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Nutritional Science at Texas A&M University, 1888-1984

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by

H. O. Kunkel

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The oral histories developed by Irvin May for the Texas Agricultural Experiment Station were a principal source of information. They were the link to those such as the Joneses, Fred Hale, John H. Quisenberry, and others whose passing occurred during the writing of this manuscript.

I dedicate this history to Paul Pearson, who played a key role in the development of scientific nutrition at Texas A&M University and who inspired me to seek a career in the field.—*H.O. Kunkel*

FOREWORD

This historical account of science and research is unique. In this document, H. O. Kunkel summarizes the evolutionary development of nutritional sciences at Texas A&M. His perspective is particularly valuable since he participated directly in several ways—first, as a student under many of the described mentors, later as a researcher and teacher, and more recently, as an administrator.

In this undertaking, Dean Kunkel applied his usual thoroughness in researching the topic, its participants, and the implications. In his unique, descriptive writing style, he develops two views. First, the events and the participants are described with some chronological sequence so we understand the components and discoveries in nutritional studies. Second, and more important, he weaves the various events and sequences into a macroperspective, by highlighting the particular significance and impact of eras of research. As these building blocks accumulate, we gain our understanding of how and why nutritional science grew and evolved as it did at Texas A&M and the Experiment Station.

The very needs which prompted nutritional studies nearly 100 years ago are still prevalent today—greater efficiency and productivity, plus a better understanding of the biochemistry and processes of animal growth and development. While farm animals were a primary research target, Kunkel also builds in the evolution of human nutrition which, too, had its distinctive history at Texas A&M.

The documentation and citations are particularly rich. With unusual care, the Dean has carefully specified the literature, personal communications, and other documentary sources, recognizing the many students, scientists, and colleagues who participated. We are appreciative of the perspective H. O. Kunkel provides for our current and future thought.

Dudley Smith
Associate Director
The Texas Agricultural
Experiment Station

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Introduction

Nutritional studies at Texas A&M University began as early as 1888, shortly after the establishment of the Texas Agricultural Experiment Station. These studies represented a high research priority and field of service to Texas farmers and ranchers, and were uniquely Texan.

An agrarian paradigm dominated the research of the Texas Agricultural Experiment Station during its first six decades.[1] Research, including nutritional research, at Texas A&M was responsive to a protocol of its own construction. The objective was to support the agricultural systems and farmers of Texas. The underlying compulsion expressed in the design and execution of nutritional and feeding experiments throughout most of the era from 1888 was that nutritional studies would support the animal agricultures as they were practiced at the time in Texas. And as the nutritional researches took root, they, like the other high-payoff researches of the Experiment Station, would in turn significantly change and restructure the technology of animal agriculture.

Every agricultural system carries with it the experience of ancestors, those practices upon which new technology builds and which constrain the innovations that are possible. The system is a product of ascent through evolutions of culture, tradition, the soil and water, and also of economics, political policy, and science. Texas agriculture developed in unique ways, quite different from the development of agriculture in the American heartland, even the South. So did Texas science.

During the late 19th century and continuing until the present time, farmers in Texas grew cotton as their principal cash crop. On their tracts of land, in the 1890's, farmers supplemented their income and supported their livestock by planting kaffir corn, feterita, and later, "milo maize." When agriculture expanded from East Texas and the Gulf Coast onto the High Plains, sorghum became a field crop second only to cotton. When animals were fed, they were fed the unique products of Texas crop production and its by-products—hegari fodder, cottonseed hulls and meal, sorghums, even sweet potato meal.[2] Grasslands and range furnished the principal support of animal agriculture, a condition existent today despite extensive commercial feedings of cattle, poultry, and dairy cows. And in the process, the component operations of Texas animal agriculture remained the functions of different groups of farmers, a division that was existent long before the current trend in the Midwest to separate livestock and poultry production from feed crop production. With rare exception cattlemen were not grain producers. Nor have grain producers in Texas ever fed animals extensively for an income. Moreover, feedlot entrepreneurs, dairymen, and poultry producers competed on the market for grain produced by other segments of the agricultural economy.

These parameters of agriculture both drove and were modified by nutritional research. The flow of the classical biochemical nutritional science—the discoveries of vitamins, essential minerals, and amino acids—did not touch Texas A&M University and the Texas Agricultural Experiment Station until the age of nutrient discovery was almost over in 1940.[3] But certain universal principles emerged out of the nutrition researches at Texas A&M. These are the highlights of our history.

The Beginnings

Nutritional science at Texas A&M University began in the Department of Chemistry. On the establishment of the Texas Agricultural Experiment Station in 1888, the professor of chemistry doubled as the chief chemist of the station.[4] Called by *Texas Farm and Ranch* one of the South's best chemists,[5] Henry Hill Harrington solicited the support of his associate Duncan Adriance to initiate feeding tests with dairy cattle and perform the proximate analyses on Texas feeds. They reported the first unusual attribute of cottonseed as a feed: when fed to dairy cows, cottonseed and cottonseed meal raised the melting point of butter. The mystery was not resolved until some 70 years later when biochemists Raymond Reiser and P. K. Raju discovered that cyclopropenoid fatty acids, such as those in cottonseed oil, would alter fatty acid metabolism.[6]

George S. Fraps, with a Ph.D. in chemistry from Johns Hopkins University, with the cooperation of Professor F. R. Marshall and John C. Burns of the Division of Animal Husbandry picked up the work and carried it on for over 42 years (1904-1947). Fraps collected data on the proximate analysis of every imaginable feedstuff that might be fed to animals in Texas. A Phi Beta Kappa, Fraps apparantly was not only aware of the work of Otto Kellner and H. P. Armsby,[7] but attempted to enlarge on their work. Almost all of Fraps' researches attempted to calculate or, in later studies, to measure directly the "productive energy" of feedstuffs.

Best known for his extensive and comprehensive energy values of individual feedstuffs for growing chickens and his text, *Principles of Agricultural Chemistry*, Fraps laid the foundation for basic research in Texas soils and protected Texas farmers and ranchers from fraudulent feed claims. He calculated digestibilities and "productive energies" of feeds and foods for most farm animals and even humans. Fraps built an extensive data base and calculated his own feeding standards. His works, however, went largely unheralded until a decade after Fraps had retired in 1947.[8] Then G. F. Combs, of the University of Maryland, discovered the amino acid-energy relationship in poultry nutrition. Fraps' work took on a new and special resonance in the 1950's as a primary conceptual base for formulation of poultry feeds. Now clearly evident, Fraps' work laid the foundation for one of the significant improvements in poultry feeding in modern times.

