the selection and judging of dairy cattle. The headings for this outline, one of which is prepared for each course in a sequence, are:

Meeting Number	Topic for Lecture and Discussion	Laboratory Material	Animals to be used.	Reading Assignment	Written Assignment

The outlines are arranged to cover all meetings of each course. The first is for a freshman course in "Dairy Cattle Problems." In addition to laboratory work in judging, the following lecture and discussion topics are covered: Information on dairying in the state and nation; dairy cattle on general and specialized farms; desired dairy conformation; general score-card for dairy cattle; methods of giving oral and written reasons; selection of dairy cows and herd sires; the use of grades, high grades and purebred cattle; methods and results of Dairy Herd Improvement Associations; a long-time production program and factors influencing the quantity and quality of milk.

Another outline covers a sophomore and junior course, "Breeds of Dairy Cattle." The lectures and discussion center upon the following topics: Type defects and their evaluation in judging; breed score-cards; the show-ring classification; origin and development of the dairy breeds; characteristics of the major and minor breeds of dairy cattle; families, noted animals, herds and breeders; factors in the selection of a breed; and pedigree study. Considerable use is made of mimeographed material.

In the laboratory, judging work with frequent oral reasons, on rings of four, six, and occasionally more animals, is given. Assignments are made in the compiling of complete pedigrees and the construction of charts showing the influence of noted animals within each breed. Field trips are made to five or six leading dairy farms for observation of methods of management and for practice judging.

P6. An Assay Method for Thyrolactin.* W. W. HEATHMAN AND C. W. TURNER, Missouri Agricultural Experiment Station.

Thyrolactin, a combination of protein and iodine, has been observed to contain considerable physiological activity comparable to that produced by thyroxine. Since some iodinated proteins may show more activity than others, there was need for a simple method of assay of the various compounds produced. It is well known that the administration of thyroxine in excess, due to the high metabolic rate induced, will cause a reduction if not an actual cessation of growth in animals. For our study we have selected day old White Leghorn cockerels because of their availability throughout the year, cheapness, and normal rapid growth rate.

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 623.

The chicks are all fed a standard diet ad libitum. The experimental groups receive, in addition, varying amounts of thyrolactin and the body weight determined every other day for a period of about two weeks.

To compare with the results so obtained, other groups are fed equivalent amounts of iodine in the form of KI. As a standard, thyroxine is fed as well as desiccated thyroid tissue.

P7. Thyrolactin, A New Source of Thyroxine for Dairy Cattle.* C. W. TURNER, Missouri Agricultural Experiment Station.

The feeding of desiccated thyroid tissue or the injection of thyroxine has been shown in a series of experiments to cause a rapid rise in the rate of milk secretion, including the percentage content of fat and solids-not-fat. This observation has been of great scientific interest because it has indicated a role of another hormone in regulating the level of milk secretion of dairy cattle. The practical value of this discovery has been nullified very largely by the exorbitant cost of thyroxine and of desiccated thyroid tissue. It now appears possible that this handicap to the practical application of this discovery may soon be removed and that surplus skimmilk may become the agent by which cows can be injected to produce more milk.

For many years it has been known that when iodine is mixed with protein under certain conditions, it becomes chemically united with the protein and free iodine is no longer present. During the past year or two the evidence has become increasingly convincing that protein so treated contains physiological activity comparable to that produced by thyroxine. In fact a paper has appeared in which the claim was made that crystalline thyroxine could be extracted from a preparation of iodinated casein.

Because of our knowledge of the value of thyroxine in stimulating milk secretion and the great practical value of a cheap source of this material, we have begun a study to determine what iodinated proteins will supply the cheapest source of thyroxine activity and whether the cost would be such as to make practical its general use by dairymen. Our preliminary studies indicate that the feeding of small amounts will cause an increase in the heart rate of thyroidectomized and normal goats. It has also increased the milk production of goats. Work with cattle is now in progress.

We have found that fresh skimmilk can be used as the protein. To it is added finely powdered iodine with constant stirring. The casein is then precipitated by adjustment of the pH to its isoelectric point. The iodinated casein is dried and ground ready to be added to the ration.

To this product, the name thyrolactin has been given. The possible advantages of this preparation are listed below:

1. A cheap source of thyroxine activity.

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 625.

2. A product of uniform potency when prepared under standard conditions.

3. A material which can be fed as part of the ration.

4. An adequate supply of iodine in its most useful form.

It should be appreciated that this work is in a preliminary state and the only reason for presenting the material at this time is to encourage others to try out our preparations or prepare the material according to our procedure. It will thus be possible to determine in a short time whether its laboratory promise will stand the test of practical application.

P8. The Effect of Thyroxine Injections on the Physiological Processes of Dairy Cattle. VICTOR HURST, R. P. REECE AND J. W. BARTLETT, New Jersey Agricultural Experiment Station.

Over a three year period, including all seasons of the year, a series of 11 cows were injected with thyroxine in order to investigate further the thyroid-mammary relationship. Animals in the declining phase of lactation were infected for periods ranging from 5 to 147 days with doses varying from 5 to 25 mg. Synthetic crystalline and the sodium salt, put into solution by different methods, were injected subcutaneously in the shoulder region. Measurements included milk, fat, solids-not-fat, and total solids production, milk color, pulse rates, body weights and rectal temperatures. Results in production varied from negligible increases to rises of 38 per cent in milk production and 59 per cent in fat production. Seasonal variation was found to affect the thyroid-mammary relationship.

P9. The Ejection of Milk from the Mammary Gland. FORDYCE ELY AND W. E. PETERSEN, Kentucky and Minnesota Agricultural Experiment Stations.

Eight Jersey cows in the Kentucky Agricultural Experiment Station herd were subjected to a series of experiments to determine the factors involved in the ejection of milk and to what extent the nervous mechanism controls the rate of ejection of milk from the gland. The left half of the udders of three Jersey cows were sympathectomized by removing a two-inch portion of the ilio-inguinal and posterior inguinal nerves as they enter the gland in one trunk at a point immediately below the inguinal ring. These nerves are believed to furnish the only efferent stimuli to the gland tissue, although afferent stimuli are carried from the gland through the ilio-hypogastric nerve.

These three cows and five other cows were subjected to 300 experimental machine milkings to measure the effect of the denervation, fright, intrajugular injection of adrenalin, and similar injections of posterior lobe fractions on the rate of ejection. The following conclusions seem to be justified.

1. The statement of Dr. Gaines, twenty-five years ago, that the processes of secretion and ejection are separate and distinct, is confirmed.

2. The motor or efferent nerve supply to the secreting tissues serves no direct function in the ejection of milk.

3. Fright causes the prompt cessation of ejection.

4. Intra-jugular injections of adrenalin at the beginning of the milking act causes a similar cessation within thirty seconds. The larger the injection of adrenalin the more time was required before the positive act of ejection was resumed.

5. The intra-jugular injection of posterior lobe fractions (pitocin and pitressin) caused a prompt resumption of ejection within thirty seconds.

6. Some evidence is offered which indicates that naturally-produced pitocin acting upon alveoli and ductule musculature, causing it to contract, is the primary cause of ejection.

7. The theory is advanced that the positive act of ejection of milk is caused by the natural occurrence in the blood of one or more products of the posterior lobe and that the failure to let down milk is similarly caused by an increase in the blood of naturally-produced adrenalin, which probably has the opposite effect in causing the alveoli and ductule musculature to relax. It is believed that the presence of these products in the blood is brought about by afferent stimuli which reach the central nervous system from a variety of sources.

P10. Effect of Post-Hypophyseal Extract on Lactation in Hypophysectomized Post-Gravid Rats. ELISEO T. GOMEZ, Bureau of Dairy Industry, U. S. Department of Agriculture.

It was previously reported from this laboratory (J. DAIRY SC., **22**: 428) that, in addition to anterior pituitary extract plus adrenal cortical extract and glucose, the administration of post-hypophyseal extract (pituitrin) was necessary for the sustenance of young of hypophysectomized post-gravid rats. Since this report was made, additional observations have been accumulated which in general confirm our previous observations.

Injections of 2 to 5 units of pituitrin administered in two equal portions 7 to 8 hours apart, in addition to the anterior lobe and adrenal cortical extracts and glucose, permitted the young to get milk from the mammary glands and as a result of continued treatments young were reared to weaning age (25 days of age). The dosage and frequency of administration of pituitrin seemed to be factors in this phenomenon. When 10 units of pituitrin was administered in two equal portions daily, lactation seemed to be inhibited. On the other hand, while 2.5 units administered in the same manner permit the young to get milk, the same dosage (2.5 units) given in a single injection did not.

The necessity of pituitrin in the secretion and/or excretion (lactation) of milk was further indicated by the fact that withdrawal of pituitrin from the daily régime at any time during the course of the experiment was immediately followed by a rapid loss of body weight of young, terminating in death unless pituitrin injections were promptly resumed.

The average body weights of young rats reared by hypophysectomized mothers treated as above, were very much less than those reared by control animals, the latter including (1) lactating rats subjected to sham hypophysectomy, (2) normal lactating rats and (3) normal lactating rats maintained on limited daily food intake equivalent to that of the hypophysectomized lactating mother rats. The average daily food intake of hypophysectomized lactating rats was approximately 50 to 60 per cent below that of normals. The daily body weight of hyphophysectomized animals, however, was only slightly if at all reduced.

P11. The Fat Metabolism of the Mammary Gland of the Cow. J. C. SHAW AND W. E. PETERSEN, University of Minnesota.

In a continuation of the studies of blood fat arteriovenous differences on lactating cows it was found that very little blood fat is taken up by the gland immediately after milking. With the increase of the time interval following milking, blood fat is used in increasing quantities until about four hours after milking, after which time the fat is used in more constant amounts. Calcium presents a similar picture. The use of glucose and amino acids are not so affected. When one half of the udder was milked out and arteriovenous samples were taken from both sides simultaneously it was found that the unmilked side continued to use considerable blood fat, whereas the milked side used little or none. Blood calcium and acid soluble phosphorus were affected in the same direction but were less predictable, especially when the animal exhibited any evidence of disturbance. Blood glucose and amino acids continued to be used in normal amounts on both sides.

The above phenomena were duplicated by the intravenous injection of oxytocin. Large doses of oxytocin prevented the passage of fat into the gland even when the gland was distended with milk. The data indicate that the inhibiting effect of milking upon the use of fat by the gland is due to oxytocin or an oxytocic like principle. The normal passage of blood fat into the secretory cells of the lactating gland and to a lesser extent of calcium and phosphorus is associated with the distention of the alveoli and the secretory cells with milk.

When blood volume changes in the mammary gland were not encountered during the drawing of the blood samples the respiratory quotient was usually in excess of unity. Calculations of the comparative calcium and fat losses to the gland continue to show that the quantity of blood fat used by the

gland is sufficient to account for the milk fat and indicate that very little fat is derived from other sources. In fifty-one experiments in which no blood volume changes occurred in the gland the average fat arteriovenous difference was 9.0 milligram per cent. This difference was confined to either neutral fat and/or cholesterol fractions.

P12. Some Factors Influencing the Completeness of Milking. KENNETH MILLER AND W. E. PETERSEN, University of Minnesota.

The effects of the following factors upon the completeness of milking were studied:

1. Lengthening the interval between milking and stripping.
2. Manipulating the udder some time before milking.
3. Lengthening the time involved in milking.

In a study of the effect of the interval between milking and stripping, comparison was made of the milk and fat production of cows stripped immediately after removal of the milking machine and when an interval of 15 minutes was allowed.

The mammary gland was stimulated to "let down" milk by washing the gland 20 minutes before, stripping 15 minutes before, and handling with bare hands 10 minutes before milking. While there was a variation in the response by individual cows, fat production was decreased more than milk production during periods of manipulation. Twelve out of 19 cows decreased fat production significantly; 5 declined over 10 per cent and 4 more than 20 per cent. In milk production, 14 out of the 19 declined; 7 more than 5 per cent, 4 more than 10 per cent, and 2 more than 20 per cent. The variation in both milk and fat production from milking to milking was much greater when the glands were manipulated some time before milking.

To study the effect of the length of time involved in milking in 13 trials, each quarter was milked out separately, requiring about 25 minutes for the milking process. After the last quarter was milked, the milk remaining in the gland was removed following the injection of petocin. The amount secured before and after pitocin injection formed a basis for calculating the completeness of milking of each quarter. Results showed a decrease in the per cent of the total milk in the quarter in the order of milking. The last quarter milked produced only 75.5 per cent of the milk and 57.9 per cent of the fat produced by the quarter milked first.

P13. The Effect of Dinitrophenol Administration on Milk and Milk Fat. G. C. GRAF, L. M. LUDWICK AND W. E. PETERSEN, University of Minnesota.

Dinitrophenol was administered subcutaneously and orally in toxic and non-toxic doses to cows. The toxic doses were continued over a period of two days. The non-toxic doses injected subcutaneously were carried over

a period of five days, and oral administration covered a period of twenty-five days. The non-toxic doses were limited to amounts that would not affect the heart or respiration rates.

With the subcutaneous administration of toxic doses of dinitrophenol, the respiration rate was increased 41 per cent and the pulse rate 55 per cent. A marked decrease in both amounts of milk and butterfat with a marked increase in butterfat percentage resulted. The butterfat composition was altered. The saponification number dropped from 232.2 to 220.2, the iodine number increased from 34.7 to 37.7, and the Reichert-Meisl number increased from 24.4 to 27.4. The milk became yellow from dinitrophenol. Lactose decreased 38.1 per cent; CO_2 increased more than 400 per cent; total nitrogen was unaffected, but casein nitrogen decreased with a corresponding increase in non-protein nitrogen. The increase in CO_2 was due to sodium bicarbonate.

In non-toxic doses dinitrophenol did not affect the amount of milk, but the total amount and per cent of fat was significantly increased. The composition of the fat was but slightly altered in the direction that was noted when toxic doses were administered. Other constituents of the milk remained unaltered.

P14. The pH of the Bovine Mammary Gland. PHILIP L. KELLY, Arkansas Agricultural Experiment Station.

Studies are in progress in which thirteen bovine mammary glands have been analyzed for pH. Tissues of six have been studied by means of colorimetric indicators while the remaining seven were studied by means of a potentiometer as well as indicators in some instances.

Studies with colorimetric indicators indicated that the various types of cells present may normally contain a different pH with the connective tissue cells at about 7.0 and the secretory cells ranging from approximately 5.0 to 7.0. Studies with the potentiometer on slices of tissue indicated a pH range from 5.78 to 6.89 for tissue taken from alveolar portions of the gland. The secretory tissues with readings closer to neutrality were non-lactating glands.

P15. The Hormone Control of Mammary Duct Growth.* A. A. LEWIS, Missouri Agricultural Experiment Station.

As a result of work in this laboratory the theory was advanced in 1938 that a previously unrecognized pituitary factor, called mammogen, was the direct agent of mammary growth stimulation. From earlier observations it appeared probable that two fractions were present in the mammogen complex. The duct growth factor (mammogen-I) was believed to be stimulated

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 622.

by estrogen alone. The lobule-alveolar growth factor (mammogen-II) was thought to be stimulated by progestin and estrogen during pregnancy.

