History of the Dairy Science Department

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Foreword

The history of the Dairy Science Department at the University of Missouri covers a span from 1901 to the present time. From 1901 to 1984, the department was officially known as the Department of Dairy Husbandry. In 1984, the title of Dairy Science Department was adopted. From its inception, the department has been highly productive in research, teaching and extension activities pertaining to dairying.

In the past 88 years, a vast amount of material of scientific and historical value has been accumulated. The department has long been a leader in scientific publications, bulletins and circulars pertaining to all phases of dairying.

Through the years, no systematic effort has been made to organize material for a departmental history. However, both professor C.H. Eckles, 1901-1918, and professor A.C. Ragsdale, 1919-1961, preserved, stored and in some cases filed a great deal of material of historical interest. In the references listed, a brief account of the work of the Dairy Husbandry Department is reported by deans F.B. Mumford, M.F. Miller and J.H. Longwell. In 1969, professor A.C. Ragsdale summarized the work of the department in a rather tabulative, unpublished, review.

For the writing of this History of the Dairy Science Department, we have perused a multitude of departmental records, bulletins, scientific papers, reports by dairy organizations in Missouri and correspondence and have also utilized our personal knowledge of the period from 1929-1989 to date, to gather material of historical significance. Space requirements prohibit the inclusion of many items, but we trust the pages that follow will be of interest.

H.A. Herman
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History of the Dairy Science Department*

Dairy Husbandry teaching and research at the University of Missouri began shortly after the College of Agriculture (1870) and Agricultural Experiment Station (1888) was established. The beginning was quite humble and limited in scope because documented scientific knowledge in the dairy field was sparse. There were many dairy-herd operators in Missouri of the producer-distributor type who sold milk retail in the larger cities and towns. Also, most farmers kept several milk cows to provide the family with milk, butter and some cheese. It was also commonplace for small-town dwellers to keep a milk cow or two for the family milk supply. The growth and technological developments of the fourth largest source of farm income in Missouri were aided by scientific research on feeding, breeding and herd management as well as quality milk production.

The history of dairy husbandry teaching, research and extension at the University, as suggested by professor A.C. Ragsdale in 1969, may be divided into epochs, or definite periods of development.* For this summary, we have chosen four periods.

The first period begins with the establishment of the College of Agriculture (1870) and the appointment of professor Clarence Henry Eckles to head the newly established Department of Dairy Husbandry (1901). The second period 1901-19 involved the pioneering work of Eckles and Associates. The third period 1919-61 involved much growth and expansion in teaching, research and extension under the leadership of professor Arthur C. Ragsdale, department chairman, and the long-time tenure of key staff members: professor Samuel Brody, W.H.E. "Bill" Reid, Charles W. Turner, Joseph E. Edmondson, Earl R. Garrison, Harry A. Herman and others including M.J. "Pat" Regan, E.T. "Scratch" Itschner, long-time extension dairymen. The fourth area covers September 1, 1961, when professor Ragsdale retired, to the present time.

THE FIRST EPOCH: 1870-1901

In 1887, professor J.W. Sanborn, who was the second dean of agriculture (1882-89), purchased four Jersey cows and a bull. The practice of keeping complete milk records on each cow was initiated and a herd record system established. Complete breeding, calving, health, milk and butterfat records on each cow in the Experiment Station herd have been kept since 1901. In addition, data on growth, body weight and other information have been recorded and serve as the basis for research that has yielded much valuable information. In 1890, Dean Edward D. Porter fitted up a small frame building on the east side of the

*Includes excerpts from Department History—Dairy Husbandry by A.C. Ragsdale, (1969).

The first dairy building at the University was later used as a slaughter house by the College of Agriculture.

University Farm (which for many years served as the slaughter house for Animal Husbandry) with a cream separator, churn, butter worker, hot and cold water, etc. This became the first Dairy Building at the University.

Interest in dairying grew throughout the state following the Civil War. By 1890, the Missouri census reported about 710,000 milk cows. For the most part, these were cattle of rather nondescript breeding kept for both meat and milk. Shorthorns, Devons and Durhams were fairly prominent. The marketing of milk and cream added to the income of most farms. Herds were small with an average of eight milk cows. Small creameries engaged in the making of cheese and butter were established throughout the state. It was not until the last quarter of the 19th century that purebred (registered) dairy cattle began to grow in numbers in Missouri.

FIRST DAIRYMEN'S ORGANIZATION FORMED

With dairying coming into prominence, the first dairymen's organization in Missouri was formed. This was the Missouri State Dairy and Creamerymen's Association. The first meeting, Sept. 24, 1890, in Kansas City, Mo., drew people from throughout the state. The meeting was arranged by Levi Chubbuck, secretary of the State Board of

Agriculture, Jefferson City, Mo. At this meeting, plans were laid for an educational program involving the State Board of Agriculture, the University of Missouri College of Agriculture and the Missouri State Dairy and Creamerymen's Association. Officers were elected as follows: President, W.M. Lewis, St. Joseph; Vice President, C.A. Adams, Chillicothe; Treasurer, A. Uhlman, Irondale, and Secretary, J.M. Smith, Meadville. The organization grew in numbers and strength and was a vital force in getting legislative support and recognition for the growing dairy industry in Missouri. Throughout the years to follow, there were close working relationships between the Dairymen's Association and the Department of Dairy Husbandry at the University. The weathered minutes of the association's annual meetings from 1892 forward relate resolutions adopted to request the state legislature to provide funds for a new dairy barn at the University and to provide support for veterinary assistance in stamping out tuberculosis in cattle.

The first bulletin involving dairying (Mo. Agr. Exp. Sta. Bul. 26) was published in 1894. The bulletin explained the care of milk and the making of butter on the farm.

Beginning in the winter of 1895-96, a course in dairying was offered. A special instructor was hired and arrangements made for teaching proper methods for the making of butter and cheese and testing milk for butterfat (the Babcock Butterfat Test came into use in 1890). Some minor feeding experiments were conducted, and a study of milk creaming and churning was made. Tests of some of the new dairy equipment coming on the market as well as studies on the milk-producing ability of milk cows were also conducted.

DEPARTMENT OF DAIRY HUSBANDRY ESTABLISHED 1901—THE SECOND EPOCH

With dairying gaining headway in Missouri and the College of Agriculture gaining favorable recognition, the 41st General Assembly (Missouri Legislature) enacted a law, which was approved April 17, 1901, establishing a Department of Dairy Husbandry in the College of Agriculture. The first major building for instruction and research in dairying was also provided for by the legislature. An appropriation of $40,000 for the construction of "laboratories for livestock judging, dairy instruction and veterinary science was made." The dairy building proper cost about $30,000. This building provided facilities for teaching and research, with laboratories and office space. It was remodeled in 1937-38 with a new wing added as part of a new and much-improved dairy building later named Eckles Hall. The building

now houses the Food Science and Nutrition Department with the name of the Dairy Husbandry Department changed to Dairy Science Department and office and laboratories located at the Animal Science Research Center.

When the legislature in 1901 enacted a law establishing a Department of Dairy Husbandry, the duties of the professor of dairy husbandry were set forth, and $5,000 was appropriated for maintenance. Clarence Henry Eckles, a graduate of Iowa State College (University) with a master's degree in bacteriology, was selected in June 1901 to head the new department.

Professor Eckles was a wise choice. He is credited with "putting dairy husbandry at the University of Missouri foremost on the map of the world." He not only conducted innovative research in feeding and managing dairy cattle; he was a great teacher and worked well with farmers. He was generally credited with "having his feet on the ground." He traveled throughout the state talking to farmers and dairymen, analyzing their problems and planning research and instruction to meet their needs.

Prof. A.C. Ragsdale describes Eckles' progress in those early years as follows: "A special course in dairying was offered in the winter of 1901-02 and five short courses. Students enrolled in courses in farm dairying, farm sanitation, judging and testing dairy products, and creamery buttermaking. A course in dairying was required of all students completing the collegiate course in agriculture. The following year 16 students enrolled in a course in elements of dairying, and three in a course in milk production. Five years after the department was established, the collegiate enrollment in dairy husbandry courses totaled 59. After 10 years (in 1911-12), the enrollment in dairy husbandry courses numbered 253. After reaching a maximum of 320 students in 1913-14, the number had dropped due to war conditions to 96 in 1918-19, the year Professor Eckles left Missouri. Since then the increase has been marked, reaching 211 ten years later (1928-29), 537 in 1938-39, and gaining steadily in the years to follow."

The first of many Experiment Station bulletins from the pen of Professor Eckles was published in 1902 (Mo. Agr. Expt. Sta. Bul. 56). He reported that the total annual value of dairy products produced in Missouri at that time was $17,852,588. H.J. Waters, then director of the station, stated: "It is very gratifying to be able to report that the dairy industry is growing more rapidly in the state now than ever before, and if the present rate of increase is maintained, it will be but a matter of a few years until Missouri will be recognized as one of the leading dairy states of the Union." Today that prophecy has been fulfilled far beyond the expectations of Dean Waters.

Clarence Henry Eckles, a graduate of Iowa State College (University), was selected in June 1901 to head the new Department of Dairy Husbandry.

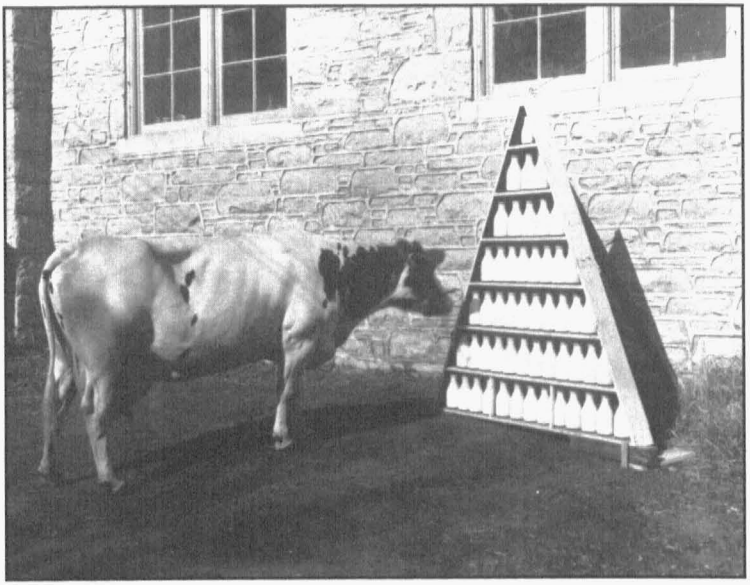
In 1910 a cow helped put dairying in Missouri and the College of Agriculture in the national and international spotlight. No history of the dairy department is complete without mention of "Old Jo."

MISSOURI CHIEF JOSEPHINE—WORLD RECORD

Missouri dairying and the then Department of Dairy Husbandry received worldwide attention in 1910 when one of the foundation Holstein cows, purchased from E.M. Moore, Cameron, Mo., Missouri Chief Josephine 64867, produced 26,861.5 pounds of milk, containing 740 pounds of butterfat, in one year. "Old Jo," as she was fondly known, held the world's record for 30, 60 and 90 days' milk production, and her yearly record was second in the world. She attracted much attention, and in 1911 was exhibited on agricultural trains throughout America, traveling more than 4,000 miles and viewed by more than 100,000 persons (it was the custom in the early days (1900-40) for railroads to run what were called "agricultural trains" featuring livestock, poultry and crop exhibits and educational lectures in order to stimulate production in areas they served).

Not only was "Old Jo" a great producer, but a reproducer, through her granddaughter, Campus Josephine Galaxy, that left six daughters and five sons in the University Dairy Herd. She did much to build the herd to national prominence and is considered, more than any to date, the cow that helped make Missouri famous as a dairy state. For example, a story is told that one day an out-of-state youth visited Eckles regarding enrollment in dairy courses. Prof. Eckles said, "How did you learn about me and the University of Missouri?" The would-be-student replied, "I don't know much about you, but I do know about Missouri Chief Josephine and her world records. That's why I came here!"

The excellence of the research work in dairy husbandry under the



Missouri Chief Josephine poses in 1910 with one day's milk production.

guidance of professor Eckles attracted many graduate students from all parts of the United States. During the years from 1912 and 1918, various problems were being studied. Among these were included a study of the nutrients required for milk production, silage investigations, factors influencing the growth of dairy cattle and the development of "normal growth standards." The men trained by professor Eckles during this period were in wide demand by colleges and agricultural experiment stations, the U.S. Department of Agriculture and commercial institutions. Through these channels, the research work carried on in dairy husbandry in many stations was influenced by the training, guidance and leadership of professor Eckles.

Research in dairy husbandry at the Missouri station from the early days to the present includes what is commonly called "applied research," but most noteworthy has been a long time leader in "basic research." The general objectives in research have been the discovery of new facts concerning the improvement of dairy cattle and the production and processing of milk and its products for the benefit of mankind. Some of the significant early research, now considered classical, under Eckles' guidance, demonstrated that the superior milk-producing cow is not the one with the best coefficient of digestion. Rather, it is the cow with the inherited capacity to consume large amounts of feed and using those amounts above maintenance for milk production. Eckles often said, "the main thing a high producer inherits is a good appetite." In

fact, there is little difference among cows in the coefficient of feed digestion.

Further research dealt with the role of endocrine glands in mammary development and milk secretion to discover the causes of difference in milk production among cows. These efforts were undertaken by C.W. Turner and associates, beginning in 1927.

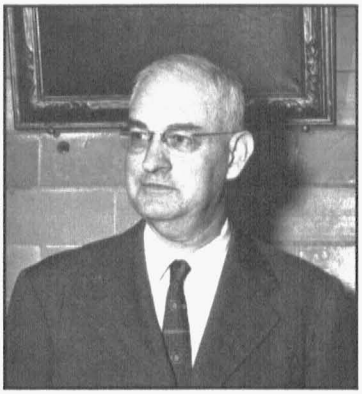
Beginning in 1906, a cooperative project between the Dairy Husbandry Department (UMC) and the Dairy Division of the U.S. Department of Agriculture to study factors affecting the composition of milk was developed. Under professor Eckles' supervision, R.H. Shaw, a Dairy Division chemist, began an exhaustive study of the composition of milk. A series of bulletins on this subject was published during the years of 1909-13. Another chemist, Leroy S. Palmer, a University graduate, assisted.

In his research, at the encouragement of Professor Eckles, Palmer utilized Chromatography to study milk pigments. His Ph.D. thesis was entitled "Carotin-The Principal Natural Yellow Pigment of Milk Fat". Palmer's work is very significant because he demonstrated the importance of chromatography before most of Europes leading scientists utilized it. Many scientists, including six Nobel Prize Winners, utilized his methods as a foundation for research. Palmer followed Professor Eckles to the University of Minnesota in 1919 and continued chromatography research until his death in 1944. Beginning in 1948 Dr. Charles W. Gehrke, Professor of Biochemistry at the University of Missouri became internationally known for developing chromatographic methods for separating and analyzing important biological molecules.

THE THIRD EPOCH—THE RAGSDALE YEARS 1919-61

Early in 1919, Professor Eckles was called to head of Dairy Department at the Minnesota College of Agriculture, thus closing the second epoch of the history of the department.

His successor as chairman of the University of Missouri Department of Dairy Husbandry was professor A.C. Ragsdale who took the reins April 1, 1919. Professor Ragsdale was a University graduate with dairy training under Eckles. Before heading the department, Ragsdale spent several years as an extension dairyman in Missouri. He assisted in organizing some of the first cow testing associations (now DHI) and one of the early Purebred Bull Associations in the state. His tenure as department chairman was long (42 years) and very productive.



Arthur Chester Ragsdale served as chairman of the Department of Dairy Husbandry from 1919-1961.

Among the productive research programs conducted by the Dairy Science Department were studies on growth standards, nutrients required for growth, maintenance, milk production and reproduction. Methods were also developed for accurately estimating live weight, condition, efficiency and profitability of dairy cattle. Studies were made by Samuel Brody and associates on growth and development and environmental physiology with special reference to domestic animals. A great deal of basic information in these areas was amassed. Several departments in the College of Agriculture, a number of federal agencies and the Herman Frasch Foundation cooperated in the conduct and financial support of this work. In 1948, a psychroenergetic laboratory was constructed on the farm campus, and a series of studies on the physiological response of cattle to climatic and environmental conditions were made. This work is being continued by one of Brody's former students, Harold D. Johnson, a staff member of the Dairy Science Department. Brody published research bulletins and scientific papers. His book *Bioenergetics and Growth* is a classic in its field.