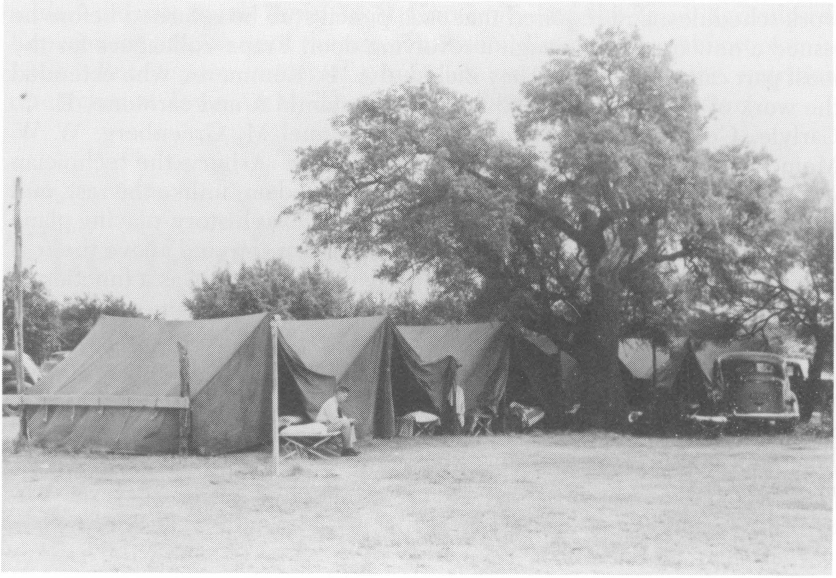
An autocratic master who ran his laboratory in the mode of a European professor, Fraps rigidly handled personnel, imposed inelastic work schedules, and required that each pencil stub be returned before he issued a new one. As through a revolving door, Fraps' colleagues for the most part came and went. They included A. R. Kemmerer, who extended the work of the Division of Chemistry to vitamin A and carotene, E. C. Carlyle, George Smith, Simon Wender, Samuel M. Greenberg, W. W. Meincke, and Raymond Reiser. Samuel E. "Doc" Asbury, the technician who came with Fraps from North Carolina, stayed on, unlike the rest, and became a legend in his own right, lecturing on Texas history, playing piano duets, and tending climbing roses on trellises that towered above the roof of his campus home. Survival as a member of the team was a function of one's sense of humor. But Fraps' retirement was unlamented, even though he stood as the most prolific publisher in the history of the Texas Agricultural Experiment Station with approximately 400 technical articles and a host of bulletins. Driven by an obsession to receive credit for every research accomplishment of his staff, the gold-rimmed-spectacled Fraps had but grudging respect. Yet Fraps stands as a titan in nutritional science at Texas A&M.

The Feedings

Research with large animals during the early history of the Texas Agricultural Experiment Station was often an experiment of expedience, controlled but generally not sophisticated, and was done mainly at the substations. Applied research in the feeding of large animals at these field units existed by 1917 at the Spur substation and, for nearly four decades, it moved under the inspiration of John McKinley Jones. With academic degrees from the Universities of Wyoming and Missouri, Jones, like Fraps, seemed to welcome constantly new challenges as if to prove himself. Jones came to the Texas Agricultural Experiment Station from New Hampshire in 1914, and from 1918 until 1947, he was Chief of the Range Animal Husbandry Division.

Like others in the Experiment Station in its early decades, Jones catered to immediate public concerns. Jones set the pattern of calling meetings of "feeders and stockmen" when a "test" was closed, first at the Spur substation, then regularly at Beeville, Big Spring, and Balmorrhea. The idea culminated with the Annual Ranchers Roundup at Sonora. For two days, ranchers and researchers listened to reports on every project underway plus talks by cattlemen and sheepmen, camped out in a pasture, and danced and drank into the night. Daytime attendance was estimated at 1,500 to 2,000.

Jones involved farmers and ranchers in animal feeding experiments soon after his arrival in Texas. Generally, prominent ranchers would provide animals and facilities and wholly finance the tests. Prominent names such as J. E. Boog-Scott, Joe Finley, R. M. Kleberg, Robert J. Kleberg, Jr., and E. K. Fawcett thread through the records.



John McKinley Jones was Chief of Range Animal Husbandry at Spur from 1918 to 1947. (Photograph, 1940. Courtesy, TAMU Agricultural Research Station at Sonora.)

The Annual Ranchers Roundup at Sonora evolved from J. M. Jones' practice of calling meetings after a test was completed. Participants pitched their tents in a pasture (opposite, above) *and attended talks by researchers and fellow stockmen* (opposite, below). *(Courtesy, TAMU Agricultural Research Station at Sonora.)*

Continuing cooperative activity with the King Ranch group led to the confirmation that phosphorus was the limiting nutrient in South Texas cattle production. Hubert Schmidt of the Division of Veterinary Research had identified a causative organism in loin disease in 1926.[9] But the missing link was a deficiency of phosphorus in the rangeland forages. Phosphorus-deficient animals ate carcasses of their dead associates. Taking this clue, scientists learned that phosphorus deficiency could be prevented if ranchers supplied breeding cows with only 65 grams of phosphorus daily, either in form of bone meal or disodium phosphate. Assisted by animal husbandman John H. Jones, John McKinley Jones demonstrated that phosphorus deficiency had also caused "creeps" and reduced calf crops and rates of growth.[10]

These achievements rank with the control of the cattle tick as keys to the development of a cattle industry in South Texas.

Sorghum came to Texas early in the 20th century because it was drought-resistant and corn did poorly. Like corn, sorghum proved to be a seed deficient in certain nutrients, but, as with corn, that would be outweighed by the fact that the sorghum plant proved to be a tremendous manufacturing system. The smaller-seeded sorghum would yield to corn in some situations where corn could be as economically produced and transported to the feeding site. Sorghum would not replace all the corn in the diets of broiler poultry. But the genetic diversity available for sorghum development proved to be greater than for corn. Thus feeding trials were as important to sorghum breeding as to the establishment of sorghum as a significant feed grain.