A study was made of 545 cattle pituitaries to determine the mammogen-I content during growth, pregnancy and lactation. The highest content of this hormone was found in young growing heifers during the first estrous cycles when the mammary duct system is actively developing. The content of mammogen-I found in the pituitaries of pregnant cows was well correlated with mammary gland development during that period reaching a peak at about mid-pregnancy when the growth of the mammary elements is probably most rapid. That lactating cows had more mammogen-I than did dry cows may indicate that the hormone is required to aid in maintaining the functioning gland. The theory that the content of mammogen I in the pituitary is correlated with the estrous cycle was further substantiated in that cows with corpora lutea in the ovaries had considerably more hormone than cows with follicles alone. Furthermore, male rabbits given estrogen had twice the pituitary content of mammogen-I as did normally pregnant does.

It is generally recognized that dairy cows have larger udders and mammary glands than beef cows such as Angus and Hereford. That these differences in size and development are due to genetic factors has long been appreciated but the physiological mechanism by which these inherited differences are expressed has been unknown. This study has shown for the first time that dairy cows exceed beef cows in the rate of secretion of the mammogenic duct growth factor by the pituitary.

Extracts of anterior pituitary containing mammogen-I were shown to develop complete mammary duct systems in male and spayed female mice, rabbits and rats. A large series of hypophysectomized female rats given mammogen-I responded with active proliferation of mammary ducts. Castrate male guinea pigs, which respond to estrogen administration with complete mammary development, showed only duct growth response to mammogen-I extract. Evidently estrogen in this species causes secretion of both mammogenic factors in the pituitary resulting in both duct and lobule-alveolar development whereas direct administration of mammogen-I causes only duct development.

The assay technique for mammary duct growth using the male mouse is as applicable to synthetic mammary growth chemicals as to pituitary tissue and extracts. Assay of several of these pure chemicals showed that estradiol benzoate and stilbestrol were 100 to 240 times as active per unit weight as estrone. Estriol, anol and triphenyl ethylene were about equal in potency at 1/30 to 1/35 the activity of estrone. All previous comparisons between estrogenic chemicals have been on the basis of genital response; vaginal, ovarian or uterine. Such assays were found not to give a reliable estimate of mammary growth potency.

P16. The Mammogenic Lobule-Alveolar Factor of the Anterior Pituitary.* JOHN P. MIXNER, Missouri Agricultural Experiment Station.

Recent studies conducted in these laboratories on the physiology of mammary gland growth have made it necessary to postulate the presence of a second mammogenic hormone which is secreted by the anterior pituitary (AP) and which is directly responsible for the growth of the lobule-alveolar (milk secreting) system of the mammary gland.

White virgin female mice weighing between 10 and 20 grams were used as experimental animals in this study. Such animals have a well developed duct system of the mammary gland, but the lobule-aveolar system which develops only under the influence of pregnancy or pseudo-pregnancy is absent. These animals are ovariectomized and an abdominal mammary gland is taken at the same time as a check on the state of development present in the glands.

Injections of fresh pituitary material obtained from pregnant cattle into these mice caused the proliferation of the lobule-alveolar system of their mammary glands to the condition comparable to four to eight days of pseudo-pregnancy or pregnancy. Such pituitary material has considerable mammogenic duct growth potency as assayed on male mice by the method developed in this laboratory.

An extract of cattle pituitaries has been prepared by extracting the material with warm alcohol and ether. The alcohol and ether is evaporated and a lipid-like material is left. Twenty-five hundredths of a milligram of this material will cause definite duct stimulation in the male mouse which normally has only mammary gland rudiments. This same extract when injected into ovariectomized virgin female mice in amounts ranging from 0.25 mg. to 40 mg. and for injection periods varying from six days to thirty days failed to cause lobule-alveolar stimulation.

A protein-like fraction of the pituitary gland secured by acetone, drying the fresh pituitary caused lobule-alveolar development in these castrate female mice in amounts comparable on a dry basis to the amount of fresh pituitary material required to secure similar development.

It appears then that there are two mammogenic factors of the AP which control mammary gland growth and that a chemical separation of these factors has been effected by the methods of extraction and fractionization used.

As a result of the various experiments it was decided that the female mouse was a suitable assay animal. A mammogenic lobule-alveolar mouse unit is tentatively defined as the amount of material required per mouse, injected over a period of six days, to secure definite lobule-aveolar develop-

* Contribution from the Dept. of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 624.

ment in 50 ± 10 per cent of 10 or more castrate, nulliparous, female mice weighing between 15 and 20 grams.

Preliminary assays on lots of pregnant and non-pregnant cattle pituitaries have been determined. One hundred and twenty-five milligrams of pregnant cattle pituitary has given a mouse unit, while six hundred milligrams of non-pregant pituitary failed to give a response. This agrees well with results predicted on the basis of the physiology involved.

P17. The Effect of Nembutal Anesthesia on the Rate of Milk Secretion, the Resipratory Quotient, and Uptake of Milk Precursors by the Lactating Mammary Gland.* E. P. REINEKE, Missouri Agricultural Experiment Station.

The recent reports of Petersen and Shaw seriously question the validity of results obtained in milk secretion studies by comparison of arterial and mammary venous blood samples drawn from normal intact animals, and recommend as a more exact procedure the use of mammary gland perfusions. While this technique appears very attractive from the standpoint of eliminating some of the variables encountered in an intact animal, it is open to the objection that the storage depots of the body are eliminated from the system, and therefore, the blood can hardly be considered as representative of normal arterial blood after it has traversed the mammary gland one or more times. Furthermore, it is not known whether the endocrine factors that are undoubtedly concerned in lactation will function in such a system. It would appear that until more information is obtained on this question the respiratory quotient of a perfused udder is of doubtful significance so far as normal lactation is concerned.

A simple method of eliminating excitement or other psychic factors that might tend to upset the normal level of blood constituents during sampling of the intact animal is to completely anesthetize the animal with nembutal. Contrary to what might be expected, totally anesthetized goats continue to secrete milk of normal composition, at an undiminished rate. Uptake by the mammary gland of the known precursors of milk proceeds at the usual rate, and the respiratory quotient is quite constant.

In a series of arterial and venous samples drawn simultaneously from lactating goats under nembutal anesthesia the average respiratory quotient was 1.09, mean deviation 0.0596. Samples drawn after both the artery and vein had been anesthetized locally with apothesine yielded a mean respiratory quotient of 1.15, mean deviation 0.152.

Normally lactating goats, sampled without anesthesia gave a mean respiratory quotient for the mammary gland of 1.17, mean deviation 0.1895.

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series, No. 621.

While the average respiratory quotients as determined by the three procedures were nearly identical, the technique of sampling under nembutal anesthesia eliminates much of the variability encountered with other procedures. These results are in agreement with previous reports from this laboratory that the respiratory quotient of the mammary gland of the lactating goat is above unity, indicating synthesis of a portion of the milk fat from carbohydrate. Comparisons of the ratio of the uptake of glucose plus lactic acid to fat with the ratio of lactose to fat in the milk show that under the conditions of these experiments the fat taken up from the blood is insufficient to account for the milk fat.

Analyses of the carbohydrate portion of the plasma proteins indicate that carbohydrate is taken up by the lactating mammary gland in significant amounts as a portion of a glycoprotein complex, while arterial and venous samples drawn from dry goats show no significant uptake of this complex. This "glycoprotein sugar" if metabolized in the mammary gland could serve as an additional source of carbohydrate either for lactose formation or the synthesis of milk fat.

P18. A Modification of the Allen Blood Fat Procedure. J. C. SHAW, University of Connecticut.

To increase the accuracy of the method the fat tube is completely immersed in water in a constant temperature bath and the reading of the fat column is made through a glass window. The reading is made by means of a reading microscope mounted on a cathetometer with a vernier scale graduated to 0.1 millimeter. This apparatus is also used in the calibration of the capillary tube. A longer and more slender fat tube with a straight filling neck facilitates the addition and mixing of the reagents. The digestion is carried out at 87.5° C. in a constant temperature water bath and the tubes are centrifuged in a heated centrifuge.

P19. A Study of Some Methods for the Prediction of Butterfat Percentage in Herds of Ayrshire Cattle. G. A. BOWLING AND D. N. PUTNAM, West Virginia Agricultural Experiment Station.

This study was undertaken in an effort to determine the transmitting ability of bulls for butterfat tests by an analysis of their pedigrees.

The study included sixty-six Ayrshire sires with five or more tested daughters out of tested dams. A daughter-dam comparison was made for each sire, using only first calf herd tested lactation records not exceeding 305 days in length. No conversion factors either for age or frequency of milking were used.

A three generation pedigree was tabulated for each sire studied, listing the tests of each of the three nearest dams (if tested) and the average tests

of all of the tested progeny of each of the three sires and the three dams in the pedigree.

The following plans were used to determine the "Transmitting Ability" of a sire.

Plan A: Average the tests of the daughters of the sire; the tests of the daughters of the dam, and average the results.

Plan B: Average the tests of the daughters of each of the three nearest sires; the tests of the daughters of each of the three nearest dams, and average the results.

Plan C: Average the tests of the daughters of each of the three nearest sires; the tests of each of the three nearest dams, and average the results.

Plan D: Average the tests of the daughters of each of the three nearest sires, and average the results. The females of the pedigree are not considered.

Plan E: Average the test of the three nearest dams. The males of the pedigree are not considered.

Plan F: Average the average tests of the daughters of the sire with the test of the dam.

Plan G: Average the tests of the daughters of the sire; the tests of the daughters of the maternal grandsire, and average the results.

In each case the "Predicted Average Test" of the daughters of a bull is found by averaging the "Transmitting Ability" with the average test of the cows to which the bull is to be mated.

The results of the study seem to warrant the following conclusions:

1. Although there is no significant difference in the results obtained by the use of any of the plans, excepting Plan E, the plans A, F, B, D, C, G, E have the following respective correlation coefficients: .6621, .5748, .5554, .5509, .5423, .5253, and .4435.

2. The plan involving the average tests of the three nearest dams in a pedigree is the least accurate of the plans studied in measuring the transmitting ability of a bull.

3. When predicting the transmitting ability of a bull it is most desirable to use the tests of the progeny of the animals involved.

The authors wish to acknowledge the cooperation of the Ayrshire Breeders' Association in supplying the data for this study.

P20. The Use of Cellular Antigens in the Blood of Cattle for Determining Parentage. L. C. FERGUSON AND M. R. IRWIN, University of Wisconsin.

Numerous antigenic substances have been identified in the red blood cells of cattle by means of antisera prepared by immunizing cows against the blood of other cows. The results of a genetic analysis of each of the nine-

teen antigens studied indicate that the cells of an animal contain a particular antigen only if one or both parents likewise possess it. Furthermore, each of the cellular antigens seems to behave as a unit in inheritance, *i.e.*, each is presumably controlled by a single gene. Nineteen of these substances have been identified and designated as A, B, C, etc. From the genetic evidence available for nine of these, each seemingly represents one member of each of nine pairs of contrasting characters (or of multiple allelic series). Whether the contrasting character or characters of any one or all of these are recessive in nature or are completely expressed in the heterozygote is unknown at present. Although no evidence exists for the interaction of genes in producing these cellular substances, the possibility cannot be ruled out.

On the basic assumption that these antigenic substances are gene-determined, they may be used for the exclusion of parentage. For example, the cells of an animal do not contain antigen "A" if neither parent carries it, so if "A" is present in the blood of an alleged offspring from such a mating, there is evidence of confusion in the records.

In the practical application of this method to "field" cases, a blood sample is required from all of the animals involved, *i.e.*, sire, dam, and offspring. By means of exclusion it is possible, in most cases, to determine the parentage of animals, (1) when two or more calves are mixed before being properly identified with their respective dams; (2) when the sire of a calf is unknown because the dam was served by two or more bulls; and (3) when the validity of the registration of a particular animal is questioned.

P21. Effects of Inbreeding in Dairy Cattle (Progress Report). G. E. DICKERSON, Wisconsin Agricultural Experiment Station.

In order to determine the possibilities which lie in the development and utilization of distinct superior lines of dairy cattle, relatively uniform in transmitting ability, we need to know: (1) what the average effect of inbreeding is on growth, conformation, reproduction, and production, (2) how much variability there is between different sires or foundation stocks in ability to withstand inbreeding, and (3) what the effects of heterozygosis are in crosses between lines and what influence the level of homozygosity of the lines crossed has on these heterosis effects. This information is particularly necessary for animals whose average transmitting ability is distinctly superior in outbred matings, and, once obtained, would permit a more dependable evaluation of the breeding methods available for dairy cattle improvement than is now possible.

Data on growth, conformation, reproduction and production have been systematically obtained over a three-year period from three large Holstein herds in which comparisons between inbred and outbred progeny by the

same sire are available. The amount of inbreeding varies from sire-daughter matings with some sires to half or three-quarter sister matings with others. Enough data are now available on birth weight (71 inbred and 100 outbred calves*) and measurements at 6 months of age (58 inbred and 73 outbred calves*) to make a preliminary analysis of the effects of inbreeding among the progeny of eight sires.

Calves averaging sixteen per cent inbred (equivalent to about three generations of half-brother sister mating, or two-thirds as much as one generation of sire-daughter mating) averaged nearly ten per cent lighter at birth than non-inbred calves by the same sires, after correction for weight differences due to sex and age of dam. This decline in birth weight held for both sexes and for six of the eight sires. Differences in the inherent size of the dams of the inbred and the outbred calves may explain the heavier inbred calves for two sires. These results show that birth weight is determined to an important degree by the calf's own size inheritance, since the dams of the inbred calves were not inbred animals themselves. Tentatively, it appears that the size difference in favor of the outbreds becomes proportionately smaller rather than larger with growth up to 6 months of age.

P22. Results of Twenty Years Work on Proving Bulls at the Huntley, Montana, Field Station. R. R. GRAVES, J. R. DAWSON AND D. V. KOPLAND, Bureau of Dairy Industry, U. S. Department of Agriculture.

About twenty years ago a dairy cattle breeding experiment was started at the Huntley, Montana, Field Station of the Bureau to determine if high levels of production could be fixed and maintained in a dairy herd by the continuous use, for successive generations, of sires that had proved their ability to transmit the factors for high levels of milk and butterfat production. At the present time the 7th successive proved sire is in use. The daughters of these proved sires have been tested for production under uniform conditions, and the sons have been loaned to dairymen in the vicinity of the Huntley Station who are members of dairy herd-improvement associations. Since this work started a total of 126 bulls have been loaned. They have sired 3,058 females. Seventy-three of these bulls now have three or more daughter-dam pairs with records. The 924 daughters of these 73 sires produced an average of 11,178 pounds of milk, 3.65 per cent butterfat and 403 pounds of butterfat, calculated to a mature equivalent basis. The 924 respective dams had an average production of 10,226 pounds of milk, 3.56 per cent butterfat and 364 pounds of butterfat, an increase of 9 and 11 per cent. The daughters of 15 of the 73 sires failed to exceed their dams in milk production, and the daughters of 12 of the 73 sires failed to excel their dams in butterfat production.