Beginning in 1927, another highly productive area of research was initiated by Charles W. Turner focusing on the endocrinology of milk secretion. This work involved the development of the mammary gland during the early embryonic state, puberty, pregnancy, lactation and involution. These studies included the role of the hormone lactogen, which stimulates milk secretion, and several other hormones of the anterior and posterior pituitary glands, which play a role in reproduction and lactation. Radioactive isotopes were used to study the rate of thyroxine production by the thyroid gland and the consequent effects on milk yields. The departments of animal husbandry, dairy husbandry, poultry husbandry and veterinary science cooperated in some of these studies. Several private business concerns and federal agencies aided in the financial support of this research.

In the course of these studies, in order to secure information on the precursors of milk, the volume of blood and plasma was measured by the indirect dye method in large animals for the first time (Turner and Herman 1931). A method for measuring the volume of blood flowing through the udder was devised, and the gross efficiency of the mammary gland determined to be more than 90 percent. That is, the energy required to transform milk precursors from the blood into milk is less than 10 percent of the total energy involved. The knowledge gained concerning the mammary gland, the hormones of the endocrine glands and precursors of milk has been of value to the medical profession, manufacturers of milking equipment and to dairy operators. Turner was a highly prolific writer and has research bulletins and scientific papers to his credit.

The work on the physiology of milk secretion and endocrinology is now carried on by Ralph R. Anderson of the Dairy Science Department staff.

Throughout its tenure, the dairy department has continuously conducted research on the nutrition and reproduction of dairy cattle. Much of professor Eckles' early efforts were directed to improved feeding and management of milk cows. These studies are continued in a wider scope, with higher producing cows, modern equipment and new roughages and feedstuffs and advanced methods of analysis. These studies take on new dimensions each year.

Studies have been conducted on dairy cattle breeding and management, diet and growth, rumen bacteriology, biochemical and biophysical characteristics of plant cells, soil fertility and forage quality. In the area of dairy cattle breeding, the dairy department was among the first to develop sire analysis methods utilizing mature equivalent measures and sire indexes. Several studies on the University Holstein herd indicated that a fairly high level of inbreeding resulted in lower milk-producing offspring.

Beginning in 1936, the department, under the leadership of H.A. Herman, assisted by F.F. McKenzie, Department of Animal Husbandry, began pioneer work on artificial insemination. Semen characteristics, both physical and biochemical, were exhaustively studied. The techniques for collection, evaluation, processing, storage and use of semen in the extended (diluted) state were made. In June 1938, the department pioneered the second artificial breeding cooperative association in the nation. It was established at Hughesville, Mo., in cooperation with the Farm Security Administration in order to service some 500 head of milk cows on a federal colony farm project. In 1941, the department offered what is believed to be the first college-level course in artificial insemination in the nation.

RESEARCH DAIRY PRODUCTS AND MICROBIOLOGY

The manufacture of dairy products, quality control measures involving bacteriological studies and merchandising has been emphasized in the research efforts of the dairy department throughout the years. As mentioned earlier, the first studies began in 1894 and were later carried on by professor Eckles, R.H. Shaw, LeRoy S. Palmer and later (1919-20) Arthur S. Dahlberg. In 1919, Professor William H.E. Reid was hired to head up the dairy manufacturers and products division. He also supervised the operation of the University Creamery where dairy products including milk, butter, ice cream and cheese were dispensed to the public. Prior to 1920, the department operated a "Saturday butter route" in Columbia with deliveries made by a horse-drawn milk wagon. A University of Wisconsin graduate, professor Reid carried on a vigorous program in teaching and research, and he maintained a strong working relationship with industry leaders throughout the nation.

The projects involved included ice cream quality and merchandising; composition of milk and its products; factors affecting the quality and storageability of cottage cheese; dairy products—whey solids and cultured products; dairy plant operations and dairy plant automation. Bacteriological studies were made of dairy products as well as strains of bacteria from the bovine mammary gland.

Associated with Professor Reid in the course of these investigations were professors Earl R. Garrison, Joseph H. Edmondson, Robert T. Marshall, Wendell Arbuckle, Dean S. Shelley and others.

Techniques were developed for measuring the size and type of ice crystals formed in ice cream. A direct correlation between size of ice crystals and relative smoothness of ice cream texture was demonstrated. A technique was also developed to measure the type and size of lactose crystals in ice cream, with both alpha and beta lactose being measured. The type and size of crystal was correlated with the degree of the sandy defect in ice cream.

Formulas for ice cream were developed in which it was possible to substitute 25 percent corn sugar for sucrose. Improved quality of body and texture was achieved and savings in ingredient costs, as well. Studies on the use of liquid sugars, whey solids, stabilized non-fat milk solids and emulsifiers were conducted, and the technique of time-lapse photography was used to determine differences in melting rate as influenced by ingredients.

This research has aided in the development of modern processing methods and procedures and in the designing of new equipment, making it possible to manufacture a higher quality of ice creams and sherbets.

A list of courses offered in dairy products, and graduate degrees awarded are attached. In 1967, the dairy products and bacteriological studies were transferred to the Department of Food Science and Nutrition.

THE CURRENT-PERIOD

The fourth period or epoch for the Dairy Science Department covers 1961, when professor Ragsdale retired, to the present. In 1961, Charles P. Merilan succeeded professor Ragsdale as department chairman and served one year. Joseph E. Edmondson became chairman in 1962 and served until 1967 when he transferred to the Food Science and Nutrition Department. Harold D. Johnson was appointed chairman in 1967 and served until 1978 when Fred Martz became chairman. Martz served until 1982 when Rex Ricketts, Extension Dairy Specialist, was appointed interim chairman. Martz became affiliated with the National Forage Laboratory. In 1984, Dr. Ricketts was named chairman for the Dairy Science Department.

Rex E. Ricketts, Extension Dairy Specialist, is the current chairman of the Department of Dairy Science.

In 1984, the Dairy Husbandry Department was officially designated the Department of Dairy Science. The department moved to the newly constructed Animal Science Research Center. It remains a separate department with its own staff and department chairman.

The major research projects in the department continue.

Environmental physiology studies are carried on by Harold D. Johnson and associates as is research in growth and development of domestic animals.

Research on the endocrinology of milk secretion is carried on under the leadership of Ralph R. Anderson.

Studies on dairy cattle breeding; artificial insemination, embryo transfer and general reproductive physiology are now carried on by C.P. Merilan and John Sikes. This research involves factors affecting semen fertility, conception rate and associated areas. Sikes has a statewide embryo-transfer program underway in cooperation with various herd

owners and with the assistance of several veterinarians.

Another very productive line of research dealing with the endocrine mechanisms controlling bovine reproduction; endocrine changes associated with follicular development and the development of overian cysts; and uterine mechanisms associated with subnormal luteal function in cattle is underway by H. Allen Garverick. Some of this research is in cooperation with the College of Veterinary Medicine and the Department of Animal Science.

In the area of bovine nutrition, a major project is conducted under the leadership of Ronald L. Beleya. Studies are being conducted on: factors affecting forage and fibrous diet utilization, the efficiency of dietary energy and protein utilization and improving laboratory application of forage quality.

THE LIVESTOCK NUTRITION LABORATORY

The Livestock Nutrition Laboratory Service was established in 1981 by the Missouri Dairy Improvement Federation as a means to provide a reasonably priced, quality service for the dairymen and farmers in the state of Missouri. Since that time, analyses have been performed on samples that have come from coast to coast. The lab is certified with the National Alfalfa Hay Testing Association, which is sponsored by the National Hay Association and the American Forage and Grasslands Council.

Some of the analyses that are available from the lab include Moisture, Crude Protein, Available Protein, Acid Detergent Fiber, Neutral Detergent Fiber, Total Digestible Nutrients, Net Energy Lactation, Net Energy Gain, Net Energy Maintenance, Nitrate, Urea, Salt, Fat, Ash, Water and Manure analysis. Mineral analyses include: Calcium, Phosphorus, Magnesium, Potassium, Sodium, Sulfur, Iron, Copper, Manganese and Zinc. Fescus stems can be analysed for Tall Fescue Endophyte Fungus.

The laboratory is currently under the management of Steve Weiker, who is also acting Missouri DHI Association manager. Andy Clubb is the laboratory supervisor, and seven to eight other employees make up the laboratory staff.

Volume has been gradually increasing from a total of 7,755 samples in 1984 to a new high of 12,419 in 1986. Major company accounts with Monsanto and MFA have provided a strong base for increasing volume.

Hay-judging contests have become popular in the past couple of years, and the Livetock Nutrition Laboratory has been the official testing laboratory for the hay contests held in Missouri. Also, many

Built in 1913, this University of Missouri dairy barn had 56 stanchions for cows in milk, eight box stalls, calf pens, equipment and feed storage. It was considered a state-of-the-art facility.

analyses have been conducted for University of Missouri and Extension projects across the state.

THE DAIRY HERDS AND FARM OPERATIONS

The University dairy herd and the dairy farm operations are an important part of the teaching, research and demonstration facilities of the Dairy Science Department.

The dairy herd had a modest beginning in 1897 when four Jersey cows and a bull were purchased. From this foundation, a herd of more than 60 head was built up. The Jersey herd was quite successful, but in the 1960s when the dairy farm moved from the University campus to its present location in the interest of economical operations, the herd was dispersed. The Holstein herd was founded in 1902 when four purebred females were purchased. No additional females have been purchased since, but in 1931, F.W.A. Vesper, owner of Fredmar Farms, Jefferson Barracks, Mo., made the University a gift of 52 purebred Holsteins. This addition added much to the genetic base, particularly through the influence of the bull Triune Supreme. The Holstein herd at present numbers about 260 herd with a milking herd of some 122 head averaging 17,700 pounds milk, 627 pounds butterfat.

Prior to and during the early 1900s, a small Milking Shorthorn herd was maintained. The herd was of top quality, and some of Missouri's early Milking Shorthorn herds were started by purchases from this herd.

Harry Ball served as dairy herdsman and farm superintendent from 1918-1959.

As the Holstein herd grew in size, the Milking Shorthorn were closed out.

In 1907, an Ayrshire herd was started and maintained until 1936 when the entire herd of 36 head was sold to a Kansas breeder. At that time there was only limited interest in Ayrshires among Missouri dairymen.

Guernseys had their beginning in the University herd in 1925 when four females and a bull were purchased. The herd grew slowly; of the first 20 calves born, 19 were males, somewhat defeating the law of averages. The herd was augmented with eight heifers in partnership with Sunnymede Farm, Bismarck, Mo. The herd grew to 30. It was sold in 1952 when the Foremost Guernsey herd was given to the University by J.C.Penney.

Harry Ball - No history of the University of Missouri Dairy Herd would be complete without mention of Harry Ball, herdsman and farm superintendent from 1918 to 1959. Mr. Ball was born on a farm near Curryville, Mo., in 1889. He graduated from high school in Columbia in 1910. He began working for the University in 1907 as an errand boy for Dean H.J. Waters. In August 1908, he became a milker for the Dairy Department, and in 1910 he milked Missouri Chief Josephine in the later part of her world-record lactation. He farmed for himself from 1913 to 1917 and in 1918 returned to the University to become herdsman.

Mr. Ball was a meticulous, dedicated man with his farm, and his

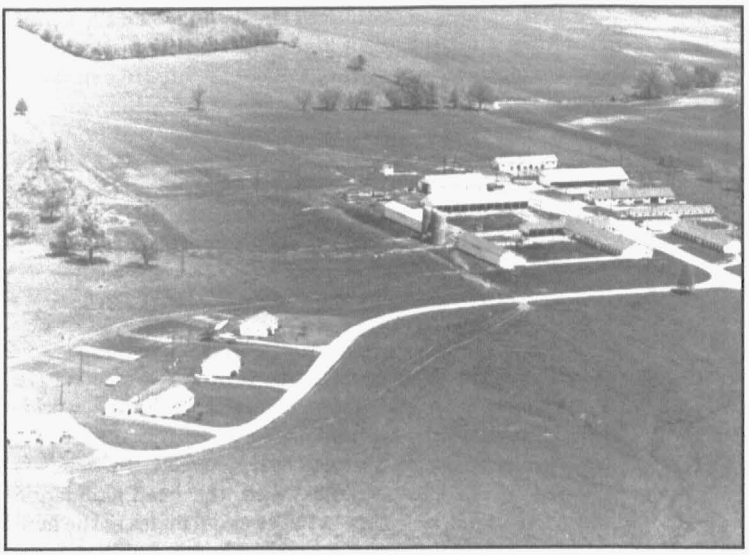
herd records were always neat and complete. He saw to it that the barns, the cattle, the pastures and the cropping areas were kept clean and orderly at all times. Hundreds of students worked as part-time milkers, feeders, cleaners and farm employees. He took much personal interest in students and aided many with fatherly advice. He will long be remembered for the kindness, dedication and dependable service he gave the dairy department for more than 40 years.

THE FOREMOST GUERNSEY HERD

In January 1952, J.C. Penney, chain store founder and a native Missourian, made a gift to the University consisting of the world-famous Foremost Guernsey herd, the farm at Hopewell Junction, N.Y., and other assets. The herd of some 300 head of registered Guernseys was started by Penney some 30 years earlier with the best foundation animals available. Penney added top-rated males and females to the herd continuously through the years and spared no expense in building what many authorities considered the best Guernsey herd in the world. The Penney gift included 250 head of registered Guernseys, the farm at Hopewell Junction, all equipment and a foundation fund of some $250,000 to aid in perpetuation of the herd. The total value of the gift was about three quarters of a million dollars. The terms of the gift made it possible to purchase some 600 acres, west of Columbia, erect the necessary buildings and move the herd to Columbia. Penney strongly believed that superior breeding herds should be continued for generations. This was his goal in making the gift to the University. Penney requested that the herd of Guernsey cattle be maintained by the College of Agriculture, Department of Dairy Husbandry, on a farm provided by the University. Assets of the Foremost Guernsey Association, Inc., were to be used to provide land, buildings and improvements. The remaining capital assets and moneys from the farm and herd operations were to be used as best deemed by the University in the further development and improvement of the herd and farm and for such research, teaching, demonstration, and additional activities as deemed appropriate by the University.

Penney said, "It is my desire that the name "Foremost Guernsey," now well and favorably known throughout America, be continued, believing it will be a great asset, and continue to be an outstanding name in Guernsey history."

Laurence R. Rainey—The first superintendent of the Foremost Guernsey Farm was Laurence R. Rainey, who was hired in 1952 when the Foremost herd was being moved to Missouri from New York.



Built from the Penney Gift Funds, the Foremost Guernsey Farm was a cluster of barns for cattle, exercise lots and feed storage. Four of the dwellings for employees can also be seen in the foreground.

J.C. Penney (left) and A.C. Ragsdale pose in 1952 at the Foremost Guernsey Farm with the cow Foremost Quantity and the Otto Liehers Trophy for lifetime milk production.

Laurence had a long and distinguished career with Guernsey cattle. His career started in 1930 when he became herdsman at Sunnymede Farm, Bismarck, Mo. In 1932, he moved to St. Albans Farms near St. Louis, owned by Irene Johnson. From a start with 10 cows, he built the herd to more than 500 head of registered and grade cattle. Due to flooding from the Missouri River, the herd was dispersed in 1952.

He served with distinction as superintendent of "Foremost" for 19 years, retiring in 1971. During his tenure, he maintained and expanded the best of the Foremost bloodlines.

Bryan Lail—The first herdsman at Foremost Farm was Bryan Lail,

who was associated with Laurence Rainey at St. Albans Farms, as herdsman, for 13 years. Bryan was a "cow man" in every sense of the word. He deserves much credit for maintaining a high level of production and keeping the herd presentable while he was in charge. During his tenure, the Foremost herd was the fifth highest producing Guernsey herd, more than 100 cows in milk, in the United States. Mr. Lail retired a few years after Laurence Rainey, but his contributions to the herd will long be remembered.

At the present time, the Foremost Guernsey herd totals 72 head with 35 cows in milk averaging 12,437 pounds milk, 569 pounds butterfat. The Foremost Guernsey herd and farm was operated as a separate unit, as was originally intended, until 1979. The University of Missouri Holstein herd, on an adjoining University farm, was operated as a separate research and teaching unit. Due to budget limitations, the Holstein milking cows were all moved to the Foremost Farm. The Holstein farm was converted to a dry cow and heifer facility. This move has been to the detriment of the Foremost Guernsey herd from the standpoint of milk production and general appearance and is a situation the Dairy Science Department hopes to improve.