Some of the first estimates of the nutritional value of sorghum grain were made on the eve of World War I, by A. B. Conner, a director of the Texas Agricultural Experiment Station, J. W. Carson, then State Feed Inspector, and Fraps.[11] Initial tests of Sudan grass and feterita were conducted at Chillicothe on a 32-acre farm with expenses initially borne by the Office of Forage Crops, Bureau of Plant Industry of the United States Department of Agriculture.[12]

By 1912, John Cardwell Burns, a young, easy-going, hardworking head of the Animal Husbandry Department, had begun feeding experiments on the campus and included sorghum in his feeding program. Due to lack of funds and the press of teaching responsibilities, these experiments appeared as elementary studies more to answer questions of production than of nutritional needs. But they signified campus-based research concern,[13] and, a rarity for those days, cooperation between the teaching and research divisions of the agricultural complex at Texas A&M.

R. J. Kleberg, Jr. (left) *observes while ranch hands administer phosphorus supplements to cows. (Courtesy, King Ranch, Inc.)*

The Pens of Spur and Other Places

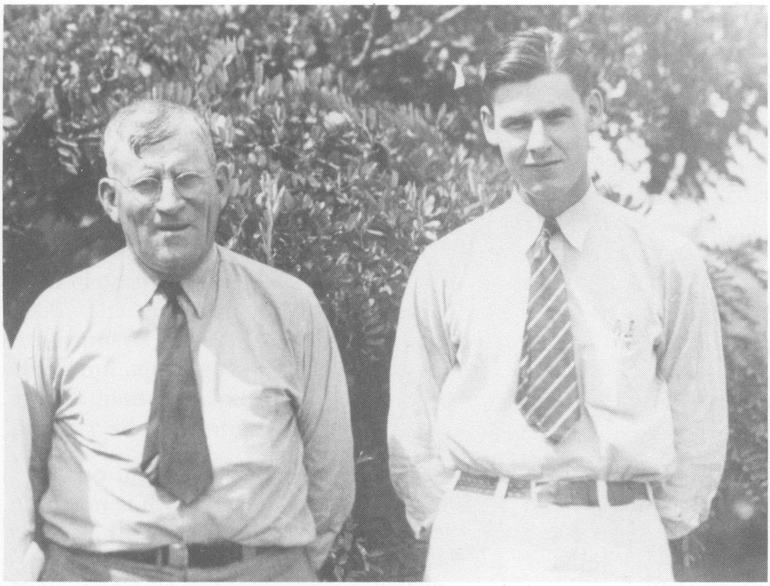
In events approximately parallel, as nearly as can be determined, comparisons of sorghum with corn fed to breeding flocks of sheep were also conducted by Jones under the careful eye of the storied Ray E. Dickson, Superintendent of the Spur Substation. Dickson, better known as the researcher whose work led to national soil conservation legislation, reported that sorghum had about 95 percent the value of corn for sheep.[14]

Spur, however, is in the heart of the Rolling Plains of Texas and that was cattle country, not sheep land. Cattle were also brought into the station in the winter of 1918-1919 and again Dickson estimated the value of sorghum to be 95 percent that of corn for cattle, an estimate that still has practical reverberations. Chillicothe, the principal site for sorghum breeding, and the cradle of commercial hybrid sorghum, lay less than 100 miles away. And it followed that the feeding pens at Spur would be used into the 1930's for "proof of the pudding," the test of the nutritional value of a variety or of a method of using different kinds of sorghum for grain, for forage, or for silage.

The Spur station would never have enough rangeland to support a cow-calf operation. So it was its feeding pens that remained central to work with cattle. And that work would be constrained by the missions to produce the beef that the eater would select and to solve the problems of the Texas feeder. In Texas, then, the kind of beef people chose to eat was anything but high choice and prime grades.

Though sorghum would increasingly become the predominant feed, the feeds available in great amounts in the 1930's were the by-products of cotton—cottonseed meal and hulls.[15] A 20:80 meal and hulls mixture was the standard fare for feedlot cattle in the 1930's. After three months, the cattle began to go blind; however, a pound of alfalfa hay a day would prevent the problem. John K. Riggs was employed in 1936 and given the job of finding out why that was. The nutrition student of today could suggest the cause immediately, but experimental night blindness had been shown in chickens less than a decade before, and carotene had been reported as provitamin A only in 1929.[16] Riggs, collaborating with Hubert Schmidt, Fred Hale, and John H. Jones, was able to work out the rates of vitamin A depletion and establish quantitative requirements of cattle for vitamin A in terms of carotene.

The feeding pens at Spur, with Paul Marion in charge, were used for experiments with feed additives in the 1950's. They were used later to test the concept of feedlot cow-calf production, and by Lowell Schake for studies of behavior of cattle.[17]



Ray E. Dickson (left), *Superintendent of the Spur substation, and John K. Riggs, Assistant Animal Husbandman, in 1938. Riggs later directed beef cattle research and academic programs at College Station until his retirement in 1979. (Courtesy, TAMU Agricultural Research Station at Spur.)*

Group of cattle in a 1936 experiment involving vitamin A. (Courtesy, TAMU Agricultural Research Station at Spur.)

Paul Marion was in charge of the feeding pens when experiments with feed additives took place in the 1950's at Spur. (Courtesy, Mrs. Paul Marion.)

A field day at the Spur substation, circa 1942. (Courtesy, TAMU Agricultural Research Station at Spur.)

At various times field units at Big Spring (early 1920's), Balmorrhea (1928-29), Beeville (1931), Bushland near Amarillo (1943-1966), the Texas Tech University's Research Center at Amarillo (ca. 1950-1980), and the shifting location beginning with dairy cattle investigations at Troup in the late 1920's, moving into Tyler and then to Overton by 1965, were also sites for Experiment Station feeding experiments with cattle. The surge from 1962 onward that built the massive feedlot industry in Texas made these sites obsolete. Now, Spur has been phased out of cattle feeding experiments. Balmorrhea served for a while to provide the intitial evidence that rates of growth and gain in cattle were in part hereditary, but was closed in 1966. The animal facilities at Beeville and Overton are used today for experiments in reproductive physiology. However, the USDA Center at Bushland and the companion Texas A&M University Center at Amarillo, after a hiatus for more than a decade, were reestablished in 1977 as a primary site for intensive fundamental nutrition research on beef cattle.