* As of March, 1940.

P23. Average Useful Life-Span, and Causes of Losses of Dairy Bulls. R. B. BECKER AND P. T. DIX ARNOLD, Florida Agricultural Experiment Station.

Data have been accumulated with the cooperation of breeders, breed secretaries, and many of the Colleges of Agriculture of the United States and Canada, concerning the useful life-span of bulls, the owners of which valued them sufficiently that their natural lifetime was completed. Bulls culled because of unsatisfactory progeny, to avoid inbreeding in small herds, or because of having access to a more desirable bull, were not included in any of the tabulations.

The average useful life-span of good proved bulls of four dairy breeds, born prior to 1925, were: for 99 Ayrshires, 11.19 $\pm$ 2.75 years; 172 Guernseys, 10.45 $\pm$ 2.58 years; 277 Holsteins, 10.77 $\pm$ 2.66 years, and for 197 Jerseys, 11.07 $\pm$ 2.56 years.

Causes of losses among 1,097 bulls of the same four breeds, based on 126 Ayrshires, 302 Guernseys, 399 Holsteins, and 270 Jersey bulls of all ages, were: sterility, 27.6 per cent; died of undiagnosed causes, 23.3 per cent; old age, 10.3 per cent; accidents, injuries and broken bones, 6.8 per cent; wire, nails, and other foreign bodies, 5.4 per cent; lameness, rheumatism, bad stifles and feet, 4.4 per cent. The total losses from infectious diseases amounted to 12.8 per cent, of which pneumonia and lumpy jaw (actinimycosis) accounted for 2.1 per cent each; tuberculosis, 1.8 per cent; Bang's disease reactors, 1.3 per cent; tumors and abcesses, 1.0 per cent.

Life expectancy tables are being calculated. Further records will be accumulated for use in this study over the next five years.

P24. The Inheritance of the Solids-Not-Fat Percentage in Dairy Cattle. H. C. MOORE AND K. S. MORROW, New Hampshire Experiment Station.

Studies at this station carried on for the last four years on the abnormal relationship (ratio) of fat to solids-not-fat in milk indicate that the cause of variations in solids-not-fat of mixed herd milk from month to month is due largely to the make-up of the milking herd.

The influence of the factor of inheritance upon the solids-not-fat percentage in milk from individual cows was studied, using the method employed by the United States Department of Agriculture in proving bulls for milk and butterfat production. Using only purebred animals, dam and daughter comparisons on the progeny of three Holstein and two Jersey bulls have been completed.

The results tend to indicate that the three factors, milk production, percentage of butterfat, and percentage of solids-not-fat may be inherited separately. A given sire may not affect at all or may decrease or increase

percentage of solids-not-fat, irrespective of changes in percentage of butterfat or total milk production.

One sire increased the solids-not-fat content 0.16 per cent, although showing a decrease in butterfat percentage of 0.21 per cent, with no significant change in milk production. Another sire, used in the same herd, increased the solids-not-fat and butterfat percentage 0.28 per cent and 0.24 per cent respectively, with an accompanying increase in milk production of 242 pounds. A third sire, used in a different herd, lowered the solids-not-fat content 0.11 per cent and increased butterfat percentage 0.06 per cent, and milk yield 428 pounds.

Of the other two sires, one increased milk production 938 pounds and decreased the fat percentage 0.18 per cent without a significant change in solids-not-fat percentage. The other decreased milk production 1118 pounds and at the same time increased both the fat and the solids-not-fat percentage at about the normal relationship of these constituents in milk.

An interesting comparison was available wherein a group of eight daughters of sire B out of paternal sisters (daughters of sire I) all showed an increase in percentage of both solids-not-fat and butterfat. Proportionally, the increase in percentage of solids-not-fat exceeded the expected value in relation to the increase in percentage of butterfat.

P25. Some Factors Affecting Breeding Efficiency in Dairy Cattle. R. E. Erb, J. W. Wilbur and J. H. Hilton, Purdue University.

A study of the breeding efficiency in the Purdue University dairy herd for the twenty-year period (1920–40) revealed considerable seasonal variation. The month of May with 74.3 per cent had the highest average efficiency and the month of August with 58.2 per cent the lowest average efficiency for the year. The twenty-year study included 1,440 services resulting in 922 conceptions. No services were included unless they resulted in calving while the animals were still in the Purdue herd.

The data also show that 72.1 per cent of all conceptions resulted from a single service, with 18.7 per cent from the second service, 6.3 per cent from the third service, 2.3 per cent from the fourth service and 0.65 per cent from over four services.

There was considerable variation in breeding efficiency between sires used in the herd during the period covered in this study. One and two-year-old bulls had the highest breeding efficiency but showed a gradual decline with age thereafter.

An analysis of the prominent cow families in the herd indicated that some families have a higher breeding efficiency than others. This may be an inherited characteristic.

P26. Early Recognition of the Freemartin Condition in Heifers Twin-Born with Bulls. W. W. SWETT, C. A. MATTHEWS AND R. R. GRAVES, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

According to definition a freemartin is a sexually imperfect female calf twin-born with a male. Occasionally a heifer born co-twin with a bull is normal. Because of the uncertainty, many breeders follow the practice of destroying all such animals soon after birth. Some breeders, however, are willing to spend the time and expense necessary to raise them to breeding age in the hope that they will be sexually normal.

A study has been made of the conformation, anatomy and udder characteristics of 17 heifers that were born co-twin with bull calves. Fifteen of them proved to be freemartins. The other two apparently were normal although their normalcy could not be established with certainty because of the fact that they were slaughtered before they reached the age of sexual maturity.

A number of physical characteristics were found to be associated with the freemartin condition. These characteristics should be useful in determining at an early age whether or not any individual female born co-twin with a bull calf is likely to be capable of reproduction. Four characteristics which occurred with high frequency in freemartins were: (1) A retarded development of the mammary gland tissue, (2) an atypical form of the mammary gland tissue, (3) the occurrence of a fold of skin, sometimes containing a cord, extending along the median plane of the body a part or all of the way from the vulva to the navel, which is referred to as a "rudimentary penis," and (4) an enlarged clitoris. In some of the freemartins all of the described characteristics were found. In others only one or two were detected. One or more occurred in every one of the 15 cases that proved on autopsy to be sexually deficient, but none was found in the 2 cases that were found to have normally developed internal genitals at the time of death.

The chances are slight that the heifer twin-born with a bull calf will be sexually normal. In some cases positive determination probably cannot be made until the age of sexual maturity. If one or more of the abnormalities described are present it probably will be good economy to dispose of the animal.

P27. Some Factors Relating to Bloat in Cattle. DWIGHT ESPE AND C. Y. CANNON, Iowa State College.

There is little difference in the rate of gas formation between finely cut fresh alfalfa and bluegrass, when placed in rumen fluid and held at 37½° C. Amounts of salt, soda, hydrated lime or combinations of the three which the cow will tolerate in her drinking water increase rather than suppress gas formation. Frosting of alfalfa or bluegrass does not materially change the rate of gas formation.

P28. Extreme Rarity of Cancerous Growths in the Cow's Udder. W. W. SWETT, C. A. MATTHEWS AND R. R. GRAVES, Bureau of Dairy Industry, U. S. Dept. of Agriculture.

A study of the anatomy of the udders of more than 400 cows, heifers and freemartins over a period of several years has brought to light lesions of various types. In addition to sizeable abscesses, clefts, and the development of fibrous and scar tissue that usually followed infection or injury, small abscesses, cysts and deposits of various kinds have been found that were not anticipated and for which no plausible explanation can be found in the recorded history of the cow.

It is particularly noteworthy that, in the hundreds of udders examined no growths or tissue changes that appeared to be of a cancerous nature have been found, despite the fact that 31 per cent of the 313 cows of lactating age were over 8 years of age and presumably had reached that period of the life cycle in which mammary cancer may be expected to make its appearance in susceptible species.

These observations are supported by results reported by a number of investigators who have concluded that cancer is virtually non-existent in the bovine mammary gland. In fact, as a result of reviewing the laboratory findings in connection with tumors observed in connection with the meat inspection activities of the Bureau of Animal Industry involving the slaughter of many millions of cattle over a period of years, the conclusion was reached that cancerous growths in the bovine mammary gland are very rare, and that those that were found apparently had originated from carcinoma of the skin and invaded the udder from that source.

In the light of recent studies with mice which show that the breast cancer incidence may be increased in the young of a low cancer strain if they are allowed to nurse females of a high cancer strain, or vice versa, it is gratifying to know that the cow's udder—the source of one of the most important foods used for human consumption—is practically free from cancerous growths.

P29. Heavy Corn Feeding as a Contributory Factor to the Development of Mastitis. EARL N. MOORE AND H. O. HENDERSON, West Virginia Agricultural Experiment Station.

In recent years considerable thought has been given to certain contributory factors which might predispose animals to mastitis. The quantity and quality of the ration has been mentioned as a contributory factor.

With this thought in mind a study of the effect of heavy corn feeding as a contributory factor to the development of mastitis has been made. A concentrate ration composed of corn, corn gluten feed and necessary minerals was fed to 14 experimental animals. A control group of 13 cows was fed the

regular herd ration. The digestible crude protein, and total digestible nutrients was approximately the same in both rations. Alfalfa hay, corn silage with pasture in season, constituted the roughage.

The two groups of animals were divided as evenly as possible taking into consideration the age, number of lactations, and previous history of mastitis. Likewise the production level was practically the same between groups, which averaged over 11,000 pounds of milk. Half of the animals were observed for one lactation and the others completed approximately two lactations.

To detect the presence of mastitis the following tests were conducted at intervals of 14 days: (1) Physical examination, (2) Strip cup, (3) Brom thymol blue, (4) Chlorine determination, (5) Hotis test, (6) Leucocyte count, (7) Microscopic examination and (8) Blood agar plates.

An analysis of the results failed to show any appreciable difference in the incidence or severity of mastitis of the two groups. The different test methods used showed fairly good agreement.

P30. Short-Wave Diathermy Treatment of Bovine Mastitis.* C. W. McINTYRE,† A. C. RAGSDALE, AND E. R. GARRISON, Missouri Agricultural Experiment Station.

Short-wave diathermy applications of one hour daily were applied to the udders of cows secreting abnormal milk or with abnormal udder conditions in three purebred dairy herds and of one and one-half hours duration in a fourth herd. The diatherm used had an input power of 275 watts with a 6-meter wave-length and a frequency of 50 megacycles per second. Each cow in the first three herds was treated daily, so far as possible, until a negative test was obtained for all quarters of the udder, or until the termination of the experimental period here reported. In the fourth herd treatments were made for five consecutive days each week and samples of the milk for testing taken on the seventh day.

Positive quarters were determined by the Hotis test, supplemented by the plate count for number of bacteria, a microscopic examination of the incubated milk to determine the type of bacteria, body cell count, chloride test, strip cup or physical examination of the udder. Hotis tests were made on the milk from each of the quarters of the udders of all cows at frequent intervals. Samples showing no color change of any kind were classified as negative. All others were classed as positive or suspicious. Suspicious samples were then examined microscopically.

Ninety-two cows were treated with short-wave diathermy. Thirty-eight of these had been infected for more than 6 months and 54 for less than 6

* Paper No. 620 in the Missouri Agricultural Experiment Station Journal Series.

† Superintendent of the Hatch Dairy Experiment Station, University of Missouri and Bureau of Dairy Industry, U. S. Department of Agriculture.

months. According to the Hotis test the 38 cows infected longer than 6 months were positive in 101 quarters. Seven or 18.4 per cent of the cows became negative in all quarters after an average of 76 treatments for the group. However, the total number of positive quarters at the beginning of treatments was 101 as compared with 94 at the end of treatments, a decrease of only 7.0 per cent.

The 54 recently infected cows were positive in 81 quarters. Twenty or 46.5 per cent of the 43 cows positive in one or more quarters became negative in all quarters after an average of 41 treatments for the group. The total number of positive quarters at the end of treatmetnt was 41, a decrease of 50.0 per cent.

Combining all herds and groups the 92 cows showed a reduction in the number of quarters positive to the Hotis test of from 182 to 135 or 25.8 per cent during the period covered by diathermy treatment. Shortly after the end of the treatments, however, the number of positive quarters increased to 174 or partially exactly the same number at the beginning of the experiment. Milk produced by all except a few cows was normal in physical condition and appearance at the time of the last treatments, although a number of additional cows again showed abnormal milk on subsequent tests.

The types of bacteria, plate count, body cell count, and per cent chlorides were determined on 35 of the 38 cows infected more than 6 months and 48 of the 54 cows infected less than 6 months. The first tests were made July 5 to 12, 1939, and the second tests September 8 to 14, 1939, but are not available for the dates of the first and last Hotis tests.

The data presented indicates a very definite improvement in the physical condition, appearance and flavor of the milk of cows when treated with diathermy under the conditions of this investigation. This is obviously of great economic importance to the dairymen. The data is equally definite in indicating only temporary improvement, or simply an arrested condition, when results are measured by the Hotis test. There is no evidence of significant change in types of bacteria, plate count, body cell count or per cent chlorides over a two-month interval during the period covered by the tests. Finally the experimental work reported must be considered as preliminary and no final conclusions are drawn by the authors.

P31. Purified Diet Studies with Calves. P. E. JOHNSON, J. K. LOOSLI AND L. A. MAYNARD, Cornell University.

The purified diet technique was used to study the growth requirements of dairy calves. The calves were started on the purified diets at two to ten days of age. A mixture of casein, lactalbumin, sugar, butter or lard, minerals and water was fed as a substitute for milk. A dry feed composed of casein, starch, sugar, cottonseed oil, cellophane and minerals was kept before the calves after the first few days, and they were transferred to the dry feed completely after about three months.

The growth rates of the 15 calves studied were below normal in most cases in comparison with Ragsdale's Standards. Poor food consumption associated with periodic digestive upsets seemed to be largely responsible for the slow growth. It was necessary to supply about 25 mg. of magnesium per kilo of body weight to prevent hypomagnesiemia, convulsions, paralysis and death. Diets devoid of thiamin or riboflavin gave as good growth as those containing yeast or liver supplements. No improvement in the rate of growth or general well being of the calves was noted when the "grass juice factor" or vitamin C was added to the diet.

P32. Changes in pH and in Bacterial Count of Milks Sham Fed to a Dairy Calf. GEORGE H. WISE, G. W. ANDERSON AND J. C. JONES, South Carolina Agricultural Experiment Station.