Many outstanding animals have been produced in the University's dairy herds, including Missouri Chief Josephine, mentioned earlier. But in addition, the home-bred Holstein bull Campus Aaggie Sultan in the 1940s was the highest indexed sire for production in the United States. In 1949, the "Excellent" cow U-MO Vesper Man-O-War Zirc Ella become the state champion 5-year-old with 19,751 pounds of milk containing 741 pounds of butterfat in 305 days. Many cows in the Holstein herd have produced more than 150,000 pounds of milk in a lifetime. In the Foremost Guernsey herd, one of the most outstanding foundation cows, included in the Penney gift, was Foremost Quantity with an official lifetime production of 137,889 pounds of milk and 6,294 pounds of butterfat in eight lactations. She was awarded the Liebers Trophy for lifetime production in 1952 by the American Guernsey Cattle Club.

The herds have been in continuous production and official classification programs since their founding. Strict disease-control programs are followed, and the herds have been accredited free of tuberculosis and Bang's disease.

The University dairy farms, including Foremost Farm, comprise some 1,065 acres with about 600 acres of crop land. The present dairy farm staff consists of Lee Telega, Supervisor; John Denbigh, Asst. Supervisor and Herdsman, two full-time milkers, two feeders, one crop foreman and four to five part-time student workers. The dairy farm and herds are under control of the Dairy Science Department. Most of the

roughages required by the herds and some grains are produced. An improved pasture system is carried out.

Throughout the years, many students in the College of Agriculture have assisted with the dairy herd and farm operations including milking, feeding, crop production and research projects underway. These students not only gain valuable experience, but earn part of their college expenses.

THE HATCH DAIRY EXPERIMENT STATION

The Hatch Dairy Experiment Station, located just south of Hannibal, Mo., on U.S. Highway 61, was started in 1930 and continued operations until 1968. The farm of 116 acres, known as Strawberry Hill in early years, was the home of William Henry Hatch, Congressman from Missouri 1878 to 1894 and was bequeathed to the state of Missouri by his daughter, Sarah Rhodes Hatch, on her death in 1923.

Congressman Hatch sponsored more than 50 bills in the U.S. Congress pertaining to agriculture. He was responsible for the Federal Hatch Act for the establishment of Agricultural Experiment Stations in connection with colleges of agriculture in each state and continuing appropriations for them. He was chiefly responsible for establishment of the position of Secretary of Agriculture in the President's cabinet; establishment of the Bureau of Animal Industry, USDA; the first national livestock sanitary law to prevent the spread of infectious diseases of domestic animals; the first oleomargarine law; to prevent adulteration of foods and drugs; the taking of the agricultural census, and numerous other bills of great significance of agriculture. At Strawberry Hill Farm, Hatch maintained a registered Jersey Cattle herd, Kentucky trotting horses and Southdown hogs. After being defeated in his bid for Congress in 1894, he continued to work for pure dairy products, as president of the National Dairy Union. He died at Strawberry Hill in 1896.

The development of the farm began in 1930, after the state of Missouri assigned it to the University of Missouri College of Agriculture, to start a dairy experiment station. The 55th General Assembly of Missouri and the U.S. Congress provided appropriations for establishment and operation of the Station. Operations were administered jointly by the Dairy Husbandry Department, University of Missouri, and the Bureau of Dairy Industry, United States Department of Agriculture.

The research program at the Hatch Station involved: (1) The establishment of a strain of Jersey Cattle pure for high production. (2) Collection of complete records for production, type, reproduction,

The home of William Henry Hatch, Congressman from Missouri, was bequeathed to the state of Missouri and in 1930 became the site of a dairy experiment station.

health, genetic characteristics, etc. as a basis for further studies, and (3) Pasture investigations involving different crops, systems of grazing and weed control.

The first superintendent of the Hatch Dairy Experiment Station was C.W. McIntyre, 1931-1945. He was succeeded by R.E. Leighton 1946-1947, and he was followed by Horace S. Peet 1949-1968.

In 1945, the Bureau of Dairy Industry, Washington, D.C., due to budget restrictions, withdrew its support of the Hatch Station. With state aid, the Station was continued until 1967 when support dwindled and the University turned the farm back to the state of Missouri. It has since been developed as one of the regional divisions for the Missouri State Highway Department. The beautiful Hatch residence, the barns and other buildings were demolished to make room for the State Highway Department sturctures. The rolling hills, covered by lush grass, continue as a silent tribute to William Henry Hatch and Strawberry Hill.

STUDENT ACTIVITIES

Students enrolled in dairy science courses at the University engage in several activities closely related to scheduled class work. Included are: *The Dairy Club*. The students' Dairy Club has functioned since 1906. Its purpose is to acquaint students with the broad educational program provided by the University; to enable students to gain contacts with dairy industry leaders and the various opportunities for vocations in the field; to sponsor and encourage student projects associated with dairying

and to provide an atmosphere for developing leadership and social contacts.

Professor Eckles was responsible for initiating the first Dairy Club. It has functioned, with fluctuating student enrollment, for more than 80 years. The club has monthly, or more frequent, meetings; usually a program with a speaker from the industry is arranged. Members of the Club assist with meetings, shows, sales and other events staged by the Dairy Science Department. For many years, the club published an annual termed "The M.U. Milkman," which carried information on departmental projects and programs, items about each staff member and a list of student members and graduate students. The publication served a very useful purpose as a "get acquainted" medium for students, the staff and the out-state dairy industry. Since 1938, the club has sponsored an Annual Collegiate Dairy Cattle Judging Contest. With any student in the College of Agriculture eligible to compete, except previous contest winners and members of University Judging Teams, this contest has attracted many participants. There are awards for teams and individuals.

The club usually holds an annual picnic honoring retiring officers and electing a new slate.

DAIRY CATTLE JUDGING TEAMS

The University of Missouri College of Agriculture has the distinction of being the first to send an Intercollegiate Dairy Cattle Judging Team to a national contest. The first such contest was held in 1907 at the National Dairy Show in Chicago, Ill. A team, consisting of five dairy students, coached by professor C.H. Eckles, was entered in the contest. No other teams appeared. The University team members staged a contest among themselves - and were declared the winners. It was the only team Eckles coached at the University. Members of the 1907 team were: O.E. Reed, who became the first Chief of the Bureau of Dairy Industry, USDA, Washington, D.C.; R.H. Mason; C.E. Snellings; Norton Shepherd, dairy farmer, Columbia, Mo., and H.E. McNatt, a staff member and coach of the 1909 and 1910 teams.

The 1908 team was coached by O.E. Reed. This team consisted of: P.M. Brandt, later head of the Dairy Department, Oregon State University, Corvallis; H.A. Henley, later a member of the staff, Department Soils, University of Missouri; E.V. Ellington, later head of the Dairy Department, Washington State University, Pullman, and J.B. Gordon, Manager, Bureau of Raw Materials, American Vegetable Oil and Fats Industries, Washington, D.C.

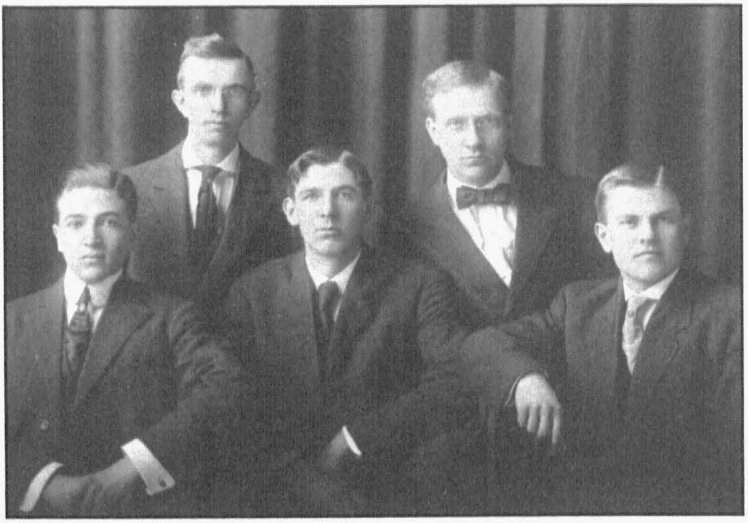
Over the years many well-known individuals in the dairy field have served as coaches of the University Dairy Cattle Judging Teams. A brief

The 1942-43 Dairy Club members, graduate students and dairy husbandry staff stand in front of Eckles Hall. From left, top row: Sanders, Kinkead, Broyles, Mullings, Brody, Deters, H. Luce, Uhland, Madden, Spalding; third row: Thomson, Latimer, Stevens, Greer, French, Mixner, Koger, Cups, Clary; second row: Beck, Nicholson, Martin, Wehmer, Pipes, Francis, C. Edmonson, L. Luce, J. Edmondson, Stailey, Turner; bottom row: Ragsdale, Busch, Joslin, Berry, Wells, Thomas, Hines, Patterson, Bergman, Kibler, Herman.

listing is shown below.

Year	Coach	Year	Coach
1907	C.H. Eckles	1919-1921	W.W. Swett
1908	O.E. Reed	1922-1924	W.P. Hays
1909-1910	H.E. McNatt	1925-1928	E.C. Elting
1911-1912	E.G. Woodward	1929-1931	Warren Gifford
1913-1914	W.M. Gegan	1932-1942	H.A. Herman
1915	No Contest (WWI)	1943-1945	No Contest (WWII)
1916	L.W. Wing	1946-1952	H.A. Herman
1917	W.W. Swett	1952-1956	P.R. Cornelison
1918	No Contest (WWI)	1956 & cont.	J.D. Sikes

Students who are fortunate enough to be selected for the Intercollegiate Dairy Cattle Judging Teams gain valuable experience and new perspectives of the dairy cattle industry: travel, meeting prominent cattle breeders, viewing many good herds and becoming acquainted with industry leaders. Contact with members and coaches of competing teams brings experiences that carry over after graduation. Of course the challenge to win at the contests is very high. The University of Missouri Dairy Cattle Judging Teams have been the high teams at the National Collegiate Contest several times and usually rank in the upper half of the contest. Some of the University teams and individuals are shown in the



The 1908 Dairy Cattle Judging Team members were: from left, J.B. Gordon, E.V. Ellington, H.A. Henley, P.M. Brandt and Coach D.E. Reed.

The Dairy Cattle Judging Team of 1949 were National Collegiate Champions, Hoard's Dairyman Contest. They are: from left, Coach H.A. Herman, Clarence Boss, Marie Cervinka, Lester Gray, Robert Ralston, Ronald Cox, Morris Ewing, Pery Proffit, Dan Fields, Wallace Leavitt and J.W. Cobble, assistant instructor.

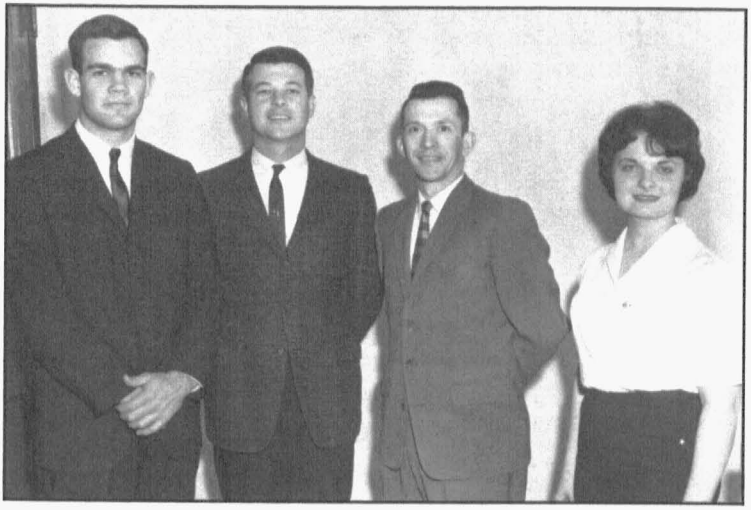
accompanying pictures. The individuals who are members of judging teams are usually found in prominent leadership positions in later years. Missouri has its share of such individuals including, to name only a few of many: C.R. Johnston, President, Missouri Farm Bureau, 1947; Dr. Rex Ricketts, Chairman, Department Dairy Science, University of Missouri, 1961; Marvin Oetting, Supt. of Agriculture, School of the Ozarks, Point Lookout, Mo., (High individual 1959 Intercollegiate Contest), and Zane Akins, Secretary, Holstein Association of America, Brattleboro, Vt., 1960.

Coach H.A. Herman and the 1952 Dairy Cattle Judging team.

The 1959 Dairy Cattle Judging team placed first in the intercollegiate contest in Chicago and was the recipient of the Otto Schnerring Trophy. Made of Georgian silver, the rotating trophy was insured for $14,000. Team members were: from left, Marvin Oetting, Aubrey H. Letsinger, Prof. Ragsdale, Prof. John D. Sikes, Joe Ben Whetstine, and Duane Scott.

DAIRY PRODUCTS JUDGING TEAMS

Beginning in 1954, the University sent an Inter-collegiate Diary Products Judging Team to national and international dairy products judging contests. The first contest was in Chicago, Ill., in connection with the International Dairy Show. The Missouri team was coached by J.H. Gholson and consisted of Duane Leiter, John Campbell, Glen



The 1963 Intercollegiate Dairy Products Judging Team members were, from left: H.T. Roth, D.B. Weddle, Coach R.T. Marshall and Anne Geiger.

Huskey and Phillip Warren. There were eight teams entered, and Missouri placed fourth in the contest for all products, second in cheese and ice cream, seventh in milk and eighth in butter.

A team has been entered in National and International Inter-Collegiate Contests every year since. The University team has won the International Contest three times and has been high team for individual products many times. There have also been many first place individuals in the various-products division. J.E. Edmondson coached the team from 1955 through 1958. Kenneth L. Smith coached the 1959 to 1960 team. Robert T. Marshall became coach in 1961 and has continued with the assistance of professor Dean Shelley since 1969.

Beginning in 1953, the students' Dairy Club has sponsored a Collegiate Dairy Products Judging Contest. Milk, butter, cheese and ice cream are judged. The high individual in the judging of each product is awarded an engraved plaque and a trophy. This event has became popular among students. Since 1968, the conduct of the contest is carried out by the staff of the Department of Food Science and Nutrition with the assistance of members of the Inter-Collegiate Dairy Products Judging Teams.

HISTORY OF DAIRY SCIENCE EXTENSION

Extension work has long been an important part of the educational program of the Dairy Department and the Missouri College of Agriculture. While not so designated, extension activities in dairy husbandry started years before 1912, when the county agent system was launched in Missouri, and 1914 when the Smith-Lever Act by Congress made possible the organizations of the Agriculture and Home Economics Extension Service.

As early as 1890, the State Dairymen and Creamerymen's Association and the State Department of Agriculture were carrying out some programs to improve and promote dairying in the state. In 1901, professor C.H. Eckles, the head of the newly established Department of Dairy Husbandry at the University, toured the state contacting dairy farmers and dairy plant operators. Meetings were held and lectures presented on many phases of herd management and the manufacture of quality dairy products.

The State Dairymen and Creamerymen's Association played an important role and kept pressure on the State Assembly to provide funds for buildings and equipment and staff members at the University's Dairy Husbandry Department. That organization and the State Department of Agriculture worked closely with professor Eckles on programs dealing with quality milk production, selling dairy products, creamery operations, control of tuberculosis in cattle, fair trade practices and other legislative matters, including establishment of the State Dairy Commission. R.M. Washburn became the State Dairy Commissioner in 1905. Some years it was difficult to get the State Assembly to fund the office.

With the dairy industry growing in the state and farmers receiving $20 million in milk sales annually, in 1916 the University of Missouri Board of Curators authorized the appointment of a traveling dairy instructor with the stipulation that he devote full time to organizing and instructing dairy associations and dairy farmers in Missouri. Available records do not make it clear whether this "traveling instructor" was appointed, but in January 1914, J. Watson was appointed Dairy Specialist. He served for only four months. From July 1915 to April 1919 A.C. Ragsdale, who later served 42 years as Chairman of the Dairy Husbandry Department, served as the extension dairy specialist. There have been many extension dairy specialists since 1914. A listing of names and period of tenure of the specialists who contributed much success to the development of the dairy program in Missouri follows. Special mention should be made of M.J. "Pat" Regan who served from

1920 to 1957. Another is E.T. "Scratch" Itschner who, after working many years as a county agent, served as extension dairy specialist from 1942 to July 1963. Still another is Fred H. Meinershagen who served from 1953 to 1978, when he retired. At present, Barry Steevens and Rex Ricketts are the dairy extension specialists. Beginning in 1962, department chairmen were assigned some (10 percent or more) extension activities as well as departmental operations.