The mantle of responsibility for research in the applied beef cattle nutrition shifted in the late 1950's to John K. Riggs. Riggs, who began his work at the substation at Spur on vitamin A in range cattle, came to College Station in 1941 as a member of the teaching faculty. But, in the 1950's, when teaching and research were recombined, he continued to develop information regarding the feeding value of by-products for cattle: citrus, wood and dried molasses, sorghum gluten feed and gluten meal, by-products of the milling industry, and animal and vegetable fats. He developed a system of autoregulation of consumption of supplemental feeds for range cattle using salt and gypsum.

He initiated the concept of consolidated progress reports on beef cattle research as a means of communication with producers, researchers, and educators. During the same period of time, Riggs was given the general leadership in beef cattle research and academic programs, a position he held until retirement in 1979.[18]

Low-keyed, cautious, and always the student, Riggs personified the dictum of Henry St. John, "It is the modest, not the presumptive inquirer, who makes a real and safe progress." For over a decade and a half beginning about 1960, the nutritional researches of Riggs and his students and colleagues keyed on those factors which affected or could improve the nutritional quality of sorghums. He studied the nutritional significance of natural and varietal variability of the grain. Through a sequence of experiments quite different from those employing treatment with heat, Riggs was able to confirm the notion that processing could increase the nutritional value of sorghum for cattle. His techniques mainly involved adding water and allowing the grain to absorb it, undergoing some biochemical change. He called it reconstituted grain.[19]

Some 75 students received advice and direction from John Riggs as they obtained the M.S. and Ph.D. degrees. Of these, Lowell Schake stayed on to be a member of the faculty and to focus on the cattle feedlot industry.

The Return to Chemistry

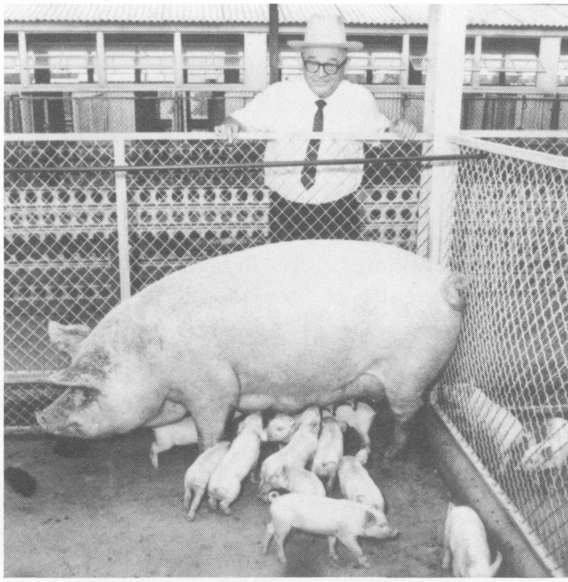
Fred Hale, Chief of the Experiment Station Swine Division from 1925 to 1947, laid the groundwork for the development of the efforts in scientific nutrition in the 1940's and 1950's, mainly by inspiration and extending the institutional vision. Starting also with the general mission of encouraging greater usage of Texas feed products, Hale began his tests on the use of cottonseed meal in swine diets, a feed material that because of its gossypol content was previously regarded as too toxic to feed for monogastrics.

Hale's most significant contributions were two. Experiments in the early 1930's demonstrated that maternal vitamin A deficiency could cause congenital malformations of the eye (microphthalmia) and of the mouth of the pig. These landmark experiments demonstrated for the first time a relationship between congenital abnormalities and maternal nutrition, a finding that was to have implications in medical research.[20]

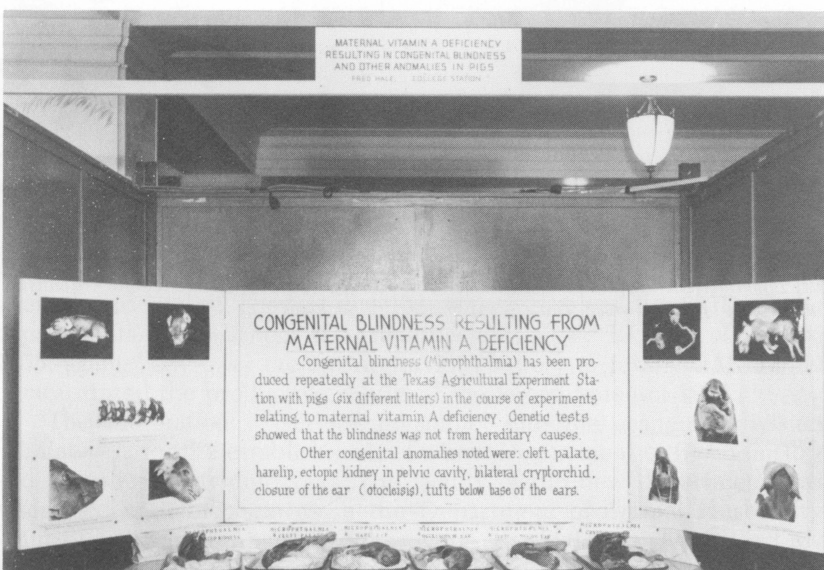
Hale's second major contribution derived from the perception that nutritional studies on feedstuffs required chemical description. At Hale's proposal, a chemical laboratory was built.[21] Carl M. Lyman, a student of Charles Glenn King of vitamin C fame and of Roger Williams, with whom he worked in the discovery of pantothenic acid, came to man the laboratory. Lyman was joined in time by Bryant Holland and Kenneth Kuiken, and a team of technicians.