In order to ascertain the extent to which the hydrogen-ion activity and the bacterial count of milks are altered in passing through the oral and esophageal cavities of the calf, pasteurized whole milk and unpasteurized separated milk were sham fed. As the calf consumed the milk from a nipple feeder, the liquid (milk mixed with various secretory fluids) was collected through a conduit inserted into the distal end of the esophagus, the entrance being made progressively via a ruminal fistula, the rumen and the cardia.

An unconsumed sample (control) and its corresponding sham fed sample were incubated at a temperature of 37° C. for 12 hours, during which time routine bacterial plate counts (on liver infusion agar) and pH determinations were made every two hours. In addition pH measurements were made on the sham fed whole milk at ten-minute intervals during the first hour.

The control pasteurized whole milk during the twelve-hour period gradually increased in bacterial count from 396 per cc. to 68,600,000 and decreased in pH from 6.61 to 6.12. The bacterial count of the corresponding consumed sample immediately after collection was 119,000 per cc., a considerable increase resulting from sham feeding. After collection, the number of bacteria decreased to 22,050 per cc. during the first four hours but slowly increased during the next eight hours to 667,875 per cc., a count markedly less than in the control incubated the same length of time. As the bacterial count decreased, there was an increase in hydrogen-ion activity, the pH dropping to 5.50 by the conclusion of four hours, the rate of decrease being greatest during the first 30 minutes following feeding. The pH showed no perceptible change from the fourth to the tenth hour, but subsequently began decreasing again.

In the control unpasteurized separated milk the bacterial count increased and the pH decreased throughout the entire period, the rate of change being somewhat greater than in the control sample of pasteurized whole milk. The alterations of the consumed separated milk, after the initial increase in bacterial count resulting from sham feeding, were in the same order as, but of a greater magnitude than, in the control.

Rancidity accompanying the rapid decrease in pH of the sham fed whole milk suggested that lipolysis was involved. The indications are that the source of the enzymes is the saliva and/or other fluids in the mouth and esophagus. However, the evidence is not adequate to warrant a final conclusion.

Since the sham fed separated milk manifested no bacteriacidal properties, some phase or product of the lipolytic reaction evidently was responsible for the lethal effect of the sham fed whole milk medium. Increased hydrogen-ion activity was probably a factor inhibiting multiplication but is not generally considered to be lethal. Lowering of surface tension by fatty acids liberated in the reaction was perhaps a factor preventing the growth of many bacteria. Since differential counts were not made, the relation of the change in bacterial quality to the change in total count cannot be assessed.

P33. Studies With Barn Air-Cured Alfalfa Hay. C. E. WYLIE, S. A. HINTON AND J. A. SCHALLER, University of Tennessee and Tennessee Valley Authority.

Continuing studies of curing hay in the barn and feeding value of air-cured hay, investigations were conducted during the summer of 1939 on automatic controls for curing equipment and curing hay to depths greater than 10 feet, which was previously considered a maximum depth.

The barn-curing system consists of air ducts, constructed of lumber on the floor of the hay mow. Partially dried hay from the field is stored as usual in the mow, over the air ducts. An electrically driven blower connected to the air ducts forces air through the hay and removes the moisture.

The most promising method of automatic control for the curing equipment embodies the use of a humidistat and time switch. The humidistat is located outside the barn, and starts or stops the motor according to the relative humidity of the air. The time switch will start or stop the motor for a short operating period at any time desired by the operator. This method required a minimum amount of attention and worked accurately and satisfactorily.

Alfalfa hay was cured without heating or molding to a depth of 10 feet by using the floor ducts. Hay was also cured satisfactorily to a depth of 18 feet by using flexible ducts placed on top of the first 10 feet of hay. Further investigations on curing hay to depths greater than 10 feet are planned for the summer of 1940.

The average power requirement for curing hays of 45 to 50 per cent moisture content to 20 per cent moisture content, using a 5-horse-power motor and a blower delivering 12,000 cubic feet of air per minute, is 43 k.w.h. per ton of dried hay. During each of the winters of 1937–38, 1938–39, and 1939–40, ten yearling heifers from the University dairy herd were fed for 150-day periods. These heifers were divided into two groups as equally as

possible, according to number, breed, age, weight, height, and heart girth. One group of heifers was fed all the air-cured hay that they would consume, while the other was fed field-cured hay ad libitum. Two pounds of grain and ten pounds of corn silage per animal per day were fed to both groups. The heifers in both groups have made normal growth with no marked difference in favor of either.

On all analyses the protein content of the barn-dried has been much higher than the field-cured hay. Samples of the air-cured hay averaged 16.78 per cent protein in 1938–39 and 17.88 per cent in 1939–40. Samples of the field-cured hay have averaged 12.97 per cent protein in 1938–39 and 13.09 per cent in 1939–40.

The result of three years' studies on curing hay in the barn and testing its feeding value have shown that a high quality of hay may be obtained by completing the curing in the barn after partially curing in the field.

P34. Dried Grapefruit Pulp for Milk Production. P. T. Dix Arnold, R. B. Becker and W. M. Neal, Florida Agricultural Experiment Station.

During 90-day double-reversible feeding periods in each of three consecutive years, dried grapefruit pulp was compared with dried beet pulp in balanced dairy rations. These were fed to 24 Jersey cows at a level to supply 40 per cent of the T. D. N., replacing one-third of the hay and silage, and a part of the mixed concentrates.

The production of 100 lbs. of milk (Jersey) required the consumption of 106.8 lbs. corn silage, 34.7 lbs. No. 1 alfalfa hay, 42.5 lbs. of dried grapefruit pulp, 9.75 lbs. cottonseed meal (41 per cent) and 9.75 lbs. corn feed meal. Likewise with 47.6 lbs. of dried beet pulp, the cows ate 110.1 lbs. corn silage, 36.2 lbs. alfalfa hay, 9.85 lbs. cottonseed meal and 9.85 lbs. of corn feed meal, while producing 100 lbs. of milk.

Neglecting changes in body weight, 42.5 lbs. of dried grapefruit pulp were equivalent to 45.1 lbs. of dried beet pulp, as used in these trials. Milk yields obtained were slightly to the advantage of the grapefruit pulp, and gains in body weight slightly in favor of dried beet pulp.

It is concluded that dried grapefruit pulp is equal in feeding value to dried beet pulp, when fed as a carbohydrate concentrate in mixed dairy feeds.

P35. The Value of the Qualitative Color Test in the Study of Ketosis. C. W. Duncan and C. F. Huffman, Michigan Agricultural Experiment Station.

The purpose of this experiment was to study the incidence of ketosis in dairy cattle and to correlate the intensity of the color obtained by the use of a qualitative color test with the actual amount of ketone bodies found in the

urine by the Van Slyke technique. Approximately 1,400 milking cows in state-owned herds were tested for the presence of ketone bodies in the urine. Forty-five per cent of the cows responded to the color test, whereas less than 10 cows actually exhibited clinical symptoms of ketosis.

In recording the results of the qualitative test the intensity of the permanganate color was classified as follows: 1 +, faint color; 2 + and 3 +, more pronounced color; and 4 +, intense color. When the actual quantities of total ketone bodies were determined for each classification, it was found that the mean values indicated a general agreement with the above classification but when each range of values was taken into consideration, no definite correlation could be established.

The acetone and acetoacetic acid fraction and the β-hydroxy-butyric acid fraction of the total ketone bodies were then determined quantitatively. The mean values found for the acetone and acetoacetic acid fraction showed more correlation with the color test than the total ketone bodies. The range of values for each color classification again showed so much over-lapping that it was concluded that the color test ordinarily used by the veterinarian is of doubtful value in estimating the amount of ketone bodies being excreted by the cow or in the severity of ketosis. This conclusion was further verified when it was found that appreciable quantities of ketone bodies, chiefly β-hydroxy-butyric acid, were present in urine samples which gave negative color reactions. These results suggested the possibility that cows may be excreting significant amounts of ketone bodies in the urine normally.

The diurnal variations in the excretion of ketone bodies were determined for eight cows on metabolism trials and it was found that the excretion increased as rumen digestion progressed. The maximum amount of ketone bodies is excreted in the urine at approximately 5–6 hours after feeding. This observation is in agreement with rumen digestion studies in which it was found that the maximum acidity of the rumen occurs at the height of rumen activity.

The qualitative color test, in the absence of visible clinical symptoms, is not a satisfactory indication of the degree of ketosis in dairy cattle because of the lack of a definite quantitative relationship. The results of random sampling may be further invalidated unless the diurnal variation in the excretion of ketone bodies is also taken into consideration.

P36. Blood Sugar and Carbon Dioxide Combining Power of Plasma in Relation to Ketosis in Dairy Cattle. J. F. SYKES, C. W. DUNCAN AND C. F. HUFFMAN, Michigan Agricultural Experiment Station.

In a study of ketosis, the total ketones of the blood, blood sugar and carbon dioxide combining power of the plasma have been determined on a large group of mature dairy cattle. Some of these were made at weekly intervals over considerable periods. With one or two exceptions, clinical

symptoms of ketosis were not evident. With increasing degrees of ketosis, the blood sugar values progressively decreased although all these values fell within accepted normal limits. The carbon dioxide combining power of the plasma remained within normal limits at all levels of blood ketones which were encountered in this particular group of cattle and showed no consistent variations which could be correlated with the degree of ketosis.

P37. The Relationship of Fat Content in the Dairy Ration to Milk and Butterfat Production. C. F. MONROE AND W. E. KRAUSS, Ohio Agricultural Experiment Station.*

Practical grain mixtures containing three different levels of fat have been fed to a herd of 90 purebred Holstein cows. These three different fat percentages of 4.9; 3.5; and 2.8 were obtained by using either ground soybeans, expeller, or extracted process soybean oilmeal as the protein supplements. The protein content of the grain mixtures was equalized as nearly as possible. In other respects the grain mixtures were practically identical.

The feeding program called for two similar trials of 160 days. During the first 50 days of each trial all the cows were fed the basal or high-fat mixture, after which they were divided into three groups, each of which received one of the different fat levels for the remainder of the trial, or 110 days.

At the time of writing this abstract one trial has been completed. There are available data from 15 cows on each of the high-fat and low-fat levels and from 10 cows on the medium-fat level. The results of this trial indicate no significant difference in milk or butterfat productions, that could be attributed to the level of fat feeding.

Data covering two 110-day experimental periods and two 50-day preliminary high-fat periods will be presented.

P38. Alfalfa Hay Cut at 3 Stages of Maturity; Its Yield, Chemical Composition and Feeding Value for Milk Production. J. R. DAWSON, D. V. KOPLAND AND R. R. GRAVES, Bureau of Dairy Industry, U. S. Department of Agriculture.

For 3 years the bureau carried on an experiment at its Huntley, Montana, field station to compare the yield, chemical composition, and feeding value of alfalfa hay cut at (1) initial-bloom, (2) half-bloom, and (3) full-bloom stages of maturity. Observations were also made on the effect of cutting at the 3 stages on the stand of the alfalfa. The alfalfa was grown under irrigation on 5-acre tracts, was harvested at the particular stage of maturity under practical farm conditions and was later fed as the sole ration to groups of Holstein cows to compare its feeding value. Cutting at the 3 stages had no appreciable effect on the stand. The 3-year average crude

* In cooperation with the Ohio State Department of Public Welfare and the Central Soya Company, Inc., Fort Wayne, Indiana.

protein content of the cuttings made at the initial- and half-bloom stages was 18.24 per cent as compared to 15.71 per cent for cuttings made at the full-bloom stage. First cuttings of all stages were inferior to later cuttings. The crude fiber content was lower for the initial- and half-bloom stages. The average yields of field-cured hay in pounds per acre were: Initial-bloom, 8938; half-bloom, 8843; and full-bloom, 6940. The average yield of crude protein obtained per acre was 1427 pounds, 1381 pounds, and 997 pounds, respectively, for the 3 stages. The digestion coefficients for crude protein were 77.7 per cent, 77.1 per cent, and 75.4 per cent, respectively, for the 3 stages. The cows fed the initial-bloom hay as their only feed produced an average of 11,099 pounds of milk and 404 pounds of butterfat (calculated to a mature basis). The cows fed half-bloom hay averaged 9763 pounds of milk and 345 pounds of butterfat, and the cows fed full-bloom hay averaged 8981 pounds of milk and 331 pounds of butterfat. There was little difference in the amount of hay consumed of the 3 stages. The nutrients furnished by the hay cut at the initial-bloom stage appeared to be more efficient than the nutrients from the hay cut at the later stages. The comparative costs per ton of the hay cut at the 3 stages were $3.72 for the initial-bloom, $3.97 for the half-bloom, and $4.23 for the full-bloom hay.

P39. Cystine as a Possible Deficiency in a Ration of Alfalfa Hay for Milk Production. C. F. HUFFMAN AND C. W. DUNCAN, Michigan Agricultural Experiment Station.

It has long been recognized that total digestible nutrients in roughages are nutritionally inferior to those of concentrates, which is the basis of Kelner's starch equivalents, Armsby's net energy values, and the productive energy values of Fraps'. In a previous report it was shown that cows fed alfalfa hay, bone meal and salt declined in milk production although more total digestible nutrients were supplied than required for maintenance and milk production. When a part of the total digestible nutrients of the hay was replaced with either corn or beet pulp an increase in milk production resulted.

The results of the Oregon workers with rats indicated that when female rats were fed alfalfa protein at a 10 per cent level as the only source of protein, milk production was reduced. The addition of cystine to this diet resulted in increased milk production.

In order to determine the possible deficiency of cystine in a ration of alfalfa alone, four cows which had received alfalfa hay alone for some time were fed cystine as a supplement. One cow was fed 40 gms. of cystine per day for 15 days. This high level of cystine resulted in a marked reduction of appetite and milk production, but a gain in body weight. The other 3 cows were fed 20 gms. per day for a period of 15 days. Milk production was not affected by the addition of cystine, although later when corn replaced alfalfa in isodynamic amounts milk production increased.

P40. The Feeding Value of Rye Stillage for Dairy Cows. K. L. TURK AND M. H. BERRY, Maryland Agricultural Experiment Station.

Considerable quantities of rye stillage are available for feeding purposes in Maryland and other states. Rye stillage is a product formerly known as distillers' rye slop. This product is produced largely from rye grains with the addition of some rye malt and barley malt. Since little data are available on this product, an experiment was conducted to determine the feeding value of rye stillage for dairy cows.

The whole slop was used in this experiment and was obtained fresh each day from the distillery. The average composition of the stillage obtained from weekly composite samples was as follows: 94.77 per cent water, 0.29 per cent ash, 1.72 per cent protein, 0.21 per cent ether extract, 0.44 per cent crude fiber, and 2.57 per cent nitrogen-free extract.

The feeding experiment was conducted for a twelve weeks' period with twenty cows of the Ayrshire, Guernsey, and Holstein breeds. The continuous system of feeding was employed. The cows were divided into two groups as equally as possible in all essential respects. Both groups of cows received one pound of U. S. No. 2 leafy alfalfa hay and 3 pounds of corn silage for each 100 pounds of liveweight per day. In addition, one group received a good concentrate mixture, containing 16 per cent total protein, in sufficient amounts to meet the requirements of the Morrison Feeding Standards. The other group received the same ration except one-half of the dry matter in the concentrate mixture was replaced by an equivalent amount of dry matter from rye stillage.