Much credit must be given to the dairy extension workers through the years, with ever-changing technology, communications and economical conditions, for bringing practical information and assisting in programs to benefit dairy farmers and their families.

From 1914 to 1969, the extension dairy specialist worked with County Agents. Beginning in 1969-1970, Area Dairy Specialists were installed in the nine principal dairy areas of the state. This move has brought close working relationships between dairymen, milk plant operators and the extension program. The state dairy specialists from the Dairy Science Department work with the area specialists, bringing up-to-date information and correlating the program.

EARLY PROGRAMS AND ACCOMPLISHMENTS - 1910-1967

The dairy extension programs in the early years involved programs for improving production per cow, herd management, disease control, better feeding, roughage production and improved pastures. Assistance was also rendered, and still continues, to milk-plant operators in becoming established and obtaining a suitable supply.

The testing of dairy cows for milk and butterfat production is an important part of the dairy program and receives strong support from extension workers. In 1911, some 60 dairymen in the Mountain Grove area formed an association, which could be the first "Cow Testing Association in Missouri" and "hired an expert," according to the minutes, to weigh periodically the milk from each cow and test it for butterfat. The members pro-rated the cost for this service. Records indicate that the dairymen in Jackson and surrounding counties formed a Cow Testing Association, under the existing U.S. Department of Agriculture rules in 1914. At that time, the average milk cow in Missouri produced about 3,600 pounds of milk and 142 pounds of butterfat.

Note: The term "Cow Testing Association" (CTA) was the Dairy Herd Improvement Association (DHIA) in the '30s and now is commonly known as DHI.

In 1938, the *Extension Dairymen's Report* states that dairy schools were held in 20 counties in Missouri. The advantages of dairying economics, outlook, digestibility of feeds, balancing rations, disease

control, genetics for type and production and dairy farm management were the topics on the program at these schools. There were 344 herds in 22 Dairy Herd Improvement Associations (DHIA) active in Missouri with 9,250 cows on test. The average production for cows on test that year was 7,130 pounds of milk and 307 pounds of fat. This represented substantial improvement in production from nine years earlier when the average was 5,184 pounds of milk and 229 pounds of fat.

The importance of better breeding was realized, and better sire programs were sponsored. "Eliminate the Scrub Bull," "Use a Registered Bull" and "Swat the Cow Freshener" were slogans of the times. The extension dairymen in Missouri and other states worked with dairy farmers to form cooperative bull associations. Usually such an association consisted of a dozen or more dairymen who combined funds to purchase four registered bulls. Each of the bulls was located on a centrally located farm. This was known as a "bull block." Three or four dairymen members of the association, who owned a share in all the bulls, would bring their cows to the "block bull" for service. The first cooperative bull association in Missouri was formed in Webster County in 1916. Professor A.C. Ragsdale was the extension dairy specialist at the time.

Professor M.J. "Pat" Regan in 1938 reported that county bull associations included the use of 86 sires. There were 118 members in 12 cooperative bull associations. An effort was made to encourage progressive dairymen to prove their herd sires and to recognize those that were proven by classifying those sires as certified sires. This work was divided into two sections, the first providing for proved bulls and the second for unproved bulls whose breeding indicated that they may later qualify as proved certified sires.

The bull associations were helpful in providing service to better-than-average sires. However, the improvement in production was not spectacular. Also, maintaining bulls, moving cows, possible spread of disease and other factors resulted in the demise of Cooperative Bull Associations when the artificial breeding programs became established in 1940.

Home processing of dairy products was quite commonplace, and the 1938 report mentions that 307 families were assisted with butter and cheese making. Also, 320 4-H members in calf clubs in 27 counties participated in dairy-cattle and dairy-project judging and in demonstrating dairy production skills.

During the World War II years, it was difficult to keep DHIA's operating. The turnover of supervisors was great. Despite the strictures of wartime upon supplies, there were 431 milking parlors constructed in 59 counties. This was the first mention, in 1943, of this innovation in construction to cut capital investment and labor. In 1944, milk

production in the state reached 4,034,000,000 pounds. Eight thousand cows were bred by artificial insemination in 43 counties. In addition, 251 dairymen were still exchanging sires under the old cooperative bull association programs. There were 27 DHIA's in operation, with 8,960 cows in the 369 herds on test. The wartime manpower shortage was greatly curtailing the interest to expand this program. Milk production reached a wartime high of 4,260,000,000 pounds in 1945, and 1941 was a year of accelerated progress in production, marketing and processing of dairy products in Missouri. The Food for Freedom Campaign brought an increase in cow numbers to 1,070,000 and increased production approximately 12 percent.

In 1946, the war having been concluded, state DHIA's made a 21 percent increase in number of cows on test. There were 34 associations with 465 herds and 12,024 cows located in 63 counties enrolled that year.

By 1947, there were four well-organized bull studs which included "87 bulls of superior breeding" being used to inseminate 49,735 cows for an increase in artificial breeding of 42 percent from the previous year.

The use of artificial insemination, A.I., in Missouri dairy herds began in 1938 when the Farm Security Administration and the Department of Dairy Husbandry with the aid of the dairy extension specialists established the first cooperative association in the state, the second in the United States, at Hughesville. Service was provided for about 500 dairy cows kept on two large cooperative farms and some 30 individual farms. As experience was gained, the results were successful. This project was discontinued in 1944 when the government sold the farms and herds. Artificial insemination associations were organized at Marshfield in 1939; in West Plains in 1940; in Carthage in 1941; in Trenton in 1941, and in 1945 the Missouri Farmers Association established the MFA Breeding Service at Springfield. By 1947, four of these bull studs were still operating with about 50,000 cows serviced. In the 1960s with frozen semen available and competitions from out-of-state A.I. organizations, in addition to a declining number of dairy herds in the state, all of the Missouri-located breeding organizations merged or were purchased by large nationally operating bull studs. In 1962, it was estimated that about 130,000 dairy cows were artificially inseminated during the year. This represented about 20 percent of the dairy cows in the state.

On April 15, 1953, M.J. Regan obtained a leave of absence from the Extension Project to assist with the Point Four Program to Iran. He returned in June, 1955, and resumed his position as project leader until July 31, 1957, when he again took leave to assist with the Point Four Program in Costa Rica. E.T. Itschner assumed project leadership during

the absence of Mr. Regan, and until July 30, 1963. He retired December 21, 1963. W.H. Cloninger resigned on December 15, 1953, to accept a teaching position at Texas Technological College, at Lubbock, Texas. Fred H. Meinershagen joined the Extension Project on October 15, 1953, and became project leader on July 1, 1963.

Beginning in 1954, bulk milk cooling made its debut in Missouri. There were approximately 8,000 farms producing Grade A fluid milk. The high point in milk production had been reached in 1950, with 4,132,000,000 pounds having been produced that year. Cow numbers had reached an all-time high in 1933 of approximately 1,068,000, and had fluctuated within a range of 900,000 to 1,000,000 until 1954. In the early 1950s, there were more than 100,000 farms in Missouri selling milk or cream. With the advent of the bulk tank, bulk milk handling was a major step in the technology of milk marketing. This equipment is typical of the mechanization that allowed a great degree of specialization and a reduction in numbers of cows and farms involved in dairy production.

The price-cost squeeze for dairymen was becoming a problem in 1957, and the extension workers promoted the Weigh-A-Day-A-Month testing program. This offered a low-cost method for dairymen to determine the production and profitability of cows. This program rapidly enrolled some 400 herd owners with 7,000 additional cows in addition to the 1,500 cows on Owner-Sampler form of record keeping and 22,500 on Standard DHIA. There were now about 44 dairy herd improvement associations in the state. The first use of electronic computers in DHIA came in to use.

Raymond G. Hinders assumed the position of extension dairyman on October 1, 1963, and directed the Dairy Herd Improvement Program following the retirement of E.T. Itschner in December of that year.

In 1962, a new brucellosis law now forced reluctant counties to take action under the Brucellosis Eradication Program. The goal of a modified certified free state was near at hand.

Early in the 1960s, mastitis began to receive greater attention. There was increased interest in the control of so-called "abnormal milk." On October 14, 1964, through the efforts of the Department of Dairy Husbandry and the Extension Project, the Missouri Mastitis Council was formed. This Council has been very active in promoting control measures for mastitis.

Alfred G. Lane was employed as extension dairyman beginning September 1, 1965, and assumed leadership of the DHIA program on the resignation of Raymond G. Hinders.

DAIRY EXTENSION 1968-1987

The information to follow was largely provided by Barry Steevens, State Dairy Specialist and Rex Ricketts, Chairman, Dairy Science Department, and part-time dairy extension.

In 1968, the Dairy Extension program was guided by Fred Meinershagen, Leader and Al Lane, in charge of the DHIA work. Through improved breeding and management, Missouri herds on DHA test increased milk production from 11,939 pounds milk per cow in 1968 to 14,807 pounds in 1986. The dairy cow numbers decreased from 800,000 cows in 1968 to the present herd of 225,000. Production from all cows in the state of Missouri has increased from 7,930 pounds of milk in 1968 to the current level of 12,907 pounds of milk.

In 1970, Rex E. Ricketts joined the Dairy Extension staff to guide the DHI program. Al Garverick became a member in 1971 to provide support in reproductive management.

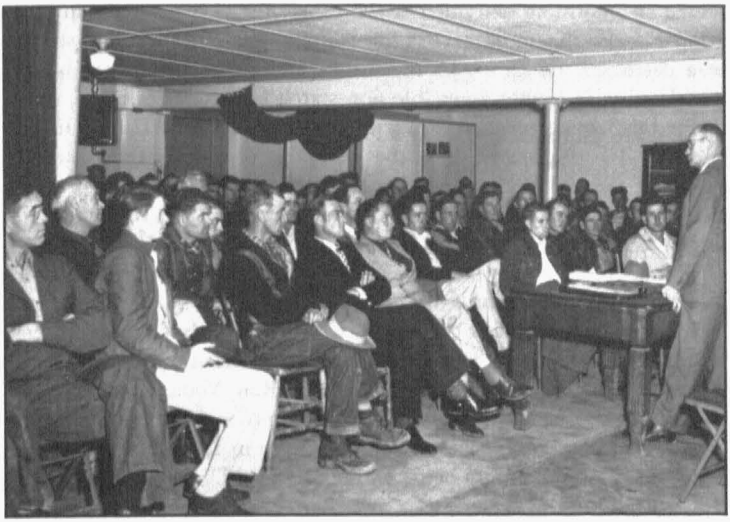
In 1971 the Babcock method of testing for milk fat gave way to electronic testing, which greatly increases the speed and accuracy of milk testing and service to the dairymen.

In 1976, Missouri had the first Verified Identification Program (VIP) cow in the United States; this was Staiger Alice Chief owned by O.F. and Gene Staiger, Billings, Mo. The VIP program allows dairymen to identify grade cows and maintain more accurate records.

Interest in the importance of controlling mastitis and increasing milk production per cow led to the Missouri DHI Federation purchasing an electronic somatic cell counting machines in 1980 to provide dairymen with information to help monitor herd health.

During 1981, the Missouri DHI Federation purchased forage-testing equipment and entered into a forage-testing program known as the Livestock Nutrition Laboratory Services, Columbia, Mo. The laboratory is currently located at the Holstein farm northwest of Columbia. The laboratory processed more than 12,000 samples in 1986. For more information, see the sections on Current Department Acitivities.

As responsibilities of the DHI Federation grew, a general manager was hired in 1983. The first general manager was Robert Albrecht. The effect of the 1983 milk diversion program resulted in a reduction of cows on test from 79,000 cows to 66,000. Following the milk diversion program in 1983 and 1984, a whole herd buyout program was implemented to help reduce the milk surplus problem. This resulted in cows on the DHI test being reduced from 66,000 to 59,000 head. Recognizing the importance of records, dairymen have continued to adopt the DHI program. In 1986, there were 60,000 cows participat-



A meeting of dairy farmers in West Plains in 1960 meet with E.T. "Scratch" Itschner, dairy specialist, to discuss the DHIA program.

ing in the Missouri DHI program, representing 27 percent of the milk cows in Missouri.

FEEDING AND NUTRITION

Major extension emphasis through the 1970s and the 1980s focused on quality forage. A continual shift from fescue grass pasture to legumes such as alfalfa and clover was emphasized. As dairymen learned the value of the forage-testing programs and recognized the importance of quality forage, legume forages with net energy values of 0.6 megacals per pound or greater were being fed to dairy cows. Dairy cows responded with increased production. Program emphasis focused on harvesting techniques using hay preservatives, allowing the dairyman to harvest alfalfa hay without losing many leaves.

The large round bale appeared in the early 1970s. This labor-saving concept was quickly adopted by many of Missouri's dairymen. However, because of the methods of handling, severe forage quality deterioration occurred. The large round bales became soaked with rainwater in the fall, and feed value suffered. Many dairymen went back to feeding the square bale. Others began storing large round bales in sheds and hay barns to preserve the quality.

Forage testing and ration balancing was also encouraged. Rex Ricketts gave leadership to complete ration formulation in 1974. Interest developed in feed byproducts as a cost saving and/or ration improving method. Such feedstuffs as corn gluten feed, dried distillers grains, whole cotton seed, wheat midds and soybean hulls were adopted by dairymen in balance rations. Extension efforts in 1984 through 1986

focused on informing dairymen of the value of feed byproducts in cost saving and also the importance of low starch diets. High levels of starch are a detriment to rumen fermentation, and dairy rations are being formulated with highly digestible non-starch feedstuffs.

Feeding management became a major thrust in 1980. This included the Total Mix Ration (TMR), the grouping of cows on production levels and the use of computer feeders. The computer feeder proportions the correct amount of concentrate for each cow. This technology is steadily being adopted by dairymen in the 1980s.

Management - Improvements in dairy cattle management continue to receive attention by the dairy extension staff. One major innovation included use of the outdoor calf hutch, which aids in the survivability of calves. Many different designs were developed, and most all worked.

Leadership by Fred Meinershagen and Ron Young, Area Dairy Specialist at Ozark, Mo., encouraged dairymen to use free stall housing. Many free stalls were built in the state. A survey in 1982 indicated more than 50 percent of all dairy herds on the Missouri DHI program utilize free stall housing.

Barry Steevens, the newest State Extension Specialist, joined the extension staff in 1978. Special emphasis was given to milking management and correct design of milking equipment. Labor-saving techniques were adopted as herds grew in size. In 1987, many dairy herds expanded to 100 to 150 cows. Improved dairy cattle management and health was being stressed. Two very important concepts promoted by the Missouri Mastitis Council are: 1) teat dipping and 2) dry cow treatment. The adoption of these two practices reduced mastitis problems by more than 50 percent. Along with the efforts to improve milk quality, the Missouri State Milk Board adopted guidelines of reducing somatic cell counts from 1,500,000 per milliliter to 1,000,000 for Grade A milk.

Dairy Extension continues to adopt new technology. Area dairy specialists and state extension specialists began using computers in 1980, and by 1984 computer ration programs were available in every dairy specialist's office.

In 1985, in a joint effort, the Dairy Science Department, the Missouri DHI Federation, and the Missouri Dairy Association started publishing a quarterly paper entitled *Missouri Dairy News*. This paper is circulated to dairymen throughout the state and is a valuable media for transmitting information to dairymen.

Credit must be given the many dairy extension specialists, whose combined efforts over a period of more than 75 years, have done much to advance the state dairy industry and improve the living standard for dairy farmers and their families. A list of dairy extension specialists from 1910 to date is included in this section.