The job of Lyman and his co-workers was to analyze the proteins of feedstuffs for their amino acid configurations. And for a better part of a decade, first working on methods of microbiological assay for the nutritionally essential amino acids in natural feedstuffs and after, developing a reliable method for tryptophan, Lyman built data on almost every type of feed material, for anyone interested in the quality of protein.[22]

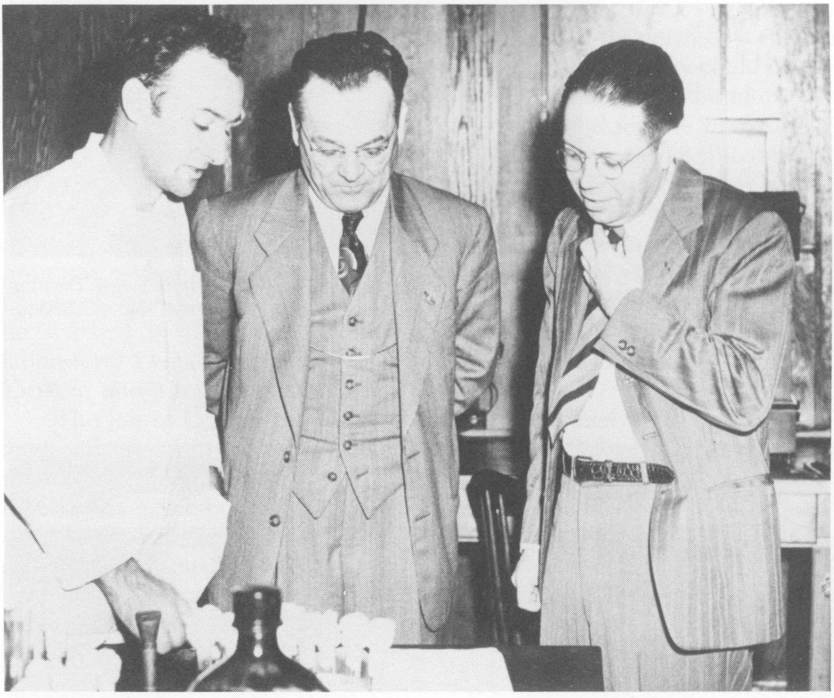
In 1947, Lyman's group became part of the new Department of Biochemistry and Nutrition, but Hale in the swine section of the coordinated Department of Animal Science persisted in his belief that swine nutrition had to have a sound chemical base. He encouraged his new colleagues, T. D. Tanksley, Jr., and W. B. Thomas, to acquire skills in nutritional biochemistry, and they did so as students of Carl Lyman. The special complication of the presence of gossypol and related pigments in cottonseed meal continued as a main thrust of Lyman's laboratory until his untimely death in 1969.



Fred Hale, Chief of the Experiment Station Swine Division from 1925 to 1947, checks on an experimental sow. (Courtesy, Texas A&M University Archives.)



Hale's experiments with vitamin A in swine had implications for medical research. This exhibit appeared at a meeting of the Texas Medical Association in Fort Worth in 1937. (Courtesy, Texas A&M University Archives.)



Carl Lyman (right) *directed the chemical laboratory proposed by Hale* (center). *Kenneth Kuiken is at left. (Courtesy, Texas A&M University Archives.)*

Forced Union: The Department of Biochemistry and Nutrition

The year 1947 was a watershed year of critical importance in the events surrounding research in nutrition as well as other elements of agricultural research at Texas A&M. At its inception in 1888, the Texas Agricultural Experiment Station was exploited for the good of the whole A. & M. College of Texas.[23] The professor of agriculture also directed the Texas Agricultural Experiment Station. As noted earlier, the professor of chemistry was also appointed as the chief chemist of the station. Salaries were drawn in part or whole from the Agricultural Experiment Station. The Experiment Station helped the college to sell farmers on the idea of scientific farming and on the value of the institution itself. But the administrations and activities of the School of Agriculture, Experiment Station, and Extension Service when established in 1914 would flow independently, and by 1946, little interrelationship, exchange, or mutual support existed among the instructional, research, and extension function. The extent of division was no better illustrated than in the fact that there were three departments of animal husbandry on campus: a teaching department, and a division of range animal husbandry, and a swine division in the Agricultural Experiment Station.

The year 1947 saw an integration of these entities under the Vice President for Agriculture, D. W. Williams, and the leadership of Dean Charles N. Shepardson, Director Ide Peebles Trotter of the Texas Agricultural Extension Service, and Director R. D. Lewis of the Texas Agricultural Experiment Station. They implemented a plan that placed Extension, Experiment Station, and academic personnel under the same roof, under one department head. The plan provided for the first time extensive numbers of appointments of faculty with both academic and research responsibilities. What followed was an unprecedented development of strength and vitality. The fact that 154 persons received the Ph.D. in the departments of the School of Agriculture during the 10 years of 1949 to 1958, against ony 6 for the entire previous history of Texas A&M, amply demonstrated the productive results of the forced union of 1947.

The integration of service personnel into the academic division facilitated, also, the establishment of a new Department of Biochemistry and Nutrition that same year. The faculty of the new department was assembled with biochemists in the Department of Animal Husbandry (Paul B. Pearson, Bernard S. Schweigert), the Swine Division (Carl M. Lyman, Kenneth Kuiken), and the State Chemist (Raymond Reiser, L. R. Richardson), concentrating and nurturing the basic nutritional sciences. But as the discipline of biochemistry would soon begin its course of development far beyond its synonymity with nutrition, nutritional science began to diffuse back into other departments, first with joint faculty appointments and then with new faculty positions. Nutrition research at Texas A&M and in the Agricultural Experiment Station today is substantial but widely dispersed, serving both as a contributory discipline and a subject of interest in its own right.

The appointment of Paul B. Pearson as Professor of Animal Nutrition in 1937 joined for the first time nutrition research in the Agricultural Experiment Station and the School of Agriculture since the days of Fraps, Burns, and Marshall. He was designated a distinguished professor in 1946. Pearson first taught undergraduate and graduate courses in nutrition in the Department of Animal Husbandry and in 1946 received an Experiment Station appointment as nutritionist in the Division of Veterinary Science, signaling the beginning of the end of the long separation of College and Experiment Station. He became the first head of the Department of Biochemistry and Nutrition but was succeeded after three years by Carl Lyman when Pearson left Texas A&M for the Atomic Energy Commission. Pearson's research was in the classical biochemical mode of the time, with emphasis on the requirement for and metabolism of vitamins—nicotinic acid, pantothenic acid, riboflavin, choline, folic acid—in a range of animals: the horse, sheep, rabbit, chicken, and turkey as well as man. Pearson's studies thus became part of the literature that provided information for setting quantitative requirements of animals for the B-vitamins. Pearson's laboratory also engaged in studies on the metabolism of magnesium in animals primarily in an attempt to understand the metabolic cause of grass tetany.[24]

Pearson brought some early national recognition to the nutrition program as a member of the National Research Council Committee on Animal Nutrition and as chairman of its subcommittee on sheep and horses. Pearson recruited young faculty with potential distinction: B. S. Schweigert, who went from Texas A&M to the University of Chicago and on to head departments of food science and nutrition at Michigan State University and the University of California-Davis; Ralph T. Holman, who came to Texas A&M from the University of Upsala (Sweden) to research edible oils and who left to build a distinguished career as director of the Hormel Institute of the University of Minnesota leading to election to the National Academy of Sciences. The principal outlet for publication of research results in nutrition moved from Experiment Station publications to the national scientific journals.[24]