No significant difference in milk production in favor of either ration was observed. When the milk production of both groups was equated to an equal energy basis of 4.0 per cent fat, the 10 cows receiving the stillage produced daily an average of 21.03 pounds of milk while the cows receiving the normal ration produced daily an average of 20.11 pounds of milk. It took 19.68 pounds of rye stillage to replace one pound of grain mixture. With a good grain mixture valued at $30.00 per ton, the value of the stillage was found to be $1.52 per ton.

Some difficulty was encountered in getting the cows to consume the stillage at the beginning of the experiment. Its palatability was increased by the addition of approximately one-half pint of cane molasses per cow per day until the cows become accustomed to drinking it. Also, the stillage was more palatable when fed at a temperature of approximately 100° F.

Since the amount of stillage fed was substituted for one-half of the dry matter in the concentrate mixture, the amount consumed by each cow varied from week to week for the same cow and for the different cows. One cow, an Ayrshire, consumed an average of 139.7 pounds of stillage per day. On the other hand, one of the lower producing cows consumed only 26.2 pounds of stillage per day. For all cows, there was an average daily consumption of 45.07 pounds of stillage.

There was some difference in the average weights of the cows in favor of those receiving the normal ration. The cows receiving the stillage lost an average of 13.2 pounds per cow during the 12 weeks of the experiment, while those on the normal ration gained 1.8 pounds per cow during the experimental period. Most of this loss was due to three cows that lost considerable flesh before they became accustomed to the stillage. All of the cows that readily consume the stillage maintained their weight satisfactorily and four of them gained weight.

Rye stillage had no deleterious effects on the flavor and odor of the milk in this experiment. The stillage was fed immediately after milking in all cases.

There was no evidence that feeding rye stillage would increase the incidence to mastitis.

P41. Fermentation Studies on Alfalfa Silage Prepared by the Phosphoric Acid and Molasses Methods. H. D. McAuliffe, R. W. Stone and S. I. Bechdel, The Pennsylvania State College.

Alfalfa silages, prepared under exactly comparable conditions with various concentrations and mixtures of molasses and phosphoric acid, have been studied with respect to the micro-organisms present and the chemical changes produced. The fodder, a uniform third cutting of alfalfa, was ensiled in six small experimental silos. Serial samples for bacteriological and chemical analyses were taken from various levels by drilling holes through the silo and removing the silage with a soil auger.

Earlier investigations correlated inferior silages with a high pH and a high content of volatile acids. In spite of large numbers of lactobacilli, the amount of lactic acid was small. Serial analyses showed the first stage of the fermentation to be normal with an increase in lactic acid to a relatively high level and a corresponding drop in pH and in fermentable sugar. When the reducing sugar decreased to approximately 1 per cent by dry weight, a second stage of fermentation brought about a lowering in the lactic acid content and an increase in pH. The fate of the lactic acid was suggested by the continued increase in volatile acids; however, there was no apparent change in the bacterial flora during the secondary fermentation.

Although the six silages were apparently normal as a whole, several levels showed the abnormal fermentation previously observed. Differences in pressure at various levels or lack of uniformity in mixing of the molasses and acid with the fodder may explain the abnormal fermentation that occurred in different sections of the silages.

P42. The Losses Resulting from the Ensiling of Legumes and Grasses with Varying Amounts of Phosphoric Acid. O. L. Lepard and E. S. Savage, Cornell University.

Three experiments were designed to determine the losses and changes accompanying the ensiling, with varying amounts of phosphoric acid, of the following crops: mixed grass, clover and alfalfa; timothy and other grasses; and medium well matured soybeans.

Farm size silos were used and each was filled with a particular crop. The silos were divided into layers separated by waterproof rubber sheets. A definite amount of acid (68 per cent food grade phosphoric acid), varying from 0 to 24 pounds per ton was added to each layer. The losses of the following were determined: total weight, dry matter, crude protein, ether extract, crude fiber, and ash. Other determinations made included temperature changes, pH, and volatile constituents.

The layer method, when the layers are separated by waterproof material, is satisfactory for making experimental divisions in the silo when material low enough in moisture to prevent excessive drainage is used. Relative results may be secured from material which has drained excessively.

Natural moisture is an important factor in the preservation of silage. It should be as high in moisture as possible without allowing drainage. This cannot be stated as a definite percentage as it depends on the type of crop, fineness of cut, packing and depth of material in the silo. Practically, one must develop the art of determining when a crop is at the right stage for ensiling.

The loss of nutrients from silage which drains excessively may be no more than that of a dry silage, because of spoilage and chemical changes, aided by the presence of more air in the dry material.

The addition of water to a dry crop when ensiled is apparently not a desirable practice. The water does not make a homogeneous mixture, but forms channels and runs down through the silage. This may wash out the added preservative.

The pH was not related to the amount of acid added in the case of timothy and other grass silage or of the mixed silage (grass, clover, and alfalfa). There was a definite relationship in the case of the soybeans in that a lower pH resulted from the addition of larger amounts of phosphoric acid.

There was no apparent relationship between the amount of acid added and the dry matter or the individual nutrient losses.

High temperatures did not result in a low moisture silage unless large amounts of air were incorporated in the silage. Temperatures of various lots of silage containing from 50 to 82.5 per cent moisture were determined. In each case the temperature rose from 4 to 10 degrees centigrade above the ensiling temperature, reaching a maximum of from 26 to 38 degrees centigrade in about 18 days. It then declined in relation to the climatic conditions.

P43. Effect of Depth of Corn in the Silo on Weight of Corn Silage.
JOSEPH B. SHEPHERD, Bureau of Dairy Industry, U. S. Department of Agriculture.

At the Beltsville Research Center most of the corn is siloed when the ears are slightly dented to well-dented, but before they are fully dented and hard. From 1937 to 1939 data were obtained on the weight of green corn put in 8 silos, on the total weight of corn silage removed from 6 silos, and on the weight per cubic foot at different depths of the corn silage removed from 5 of these silos.

The silos, 14 feet in diameter, were filled to depths of 41 to 45 feet. Twenty-five to forty tons of corn were put in daily. A jointed pipe distributor was used inside the silo. Most of the corn was chopped in ¼-inch lengths and tramped by one man.

At filling time, an average of 148.2 tons of corn with 71.92 per cent moisture was put in each of 8 silos. The corn averaged 42.37 feet in depth. The calculated weight per cubic foot was 45.45 pounds corn containing 12.74 pounds dry matter.

This weight of corn is 14.5 per cent higher than that calculated by Chase and slightly higher than that calculated by McCalmont for the same diameter of silo and depth of corn. The calculated weight per cubic foot for the different silos ranged from 42.60 to 50.69 pounds corn and 11.83 to 14.16 pounds dry matter. Corn with the highest percentage of dry matter weighed the least but contained the most dry matter per cubic foot. Well eared corn weighed more, and contained more dry matter per cubic foot, than corn that was only fairly well eared.

As the silos were emptied, the silage was carefully removed until the surface was level without bumps or hollows, at approximately two-foot intervals, and the weight of the silage per cubic foot was calculated separately for each section.

The amount of spoiled silage on top varied from 2,180 pounds for silage stored 28 days to 5,760 pounds for silage stored for 556 days. Losses of dry matter ranged from 8.36 to 27.59 per cent per silo, depending largely upon the length of time stored.

Average weights of corn silage per cubic foot at different depths for 4 silos averaging 27.63 per cent dry matter were found to range from 17.7 pounds at one foot to 54.8 pounds at 35 feet, with little or no increase at greater depths.

From the top of the silage to a depth of 30 feet, the settled silage averaged 47.4 pounds per cubic foot, with a dry matter content of 13.1 pounds. This is a 22 per cent greater weight of corn silage than the figure of 39.0 pounds given by Eckles, Reed, and Fitch for the same depth of silage, a difference explainable by the difference in the moisture content.

A table has been prepared showing the total weight of settled silage down

to different depths. From this table the quantity of silage removed and the quantity remaining in the silo can be easily calculated at any time.

P44. Broomcorn Silage for Dairy Cattle. K. E. HARSHBARGER AND W. B. NEVENS, University of Illinois.

Two hundred twenty-three thousand acres of broomcorn were grown in 1939 in the six principal producing states of the United States. About one-eighth of this acreage and one-fourth of the harvested crop were grown in Illinois.

As a rule, the brush is the only portion of the crop used and the remaining stalks are plowed under. Farmers seem to hold the opinion that the broomcorn plant is unpalatable and may be poisonous to livestock.

An investigation was conducted (a) to determine the yields of dry matter in the stalk portion of the broom corn plant; (b) to find a suitable method for the preservation of the stalks as silage; and (c) to study the feeding value of the silage. Two varieties commonly grown in Illinois, Black Jap and White Italian, were used.

Beginning on August 9 and at intervals up to September 20, portions of the crop from measured lengths of row were harvested for determinations of yields and for silage.

Results. The yield of dry matter in the stalk portion of the broomcorn crop at the usual stage for brush harvest was found to be equal to that in adjoining plots of hybrid corn harvested for silage. Broomcorn stalks ensiled with no treatment produced silage which was either completely spoiled or very low in acidity and in poor condition at the time the silos were opened 8 to 9 months after filling. Treatment with molasses at the rate of 100 pounds to a ton proved effective in the production of silage that had good keeping qualities and fair feeding value. In this investigation, the best stage for ensiling appeared to be at the time the brush is harvested. Chemical analyses show that broomcorn silage is lower in protein and higher in ash and crude fiber than is corn silage.

P45. Comparison of *Lespedeza sericea* Silage, Alfalfa Silage, and Corn Silage for Dairy Cows. S. A. HINTON AND C. E. WYLIE, University of Tennessee.

In order to determine the value of *Lespedeza sericea* as a silage crop and to determine its comparative feeding value with that of corn silage and alfalfa silage, two small silos of ten tons capacity each were filled, one with *Lespedeza sericea* and one with alfalfa. Corn was ensiled in a 200 ton concrete silo.

The alfalfa used was first cutting, cut in early bloom stage on May 25, 1939. The alfalfa was raked and loaded as quickly as possible. The moisture content of each load was determined by the Stark toluene method.

The average moisture content of the alfalfa at the silo was 66.1 per cent. This was adjusted to 70 per cent by adding water at the time of filling. The alfalfa was treated with a mixture of 60 pounds of blackstrap molasses and 10 pounds of 80 per cent phosphoric acid to each ton of green material. This mixture of molasses and acid was diluted with an equal part of water to facilitate flowing and applied with a Papec automatic molasses feeder attached to a Blizzard 500 ensilage cutter. The power requirements for cutting, using a 40 h.p., 3 phase motor, was 2.01 k.w.h. per ton.

The *Lespedeza sericea* was first cutting, cut on June 5 and 6 when the plants were from 12 to 15 inches in height. The moisture content was determined and adjusted to 70 per cent. The *sericea* was treated with a mixture of 60 pounds of molasses and 10 pounds of 80 per cent phosphoric acid applied by the same method that was used in the case of the alfalfa. Both the alfalfa silage and *Lespedeza sericea* silage were of excellent quality and were eaten readily by dairy cows during the winter of 1939–40.

In the feeding trials 12 cows in milk were selected. These cows were divided into three groups as equally as possible according to number, breed, age, size of animals, stage of lactation, milk production, and condition at the beginning of the experiment.

Cows in group I received 20 lbs. of corn silage, those in group II, 20 lbs. of *Lespedeza sericea* silage, and those in groups III, 20 lbs. of alfalfa silage. All groups were fed ground alfalfa hay ad libitum, and 10 pounds of a grain mixture to balance with roughage.

The results of the first 120 days of the feeding trials show that all groups maintained normal body weight. The production of all groups has been normal, with groups I and III producing slightly more milk and butterfat than group II. Group I has produced 12,599 pounds milk, 555.5 pounds fat; group II, 11,740 pounds milk, 506.5 pounds fat; group III, 13,277 pounds milk, 566.8 pounds fat. Group I has consumed approximately 400 pounds less hay than has group II or group III.

P46. Composition and Nutrient Value of Sugarcane as Fresh Forage, Shocked Fodder and Silage. W. M. NEAL, Florida Agricultural Experiment Station.

Immense yields and diverse adaptability recommend sugarcane as a forage crop for the lower coastal plains. Three methods of feeding are: as a soiling crop, as shocked fodder, and as silage. Digestion coefficients for sugarcane in the three forms were found to be: for crude protein, 20, 00 and 00; for crude fiber, 55, 50 and 53; for nitrogen-free extract, 69, 65 and 45; and, for crude fat, 56, 46 and 41. The digestion trials were conducted with four steers over 20-day experimental periods.

Total digestible nutrient contents on the dry basis were calculated to be: 62.0 per cent for fresh forage, 57.5 per cent for shocked fodder, and

45.5 per cent for silage. Assigning an index value of 100 to the digestible nutrient value of fresh cane, and allowing for silo fermentations and losses in shocking; then, shocked cane has an index of 84, and silage of 62.

P47. Is Timothy Hay Adequate in Calcium for Optimum Growth of Dairy Heifers? H. T. CONVERSE, EDWARD A. KANE AND EDWARD B. MEIGS, Bureau of Dairy Industry, U. S. Department of Agriculture.

There is a wide difference in the requirement of calcium for normal growth in dairy cattle as stated by different experiment stations. These different requirements were summarized by Mitchell and McClure in 1937 as more than 0.43 per cent calcium in the total ration for the Massachusetts Station; as more than 0.25 per cent for the West Virginia Station; and as 0.24 per cent or less for the Michigan Station. Both the Massachusetts and West Virginia stations reported better gains in body weight when at least a portion of the hay fed was alfalfa. The gains in weight at the Michigan Station were as large on the timothy ration as on the alfalfa ration.

Since 1935 a number of heifers raised in the nutrition herd for long time feeding experiments have been fed No. 3 timothy hay with or without bone meal as a supplement. The hay and concentrates fed have been described in previous papers. The grain mixture is high in protein to supplement the timothy hay and contains about 0.15 per cent calcium. The timothy hay used was as low in calcium as could be found on the local market, usually ranging from 0.25 to 0.35 per cent calcium and averaged about 0.30 per cent. Bone meal when fed was mixed first at the rate of 3 per cent and later at 6 per cent of the grain mixture, and the feeding of it was started at six months of age, at the end of the milk feeding period. The Holstein heifers received on the average about 2.0 kgs. of grain and 5.0 kgs. of hay. The daily calcium intake for the group without bone meal was about 18 gms. for the Holsteins and about 13 gms. for the Jerseys.

Eighteen heifers have completed the experimental feeding period of one year, from 6 to 18 months of age. Seven of these received the basal ration of grain and timothy hay and seven received the bone meal supplement. Where possible the animals were paired, the calf making the larger gain during the milk feeding period being placed in the bone meal group. Two calves in each group were not well paired.