Dairy Extension Specialists	
J. Watson	January 1914 - April 1914
A.C. Ragsdale	July 1915 - April 1919
M.H. Keeney	August 1919 - December 1919
E.M. Harmon	December 1918 - July 1926
M.J. "Pat" Regan	January 1920 - April 1953
	June 1955 - July 1957
I.G. Gibson	January 1925 - October 1925
A.F. Stephens	January 1926 - September 1929
J.E. Crosby, Jr.	November 1929 - December 1933
V.L. Gregg	January 1930 - March 1932
Warren Gifford	January 1939 - August 1939
W.H. Cloninger	January 1940 - October 1942
	January 1947 - September 1949
	August 1951 - September 1953
E.T. Itchner	October 1942 - July 1963
Fred H. Meinershagen	October 1953 - February 1978
C.P. Merilan (10%)	January 1962 - September 1962
J.E. Edmondson (10%)	September 1962 - September 1967
Raymond G. Hinders	October 1963 - November 1965
Alfred G. Lane	September 1965 - September 1970
H.D. Johnson (10%)	October 1967 - September 1978
H.A. Garverick (20%)	September 1971 - Present
Barry J. Steevens	April 1978 - Present
Frederic A. Martz (10%)	September 1978 - June 1982
Rex E. Ricketts (50%)	November 1970 - 1984 - Present

COOPERATION WITH THE INDUSTRY

The Department of Dairy Science, beginning with the Department of Dairy Husbandry in 1901, has had a close working relationship with the various dairy organizations, farmer-owned cooperatives and corporately owned dairy businesses in Missouri. It has also enjoyed friendly working relations and cooperation with the Missouri Department of Agriculture and other state and federal agencies.

When the Missouri Dairymen and Creamerymen's Association was organized in 1890, efforts got underway, in cooperation with the State Department of Agriculture, to promote and improve the state's dairy industry. When the Department of Dairy Husbandry was established in 1901, a close working relationship with the industry and dairy-related farmer groups began and continues to this day. As the dairy industry grew in Missouri, the scope of activities of many organizations

expanded. In 1902, the Missouri Dairymen and Creamerymen's Association changed its name to The Missouri State Dairy Association in order to encompass more dairy farmers. At the same time, the manufacturing segments of the industry such as cheese, butter, dried milk, ice cream manufacturers and milk handlers were forming their own specialized organizations. This trend continued largely with the manufacturing and processing group forming the Dairy Industries Council to work in an organized way on legislative matters affecting their operations. In 1938, because their goals were similar and in most cases their officers the same, the Missouri State Dairy Association and the Dairy Industries Council merged. The name Dairy Industries Council prevailed, and that organization continued until 1961 when it gave way to The Association of Missouri Dairy Organizations (AMDO), which has its goal the protection and advancement of the dairy industry in the state. AMDO has only organizations, or dairy affiliated businesses, as members. It might best be described as an "umbrella" organization, aiding all phases of the dairy industry. Among AMDO's activities are support of a dairy youth program, the state 4-H Dairy Cattle Judging Team, legislative matters, herd improvement and dairy exhibits. One of its accomplishments is establishing a Missouri Dairy Hall of Honors to recognize Missouri dairy leaders and dairy cattle breeders who have achieved success and aided the industry. The Hall of Honors is located in Room S-116, Animal Science Center, University of Missouri. AMDO is supported by industry contributions and modest membership dues.

In 1983, the newest dairy organization in the state, the Missouri Dairy Association, was formed. It has as members dairy producers and involves a check-off payment of 15 cents for $100 of milk sold. Funds will be used to advance and promote Missouri dairying including research at the University and other worthy projects. The MDA has launched a quarterly dairy publication, the *Missouri Dairy News*, which reaches all Missouri dairymen and promises to be an important factor in imparting information and building good will.

Among the producer groups in Missouri that have had a longtime working relationship with the Dairy Science Department, in addition to those mentioned earlier, are: The Missouri Jersey Cattle Club, organized in 1908; Missouri Holstein Association organized in 1918; Missouri Guernsey Breeder's Association 1928; Missouri Ayrshire Breeders Association; Missouri Brown Swiss Breeders Association; and Missouri Milking Shorthorn Breeders Association. Various members of the dairy department staff, including extension dairymen, have served as secretary of these breed organizations.

On the dairy processing and manufacturing front, dairy plant fieldmen and milk sanitarians for years W.H.E. Reid served as secretary-treasurer of the state association for butter manufacturers, ice

cream makers, cheese plants, milk distributors and others. These affiliations are now carried on by R.T. Marshall and others in the Department of Nutrition and Food Science.

The working relations between the Dairy Science Department and the dairy industry of the state have resulted in building support for the College of Agriculture and advancing all facets of the industry. The favorable public relations have done much to further the constructive work of the department.

DEPARTMENT CHAIRMEN

Clarence Henry Eckles, B.S., M.S. (Hon. D. Sc.), Sept. 1, 1901-March 31, 1919.

Arthur Chester Ragsdale, B.S., M.S. (Hon. D. Sc.), Apr. 1, 1919-Aug. 31, 1961.

Charles Preston Merilan, B.S., M.S., Ph.D., Sept. 1, 1961-Aug. 31, 1962.

Joseph Emmett Edmondson, B.S., M.S., Ph.D., Sept. 1, 1962-Sept. 30, 1967.

Harold David Johnson, A.B., M.A., Ph.D., Oct. 1, 1967-Oct. 1, 1978.

Fredric A. Martz, B.S., M.S., Ph.D., Oct. 1, 1979-Oct. 1, 1982.

Rex E. Ricketts, B.S., M.S., Ph.D., Oct. 1, 1982 - Interim Chairman - January, 1985 Department Chairman.

FACULTY MEMBERS

Staff (as of Sept. 1, 1987)

Ralph R. Anderson, B.S., M.S., Ph.D.; Sept. 1, 1958, Assistant; Oct. 16, 1961, Instructor; (July 1, 1962-June 30, 1964, Asst. Prof., Iowa State University; July 1, 1964-Aug. 30, 1965, Endocrinology Trainee and Associate, University of Wisconsin); Sept. 1, 1965, Research Associate; July 1, 1966, Assistant Professor; July 1, 1968, Associate Professor; July 1, 1976, Professor.

Ronald L. Belyea, B.S., M.S., Ph.D.; Sept. 1, 1978, Assistant Professor; Sept. 1, 1983, Associate Professor.

H. Allen Garverick, June 15, 1971, Associate Professor; Sept. 1, 1976, Associate Professor; Sept. 1, 1983, Professor.

Harold D. Johnson, B.S., A.M., Ph.D.; July 1, 1953, Assistant; July 1, 1954, Instructor; Jan. 1, 1957, Assistant Professor; July 1, 1960, Associate Professor; July 1, 1967, Professor, Oct. 1, 1967-Oct. 1, 1978, Department Chairman; University of London and Oxford England,

Visiting Professor; Medical Research Council, Environmental Physiology Unit.

Fredric A. Martz, B.S., M.S., Ph.D.; Sept. 1, 1961, Assistant Professor; July 1, 1966, Associate Professor; July 1, 1971, Professor. Oct. 1, 1978-Oct. 1, 1982 Chairman, Department of Dairy Science; Oct. 1, 1982 USDA and Adjunct Professor of Dairy Science to present.

Charles P. Merilan, B.S., A.M., Ph.D.; Feb. 1, 1948, Assistant; Sept. 1, 1950, Instructor; July 1, 1953, Assistant Professor; July 1, 1959, Associate Professor; July 1, 1966, Professor of Dairy Husbandry and Research Associate Space Sciences; July 1, 1968, Professor of Dairy Husbandry and Associate Investigator, Space Sciences. Administrative positions: Department Chairman, 1961-62, Associate Director, Agricultural Experiment Station 1962-63.

Rex E. Ricketts, B.S., M.S., Ph.D.; Sept. 1, 1970, Assistant Professor; Sept. 1, 1973 Associate Professor; Sept. 1, 1981, Professor; Oct. 1, 1982, Interim Department Chairman; 1985, Chairman, Department of Dairy Science.

John D. Sikes, B.S., M.S., Ph.D.; Sept. 1, 1957, Assistant; July 1, 1960, Instructor; July 1, 1961, Assistant Professor; Feb. 1-July 31, 1967, Visiting Professor, N.I.R. Dairying, Reading, England; July 1, 1968, Associate Professor; July 1, 1971, Professor.

Barry J. Steevens, B.S., M.S., Ph.D.; March 1, 1978, Associate Professor - State Dairy Specialist.

FORMER STAFF MEMBERS

Wendell S. Arbuckle, B.S., M.A., Ph.D.; Sept. 10, 1936, Research Assistant; Sept. 1, 1937, Assistant Instructor; Sept. 1, 1940, Instructor; Feb. 5, 1951, resigned.

Samuel Brody, B.A. (Chem.), M.A., (Biochem.), Ph.D.; Sept. 1, 1920, Assistant Professor; Sept. 1, 1928, Associate Professor; Sept. 1, 1945, Professor; Aug. 6, 1956, deceased.

Clifton R. Blincoe, B.S. (Chem.), M.A., Ph.D.; Feb. 1, 1948, Assistant; Sept. 1, 1949, Instructor; Sept. 1, 1955, Assistant Professor; June 30, 1956, resigned.

Philip M. Brandt, B.S., M.A., Sept. 1, 1911, Assistant; Sept. 1, 1912, Instructor; Sept. 1, 1914, transferred to Dean's Office, Short Courses (later Department Head, Oregon State College).

William Homer Closther, B.S., M.S., Ph.D.; July 1, 1947, Assistant Professor; Aug. 1, 1951, Associate Professor; Aug. 31, 1953, resigned.

James W. Cobble, B.S., M.S., Ph.D.; Sept. 1, 1947, Assistant; Sept. 1, 1949, Instructor; Aug. 31, 1951, resigned (Later Department Head, then Dean, Rhode Island State College).

Willis B. Combs, B.S., M.A.; July 1, 1915, Assistant; (1917-18, Instructor, New Jersey College of Agriculture); July 1, 1919, Assistant Professor; June 30, 1920, resigned.

Paul R. Cornelison, B.S., M.S.; Dec. 1, 1941, Assistant Professor; July 1, 1953, Associate Professor; June 30, 1957, resigned.

James E. Crosby, B.S., M.A.; Oct., 1929, Instructor (Dairy Specialist); July 17, 1937, transferred to Triple A Program, Extension Service.

Arthur C. Dahlberg, B.S., M.S., Ph.D.; Sept. 1, 1919-Aug. 30, 1920, Assistant Professor.

Henry C. Damm, Ph.D.; July 1, 1959-Oct. 16, 1961, Research Associate.

Clarence H. Eckles, B.S., M.S. (Hon. D. Sc.); Sept. 1, 1901 through Mar. 31, 1919, Professor and Department Chairman (Apr. 1, 1919, Professor and Chairman, Dept. of Dairy Husbandry, Univ. of Minnesota until his death, Feb. 13, 1933).

Joseph E. Edmondson, B.S., M.A., Ph.D.; Graduate Assistant 1939-41; Instructor 1941-48; Assistant Professor (1948-53); Associate Professor 1953-58; Professor Aug. 1, 1958. Transferred to Department Food Science and Nutrition 1967 (Acting Chairman 1967-69) Professor, Food Science and Nutrition, 1967-68.

Erwin C. Elting, B.S., M.A.; July 1, 1923, Assistant; July 1, 1925, Instructor; Apr. 1, 1929, resigned.

Milton H. Fohrman, B.S., M.A.; July 1, 1917-1919, Instructor.

Charles F. Foreman, B.S., M.S., Ph.D. Assistant Professor Sept. 1, 1951 through June 30, 1953, when he resigned.

Earl R. Garrison, B.S., M.S., Ph.D.; Sept. 1, 1926, Assistant; Sept. 1, 1928, Instructor; Sept. 1, 1930, Assistant Professor; Aug. 1, 1945, resigned.

James H. Gholson, B.S., M.S., Ph.D.; Sept. 1, 1946, Instructor; July 1, 1953, Assistant Professor; Sept. 30, 1955, resigned.

Warren Gifford, B.S., M.A., Ph.D.; Sept. 1, 1925, Assistant; Sept. 1, 1926, Instructor; Sept. 1, 1927, Assistant Professor; (Sept. 1, 1934 to Dec. 31, 1935 with U.S.D.A.); Jan. 1, 1936, Extension Assistant Professor; Aug. 31, 1939, resigned to head Department of Animal Industries University of Arkansas.

W.R. Graham, (Ph.D., University of Toronto, 1933); Sept. 16, 1936, Assistant Professor, Sept. 16, 1937 Assistant Professor and National Research Council Fellow; Sept. 16, 1938, resigned.

David R. Griffith, M.S., Ph.D.; Sept. 1, 1959, Assistant; Sept. 1-June 30, 1962, Research Associate and U.S. Public Health Service Fellow.

Clark E. Grosvenor (Ph.D., University of Cincinnati, 1955); July 16,

1956 to June 30, 1958, Research Associate and U.S. Public Health Service Fellow.

Myron W. Hales, B.S., M.S., Research Assistant in Dairy Husbandry, Sept. 1, 1930; Assistant Instructor Sept. 1, 1931; Creamery Superintendent with rank of Research Assistant, Sept. 1, 1932; resigned Oct. 31, 1933.

Erskine M. Harmon, B.S.; Dec. 1, 1918, Extension Instructor; Apr. 1, 1920, Assistant Professor; July 1, 1921, Associate Professor; July 1, 1926, Professor; Sept. 15, 1926, resigned.

Waverly P. Hays, B.S., M.S.; Sept. 1, 1922, Assistant; Sept. 1, 1923, Instructor; Aug. 31, 1925, resigned.

Harry A. Herman, B.S., M.A., Ph.D.; June 1, 1929, Assistant Instructor; Sept. 1, 1930, Instructor; Sept. 1, 1936, Assistant Professor; Sept. 1, 1942, Associate Professor; Sept. 1, 1945, Professor; July 31, 1953, resigned. Prof. Emeritus 1988, Honorary Doctor of Science UMC 1988.

Kentaro Himeno (Ph.D. 1959, University of Tokyo); Nov. 1, 1960-June 30, 1961, Research Associate.

Raymond G. Hinders, B.S., M.S., Ph.D.; Oct. 1, 1963, Assistant Professor; Dec. 10, 1965, resigned.

George A. Hindery, B.S., M.S., Ph.D.; Sept. 1, 1960, Assistant Instructor; July 1, 1964, Research Associate; Sept. 1, 1967, resigned.

Tatsuo J. Imori (Ph.D., University of Osaka, Japan); Dec. 1, 1962 to Sept. 30, 1963, Research Associate.

Takehiko D. Ishibashi (Ph.D. 1961, Kyushu University, Japan); June 1, 1964 to May 30, 1965, Research Associate.

Ernest T. Itschner, B.S., M.A.; Oct. 19, 1942, Assistant Professor; July 1, 1946, Associate Professor; July 1, 1963, Professor; Dec. 31, 1963, Professor Emeritus; deceased.

Robert G. Jensen, B.S., M.D., Ph.D.; July 1, 1950, Assistant Instructor; July 1, 1953, instructor; July 1, 1955, Assistant Professor; July 1, 1956, resigned.

W.R. Kirkam, M.S., Ph.D.; July 1, 1953 to June 30, 1954, Research Associate.

Rudolph E. Leighton, B.S., M.S.; Jan. 1, 1946, Superintendent, Hatch Dairy Experiment Station Farm, Hannibal; Aug. 20, 1947, resigned (Later Head, Dairy Husbandry Department, Texas A&M).

Raymond G. McCarty, B.S., M.A.; Dec. 1, 1936, Assistant Instructor; Sept. 1, 1938, resigned.

Charles W. McIntyre, B.S., M.S.; Dec. 1, 1931, Assistant Professor (Superintendent of the Hatch Dairy Experiment Station Farm, Hannibal); Dec. 30, 1945, resigned.

Fred H. Meinershagen, B.S., M.S.; Sept. 1, 1953, Assistant Professor July 1, 1961, Extension Professor Dairy Husbandry - retired.

William R. Miller, Ph.D.; Sept. 1, 1960 to Aug. 31, 1963, Research Associate and U.S. Public Health Service Fellow; deceased.

Theodore A. Mollett, Nov. 1, 1979, Assistant Professor, Resigned Oct. 15, 1985.

Richard C. Moon (Ph.D. University of Cincinnati); July 1, 1958-59, Research Associate, U.S. Public Health Service Fellow.

Marvin E. Oetting, B.S., M.S., Ph.D.; Sept. 1, 1960, Assistant; July 1, 1965, resigned.

LeRoy S. Palmer, B.S. (Chem.), M.A., Ph.D.; Sept. 1, 1909, Assistant Dairy Chemist (Fellow in Chemistry); Sept. 1, 1913, Assistant Professor, Dairy Chemistry and Assistant Chemist, Agr. Experiment Station; (U.S. Dept. of Agriculture); 1920, resigned.