Raymond Reiser, another charter member from the Department of Biochemistry and Nutrition, with a Ph.D. from Ohio State University and a postdoctorate study of problems in fat absorption at Duke University, first worked with George Fraps in 1940. He soon began research on the problem of vitamin A and carotene instability in mixed feeds. He found blood, a contaminant of meat and bone scraps, and lipoxidase, residual from inadequate processing of soybeans, both powerful catalysts of oxidation, to be the culprits. After three World War II years in the Army Sanitary Corps, Reiser returned to claim his job in 1945 to continue his research on fats in commercial feeds.[25]

Paul B. Pearson was the first head of the Department of Biochemistry and Nutrition, established in 1947. (Courtesy of the author.)

Raymond Reiser made major contributions to the field of lipid biochemistry. (Photograph by James E. Vance.)

Reiser's career took a significant turn in 1949 when radioactive isotopes became available. Kenneth Kuiken went to Oak Ridge, Tennessee, to learn how to use the new tool and returned to team with Reiser in writing a proposal to the Atomic Energy Commission to work out the mechanism of absorption of fat. But Kuiken left before the grant could be activated, although he had collaborated in the early work. Herman Schlenk, an immigrant from Germany and an organic chemist, synthesized isotopically labeled glycerol, and Reiser combined the labeled glycerol with fatty acids with conjugated double bonds, which are detectable spectrophotometrically. Though radioactivity had to be measured directly with manually operated equipment using Geiger-Müller tubes, the doubled-labeled triglyceride was a powerful tool. The textbook page on fat absorption resulted.[26] Reiser during the next 25 years produced extensive literature on lipid biochemistry, on methods of analysis, on transformations within the body and within the rumen, and on metabolic diseases, cholesterol metabolism, and atherosclerosis. These latter interests brought both distinction and occasion for dispute and debate.[27]

No history of nutrition research at Texas A&M would be complete without noting Reiser's successful development of a synthetic diet for the pink bollworm, which had been regarded as an obligatory insect, depending entirely on plants belonging to the family Malvaceae.[28] Diets, refined later by Erma Vanderzant of the USDA Entomology Research Division working at Texas A&M university, permitted colonization of the pink bollworm and boll weevil, and out of that have come control measures and the bases for the integrated management of pests.

L. R. "Ray" Richardson arrived from the University of Missouri in 1946. His appointment in the State Chemist's laboratories was short for he, too, became a charter member in Biochemistry and Nutrition. Richardson spent some years in studying nutritional requirements over the entire life cycle of the rat, but most of his attention turned to environmental factors affecting the nutritive quality of foods: the environment of plant production, the effects of sterilization of food by gamma radiation, the effects of mold growth on feeds. Perhaps Richardson's most significant institutional contribution was as head of the Department of Agricultural Analytical Services, the successor department to the State Chemist, where he restored a certain public confidence in the chemical backup of the regulatory activities of the Texas Feed and Fertilizer Control Service.[29]

As a unit, the Department of Biochemistry and Nutrition had one of its most significant impacts as the bellwether of the stirrings of a predominantly undergraduate Texas A. & M. College into a university with a promising graduate program. By 1964, the department had produced more doctorates than any other in the university. Its first head of department, Paul B. Pearson, also held the position of Dean of the Graduate School. The department was organized in the concept that graduate study was a principal mission and therein it succeeded.

The Problem Solvers

Self-confident, flamboyant, and inevitably controversial, James Russell Couch erupted on the nutrition setting in Texas in 1948. Couch, a graduate in Animal Husbandry from Texas A&M, had been employed in 1931 by Ross Sherwood, Chief of the Poultry Division of the Experiment Station, to do research in poultry husbandry. Couch did not count his next ten years as very productive, but credited his inspiration toward a career in scientific nutrition to G. S. Fraps (he was Fraps' only graduate student) and Paul Pearson.[30] After five and one-half years of World War II duty in the Army, Couch took a Ph.D. from the University of Wisconsin. "Hungry," as he put it, and armed with the self-assurance of a student of Conrad Elvehjem and the Wisconsin school, Couch inherited Paul Pearson's laboratory and launched over 27 years of prodigious research productivity, publishing some 300 scientific papers, guiding nearly 60 students to doctoral degrees, presenting scores of papers at meetings, and writing hundreds of popular articles.

Couch's second career came on the heels of the end of the era of discovery of vitamins and at the beginning of the industrialization of poultry feeding. Prior to 1950, poultry production concentrated mainly in farm flocks. Suspected of unneeded service, the feed industry relied heavily on "Big Five" formulas for both poultry and swine: one part each of meat scraps, corn, wheat bran, wheat middlings, and oats for poultry. But formula feeding and the feed industry were soon to see their most interesting decades.

Couch's tests to replace the "Animal Protein Factor" with impure vitamin B_{12} led immediately to the discovery of growth effects of antibiotics in 1950.[31] Tests of other antibacterial agents soon followed. Combs of Maryland discovered the amino acid-energy relationship and Fraps' data on productive energy were put to use.[8] Couch and his students extended the work to turkeys, laying hens, and replacement pullets.[32]

Couch and his students studied extensively the roles of vitamin B_{12}, folacin, vitamin A, and vitamin E in poultry nutrition, always seeking to refine the poultry diet. And through the years Couch searched for dietary factors not yet chemically described but with positive physiological effects. The routine addition of zinc and selenium to commercial poultry diets stems in part from this persistent search. But the identity of the new "B vitamin," announced as an unidentified growth factor in 1960, remained elusive.