The group that received the basal ration averaged to gain 419 pounds during the experimental period and the group that received the bone meal supplement averaged to gain 415 pounds during the period. In none of the five cases where the animals were considered well paired at the start of the experiment did the calf that received the calcium supplement gain more than the calf paired with it on the basal ration.

From another experiment, bone ash analyses are available on 2 calves that received grain and timothy hay and on 2 calves that received grain and alfalfa hay. The calves were killed at 12 months of age. There was no significant difference in the percentage of bone ash. The calves that received alfalfa hay had 60.0 and 60.1 per cent of ash in the dry and fat free humeri and the calves that received timothy hay had 60.1 and 59.5 per cent of ash. This fact gives additional evidence that timothy hay fed in liberal amounts supplies sufficient calcium for normal bone development.

P48. The Effect of Rations Deficient in Phosphorus and Protein on Ovulation, Estrus and Reproduction in Dairy Heifers. L. S. PALMER, T. W. GULLICKSON, W. L. BOYD, C. P. FITCH AND J. W. NELSON, University of Minnesota.

Low protein is the most striking accompanying characteristic of the low phosphorus rations fed to dairy cattle and other ruminants in the phosphorus deficient region of Minnesota. An experimental study of the effect of this dual deficiency on reproduction and associated physiological phenomena in cattle was begun in December, 1933, and continued until August, 1939. Two heifers, 22 months of age, and nine calves, five to eight months of age, were placed on rations consisting largely of prairie hay (deficient in phosphorus and protein) for periods ranging from 24 to 59 months for the different animals. A small amount of grain mixture was also fed consisting of two or more of the following ingredients: corn, oats, corn gluten meal (low phosphorus) and molasses beet pulp. Except for brief periods or during lactation (involving two animals) the daily intake of digestible crude protein and phosphorus was quite uniform for each animal, the former varying among the different animals from averages of 0.42 to 0.75 pounds and the latter from averages of 4.9 to 7.8 grams. Consumption of total digestible nutrients was also subnormal, due to the deficiencies imposed. The older animals took on an emaciated, unkempt appearance. The calves grew at a subnormal rate; they developed rough coats and were coarse and unthrifty appearing, with overdeveloped skulls and undersized bodies. The condition of protein and phosphorus deficiency was also shown by (a) the development of osteophagia and general pica, (b) low concentration of blood phosphate, (c) low retention of nitrogen and phosphorus and (d) subnormal mineral content of the bones.

Sexual activity and behavior were studied by Drs. Boyd and Fitch by regular and frequent examination of each animal for physical and psychological signs of estrum and menstruation, including rectal examination of the uterus and the determination of ovulation by palpation of the ovaries. It was found that the latter examination made it possible to determine ovulation with great accuracy. First ovulation was much delayed in all of

the animals, especially in the calves which were undersized, but when it began it continued with normal regularity with no instance of retained corpus luteum. Frequently, ovulation occurred without any symptoms of estrum. Obvious estrum was not always accompanied by "bulling." Menstruation in the young heifers occurred much less frequently than estrum.

Eight of the nine calves were tested for breeding efficiency after being on experiment for periods ranging from 14 to 37 months, the corresponding ages being 21 to 42 months. The oldest four animals conceived at first service when 34–42 months old and conception was also normal in the younger animals when regular ovulation became established. Ten normal calves were dropped although two died during very difficult parturition of the youngest two animals which were much undersized. The heifer that was the oldest at the time of its successful first service expelled a small mummified fetus about five weeks before term after repeated failures to induce abortion of the dead fetus; but she conceived again promptly and delivered a normal calf. Two of the other older heifers conceived a second time early in their first lactation and delivered normal second calves.

P49. The Effect of Avitaminosis A upon Vitamin C in the Bovine. W. A. KING, P. H. PHILLIPS, M. E. NESBIT, I. W. RUPEL AND G. BOHSTEDT, Departments of Biochemistry and Dairy Husbandry, University of Wisconsin.

The previous report which suggested that growing calves suffering from a vitamin A deficiency develop a lowered blood plasma vitamin C content has been confirmed. In a series of experiments with Holstein calves fed a low vitamin A ration it has been found that a reduced plasma vitamin C occurs shortly after the symptoms of avitaminosis A appear. The subcutaneous injection of crystalline ascorbic acid seemed to alleviate several symptoms associated with the lack of vitamin A. A noticeable improvement in the rough scaly condition of the hair and skin was obtained. In addition there seemed to be an attenuating effect upon retinal hemorrhages.

Calves which received the A-low ration with added crystalline carotene, at the rate of 63.3 micrograms per kilogram of body weight per day, were less thrifty than those receiving only 35.3 micrograms of carotene obtained from alfalfa. Papillary edema occurred in 2 calves which were fed 63.3 micrograms of carotene. These results suggest that the carotene of alfalfa is more readily available to the bovine than crystalline carotene given in oil, and that another factor in addition to vitamin A is involved in the prevention of the papillary edema associated with avitaminosis A in cattle. These experiments seem to indicate that the lack of vitamin C is in part responsible for the condition.

P50. Vitamin C in the Nutrition of Dairy Cattle. G. C. WALLIS, South Dakota Agricultural Experiment Station.

In the course of our studies on the role of vitamin D in the adequate nutrition of dairy cattle some observations were made which indicated a possible vitamin C deficiency as a complicating factor. In several instances the teeth were found to be loose and there was considerable hypotrophy and sponginess of the surrounding gum tissue. The incisors showed more looseness than the molars. In one animal the looseness of the incisors was so pronounced that the entire dental pad and teeth could be pushed down like the fingers of the hand. A tooth from another animal was found in the manger.

A study and analysis of the vitamin-D-deficient ration revealed that it was also very low in vitamin C. Although it is generally assumed that vitamin C is not an essential dietary factor for dairy cows it was decided to make a further study of this situation as these cows had been on the deficient ration for a much longer time than has usually been employed for vitamin C studies.

Since June of 1939 indophenol titrations for vitamin C in the milk and blood plasma have been made at least twice monthly on eleven cows. Four of these were from the vitamin-D-deficient (also vitamin-C-deficient) herd. Two others received a ration of alfalfa hay, corn, and oats. The remainder were from the main college dairy herd. Of the latter, some were on pasture during the summer while the others received only the regular herd ration of silage, alfalfa hay, and a grain mix.

Using all the figures available up to and including March, 1940, the cows on the vitamin-D-deficient ration of beet pulp and a grain mix of corn, oats, corn gluten meal, and bone meal, showed an average of 0.369 mgm. of vitamin C per 100 ml. of blood plasma; the cows from the main herd averaged 0.320 mgm.; and the cows on the ration of alfalfa hay, corn, and oats averaged 0.446 mgm. of vitamin C per 100 ml. of blood plasma. Taking the three summer months only, the vitamin-deficient cows showed an average of 0.366 mgm. of vitamin C per 100 ml. of blood plasma, those on pasture averaged 0.249 mgm., and those receiving the regular herd ration averaged 0.320 mgm.

The vitamin C studies on the milk showed that for all samples from the vitamin deficient cows the average content was 1.75 mgm. per 100 ml. of milk. For cows from the regular college herd the average was 1.79 mgm., and for the two cows receiving alfalfa hay, corn and oats it was 2.05 mgm. Figures for the three summer months taken alone show an average of 1.81 mgm. per 100 ml. of milk for the vitamin deficient group, 1.80 mgm. for the cows on pasture, and 1.77 mgm. for the cows receiving the regular herd ration.

As the level of vitamin C in the milk and blood plasma of the vitamin deficient cows was essentially the same as that of the regular herd cows even

during the summer season when some of them were on pasture there seems to be no evidence that they were suffering from a vitamin C deficiency. These observations support the conclusion that dairy cows can synthesize Vitamin C and are therefore, not dependent upon a food source for this factor.

P51. Blood Plasma Magnesium in Relation to the Vitamin D Deficiency of Mature Dairy Cattle. G. C. WALLIS, South Dakota Agricultural Experiment Station.

For approximately the last two years determinations of the blood plasma magnesium have been made in connection with our studies on the vitamin D deficiency of dairy cattle. Analyses have been made regularly at monthly intervals and more often when necessary on eight different animals. Two of these animals may be considered essentially normal from the standpoint of herd management and the others belong to the vitamin-D-experimental herd. A total of 136 magnesium analyses have been made. When these figures were averaged by cows the magnesium content per 100 ml. blood plasma was found to be as follows:

Cow	13E—normal herd management	3.28	mgm.
"	150 " " "	3.22	"
"	4E—vitamin D deficient diet plus cod liver oil supplement	3.25	"
"	6E—Developed vitamin D deficiency during the period of observation	3.27	"
"	7E—Dry cow on vitamin D deficient ration throughout. No pronounced vitamin D deficiency symptoms	3.58	"
"	8E—Developed severe vitamin D deficiency during period	3.99	"
"	417 —Four months on vitamin D deficient ration. No visible symptoms	3.08	"
"	12E—Developed vitamin D deficiency	3.84	"

The above information reveals no consistent changes which can be correlated with the development of a vitamin D deficiency. Of the three animals which developed a vitamin D deficiency during this period, two of them, 8E and 12E, had the two highest average magnesium figures and the other one, 6E, had one of the lowest figures.

A further study of the trend of the magnesium values for individual animals during this period reveals that these levels of magnesium are typical for the animals concerned and there was no consistent or significant tendency for the values to become either higher or lower as a vitamin D deficiency developed. The general level of plasma magnesium for the animal, during normal periods seemed to continue with considerable uniformity as the vitamin deficiency developed and also during the time of recovery. For instance, the average for 6E during the four months of the severest vitamin D deficiency was 3.35 mgm. as compared with 3.25 mgm. for the whole period. Similarly, 12E showed an average of 4.00 mgm. for the year and 3.81 for the last three months when the vitamin D deficiency was severe.

When she was turned out for sunshine exposure as a source of vitamin D the daily magnesium values averaged by 10-day intervals for the next 30 days were 4.08, 3.58, and 3.68 mgm. for 100 cc. of plasma respectively.

In conclusion it may be said that the levels of magnesium per 100 ml. blood plasma have been found to be slightly higher for these mature dairy cows than is commonly reported for growing animals. The average level of blood magnesium does not seem to vary significantly from normal for mature dairy cows kept for long periods of time under vitamin D deficient conditions even in those cases where the blood calcium and inorganic phosphorus may be decidedly subnormal. Neither is there a decided trend to higher or lower levels as a vitamin D deficiency develops, nor during the period of recovery.

P52. Vitamin E Potency of Certain Feedstuffs. L. S. PALMER, J. W. NELSON AND T. W. GULLICKSON (with the assistance of B. B. Migicovsky and W. W. Kielley), University of Minnesota.

Feedstuffs that are naturally deficient in ether soluble substances would be expected to be deficient in vitamin E. Other feedstuffs might be expected to lack E activity because of their nature or the manufacturing process employed even though they contain moderate amounts of ether soluble substances. Knowledge regarding the vitamin E potency of both classes of feedstuffs should help determine how widely the tocopherols are distributed in feedstuffs and should be useful in designing rations for the experimental production of vitamin E deficiency in the bovine species.

The more or less standard biological assay procedure for vitamin E, using rats, was modified in order to secure a satisfactory result when testing feeds expected to be deficient in the vitamin. Each product was tested alone when incorporated in the standard, basal, E-free ration. Some products were tested again in combination with others to determine their additive effect on reproduction. Positive and negative control groups of rats were employed, the former receiving the basal ration plus wheat germ oil of known potency and the latter receiving only the basal ration. Roughages as well as concentrates were tested. With the exception of meat scraps, fish meal, dried brewers' grains, hominy and corn bran, the ether extract of all products was less than three per cent and for some it was less than one per cent.

The following products were found to be sufficiently rich in tocopherols to insure normal reproduction in female rats when fed continuously from weaning to full sexual maturity, incorporated in the basal, E-free ration in concentrations which would be fed to cattle: Phosphorus deficient prairie hay, reed canary grass, wheat straw, rye straw, oat hulls, corn bran, molasses beet pulp, corn gluten meal, blood meal, meat scraps, fish meal, barley, hominy, wheat gluten and black strap molasses. The following products

were found to be too low in tocopherols to insure normal reproduction under these conditions although a measure of reproduction efficiency was obtained if sufficient amounts were consumed: Corncobs, dried brewers' grains and skimmilk powder. The latter two products did not give any reproduction if present as the sole source of vitamin E at less than 20 per cent level in the basal ration during the period of feeding adopted for the assay. The corncob test was made on the material extracted from the cobs by benzene. The following products were found to be either seriously deficient or entirely lacking in tocopherols in our tests: rice straw, corn starch, dried potatoes, polished rice and solvent extracted, dried distillers' grain.

A less complete study was made of the ability of some of the products mentioned to prevent the characteristic testicular degeneration of male rats which occurs when they are reared on E-free diets. The basal E-free ration containing 30 per cent solvent extracted, dried distillers' grains and the same basal ration in which had been incorporated 40 per cent polished rice, 32.5 per cent dried brewers' grains and 15 per cent skimmilk powder failed to prevent such degeneration.

P53. Carotene Content of Corn Silage. EDWARD A. KANE, HERBERT G. WISEMAN, LEO A. SHINN AND C. A. CARY, Bureau of Dairy Industry, U. S. Department of Agriculture.

In previous work from this laboratory it was reported that the carotene in corn silage may vary from 1 to 40 mgm. per kg. of wet weight depending upon the condition of the corn plant from which it was made. The average for 21 samples of silage, made from corn cut when the kernels were slightly dented and before they were fully dented and hard—as is the usual practice on the government experimental farm at Beltsville, Md.—was 9.4 mgs.

The silage fed in the dairy herd at Beltsville has been sampled twice daily every day since March 1, 1937. These samples represent as nearly as possible the silage as fed to the cows. They have been preserved in an ice box until composited monthly and analyzed for carotene. The average carotene content of 30 monthly composites from silage kept in concrete silos, made from corn cut as described above, and fed within a year of the time put up, was 13.2 mgs. per kg., wet weight. The monthly composites varied from 4 to 23.7 mgs. The average carotene in the silage fed from March 1 to August 23, 1937, was 7.5 mgs.; Meigs and Converse had one cow that calved during this period that received this silage as her only source of vitamin A. Her calf was weak at birth and died 2 days later. A cow similarly fed, except that the silage contained 13.6 mgs. of carotene per kg. of wet weight, bore a live vigorous calf; whereas another cow receiving silage that for 2 months before she calved contained 6.6 mgs. of carotene, bore a very weak calf that stood up at 14 hours after birth but was accidentally killed at 2 days of age by its mother lying on it. These results suggest that silage put

up and used as above described may or may not supply enough vitamin A for normal reproduction.

The carotene in the corn plant at the time of ensiling has been determined, and also in the silage at intervals for 2 years. The "carotene" appeared to increase somewhat when determined by the usual methods, but this apparent increase was due to an increase in the amount of colored impurity that could be filtered off chromatographically from the real carotene.