Horace S. Peet, B.S.; July 1, 1949, Superintendent, Hatch Dairy Experiment Station Farm, Hannibal; July 1, 1955, Instructor; July 1, 1956, Assistant Professor; July 1, 1968, transferred to Agricultural Research Organization, Missouri College of Agriculture, retired.

Gayle W. Pipes, B.S., M.A., Ph.D.; Sept. 1, 1954, Instructor; July 1, 1955, Assistant Professor; July 1, 1964, resigned.

Milton E. Powell, B.S., M.A., Assistant Instructor, Sept. 1, 1928; Instructor, Sept. 1, 1930 through July 3, 1931; resigned July 31, 1931.

B.N. Premachandra, Ph.D.; July 1, 1958, Assistant Professor; Aug. 31, 1960, resigned.

Arthur C. Ragsdale, Professor, B.S., M.S. (Hon. D. Sci.) Apr. 1, 1961—August 31, 1961, Prof. Emeritus, deceased.

Noel P. Ralston, B.S., A.M., Ph.D.; Sept. 1, 1937, Assistant Instructor; Sept. 15, 1939, resigned.

Ollie E. Reed, B.S., M.S. (Hon. Sc.D.); July 1, 1908 to June 30, 1910, Assistant Instructor (Later, Head Departments of Dairy Husbandry, Kansas State College, Purdue University and Michigan State University; Chief, Bureau of Dairy Industry, Director of Livestock Research, Animal Research Administration, U.S. Dept. of Agriculture, etc.)

William M. Regan, B.S., M.A.; July 1, 1914, Instructor; Feb. 1, 1916, resigned (Later Head, Department of Dairy Husbandry, University of New Jersey and University of California, Davis).

Ezra P. Reineke, B.S., M.A., Ph.D.; Sept. 1, 1938, Instructor; Sept. 1, 1942, Assistant Professor; Sept. 1, 1945, resigned.

L.G. Rinkle, B.S., M.A., Graduate Assistant, 1918.

Kenneth L. Smith, B.S., M.A., Ph.D.; July 1, 1955, Assistant; July 1, 1956, Instructor; Aug. 30, 1960, resigned.

Laxmi Srivastava, Ph.D.; Aug. 1, 1964, Instructor; Aug. 15, 1965, resigned.

Odie T. Stallcup, B.S., M.A., Ph.D.; Sept. 1, 1946, Assistant Instructor; Sept. 1, 1947, Instructor; Aug. 30, 1950, resigned.

Aubrey F. Stephens, B.S., M.A.; Sept. 26-29 and 1939-Extension Specialist.

Eric W. Swanson, B.S., M.A., Ph.D.; Sept. 1, 1939, Research Assistant; Sept. 1, 1940, Assistant Instructor; Sept. 1, 1943, Instructor; May 31, 1947, resigned.

Walter W. Swett, B.S., M.A.; July 1, 1916, Instructor; July 1, 1919, Assistant Professor; July 1, 1920, Associate Professor; Sept. 1, 1922, resigned.

Kenneth L. Tallman, B.S., M.A., Ph.D.; Nov. 1, 1947, Assistant Instructor; Sept. 1, 1950, Instructor; July 1, 1953, resigned.

Charles W. Turner, Professor, Prof. Emeritus, 1976, deceased.

Rolf Von Berswordt-Wallrabe (Ph.D., University of Stuttgart, Hohenheim); 1958-60, Research Associate.

Hiroshi Wada (Ph.D., University of Okayama, Japan); Sept. 1, 1958 to June 30, 1959, Research Associate.

Oliver Wayman (Ph.D., Cornell University); Sept. 1, 1960 to Sept. 1, 1961, Research Associate.

Clarence W. Weber, B.S., M.A.; Sept. 1, 1924, Assistant; Sept. 1, 1925, Instructor; Aug. 31, 1929, resigned.

Percy Werner, Jr., B.S., M.A.; Sept. 1, 1915, Assistant; Aug. 15, 1919, Instructor; May 15, 1920, resigned.

Ralph Williams, B.S., M.S., Ph.D.; Sept. 1, 1950 to Aug. 31, 1954, Research Associate; Sept. 1, 1960, resigned.

Walter F. Williams, B.S., M.S., Ph.D.; Sept. 1, 1950-Aug. 31, 1954, Research Associate.

Dorothy M. Worstell, B.S., M.S.; July 1, 1951, Research Assistant and Agent, U.S. Dept. of Agriculture; Feb. 16, 1956, resigned (transferred to U.S.D.A., Washington, D.C.).

HONORS AND RECOGNITION CURRENT FACULTY MEMBERS

Ralph R. Anderson, Professor. Fullbright Senior Research Fellow, 1973-74; Who's Who in Technology Today, 1983; Who's Who in the Midwest, 1976-86; Who's Who in America, 1987; UMC Gamma Sigma Delta Teaching Award of Merit, 1981-82; Vice President of Missouri Academy of Science 1986-87, and UMC Dairy Club Outstanding Faculty Award 1988.

H. Allen Garverick, Professor. Outstanding Young Men of America, 1980; Outstanding Younger Scientist, Research, Midwestern Section, American Society of Animal Science, 1982; Visiting Scholar—Agricultural Research Council, Animal Research Station, Cambridge, England, 1980-81; Invited Speaker—Univ. of Nottingham, England, Spring, 1981; Member, Physiology Committee, American Dairy Science Association, 1982-85; Chairman, Physiology Committee, American Dairy Science Association, 1984-85; Chairman, NC-113, Regional Research Committee.

Harold D. Johnson, Professor. Peterson Award for excellence in Animal Biometeorology, International Society of Biometeorology, 1972; Animal Biometeorology Award for Achievements in Animal Bioclimatology, American Meterological Society, 1972; Gamma Sigma Delta Honorary Agriculture Fraternity Faculty Research Award, UMC 1975; National Science Animal Behavior Institute, Logan, Utah, July, 1965. Chairman, Physiology Awards Committee, American Animal Science Association, 1970, 1st Bioemeteorology Conference, University of Missouri, Columbia, June, 1971. Physiology Section, American Dairy Science Association, June, 1971. Chairman and Program Chairman, Biometeorology Committee, 2nd Biometeorology Conference, Philadelphia, November, 1972. National Academy of Science Committees on: NAS-NRC Agricultural Meteorology and Climatology, 1960-66; NAS-NRC Climatic Factors and Performance of Domestic Animals, 1967-71. Rapporteur on Livestock Meteorology, Commission for Agricultural Meteorology WMO, 1972-74. Program Chairman, "Stress and Animals", International Society of Biometeorology, Israel, 1979. Chairman International Affairs Committee, American Dairy Science Association, 1979-81. Chairman, Symposium, "Dairying in Tropical Countries", American Dairy Science Association, June, 1980. Chairman, International Livestock and Management Systems Task Force involving project development, University of Missouri, 1979-present. Section Chairman, Fifty World Animal Congress Animal Production, Tokyo, Japan, 1983.

Frederic A. Martz, Professor (Adjct). Junior Faculty Award for

1972, UMC Chapter, Gamma Sigma Delta. Merit Certificate, American Forage and Grassland Council, 1978; Who's Who in American Men of Science, 1974-86; Ninth Edition Community Leaders and Noteworthy Americans, 1976; American Registry of Certified Animal Scientists-Animal Nutritionists; Distinguished Service Award, Farmland Industries, Kansas City, Kansas, 1984. Distinguished Service Award, American Forage and Grassland Council, Lexington, Kentucky, 1987.

Charles P. Merilan, Professor. Who's Who in America; Who's Who in the World; Sigma XI; Research Associate Space Sciences 1968.

Rex E. Ricketts, Professor. Who's Who in American Colleges and University, QEBH UMC Honor Society; Chairman, North Central Extension Dairyman, 1977; Task Force, Eminence Program on Commercial Agriculture 1986-87; Treasurer, Missouri Livestock and Poultry Health Council. Numerous Committees. UMC College of Agriculture.

John D. Sikes, Professor. Visiting professor—National Institute for Research in Dairying, Reading, England 1967; Gamma Sigma Delta. Numerous UMC Dairy Cattle Judging Team Awards.

Barry J. Steevens, Associate Professor. State Dairy Specialist. Faculty Improvement Award 1982. Dairy Science Club Award—Outstanding Faculty member 1983 and 1985.

SPECIAL HONORS AND RECOGNITION FORMER FACULTY MEMBERS

Samuel Brody, Professor: Guggenheim Foundation Fellowship for study in Europe, 1930-31; Recipient of the Borden Award for Research in Dairy Production, 1950; National Distinguished Service Gamma Sigma Delta award, 1955; Brody Memorial Lectureship established by colleagues, former students and friends and the King Ranch, Kingsville, Texas and administered by a special University Lectureship Committee.

Arthur C. Dahlberg, Assistant Professor: Who's Who in America; U.S. delegate to World Dairy Congress, Berlin, Germany, 1937; President, American Dairy Science Association, 1944; Recipient, Borden Award in Dairy Manufacturing, 1944; American Dairy Science Association Honorary Membership 1958 and Award for Distinguished Service, 1961.

John R. Campbell, Professor: Gamma Sigma Delta Award to Junior Faculty member for outstanding service to agriculture; Chairman, American Dairy Science Association Committee's National Student Branch and Graduate Student Research papers; President American

Dairy Science Association 1983. Distinguished Service Award ADSA 1987.

Clarence Henry Eckles, Professor and Department Chairman: Who's Who in America; President, American Dairy Science Association, 1908-1909 and 1921-22; Delegate to the International Dairy Congress, London, 1930, and Copenhagen, 1932; The Eckles Club, and organization of his former students was formed in 1916 and has been the most widely known of all such groups in the world of agriculture and related sciences. Annual meetings were held each year, first at the time of the National Dairy Show and later at the annual meeting of the American Dairy Science Association.

Joseph E. Edmondson, Professor: Superior Teaching Award, Undergraduate Level, Gamma Sigma Delta, May, 1988; In Recognition, College of Agriculture for Exemplary Contribution made in the Finest Land Grant Tradition, May, 1988; Honorary Lifetime Member, Mizzou Food Science Association, April, 1988; Certificate of Appreciation, Faculty, Mystical Seven, University of Missouri, April, 1988; The Tressler-AVI Teaching Award, National Association of College and Teachers of Agriculture, 1986; National Environmental Health Association, Certificate of Merit. (Award given annually for meritorious contributions to environmental health as a dedicated teacher in sanitation.) 1985; AMOCO Teaching Award, University of Missouri-Columbia. (Award given annually to a single outstanding teacher on the Columbia Campus of the University of Missouri.) 1982; Outstanding Advisor Award, College of Agriculture, University of Missouri-Columbia, 1981; International Association of Milk, Food and Environmental Sanitarians. Award for Excellence in teaching Sanitary Science. $1,000, 1979; Missouri Public Health Association. Presidential Citation Award for Meritorious Achievement and Contribution to Public Health Education in Missouri. 1979; Missouri Restaurant Association. Certification of Appreciation exemplifying for more than a quarter of century, outstanding qualities as Teacher, Counselor and Administrator to students and friends of foodservice, 1979; The National Institute for the Foodservice Industry. Award for Distinguished Service in Teaching the Applied Foodservice Sanitation Courses in Missouri. Over 3,000 students completed courses since 1976, 1977; National Advisory Public Health Training Council Service Award, Department of Health, Education and Welfare, 1976; Chairman of committee involving the College of Agriculture, College of Arts and Science and College of Engineering which developed a Cooperative Educational Program in 1961 for undergraduates and graduates in Sanitary Science.

Erwin C. Elting: Who's Who in America; Dairy Science., Clemson College, South Carolina, 1952.

Warren Gifford, Professor: Who's Who in America; Award, "Man of the Year for Arkansas in Service to Agriculture", 1946; Consultant and advisor to livestock and dairy organizations, both national and international.

Harry A. Herman, Professor: Who's Who in America (also Who's Who in the World; Who's Who in Education; American Men of Science; Borden Award in Dairy Production 1956; Delegate Third International Congress on Reproduction, Cambridge, England, 1956; also Fourth Congress, Hague, Neitherland, 1960; Honored Guest Dairy Shrine 1974; Man of the Year Award, Dairy Expo, Madison, WI 1973; Hall of Honors Dairy Leadership Award, Missouri 1973; Director 1966-77 American Guernsey Cattle Club, President 1969-74; Distinguished Service Award, American Guernsey Cattle Club 1977; President, Dairy Shrine 1961; Distinguished Service Award Gamma Sigma Delta 1968; Honored by Italian Society of Animal Production 1972, and by the Government of Brazil 1974; Recipient of "All Time Great Dairyman Award; Agriservices Foundation 1980; President, Purebred Dairy Cattle Association 1973; Honorary Doctor of Science, UMC, 1988.

Robert T. Marshall, Professor: President American Dairy Science Association, 1983-84; President, American Dairy Science Association (1983-84); President, International Association of Milk, Food and Environmental Sanitarians (1982-83); Educator Award, International Association Milk, Food and Environmental Sanitarians (1986); AMOCO Teaching Award, UMC (1985). Research Award Dairy Research Foundation (1976); Teaching Award - Milk Industry Foundation (1975); Honorary American Farmer, FFA (1977); Faculty-Alumni Award, UMC (1968), Junior Faculty Award, Gamma Sigma Delta (1968); Member Sigma Xi and Gamma Sigma Delta.

Arthur C. Ragsdale, Professor: Who's Who in America; President, American Dairy Science Association, 1944-45, Board of Directors, 1944-46; Honorary Life Member of the American Dairy Science Association; Official U.S. State Department delegate to the International Dairy Congress at the Hague, Neitherlands, 1953; Ragsdale Scholarship for Senior Student, $200 annually from a fund contributed by former students, associates and friends of Professor Ragsdale; President National Christian Men's Fellowship (Indianapolis, Indiana) 1948-50.

Maurice J. Regan, Professor: Life member, American Dairy Science Association.

William H.E. Reid, Professor: Dairy Industry Delegate to the World's Dairy Congress—Rome, 1956; London, 1959; Copenhagen, 1962; Munich, 1966. Secretary-Treasurer of many state and national dairy production associations.

Ollie E. Reed: President, American Dairy Science Association, 1925

and 26; Distinguished Service Award, USDA, 1952; Who's Who in America; Official delegate to International Dairy Congress, London 1928, Copenhagen 1931, Berlin 1937 and Stockholm 1949, and was chairman of the 1931, 37 and 49 delegations from the United States; Delegate 2nd International Conference on Agriculture, Mexico City, 1950 and to the International American Livestock Production meetings Turrialbo, Costa Rica; and also numerous other honors.

Ezra P. Reineke, Professor: Borden Award in Dairy Production, 1946.

Charles W. Turner, Professor: Borden Award in Dairy Production, 1940; Fulbright Research Fellowship for study in New Zealand, 1951-52; Senior Faculty Award by Gamma Sigma Delta, 1955.

RESEARCH - DAIRY SCIENCE DEPARTMENT

I. Growth and Development - and Environmental Physiology, with Special Reference to Domestic Animals.

(Harold Johnson and Associates) Influence of Environment on Growth, Lactation, Aging and Related Physiological Reactions.

The principal projects and results of the research conducted under these investigations are briefly reported in A and B, as follows:

A. Growth and Development of Domestic Animals

Early studies were concerned with growth, aging metabolism, productive processes and environment. The effect of age, weight, stage of lactation, plane of nutrition, environment and management practices upon the amount of milk secreted was studied. Substantial contributions were also made to the knowledge of the energy and nitrogen metabolism in growing and mature domestic and laboratory animals.

Based on an enormous quantity of basal metabolic data on mature domestic and laboratory animals, it was established that the ratio of metabolism to the 0.73 power of weight is independent of body size. This value of W^b or $W^{.73}$ is widely accepted as the metabolically effective body weight.

Dairy cattle, beef cattle, horses, mules, goats, poultry and rats of various ages during gestation, lactation, working and resting were used in these studies.

Of major scientific importance was the determination of the energetic efficiency of productive processes (milk, eggs, work and growth) of these many domestic and laboratory animals.

The tradition of scholarship and fundamental research cultivated by Dean H.J. Waters, Clarence H. Eckles and LeRoy S. Palmer, with the encouragement of Arthur C. Ragsdale, department chairman, made it natural for Samuel Brody, with his unusual abilities, to develop these studies on growth and energetics and subsequent investigations of environmental factors.

Cooperation - has included many departments, individuals and agencies. Brody, the early project leader, had exceptional abilities to interest and involve workers in many related fields. His success is indicated by the names of some 30 co-authors of the 66 Experiment Station Bulletins and 55 scientific papers relating to research conducted under this project prior to 1946. In that year, revisions were made involving new investigations relating to environmental and climatic factors.