Working closely with Couch, but yet independently, were colleagues R. L. Atkinson, Thomas Ferguson, and later, C. R. Creger. Atkinson, over a period of more than 25 years, used the turkey as the principal experimental subject, and thereby established many parameters of poultry nutrition in use today.[33] Ferguson, beginning in 1952, published 100 papers ranging from the nutritional histopathology to physiological effects related to nutrition to nutritional factors affecting reproduction and embryonic development, and in the process became expert in fundamental avian physiology.[34] Creger, a student of Couch and now the head of the Department of Poultry Science, continued fundamental research in search of the bases for leg weakness in broilers and turkeys, for excessive body fat in commercial broilers, and for egg shell fragility.[35]

Practical poultry research began about 1914 by analyzing commercial feeds to supply protein to laying hens, increase egg production, ensure fertility of eggs, and provide strength to newborn chicks.[36] The practical feeding experiments were carried out through the years until after World War II by Ross Sherwood, who looked at some aspects of vitamin A and D. John H. Quisenberry, designated head of the department in 1946,[37] picked up the work and with students and colleagues carried a highly productive line of research until after his retirement in 1972. His researches complemented, sometimes competed, but seldom cooperated with those of Couch and his colleagues. Yet scarcely anyone has matched the intensity that characterized John Quisenberry in his work.

Quisenberry's list of publications filled nine typed pages. His approaches were imaginative; they touched almost every aspect of the

J. Russel Couch discovered the growth effects of antibiotics in poultry in 1950. (Courtesy, J. R. Couch.)

J. Russel Couch and H. O. Kunkel (foreground) *at the International Congress of Nutrition at Edinburgh, Scotland, August 1963. (Courtesy of J. R. Couch.)*

John H. Quisenberry, head of the Department of Poultry Science, 1946-72. (Courtesy, Texas A&M University Archives.)

environment of poultry, including nutrition, with the goal of industrialized production of poultry paramount. Variations in feed requirements with age and season, bird densities, caging, and water consumption in concentrated production situations were subjects of his studies. He charted feed requirements in phase feeding systems. He even fed eggs to laying hens, as a possible model of the effects of eggs in the diets of man, and recorded beneficial effects.

The quarter century following World War II was by any measure auspicious in poultry nutrition research in Texas, and findings were extended to poultry producers in the state. The legacy of this research is the current extensive production of poultry in large concentrations, a nearly half-billion-dollar business annually in Texas.

The notion that feed additives could be beneficial also in the diets of large animals was an obvious corollary to the findings in poultry nutrition. By 1950, Robert W. Colby began tests with chlortetracycline (aureomycin) added to rations for lambs.[38] H. O. Kunkel, a student of Paul Pearson at Texas A&M and Nobel laureate James B. Sumner at Cornell, succeeded Colby in 1951, and he and his students studied the effects of antibiotics, other antimicrobial materials, corticoid sterols, and even the tranquilizer hydroxyzine, primarily in lamb diets. Fred Hale and John K. Riggs conducted some experiments with these products on swine and cattle, but these experiments were not extensive. The reasons for that lower level of interest remain a matter of conjecture, but the reluctance to do business with the feed industry was residual in animal husbandry circles in the early 1950's. Then, too, it was the day of the $2,000 or $3,000 grant from industry. Substantial amounts of additional institutional funds would be tied up in each experiment with large animals. Skittishness to make such commitments was not surprising, particularly when the expectation of death losses from enterotoxemia or urinary calculi existed as part of the experimental protocol. Such administrative wariness was replaced by a more aggressive attitude when O. D. Butler became head of the Department of Animal Husbandry in 1956.

The principal contribution of the studies on feed additives to lamb diets was the demonstration that feeding systems could be devised in which lambs in large concentrations could be safely and productively fed high-energy diets.[39] As others across the United States were demonstrating with cattle, it was no longer obligate to "hand feed," that is, to ration feed to fattening lambs. The long-taught maxim, "The eye of the master fattens the calf," lost its relevance. Skill in feed formulation and preparation replaced the need for daily, careful observation of each animal. The feedlot industry was born. Since 1960, research in ruminant nutrition in Texas as elsewhere reflected that fact.

As for Kunkel and his students during the 1950's and early 1960's, their interests were multiple. Their nutritionally directed studies centered on dietary factors that had metabolic and physiologic consequences in ruminant animals—interrelationships that affected levels of serum magnesium, dietary agents causing urinary calculi, the metabolic sequelae of ruminal development. There were also the searches for biochemical (clinical) indications of the hereditary propensity for increased growth rate of cattle.[40] But as is often the case for mission-targeted research, those searches came before their time. Measurements of such physiologic factors as endocrine activity were indirect and imprecise, and only a part of the life span, that in the feedlot, could be sampled. Significant correlations observed in one study were fugitive in the next.

One point of haunting interest was that adaptive aspects of glucose metabolism associated with age and maturing ruminal function, that is, decreased blood sugar and sensitivity to insulin treatment, seem to reflect the aggregated total previous lifetime pattern of consumption, intraruminal fermentation, and nutritive (energetic) quality of feed.[41] Ruminant animals, like humans, may have permanent changes in metabolism as a result of varying "lifestyles."

But ruminants do not eat grain alone. Much of their lives are spent on range and pasture and a new, improved technology could emerge if forage could be more productive. That thought led William C. Ellis into determined years of research on the biological factors in the animal-forage system.[42] The task ahead was tough and the work required painstaking study. The grazing system is the most complex biological system in animal agriculture.

Ellis arrived at Texas A&M in 1961 from the University of Missouri by way of the Rowett Institute in Scotland. He set out to determine the factors affecting the digestibilities of forages and found the available methods of measurement inadequate. His basic research was directed to provide new techniques and models by which he could better measure the fates of feeds through the ruminant gastrointestinal tract. He combined forces with plant breeders to provide the estimates of digestibility that led to the relase of five improved varieties of grass.[42] Over 300,000 analyses of in vitro digestibility were performed. Ellis is now moving to fruition of two decades of research accounting for the components of the system: factors affecting the frequency and duration of grazing, digestibility of the forage, microbial action in the rumen, mastication, stocking rates, age of animal, and the composition and structure of the forage plant.

Other threads of nutrition research at Texas A&M developed. I. W. Rupel, R. E. Leighton, and Gary Lane investigated a series of aspects of fiber in dairy rations and dairy calf nutrition. L. H. Breuer, in the late 1960's, reestablished research on horse nutrition, providing data that amino acid balance was important to the growth of the foal. Hagen Lippke, at the Texas A&M University Agricultural Research Station at Angleton, contributed to knowledge relating to the structure and formation of indigestible constituents in ruminant nutrition.[43] Likewise, Millard Calhoun at San Angelo refined and extended the California Net Energy Systems to Texas feedstuffs in commercial lamb feeding and now carries on the research in lamb nutrition. M. M. Kothmann has explored further the nutritionally related problems in the management of Texas rangelands. Of significance is his finding that the forages of the Coastal Prairie of Texas are deficient in potassium.