P54. Changes in the Amounts of Carotene and Vitamin A and in the Composition of Milk Fat in Artificially Induced Mastitis. P. G. MILLER, E. J. LEASE AND G. W. ANDERSON, South Carolina Agricultural Experiment Station.

A case of mastitis was induced in the left quarters of a young Guernsey cow by injections of a suspension of *Str. zooepidemicus.** Determinations of carotene, vitamin A, refractive index, iodine number, saponification number, and Reichert-Meissl number were made on the churned and filtered butterfat from the entire milkings individually collected by quarters. These determinations were made before infection, during mastitis, during sulfanilamide therapy, and for several weeks after treatment.

Before infection the milk produced on the right and left sides of the udder was essentially the same in all properties studied.

During the case of induced mastitis the milk from the infected quarters (left side) changed markedly as follows: the carotene and vitamin A in the fat more than doubled; the amount of carotene per liter of milk almost doubled; the fat content of the milk decreased; the total amount of carotene secreted in the milk per day decreased rapidly and the milk yield decreased to a low level. During the same period, milk from the normal quarters (right side) did not change very much, although a slight increase in carotene per liter of milk and per day occurred. This increase in carotene was probably due to the slight decrease in milk yield of which the fat content was higher. The milk fat from the infected quarters had a lower refractive index, iodine number and Reichert-Meissl number and a higher saponification number than the milk fat from the normal quarters.

Sulfanilamide therapy sufficient to eliminate all hemolytic organisms from the udder did not significantly affect the fat test or milk yield, but markedly decreased the carotene content of the milk fat from both the infected and normal quarters.

Upon recovery from the symptoms of active mastitis, all the various properties studied tended to return to normal, however, the milk yield and fat test remained low and the carotene of the fat remained slightly high from the quarters that had been infected.

* Isolated and identified from a case of bovine mastitis by Dr. F. B. Hadley, Division of Veterinary Science, University of Wisconsin, Madison, Wisconsin.

Histological examination of the udder tissues, soon after collecting the last samples, showed the infected quarters to be very low in active secretory tissues and to have a large increase in leucocytes and connective tissue.

P55. The Effects of Vitamin A Deficiency on the Young Male Bovine. T. S. SUTTON, W. E. KRAUSS AND S. L. HANSARD, Ohio Agricultural Experiment Station and Ohio State University.

Male calves were maintained on a ration low in vitamin A until about one year of age. These calves were paired with others of the same age, sex and breed for controls. When slaughtered, tissues were obtained for microscopic examination and assay. The following changes were noted in substantiation of the reports of Moore and others: constriction of the optic nerve, partial closure of the optic foramen, papillary edema, low vitamin A content of liver, low blood carotene and kidney degeneration. In addition the following changes were noted: Degeneration of the germinal epithelium of the testes, absence of spermatozoa in the epididymus, and an accumulation of fluid in the cleft between the anterior and posterior lobes of the pituitary. A microscopic examination of the anterior pituitary (one case) showed evidence of an extension of the Alpha cell area. An assay of the anterior lobe for gonadotropic hormone gave indications of an increase in gonadotropic activity. These pituitary changes are comparable to those previously reported in the rat and are believed to represent compensatory activity on the part of the pituitary in response to the dietary damage to the testes.

The practical significance of high vitamin A intake was demonstrated in a trial involving 86 male calves to be raised for veals. When a milk fat substitute-skimmed milk combination was fortified with vitamin A the incidence of pneumonia dropped from 46.2 per cent to 12.5 per cent. This latter incidence rate was comparable to that obtaining in calves fed whole milk and was correlated with the amount of vitamin A found in the liver.

P56. Cerebrospinal Fluid Pressure and Vitamin A Deficiency. L. A. MOORE AND J. F. SYKES, Michigan Agricultural Experiment Station.

In previous publications a type of blindness has been reported resulting from a constriction of the optic nerve. This blindness was found to be due to vitamin A deficiency. The blindness was preceded by papilledema, nyctalopia, incoordination, syncope and a decrease in the carotene content of the blood plasma. The presence of papilledema is usually considered prima facie evidence of an elevated cerebrospinal fluid pressure and this together with some of the other symptoms suggested that elevated pressures might accompany vitamin A deficiency in the bovine.

Therefore, the cerebrospinal fluid pressure was measured on young bovine fed a vitamin A deficient ration. The pressure was determined by

cisternal puncture through the dorsal opening of the atlanto-occipital articulation with the animal in the standing position, using a water manometer.

The results showed that a deficiency of vitamin A in the ration of the bovine permitted the pressure to rise from a normal of 90–120 mm. of saline up to as high as 300 mm. This increase in pressure was accompanied by lowered plasma carotene values, nyctalopia and papilledema. That these changes were definitely due to a deficiency of vitamin A was demonstrated by the fact that when crystalline carotene dissolved in cottonseed oil was the source of vitamin A and was withdrawn from the ration an elevation of pressure resulted which returned to normal when the carotene was again returned to the ration. The decline in pressure to normal was usually quite slow which confirms previous observations that the papilledema is slow to recede.

Preliminary results with dogs likewise indicate an elevated cerebrospinal fluid pressure in vitamin A deficiency although the eye changes are not so pronounced.

P57. The Effect of Carotene Consumption on the Milk Yield of Jersey Cows. O. C. COPELAND, Texas Agricultural Experiment Station.

Experiments have been conducted to ascertain the effect on milk yield of an inadequate supply of carotene or vitamin A in the ration of recently fresh and high producing Jersey cows. The amount of carotene supplied to one group of cows was 1,500 micrograms of crude carotene per 100 pounds liveweight daily, a quantity comparable to that supplied the average dairy cow in the Southwest during periods of drouth or during periods of feeding without pasturage. The other group was fed a daily allowance of 15,000 micrograms of carotene per 100 pounds liveweight, or an amount more nearly adequate with regards to supplying the carotene requirements for milk production than is commonly furnished dairy herds of this section during periods of drouth, or without green pasturage.

The results of two experiments using twelve cows in each experiment indicate that the milk yield of high producing dairy cows can be reduced through an inadequate supply of carotene or vitamin A over relatively short periods of time, especially during that stage of the lactation period when milk production is at the peak. Cows on the higher level of carotene feeding produced approximately ten per cent more milk than the cows fed on the lower level of carotene.

P58. The Vitamin A Requirements of Dairy Cows for the Production of Butter of High Vitamin A Value. II. Relative Efficiency of Carotene (Dehydrated Alfalfa Hay) and Vitamin A. J. W. WILBUR, J. H. HILTON AND S. M. HAUGE, Purdue University.

In these experiments, the criterion for the measurement of the vitamin A

requirements of dairy cows for the secretion of milk fat with maximum vitamin A value is based upon the supposition that cows are not able to secrete butterfat of maximum vitamin A value until the optimum requirements for maintenance and production have been satisfied. Since the vitamin A value of butterfat secreted by the cow is dependent on the ration fed the cow, it is apparent that whenever cows secrete butterfat of low vitamin A value, this is indication of an inadequate supply of available vitamin A in the ration. Furthermore, if more potent butterfat is produced upon increasing the vitamin A intake, this would also indicate that the vitamin supply had been inadequate. Only when further additions to the rations give no further response in the potency of the butter, is there any assurance that a point of saturation has been reached. Thus, the minimum vitamin A potency of the ration which will produce the maximum effect upon the milk fat secreted should prove to be the minimum vitamin A requirement of the cow for the secretion of milk fat of high vitamin A value.

The procedure in these tests was to reduce the vitamin A activity of the milk fat secreted by dairy cows to a low level by feeding vitamin A deficient rations. Then in successive feeding periods, definite quantities of vitamin A potency were introduced into the rations and the effect on the milk fat was determined. When dehydrated alfalfa hay was used as a source of vitamin A (carotene) the cows required approximately 550,000 Sherman-Munsel units daily to restore the vitamin A potency of the butterfat to its highest value. With vitamin A (per se) from 100,000–200,000 units in the ration daily were sufficient to effect a maximum vitamin A potency of the milk fat.

EXTENSION SECTION

E1. The Nation-Wide D.H.I.A. Proved-Sire Program. J. F. KENDRICK, Bureau of Dairy Industry.

The objective of the nation-wide dairy herd-improvement association proved-sire program is to improve the inherent producing capacity of the nation's dairy herds, that dairymen may produce milk more efficiently and profitably.

Association herds, which now have a yearly average butterfat production of 317 pounds per cow, may be further improved. The animals in these herds that have an inheritance for a high level of production may be located and their influence may be perpetuated and disseminated throughout the general dairy cow population of the nation, which has a yearly average butterfat production of only 170 pounds per cow. The 28,000 association herds may serve as a national breeding herd to supply improved breeding stock to our national dairy herd of 25,000,000 cows.

The nation-wide dairy herd-improvement association sire-proving program represents the broadest, most comprehensive, dairy-cattle improvement program ever to operate in this or any other country. Briefly, the plans call

for the eartag identification of all non-registered animals in association herds so that a geneological record may be established and maintained for all animals in association herds. As the 305-day lactation records of each cow are reported, they are permanently recorded so that dam-and-daughter comparisons will accumulate for every sire used in association herds.

At the present time approximately 80 per cent of the dairy-herd-improvement associations of the country are cooperating on the program. Association testers are now reporting identification and production records at the rate of about 1,300 per day. Up to April 1, 1940, production records had been recorded for approximately 300,000 association cows. Dam-and-daughter data are now accumulating on about 50,000 sires that have been used in association herds. More than 5,000 sires have already been proved. As the program goes into full operation, dairymen and dairy leaders are being provided with information which will enable them to improve the inherent producing capacity of dairy herds.

E2. The Importance of Selective Registration to the Dairy Industry.
LYNN COPELAND, American Jersey Cattle Club, New York City, N. Y.

Systems of selective registration have been followed for years in Holland, Denmark, and on the Channel Islands. It is recognized that these systems have been important factors in the improvement of the dairy cattle in these countries. Even in America selective registration is not entirely new for several breeds of livestock have followed selective registration based on color markings. However, no system of selective registration for dairy cattle based on production has ever been adopted in the past by dairy cattle Breed Associations in America.

The American Jersey Cattle Club in June, 1939, established a system of selective registration for Jerseys applicable to males alone and effective January 1st, 1942. After that date to be eligible for registration, a bull calf must meet certain requirements regarding the production of his immediate ancestry. A bull calf may be registered if the dam has completed a production record meeting certain requirements. If the dam has no record, the calf may be registered if sired by a good proved bull. If this qualification is not met, a calf may be registered, if sired by a bull that has sufficient proved production in his pedigree to qualify for one of the Star awards of the American Jersey Cattle Club.

Approximately ten-thousand new registered Jersey bulls are required annually to meet the demand of the breed. However, these bulls are bred by about 4000 of the approximately forty-thousand breeders of registered Jerseys in milk today. The new requirements should not adversely affect any Jersey breeder and it is hoped that the new program of selective registration will help give more recognition to Registration Certificates in the future.

E3. Utilization of Proved Sires and Sons of Proved Sires. FLOYD ARNOLD, Iowa State College.

The national program of identification and the reporting of production records to the U. S. Bureau of Dairy Industry, has greatly speeded up the program of proving sires throughout the United States. In Iowa for example during January, February and March records were received for 134 bulls. This was more than for any full year prior to 1939. The 1940 list of sires proved in Dairy Herd-Improvement Associations throughout the United States contains the names and records of more than 3,000 sires. These were tabulated in the 12 months preceding April 1, 1940.

It is not enough, however, to just compile proved sire records. Plans for keeping promising young bulls in service until proved and for extending or expanding the use of the good proved bulls should be developed and carried out. At the present time less than one sire in four—23 per cent—is alive when proved and of the living proved sires less than half—40 per cent—have shown a significant increase—25 pounds—in the production of their daughters over their dams. Sixty per cent of the living proved sires have maintained or increased the production through their daughters but only 45 per cent had daughters averaging over 400 pounds butterfat.

It is evident, therefore, that only about 1 sire in 8 is alive when proved and, as indicated by the production of his daughters, worthy of further use. The number is further reduced in practice because not all of the bulls that transmit satisfactory production do the same for type and are eliminated on this account.

The possibility of extending or expanding the use of proved sires is further complicated by the fact that by the time they are proved, their years of usefulness are numbered. A few sires—2 per cent—are proved before 6 years of age but an even greater number—3 per cent—are over 12 years. Sixty per cent of the bulls proved are between the ages of 7 and 9 years. The average age of the sires alive when proved is 8 years. According to Lush and Lacy the life expectancy of 8 year old bulls is 2.2 years. For 6-year-old bulls it is 2.7 years and for 10-year-old bulls it is 2 years.

An indirect way of extending the use of proved sires is through their sons and in this way probably more can be done than in any other. Observations made in Iowa show that Dairy Herd-Improvement Association members consider this a real possibility. The number of sons of proved sires in service grew from 93 in 1935 to 222 in 1938. The number in service in 1938 was 14 per cent of the total number. Many grandsons of proved sires (312) were also in service. Evidence indicating that sons of the better proved sires are most in demand was also noted in Iowa. Forty-seven proved sires with sons in service had 532 daughters averaging 438 pounds butterfat and they were from dams averaging 424 pounds butterfat. This is considerably above the average.

It is evident from the foregoing that there is little chance of increasing the use of proved sires except through their sons or programs designed to prove bulls at an earlier age and to keep them in service until proved. Bull studs, bull associations and artificial breeding societies offer the greatest possibilities. Much can be done also through bull record-book projects, better sire contests, sire exchange and meetings at which sire problems are discussed.

E5. Observations in the Care and Management of Dairy Bulls. R. R. WELCH, Pennsylvania State College.

The increasing interest in proved sire system of breeding calls for a greater knowledge of proper feed and care and management of dairy bulls that will assure a long life and satisfactory service of the superior sire.

Freedom and exercise of the bull is perhaps of greatest importance. Some have resorted to the use of mechanical means for exercising the bull. Such methods are not practical for the farmer breeder. Large exercise yards that furnish pasture in summer and year around day and night freedom of the bull is proving most satisfactory in Pennsylvania. Bull pens should be long and narrow.

There is a lack of knowledge, based on experimentation, on feeding the bull.

Why do some bulls fail to breed while other bulls kept under similar conditions continue satisfactory service for many years?

Why do some bulls fail to breed after being moved while others do not?

Some bulls become temporarily sterile, and later become satisfactory in service—why?

E8. Suggestions for Making Better Use of D.H.I.A. Feed Records. R. G. CONNELLY, Virginia Polytechnic Institute.

Dairy herd improvement association data may be divided into four classes: first, those vital data that establish the identity of the cattle; second, those data that indicate the milk and butterfat production; third, those data that refer to the type, quantity, and quality of feed; fourth, those financial data that establish the value of the milk in relation to the value of the feed. Taken in their entirety, these data furnish a practical basis of sound dairy herd mangement and improvement.