Financial support other than regular Station funds included:

Atomic Energy Commission	$ 77,000	
Herman Frasch Foundation	121,500	
National Research Council	28,000	
U.S. Dept. of Navy	51,390	$277,890.00

U.S. Dept. of Agriculture, including personnel and equipment, closely approximates the direct financial support given by the Agri. Experiment Station.

B. The Influence of Environmental and Climatic Factors on Growth, Lactation and Aging (Project 125 Climatic Factors)

In 1948, with the construction of the Climatic Laboratory, a series of Climatic and Environmental Physiology studies on cattle was initiated and has continued to date.

During the period 1948-1952, the principal investigations were concerned with the effects of hot and cold temperatures on both lactating and non-lactating Holstein, Brown Swiss, Jersey and Brahman cattle.

These investigations on physiology and shelter design included measurements of efficiency, milk production, growth, heat production and dissipation, feed and water consumption, thyroid activity, adrenal blood composition, hair and skin temperature, surface area, partition of evaporative and non-evaporative cooling, and the first measurements of respiratory vaporization in cattle.

In 1953, similar measurements were made on the effects of humidity; in 1954, on the effects of wind; in 1955, on thermal radiation; in 1956, diurnal temperature rhythms; and in 1956-60, growth of beef and dairy breeds at thermal neutral and hot temperatures.

The Growth and Development projects involved cooperation with Poultry/Animal Husbandry and Agricultural Chemistry Departments; the Environmental Physiology and Shelter Engineering Project with the Agricultural Engineering Department and more recently with the Space Sciences Research Center.

Financial Support other than Regular Station Funds from 1948 to 1956 included:

Dept of Navy	$25,000	
Atomic Energy Commission	90,000	$115,000

U.S. Dept. of Agriculture Construction and chief maintenance of Climatic Laboratory and personnel and technical assistance.

The principal research workers on these earlier projects were Samuel Brody, Harold Johnson, Hudson Kibler, Dorothy M. Worstell and Arthur C. Ragsdale. Many others, as indicated by the authors of publications, had leading or important parts in various investigations. Various representatives of the U.S. Dept. of Agriculture, principally R.G. Yeck, A.C. Thompson, M.D. Shanklin and L. Hahn took leading roles in their fields, as did representatives of various cooperating departments and divisions of the University. The many graduate students who assisted are listed under degrees obtained and publications listed.

The list of publications in this area has been extensive in number, depth and breadth. These include some 130 Station publications and more than 200 scientific papers. Brody especially was a prolific writer with unique abilities. He contributed to a number of books and miscellaneous publications.

The most ambitious *tour de force* of Brody's career, however, was the compilation of his book, *Bio-Energetics and Growth, with Special Reference to the Efficiency Complex in Domestic Animals*, published in 1945 by the Reinhold Publishing Corporation in New York.

This volume consisted of 1,023 pages, 25 chapters with more than 2,000 references, more than 500 illustrations and some 113 tables of data. Much of this material was taken from the Experiment Station bulletins dealing with growth and development published during the author's first 25 years of work in this field. Brody avowedly strove for an integrating principle "which would show by a word or a phrase the interrelatedness of all the phases of growth, development and aging with the energetic efficiencies and profits in milk, meat, eggs, and muscular work production through generalizing equations," so-called laws for integrating unwieldy bodies of data. Such a principle might be comparable to the theory of evolution. The nearest to such an integrating principle found by Brody was the ancient, perhaps vaguely felt, concept of physiological self-regulation propounded by Claude Bernard and more recently designated as homeostasis by W.B. Cannon.

This principle, in Brody's opinion, should apply to social as well as physiological self-regulation, including that of human society.

The complete list of publications with authors and their co-workers is appended.

In 1957 Harold D. Johnson assumed the responsibility for conduct of the project "The Influence of Environmental and Climatic Factors and Growth, Lactation and Aging." The project continued with a cooperative agreement with USDA-ARS in the original climate laboratory until 1978. For a three-year period a contract with ARS was continued (1979-1982). With the completion of the University's Animal Sciences Research Center, a very modern Climatology Laboratory became available, and in 1985 a collaborative effort was again established with ARS with a new environmental physiology project. Dr. A. Becker is the ARS project leader. In addition to ARS collaboration a series of HIH projects (H.D. Johnson, project leader) on aging of rats under varied temperature environments ws conducted (1958-1969).

Most investigations conducted in the Missouri Climatic Laboratory have been directed toward various aspects of the effect of climatic environment on dairy and beef cows. These studies have been concerned with the effect of one climatic parameter (i.e. temperature, humidity, wind, radiation) at a time on the animal above its upper critical temperature. This laboratory has developed many of the requirements on dairy shelters, temperature-humidity index (THI), comfort zones and stress physiology and has been the major world source of environmental physiological information on the lactating cow. Since 1975, approximately 40 journal articles, one book (two volumes), one book in press, eight chapters in books, 52 abstracts and 13 symposia talks and papers have been prepared by this project.

The purpose of the current research is to better undertand the nature of an optimal envionment, to define the many limitations of the environment and to determine ways to alleviate the environmental impact. Alleviation of the environmental impact on the physiology and performance of livestock, principally dairy animals, includes experiments on modification of a) the physical environment, and b) the animals' nutrition, physiological systems and genotype. With the new animal climatology facilities, these environmental modification investigations are progressing rapidly.

From the animal perspective, studies to improve nutritional, physiological and genetic modifications so that the animals' environmental requirements are lessened in stressful environments is also a current ongoing research priority. Modification of the animals' physiological systems by hormones, feed additives, etc., or the development of selection indices and use of embryo transfer to obtain more stress-resistant animals requires a greater understanding of stress and production-

responsive biological functions within the animal.

Under Harold D. Johnson's leadership, these investigations have been, or are now, supported by grants and financial aid as folows:

Project Director, NIH, Effects of Environmental Temperature on Aging, 1958-1969 $500,000 total.

USDA Cooperative Research Program, 1956-1979 (Departments of Agriculture Engineering and Dairy Science) Approx. $100,000/year.

USDA, ARS 1979-1981 $100,000/3 years.

Program Director, NIH Environmental Physiology Training Grant (Departments of Medical Physiology, Veterinary Physiology, Biological Science, Agriculture Engineering, Dairy and Poultry Science.) $150,000.

Project Leader, Environmental Physiology Agriculture Exp. Sta. funds, approximately $15,000/year plus technicians and graduate students.

Co-Director - Air Force Research Contract (1961-1963) $150,000.

NSF Contract with Egyptian Atomic Energy establishment 1975-1979 $370,000.

NSF Grant with Egyptian Atomic Energy establishment 1985-1988 $20,000.

Ministry of Agriculture Training Contract with Libya (1978-1983) $350,000 ($150,000 UMC).

Numerous International Student Grants - $100,000 (approx.).

BRODY ANIMAL CLIMATOLOGY LABORATORY FOR ENVIRONMENTAL RESEARCH ANIMAL SCIENCES CENTER

Environmental Laboratory provides special areas permitting computerized environmental control-temperature, humidity, radiation and light. It accommodates studies with large domestic animals on basic and applied aspects of animal science relating to environmental physiology, nutrition, endocrinology, genetics, biometeorology, domestic-animal management, reproduction, lactation, growth, pathology and toxicology. The lab area includes four environmentally controlled chambers and an observation room with support areas for sample and animal preparation, feed storage and milk handling.

This is a multi-chamber complex with temperature ranges of -15 C to 43 C, relative humidity from 20 percent to 100 percent and photoperiod light control. The unit may be used for species ranging from turkeys, sheep, swine and goats to cattle and horses.

Equipment and instruments in each chamber may be used for energy balance, including respiratory metabolism, vaporization and other physiological and nutritional measures.

Facilities

- Four temperature-humidity-light-controlled animal chambers (each 20′ x 30′
- Observation and environmental control room
- Milk system (including pipeline and milk storage)
- Animal preparation
- Animal surgery
- Sample preparation and processing
- Equipment storage and instruments
- Feed preparation and storage
- Overhead air conditioning and handling equipment

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The Endocrinology of Milk Secretion (Ralph R. Anderson and Associates).

The endocrinology of milk secretion, with special reference to the role of hormones in mammary gland growth and milk secretion (Dairy Science, Station Projects No. 28, 43 and 80).

A. Development of the mammary gland.

In this work, the normal development of the mammary glands of experimental and domestic animals has been followed during the embryonic state, puberty, pregnancy, lactation and involuation. On the basis of these studies, the stimulation of duct growth, lobule-alveolar development and lactation by means of various hormones was undertaken. It was observed that the growth of the ducts could be stimulated by the estrogenic hormone-and lobule-alveolar growth (which occurs during pregnancy) could be stimulated by the combination of estrogen and progesterone. In 1953, Kirkham and Turner developed a new method of measuring mammary-gland

growth and functional activity by the chemical estimation of the nucleic acids DNA and RNA.

Using DNA estimations, it was possible to measure quantitatively the growth of the cells of the mammary gland under normal and experimental condtions. This enabled us to determine the optimal amount of the ovarian hormones necessary to stimulate growth in ovariectomized animals comparable to that in pregnant animals. It was observed that individual animals varied greatly in the amount of mammary-gland tissue. As a working theory, it was suggested that the cause of the differences in animals was due to the rate of secretion of a number of hormones that synergize with the ovarian hormones to stimulate growth. A systematic study was then begun to determine what hormones would stimulate mammary-gland growth both during pregnancy and when estrogen and progesterone were given to ovariectomized animals. The following hormones have been found to be effective singularly as well as together: thyroxine, growth hormone, corticosterone, insulin and parathyroid hormone.

These observations prove that an optimal amount of a number of hormones is required for the growth of the mammary gland. When animals lack the secretion of optimal amounts of one or more hormones, the growth of the mammary glands will be restricted.

B. Hormones stimulating milk secretion.

The yield of milk secreted is limited by the size (numbers of secreting cells) of the mammary gland during lactation. If the glands are small, the maximum yield of milk will be small. In early studies, it was shown that a hormone of the anterior pituitary stimulated the secretion of milk at the end of pregnancy and in early lactation. This hormone is called *lactogen*. If the secretion of this hormone was limited, then the intensity of milk secretion in the mammary glands was less than optimal. The question arose—would other hormones synergize with lactogen and stimulate more intense milk secretion?

To answer this question, single hormones and increasing numbers of hormones were administered to lactating animals. It was observed that the hormones that stimulate mammary-gland growth also stimulated increased milk secretion, and when five or six hormones were injected together, milk yield could be doubled as compared to the control animals.

As a result, it has been suggested that the cause of the variation in the milk yield of dairy cattle is due to the variation in the rate of hormones secreted by the cow. The ideal method for selecting breeding stock in the futures could well be based on measuring hormone secretion rates.

C. Factors influencing hormone secretion rate and metabolic pathways using radioactive isotopes as tracers.

1. Thyroid hormone secretion rate.

W.R. Graham, Jr. discovered that thyroidectomy of dairy cattled caused a 30 percent to 40 percent reduction in milk yield. When such cows were fed dried thyroid glands, milk yield not only returned to normal, but increased above normal. When normal cows in declining lactation were fed thyroid or injected with thyroxine, their average milk yield increased 20 percent to 30 percent or more, and the percentage of fat also increased.

These observations led to a study directed toward producing a synthetic source of thyroid hormone. It was discovered in our laboratory that milk casein could be iodinated and then converted into thyroxine, which had three times the potency of dried thyroid glands.

This product, called thyroprotein, has been available for many years and used to increase the milk yield of commercial dairy cattle.

2. Radioactive isotopes.

Radioactive iodine (I^{131}) became available in the 1950s.

Scientists developed a method of using it to measure thyroid activity. The thyroid hormone secretion of dairy and beef cattle, sheep, and a number of experimental animals was estimated.

In the rat, extensive studies have been conducted to determine all of the factors influencing the rate of thyroid secretion. As a result of these studies, our knowledge of the physiology of the thyroid gland has been greatly expanded.

Insofar as dairy cattle are concerned, our method of determining thyroid hormone secretion rate makes possible the selection of cows and bulls based upon their secretion rate. In addition to these studies, radioactive steroid hormones have become available, and other methods of measuring secretion rate of the ovary and the adrenal glands will be developed.

In the broad area covered by this research relating to the endocrinology of milk secretion (Projects 28, 43 and 80), Charles W. Turner was the chief investigator and leader, assisted by some 12 postdoctoral fellows, 46 who completed their Ph.Ds with him, and 40 their master's degrees. Special mention should, however, be made of Ralph R. Anderson, one of the group who has succeeded Turner on the Dairy Science Department staff as project leader in this field.

The research associates, postdoctoral fellows and people completing their Ph.D., M.A. and M.S. work with Turner are named in the lists appearing elsewhere in this report.

Cooperation: Departments of Animal Husbandry, Poultry Hus-

bandry and a number of individuals representing other departments and divisions of the University.

Financial Support other than Regular Station Funds: Support of Project No. 28 has come from the American Cancer Society and the U.S. Public Health Service. The chief support of the No. 80 project came from the U.S. Atomic Energy Commission and the American Livestock Meat Board. Some small grants have come from industry sources. The itemized list is as follows:

American Cancer Society		$ 54,275.00
U.S. Public Health Service (Mammary Gland)		148,213.00
U.S. Public Health Service (Parathyroid)		72,800.00
Walnut Grove Products	$1,200.00	
Poul-An Laboratories	500.00	
Columbia Hog & Powder Co.	1,200.00	
Hy-Line Poultry	2,000.00	
Am. Vet. Med. Assn.	200.00	5,100.00
Cerophyl Laboratories		
American Livestock & Meat Board		27,750.00
National Institutes of Health:		
(Post-doctorates @ $500/year)		
Govsvenor	$1,500	
Damm	1,000	
Moon	500	
Williams	1,000	
Miller	1,500	
Griffith	1,000	
Population Council:		
Wada	1,000	
Imori	500	8,000.00
Atomic Energy Commission		372,200.00
TOTAL		$680,338.00

Special Buildings and Equipment:

1. *Laboratories* for histological work (microtome, staining baths, etc.), for hormone assay (surgical tools, dental drill, restraining surgical board, water baths), for chemical determinations of nucleic acids and hormones (spectrophotometers, chromatographic equipment for gas, column, paper and thin-layer chromatography), for radioisotope measurement (storage room for radioisotopes; rate

meters, well-counter and scaler, radiochromatograph for counting radioisotopes), for chemical extraction (either extract room), and for measuring enzyme activity (Warburg apparatus).

2. *Small-animal facilities:*
   (a) Small-animal room in the Animal Sciences Research Center, air conditioned for temperature maintenance at 78°F, for rats or hamsters, mice, guinea pigs and rabbits. Also used for moles, shrews, wild mice and ground squirrels.
   (b) Small-animal room designed to house rats at a constant temperature of 40°F for studies relating cold temperature to hormone secretion rates.
3. *Large-animal facilities:*
   (a) A milking barn, large-animal facilities and endocrine studies in lactating dairy cattle are carried out using animals in the University dairy herd and at Foremost Farm.
4. *A new Whole Body Low Level Radiation Counter* is operated by the College of Agriculture and has been used by several groups (at least four from the Dairy Department (Anderson, Campbell, Johnson and Martz) for the past three years.

Publications:

Twenty-five research and station bulletins and 75 scientific papers were published relating to this research prior to 1938. More than 650 additional station publications and scientific papers have been published.

Studies on Reproductions in Dairy Cattle
H. Allen Garverick and Associates

I. **Projects by title:**
   1) Hatch - MO-118: Endocrine mechanisms controlling bovine reproduction.
   2) Animal Health - MO-00828: Endocrine changes associated with follicular development and development of ovarian cysts.
   3) USDA Competitive Research Grant - USDA-SE-CRSR-2-2422: Etiology, turnover rate and hormone secretory dynamics of ovarian cysts in dairy cattle. (PI)
   4) USDA Competitive Research Grant - USDA-86-CRCR-1-2137: Uterine mechanisms associated with subnormal luteal function in cattle. (Co-PI)

II. **Summary of objectives, results and future work:**

The main thrust of this program is investigating the control of ovarian function in cattle. This includes factors controlling follicular growth and atresia, including development of ovarian follicular cysts and factors controlling development, maintenance and regres-

sion of the corpus luteum. Of particular interest is the study of subnormal luteal function. Many of these studies are collaborative efforts with R.M. Roberts, M.F. Smith and R.S. Youngquist of our reproductive biology cluster.

Recent studies have shown that steroid secretory patterns of developing follicles in cattle differ over different stages of the estrous cycle. Studies are now being initiated to investigate control of follicular growth under differing endocrine states and includes determination of the role of intrafollicular compounds. Exogenous treatment of cows with follicular fluid decreases follicular growth and delays estrus. Follicular fluid contains numerous peptides, including inhibin, which decreases secretion of FSH from the pituitary. Whether these compounds also have a direct effect on ovarian follicular growth was unknown. We have recently completed several studies demonstrating that follicular fluid does not have a direct effect on the ovary.

In cattle, ovarian follicular structures sometimes grow but fail to ovulate (follicular cysts). Cows are infertile as long as the condition persists. In recent years, an FDA-approved treatment for ovarian follicular cysts was developed in this laboratory. Normal ovarian cycles in cows with ovarian cysts were reestablished in 80 percent of cows within 30 days following treatment with GnRH (Cystorelin). Studies are currently in progress to determine the etiology and turnover rate of follicular cysts. Ovarian follicular cysts have been defined as anovulatory structures of 2.5 cm in diameter or larger that persist in the absence of a corpus luteum for 10 days. However, new evidence from this laboratory shows that a single cyst does not persist in most cows but regresses and is replaced by other follicular structures. Thus, the condition often persists, but the same cystic structure does not.

Subnormal luteal function is associated with reduced fertility in domestic farm animals. In cattle, the first corpus luteum formed postpartum is of short duration; the first corpus luteum formed post-partum provides a model to study subnormal luteal function. Subnormal luteal function may be due to inadequate follicular development, decreased luteotropic stimuli and premature release of and/or increased sensitivity of the corpus luteum to a luteolysin. Research from our groups has shown a premature or increased release of a luteolysin from the uterus to be a major factor associated with premature luteolysis. Corpora lutea anticipated to have a short lifespan remained functional following hysterectomy of cows, and secretion of progesterone was of normal magnitude. In other studies from this laboratory, subnormal corpora lutea were not more sensitive to the luteolytic effects of prostaglandin $F_2\alpha$, and pre- and postovulatory gonadotropin support was similar during normal and

short estrous cycles. Studies are currently underway to investigate control of release of lyteolysins from the uterus.

Physiological and Biophysical Characteristics of Cellular Mechanisms in Animal Reproduction

C.P. Merilan and Associates

These studies involve investigations of many factors affecting the survival and fertility of spermatozoa. The objectives of the projects concerned are to increase the efficiency of reproduction utilizing artificial insemination and embyro transfer.

Studies of bull semen characteristics and their relationship to fertility began in the Dairy Husbandry Department in 1936. These studies, as reported in the list of publications attached, provided the foundation for continuing studies. The initial studies in this area were concerned primarily with determination of the relationship between various semen "quality" tests and conception rates of dairy cattle under practical conditions. Fertility of semen was found to vary greatly among bulls and is largely dependent on inherited characteristics of any given bull. Factors such as ambient temperature, plane of nutrition, age, physical condition and diseases were found to influence the fertility of semen.

More recent studies have been concentrated on biochemical and biophysical characteristics of reproductive cells under various environmental conditions. The involvement of various enzyme systems in spermatozoa viability has been studied. Biochemical characterization of semen lipids and their relationship to cold shock has been studied in cooperation with the Department of Agricultural Chemistry. Optimal cooling rates for freezing semen have been determined for various semen extenders (diluters) and freezing method combinations.

Earlier research included variations in dairy bull semen, respiration rate of spermatozoa and related problems. The distribution of glycerol in spermatozoa has been studied using autoradiographic techniques with radioactive labeled glycerol. Basic studies on the effect of freeze-drying on spermatozoa have indicated that both water and other substances are removed during the drying process. Also, free radicals have been found in lyophilized semen using electron spin resonance techniques.

Microenvironmental studies with both bull and stallion spermatozoa have resulted in the development of polyethylene liner-collection cones for use with the antificial vagina used for semens collection. The use of the polylthylene cone markedly improves the survival rate of sperm cells.

The publications in this area are numerous.

Dairy Cattle Nutrition— Improving the Digestibility of Forages and Byproduct Feeds

Ronald L. Belyea and Associates

Early Investigations:

Research dealing with dairy cattle nutrition and herd management began at the Missouri Agricultural Experiment Station in 1901 when C.H. Eckles was hired to head the newly established Department of Dairy Husbandry. In January 1902, Dean H.J. Waters and Eckles issued Station Bulletin No. 56 entitled "Dairy Husbandry." That same year Dr. Eckles prepared a bulletin entitled "Feeding the Dairy Cow" and also a bulletin entitled "Raising Calves with Skim Milk." In the years following, many studies have been conducted dealing with the feed values for dry roughages, pastures, silage, grain feeds and other feed ingredients.

Some of the earlier studies proved that Korean Lespedeza became highly liginified as it matured, and digestibility was greatly reduced. It was also found that Korean Lespedeza seed could serve as a protein supplement but were high in tannic acid. In the 1940s Korean Lespedeza was widely grown in Missouri but has declined with the fescues and other forages replacing it. It was also found that multiple feeding (four or more times daily) of dairy cows was observed to increase feed intake and milk production. Moreover, it was observed that urea is utilized more efficiently among animals fed four or more times daily than among those fed only twice daily. Another investigation indicated that vitamin A may play a role in both the prophylaxis and therapy of dermatophytosis (ringworm). This is especially important to the health and productivity of cattle. Moreover, tricohphytosis in cattle may be transmitted from animals to man.

The effects of three levels of intramuscularly injected, water-miscible vitamin A were studied in a 20-month trial with 236 Guernsey cows. Herd records indicated improved reproductive efficiency as treated animals required fewer inseminations per conception and had lower percentage of retained placentas and abortions than the controls.

Blood urea nitrogen (BUN) concentration was studied and found to be a good indicator of the adequacy of dietary protein in lactating cows. Seasonal changes showed a significant BUN peak in the spring, corresponding to pasture, and a low in the winter months.

Other studies dealt with rumen function, microorganisms, ambient temperatures and levels of nutrition, and the effect of soil fertility on forage quality. It was found that high ambient temperatures appeared to decrease ruminal volatile fatty-acid concentrations. Forage protein

resulting from the use of nitrogen fertilizer appears to be quite valuable for ruminants. Many earlier investigations were concerned with diet and nutrient requirements for calves and older heifers, nutritive and biological values of lespedeza hay and pasture for dairy heifers, and various roughages and silage for growth and milk production. The leaders and principal investigators in the earlier years were H.A. Herman and A.C Ragsdale and in later years, C.P. Merilan, J.D. Sikes, K.W. Bower, J.R. Campell and Fred Martz. Many others, chiefly graduate students and members of the staffs of cooperating departments, had parts in various phases of these projects and are listed as co-authors in the list of publications attached.

Current Studies: Dr. Ronald L. Beleya, Principal Leader

These investigations have three major objectives: (a) Factors affecting forage and fibrous diet utilization. (b) Efficiency of dietary energy and protein utilization. (c) Improving laboratory application of forage quality. Summary of Findings:

(a.1) *Physical Form:* Four experiments were done in which forages were chopped or ground to different particle sizes. In one study, rate of digestion was not greatly affected by particle size, but amount of digested cell wall decreased with increased particle size. In a second study, chopped hay was digested less than long hay when fed to heifers; net energy was also depressed. In two other studies, chopped fescue and chopped alfalfa were fed to lactating and non-lactating (fistulated) cows. Chopped led to small increases in intake but decreased cell wall digestibility; milk yields were unaffected. Reducing particle size leads to increased ruminal cell wall, accounting for increased intake.

(a.2) *Forage Handling:* Alfalfa hay, grass hay and grass-legume mixtures were baled wet and treated with preservatives to reduce leaf loss and dry matter (storage) loss. Several preservatives were compared, including a high propionic acid preparation, a low propionic acid preparation, a bufferd product and urea. The high propionic acid product was effective in stabilizing hay at moistures from 20 percent to 40 percent; in the lower moisture ranges (20 percent to 25 percent) a reduced rate (.5 percent compared to 1.0 percent and 1.5 percent) of application was effective. The low propionic and buffered products were least effective and only useful in very low moisture bags (20 percent to 22 percent). Urea improved digestibility of low quality grass hay but was not as effective as propionic acid in stabilization.

(a.3) *Byproduct Feeds:* In one project, beet pulp, a feed with rapidly digesting high cell wall, was fed in different proportions with corn to measure intake and ruminal cell wall as cell wall (beet pulp) increased. As cell wall increased, intake decreased, and cell wall intake and ruminal cell wall increased. Ruminal cell wall load controls forage intake; forage intake can be predicted from ruminal cell wall load. In

another study, low and high corrugated paper diets were fed to growing heifers; corrugated paper has low digestibility and net energy values. Corn gluten feed was fed to lactating dairy cows and non-lactating fistulated dairy cows. Diets containing 10 and 20 pounds/day of dry corn gluten feed were equal to controls for intake and milk yield but 30 pounds/day of corn gluted lead to lower intakes and milk yields. Corn gluten may be associated with lower stomach pH's than typical diets and may have low effective fiber. Biomass (sludge) from a dairy processing plant was fed to fistulated beef cows; it was palatable and appeared to be a useful source of nitrogen. Five byproduct feeds were collected on 10 different days at the different processing plants. For several nutrients, daily variation was considerable, and mean concentrations were different from book values.

(b. 1) *Efficiency of Protein and Energy:* Lactating cows fed normal diets were counted in the ^{40}K counter during a complete lactation-gestation cycle to measure body composition changes. Body protein reserves were mobilized quickly (six to eight weeks); losses averaged about 20 pounds (10 percent of total protein reserves). Body fat losses were about 100 pounds, reaching a minimum at about 10-12 weeks, and provided energy for about six to eight pounds of milk per day. Body protein was restored within several weeks, but fat replenishment took several months. In another study, high producing dairy cows ate more feed, digested feed better and were more efficient in using their body reserves to sustain milk production. High producers appeared to be more efficient in digesting and metabolizing energy.

(c. 1) *Improving Application of Laboratory Analyses:* In conjection with the Missouri DHI-sponsored feed-testing laboratory, several studies have been conducted to improve feed analyses and/or their application. It was found that Missouri-grown forages can be high in cell wall and low in net energy, depending upon heat and drought. Using laboratory analyses, we evaluated prediction equations for estimating net energy. Penn. State/Cornell equations were applicable for Missouri-grown legumes and cereals, but grasses required a different equation, which we derived from forages grown at the Southwest Missouri Center, Mt. Vernon.

Studies have also been conducted on the preservation of roughages. Trials demonstrated the value of protecting large round bales from weather during storage. Storage in barn, and outside under plastic sheets, was compared with no protection. Protection improved conservation of hay in storage 10 percent to 30 percent compared to no protection. All methods of protected storage appeared to be cost-effective.

Present or Pending Outside Grant Support 1987

* Evaluation of Biomass as a Feed Ingredient and for Land Application.
  USDA Special Grants (Cooperative with J. Williams, J. Brown, T. Clevenger and M. Tumbleson)
  Year 1 - $288,000
  Year 2 - $270,000
* Grazing Management of Native and Introduced Warm Season Grasses
  (Cooperative with J. Forwood). Missouri Department of Conservation $69,598.
* Innovative Extension Funds—Byproduct Feed Potential.
  University of Missouri $20,000.
* Hay vs. Silage Upon Rumination and Digestion.
  American Guernsey Cattle Club $7000.
* AmidEast Peace Fellowship $4000 (A.H. Orma)
* Forage Quality. Missouri Dairy Association/
  Amer. Farm Products $3500.

Reproductive Physiology - Bovine Breeding; Artificial Insemination and Embryo Transfer
John D. Sikes and Associates

Investigations dealing with dairy cattle improvement through breeding have long been a part of the dairy research program. Early investigations in this area were Professors Eckles, Ragsdale, Turner, Gifford and Herman.

Studies were conducted utilizing the University dairy herd and also in cooperation with other states in the North Central Region. Some of the earlier research revealed that inbreeding tended to lower milk and butterfat productions and quite often body size at maturity. Selection was found to be the most important essential tool in controlling genetic progress.

Earlier studies were concerned with genetic factors affecting milk production and the transmitting ability of dairy sires. The advantage of using proven bulls with hundreds of offspring produced by artificial insemination in numerous herds was demonstrated in the University dairy herd by systematic increases in production.

Techniques for continuous monitoring of milking rates in multi-cow milking parlors were developed and used to determine the heritability of milking rate in dairy cattle.

Studies on semen quality and artificial insemination are reported elsewhere and are in cooperation with C.P. Merilan.

Work now in progress involves the embryo transfer (ET) method as a means of increasing the genetic influence of the female in herd-improvement programs.

The first successful transfer of an embryo in the Department of Dairy Science was accomplished by John D. Sikes and a graduate student, Guindolino R. Gerona, in 1968 using rabbits. The first successful nonsurgical recovery of bovine embryos was achieved in 1977 by a graduate student, Frank L. Barnes. Pregnancies were first achieved by a team made up of Sikes and graduate students Dennis Schmitt and Frank Barnes, in 1977-78. The first ET Holstein calves were born at the University of Missouri Dairy Farm in the early 1980s. The first calf born in Missouri from a frozen embryo was in 1979, as a result of work of the above team.

In 1985 Clifton Murphy, D.V.M. and Sikes established an embryo program at the University of Missouri that serves to train students and be of service to the cattle industry. Embryo transfer offers the opportunity to produce identical twins for use in dairy-cattle research.

By micromanipulation-three sets of twins has been produced the past year. Bovine embryos were frozen and evaluated for survival after thawing in a freezing mixture of PBX, Newborn calf serum, 10 mM Hepes Buffer and 1.4 Glycerol as compared to the same mixture supplimented with a 20 percent (18 percent Raffinose). Embryos frozen in Raffinose mixture resulted in a higher survival rate for both quality grade 1 and grade 2 embryos, 75 vs. 61 and 44 vs. 33, respectively. Pregnancies were also higher in mixture supplimented with Raffinose 18/40 vs. 14/43. Embryos at the morula stage did not tolerate freezing and thawing as well as those at the blastocyst stage (P .05) when frozen in a nitrogen vapor freezing system. The use of the enzyme-immunoassay (EIA) progesterone assay study in cooperation with the School of Veterinary Medicine indicated that recipient animals having very low or very high progesterone profiles resulted in fewer pregnancies. In a field study, recipients whose serum progesterone was under 1 ng/ml on the day of transfer had a pregnancy rate of 16.6 percent compared to a 53.3 percent for levels over 1 ng/ml. A difference significant at the 10 percent level. A 51 percent overall pregnancy rate was achieved. Current freezing techniques involve an improved method for the freezing and thawing of bovine embryos to facilitate the greater use of frozen embryos.

Grants and Gifts For Above Projects

Amount	Source
$ 5,900	Missouri Institutional Biomedical Research Support Grant RR07053 from the National Institutes of Health. 1983. B.N. Day and J.D. Sikes.

$ 5,990	Veterinary Medicine Research Grant - Non-Surgical Embryo Collection and Transfer in the Goat. 1984. W. Braun and J.D. Sikes.
$ 1,500	Monsanto Company Research Gift. 1985. J.D. Sikes.
$ 4,500	Riley-Brangus Ranch, Moberly, Missouri, Research Gift. 1985. J.D. Sikes.
$78,163	Missouri Research Assistance Act - Genetic Enhancement Through Embryo Transfer. 1986-1988. J.D. Sikes and C.N. Murphy.

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NOTE

Graduate Studies and Publications
Department Dairy Husbandry (Dairy Science)
1901 to 1989

Since the beginning of the Dairy Husbandry Department (Dairy Science Department) University of Missouri in 1901, graduate student by the thousands, and from many countries, have received training in research and followed advanced studies.

The list of students who earned advanced degrees—Master of Arts, Master of Science, Doctor of Philosophy, Post Doctoral and other degrees, numbers thousands.

Likewise the number of Station Research Bulletins, Station Circulars, Scientific papers, books and manuals published over these 88 years is enormous.

Space does not permit listing the advanced degrees awarded or the listing of the thousands of publications. However, in order to make this information available we are compiling another publication, limited in numbers, that will be available for persons especially interested.

Harry A. Herman
Rex E. Ricketts

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