When these data are used, extension dairymen place varying degrees of emphasis upon the four classes. The present tendency is to give special attention to the cattle identification and production data as a basis for measuring the inherent milk-producing qualities of related cattle. Less emphasis seems to be placed upon the feed and financial data, giving to the dairy herd improvement association program the semblance of unbalance due to over-specialization in one direction.

The proving of bulls, the identification of brood-cow families, and the general marshalling of genetic facts pertaining to the inheritance of milk-producing ability in cattle have created a great and encouraging change in the conception of practical dairy cattle breeding. The economics of a balanced program of dairy herd improvement and dairy farm management, however, suggest the need for attention to all classes of dairy herd improvement association data in order to establish the real environmental values under which efficient herds must be bred, dairy farms must be operated, and net profits must ultimately be determined. There seems to be a prevailing need for more exact and better standardized methods for collecting, analyzing, and utilizing, feed, production cost, and other types of dairy herd improvement association data that may contribute to a better understanding of the many interrelated factors that contribute to successful dairy farming.

Experience with dairy herd improvement association records in Virginia suggest: First, that the feed, financial, and production data, can be assembled with a degree of accuracy and completeness that will permit a detailed analysis of each association's herd books at the end of the record year, thereby furnishing a basis for constructive adjustments in the management of the herds and farms of the members.

Second, that when correlated with the production records, the feed and cost data may provide a rather accurate basis for measuring trends in production, efficiency, and in gauging the effects of changes in operating methods in the herd and on the farm.

Third, that the data pertaining to feed consumption, feed costs, and fluid milk values can be assembled to establish a fair basis of appraisment when indemnities are determined for cows reacting to the Bang's disease and tuberculosis tests. The same data may be used when it is necessary to determine the earning or collateral value of the herd when establishing a basis for financial credit.

Fourth, that the data pertaining to feed consumption, feed costs, and fluid milk values may be used with supplemental survey data as dependable testimony before a state milk commission in determining a fair price for fluid milk on the farm.

E9. Accuracy and Use of D.H.I.A. Feed Records. C. G. CUSHMAN, Clemson Agricultural College.

It is axiomatic that if feed records obtained through Dairy Herd Improvement Association work are to be of any value to the participating member or of any safe value in extension teaching they must be correct within reasonable limits of human error and judgment. It is to be expected that testers will make mistakes both figurative and mistakes of judgment in view of the facilities available to them on the farm for making accurate computations. There are three general types of error. First, the error in and

tendency to make estimates which can vary widely from fact; secondly, errors in computations which resolve themselves into costly omissions and pure mistakes in simple arithmetic; and third, errors due to a natural leaning of the tester toward the conservative side in his eagerness to please his member with commendable results.

A system of analysis of monthly reports which entail auditing of the monthly reports at the state office and which results in a running chart will show to a trained clerical worker a great many errors. This basic work gives opportunity for annual analyses of yearly reports which develop a great mass of superior educational material. There is no educational material more powerful than accurate and dependable records developed by farmers themselves. Such records cover a wide range of conditions which are, and always will be, met by farmers and which Experiment Stations cannot hope to cover. Thus Experiment Station material, which forms the basis for improvement in practices, must depend upon accurate farm records to adjust Experiment Station results to varying farm conditions. Superior germ plasm in dairy cattle can be of advantage to the dairy farmer only if his management practices are sufficiently expert to make the most economical use of it.

Accuracy in D.H.I.A. feed records, therefore, plus full and adequate use of the lessons these records can reveal become of paramount importance.

E10. A Method for Determining Feeding Levels in Dairy Herd Improvement Association Herds. W. T. CRANDALL, Cornell University.

At the end of the dairy herd improvement association record year it is important to know whether the production of the cows in herds is really representative of their true inherent ability. Cows supplied with amounts of nutrients below their needs will either produce on a level with those nutrients rather than on the level of their ability, or run down badly in physical condition. Cows fed more nutrients than are theoretically needed for maintenance and the work they do are likely to either produce inefficiently or to put on excessive body weight, particularly if heavy rates of grain have been fed.

The same method as outlined for use in determining feeding levels during a yearly period may be used to check on the adequacy of feeding methods for any one month.

INFORMATION NECESSARY FOR DETERMINATION OF FEEDING LEVELS

In order to determine the feeding level of a herd for a yearly period the following information is needed on the average of all the cows in the herd:

1. Live weight at start of year to determine the T.D.N. required for maintenance.

2. Physical condition at start and close of year to indicate loss or gain during the year.

3. Yearly milk production, and butterfat test to determine the T.D.N. required for production.

4. Amount and quality of all feeds fed during the year to determine the T.D.N. supplied for maintenance and production.

The Morrison Feeding Standard for dairy cows is used in determining T.D.N. requirements. In determining the T.D.N. supplied by feeds, the standard average analyses are used for grain and for succulent roughages, but dry roughages are figured on an estimated productive nutrient basis.

DETERMINING PASTURE YIELDS

In order to get a worth while estimate of the pasture yield of nutrients, a table giving the probable daily nutrient consumption of cows of varying weights on pastures of different qualities is used. Dairy herd improvement association testers report the quality of pasture each month as excellent, good, fair or poor and a weighted average is made for the season.

RATING THE FEEDING LEVEL OF A HERD

The rating on the feeding level of a herd is made after taking the following into consideration.

1. The amount of plus or minus T.D.N. supplied in feed as compared to those required for maintenance and milk production.

2. The rate of grain fed to milk produced.

3. The physical condition of the herd at the end of the year as compared with their physical condition at the start of the year.

A STANDARD OF GOOD FEEDING

A herd has been well fed when on the average the cows in the herd are in good physical condition at freshening time, maintain normal milk curves and fair physical condition during a ten months' milking period and regain good physical condition again before freshening.

Heavy feeding.

1. T.D.N. supplied are 1000 pounds or more over needs.

2. Rate of grain to milk much higher than average rate for breed with usual roughage feeding.

3. High physical condition of cows.

Good feeding.

1. T.D.N. supplied are from 200 pounds below to 1000 pounds above needs.

2. Rate of grain to milk is average for the breed with usual rates of roughage feeding and below average with heavy rates of roughage feeding.

3. Physical condition good or fair at both start and finish of year.

Fair feeding.

1. T.D.N. supplied are within 500 pounds of needs.

2. Rate of grain slightly below average for breed considering rate of roughage feeding.

3. Physical condition of cows lower at close of year than at the start.

Poor feeding.

1 T.D.N. supplied 1000 pounds or more below needs.

2. Rate of grain to milk very low for breed.

3. Physical condition much lower at close of year than at start or poor both at start and close.

4. Size of cows usually decidedly below average for breed.

The value of this feeding level analysis depends on the care which testers take in making feed reports in respect not only to the amounts of feed fed but to their quality. In instances where the analysis of a herd is of particular importance or where questionable results are obtained, an additional check on the feeding level is made from the testers' monthly reports on that herd by correlating the maintenance of daily milk production by months with the per cent of cows milking. The way in which cows hold up to normal milk production is a good indication as to whether or not a satisfactory level of feeding was maintained throughout the year.

E12. Display of Extension Teaching Ideas. E. C. SCHEIDENHELM, Michigan State College.

The extension section will again have an exhibit of extension teaching ideas.

Missouri will display three film strips. One will deal with quality of production, a second with methods of feeding, and a third with genetic information.

South Dakota will have a series of three charts which present facts to show how to decrease production costs through feeding methods.

Nebraska will portray the method used in making the junior bull ring project successful.

Iowa will display leaflets used in interesting people in keeping D.H.I.A. records.

Michigan will show their method of informing dairymen more fully about the proof on their herd sires. This will include letters to the dairymen, testers and county agricultural agents.

Other states indicating that they would exhibit but not reporting a subject were Wisconsin, Indiana (Purdue), Kansas, Texas, West Virginia, South Carolina, Alabama, and Tennessee.

E13. Type Classification Committee Report. JAS. W. LINN, Kansas State College.

The objects of the program are:

A. To offer a means of teaching individuality of animals.

B. To assist breeders in analyzing their herds from a type standpoint.

C. To be used as a means of furnishing additional information on proved bulls.

The program can be applied only to identified herds that are, at least, in their second year of dairy herd improvement association testing or to herds on breed association herd test.

The type rating shall be done by recognized official judges such as college professors, extension dairymen, or county agents with special training.

A. A state committee to approve judges for this work consisting of the head of dairy department, extension dairymen, and one active breeder to be selected by the above.

E14. Clinics for Dairy Herd Improvement Association Fieldmen. A. J. CRAMER, University of Wisconsin.

A total of 41 clinics or "check-up" schools for Dairy Herd Improvement Association fieldmen were held in 23 Wisconsin counties during 1939. These clinics for fieldmen were planned to give a review of the work required of the men in our dairymen's service program.

Where there are 3 or more associations within a county, it is our aim to hold at least two schools during the year. These 3 hour afternoon schools are held to give instructions to both beginners and experienced fieldmen. We use the more experienced fieldmen to serve as examples to the new men; they give their experiences of work with association members.

These meetings are held in the county agent's office, where field problems are discussed and threshed out. On the morning following the clinics, the supervisor inspects the work of the newer fieldmen on the farm while taking samples of milk, testing the milk, weighing the feed and ear tagging the new calves and cows. We also supervise the work done in the members' herd book, on feed sheets, barn feeding sheets, monthly report forms, identification and lactation sheets.

At some clinics the state supervisor invites the D.H.I.A. officers and directors to join the fieldmen and county agent. The significant thing about these clinics is that the farmers contribute a good many ideas to the group. The officers give methods of keeping farm account records and their ideas of the services they expect of the fieldmen. We help those fieldmen who are slipping and those who do not thoroughly understand their requirements.

The farmers and fieldmen gather around a large table so the discussion is informal. This brings about the exchange of ideas, and new practices are carried back to the farm by the fieldmen.

As a result of these fieldmen clinics, we supervisors save the state time and travel money by concentrating our effort where it is most needed. The clinics arranged with the cooperation of A. O. Follett, who supervises the

field work for Farm Account record keeping. We arranged to travel together in one car and saved the expense of running a second car.

E15. 4–H Dairy Programs, Requirements and Recommendations. H. A. WILLMAN, Cornell University.

A detailed 4–H program which will apply fully to all sections of one state or to the entire country, probably cannot be set up. The problems in connection with 4–H Dairy Club Work differs too widely between states and counties and often within boundaries.

A dairy program involving requirements and recommendations is, therefore, a large one. It composes several phases of work, each of which must be emphasized. The direction of too much attention to one single phase of work such as exhibiting will not lead to the greatest results and in the long run may lead to serious mistakes, disappointments and a lagging of interest. A program must be well balanced to bring about the type of improvement which boys and girls and our dairy business needs. Of necessity, programs should include a study of the surest methods of making progress in developing herds and all 4–H members should have an opportunity to take part in such activities or contests as Exhibiting, Records and Record Keeping, Judging, Showmanship and Demonstration team work.

Rather than to lay down too many rules and regulations, I believe we should in our 4–H dairy work take more boys and girls where they are and with the animals which they may have or usually can secure rather than to require that they start at a point which annually deprives many youths from 4–H club opportunities and benefits. Four–H dairy work should be made educational rather than regulatory in nature, therefore, I prefer to use the term recommend or urge rather than to make requirements which are often difficult to enforce. As a matter of fact, I believe that we might well under emphasize the word purebred if necessary in order to keep before the minds of 4–H club members, local leaders and parents, the importance of known ability in the selection and breeding of 4–H cattle.

For instance in our own state, we have not attempted to make any particular requirement regarding records and record keeping, but have attempted to make it a very important and definite part of the entire 4–H dairy program. As a matter of fact, we offer special incentives for this phase of work as well as for exhibiting and as a result we are getting an excellent response from the boys and girls. A short time ago a study was made of some of the 4–H records which were secured from the members in ten organized dairy clubs in which the following information was secured. These reports indicated that 221 members owned 598 head of cattle, 93 per cent of which were purebreds, 36 per cent of the cattle were in production, 91.6 per cent of those in production were on test, 66.5 per cent of those in production had completed one or more records averaging 354 pounds of fat

and 70 per cent of all 4–H cattle were selected from ancestry of known production. While this situation does not represent a cross section of the standard of dairy club work, it does suggest that better dairy work can be done. Four–H dairy work is built on the principle of herd improvement.

In the long run, a well rounded program will help us most not only in effectively attaining the general aims and purposes of 4–H club work but also in bringing about the type of improvement which the dairy business needs most.

E17. An Extension Program in Quality. J. M. Jensen, Michigan State College.

The Michigan State College Dairy Extension section has for its objective a quality program that involves the producer, manufacturer, and consumer in an approach to improvement of cream, butter, milk, and cheese.

Cream improvement is aimed at establishing grading practices and payment by grade. This is developed through educational meetings and demonstrations with farm groups, also through cream grading demonstrations with creameries.

Butter improvement is developed through a buttermaker's proficiency contest. The buttermaker is graded on his skill in scoring, analyzing and controlling fat and yeast and mold content. Technical meetings and scoring contests for creamery operators and buttermakers serve as a means of improving buttermaking operations.

The quality improvement program for milk is designed to assist the local sanitarians with promoting a better understanding by the producer of the need for quality milk, with interpretation of quality tests and with information in production problems. The microscope has been employed in making analysis of the milk supply in different areas with records kept of the analysis from one year to another. Assistance is given to producer distributors in designing and equiping milk pasteurizing plants.

Cheese improvement consists mainly in demonstration of quality tests on the milk supply, followed by the development in one county of a continuous quality improvement program that is conducted jointly by all the cheese factories in the county, with some financial assistance contributed by the county board of supervisors.

Consumption improvement consists partly in developing organized effort in the counties for furthering local usage of all dairy products. Demonstrations in food value and in evaluation of quality in dairy products before home economics groups, dairy and food councils and general consumer groups have been employed. F.F.A. judging of dairy products has been developed with the assistance of members of the dairy staff and the vocational education departments.

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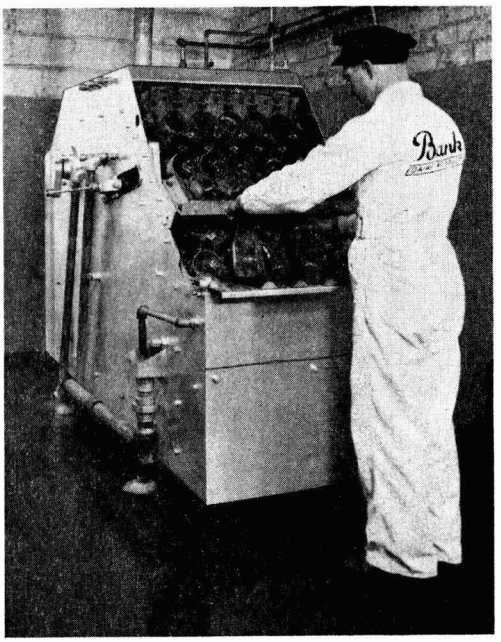

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