Resurgence

Perhaps no signal sounded more loudly that an era in nutritional science had passed at Texas A&M as well as throughout the United States than the 1966 change of the name of the Department of Biochemistry and Nutrition to Biochemistry and Biophysics.[44] That change reflected not only the dispersal of nutritional science out of Biochemistry and Nutrition to the Departments of Animal Science and Poultry Science beginning in 1962, but also the bold and sometimes errant era at Texas A&M when the university launched its reach for excellence and amplification of its scientific stature. Ironically, strength in biophysics has yet to develop. Perhaps, the nutritional sciences paid a price.

But the science of animal nutrition was also in transition nationally. The decade of the 1960's saw the end of the period of discovery of essential nutrients. Physiologically active additives (adjuvants) to animal diets were challenged on the fears for safety of the product in human diets, and the cost of development of new ones became prohibitive. Linkages with cancer took diethylstilbestrol and other additives out of formulations for farm animals and poultry, and the continued use of others is challenged today. For example, the demonstration of intergeneric transfer of genetic material (plasmids) of microorganisms has raised enough doubt among scientists to threaten the continued use of dietary antibiotics in animal agriculture. As a result of all this, industrial support of nutritional research in the Texas Agricultural Experiment Station waned. And even as powerful instrumentations and techniques became available in the 1970's, progress became more costly. New improvements in the efficiency of feed utilization were smaller and less frequent.

Problems of bioavailability of nutrients, however, became more significant both in human nutrition and in animal agriculture. The Experiment Station breeding program made available new genetic diversity in sorghums and cotton, changing the structures of the seeds and thereby their nutrient and toxin contents. The elucidation of function of selected or combinations of nutrients remained a central theme in nutritional science. The interactions of diet and gene expression, stress, and disease conditions took on new consequence as linkages grew between the College of Agriculture and the recently established College of Medicine. These and other factors led to a quiet but clear resurgence of nutritional research in the Agricultural Experiment Station and at Texas A&M in the latter half of the 1970's and on into the 1980's.

Hagen Lippke, Millard Calhoun, M. M. Kothmann, and W. C. Ellis continue their efforts. They are joined by an ever larger corps of scientists who incrementally expand the ranges of nutrition research.

The work of T. D. Tanksley, Jr., from 1965 on, and Darrell Knabe carried on in the genre of swine nutrition research of the past: Their research contributed to improving the uses of the principal feedstuffs of Texas, sorghum and cottonseed meal, and was directed toward answering the problems of Texas pork producers. But their work also spanned the fundamental research on the digestibilities of amino acids in feedstuffs.[45] Their methods became more sophisticated and precise and finer aspects of the bioavailabilities and feed biochemistry were explored and exploited in an industrialized swine agriculture. Their researches on sorghum now cope with the extensive collections of sorghum cultivars with varying endosperm structures and tannin contents of sorghums available to plant breeders. They explore the effects of changes in storage conditions and the deficiencies and variable digestibilities of lysine and threonine with a goal of precise formulations of rations for swine.

The current course of equine nutrition is directed at understanding the partitioning of nutrients as they pass through the digestive tract. Gary D. Potter and J. L. Kreider measured the nutritional requirements of pregnant and lactating mares, weanling foals, and severely stressed exercising horses,[46] documentation that seems long overdue in the annals of animal science.

Research in fundamental poultry nutrition was handed in early 1983 to younger scientists, J. R. Veltmann, out of the University of Georgia, and C. A. Bailey, a student of Creger. The effort in Poultry Science is concentrated on bioavailabilities of minerals, calcium transport, and nutritional, environmental, and hormonal factors in mineral metabolism.

Inquiries related to cattle nutrition increasingly center on the structure of the system. L. M. Schake integrated both economic and biological studies of processing and ruminal fermentation of sorghums in the performance of growing and feedlot calves, demonstrating again that variety and processing of sorghum have significant effects.[47] Floyd Byers had amplified new concepts of regulation and physiological partitioning of protein growth and lipogenesis in tissue storage and retrieval in beef cattle.[48] David P. Hutcheson has initiated intensive studies of nutrition and diseases of feedlot cattle at Bushland and Amarillo.[49] Carl Coppock has directed his research to the intricacies of the dietary cation-anion relationships on milk production of dairy animals, particularly during hot weather.[50]

Gerald Schelling joined the faculty of Animal Science in 1979 to round out the capability for study of energy and protein metabolism in ruminants.[51] And L. Wayne Greene joined in 1982 to reestablish research on the unrelenting problems of mineral metabolism in ruminants.

Nutritional research at Texas A&M has extended to aquatic animals as well. As some of these animals, such as the *Talapia* species, consume both directly or indirectly organisms that fix atmospheric nitrogen, they promise to be an increasingly important contribution to protein supplies in the world. The growth of the channel catfish industry has led to demands for research concerning intensive culture schemes. Robert Stickney[52] of the Department of Wildlife and Fisheries Sciences set in place a program of investigation of the nutritional requirements of freshwater fish, both exotic and domestic, contributing to the fundamental knowledge of the nutrition of a new experimental but increasingly important food animal. Stickney and his colleague Edwin H. Robinson, who joined the Department of Wildlife and Fisheries Sciences in 1981, are among the small number of investigators of the nutrition of cultured fish to receive the recognition of elected membership in the American Institute of Nutrition. Their election signified a growing scientific importance of such work.

Interest in basic nutritional sciences has emerged again in the past decade. The Department of Biochemistry and Biophysics remained central to the effort as George Bates, Edward Harris, Roscoe Lewis, Randall Wood, E. G. Sander, and Joseph Nagyvary each contributed new knowledge. Bates, for more than a decade, studied the ramifications of iron metabolism in laboratory animals and humans and the elusive availabilities of dietary iron as its digestion is affected by chemical state and other constituents of a diet.[53] A faculty member since 1973, Harris concentrated his work on the biochemistry of copper transport in the body and the effects of perturbations of copper metabolism on enzymatic activity, and demonstrated the link of dietary copper with the regulation of lysyl oxidase and, hence, the development of connective tissue.[54] Nagyvary interrupted his work on the chemistry of nucleotides in the early 1980's to demonstrate the hypolipidemic mechanisms of a binding of lipids to pectin.[55]

Wood, concerned with the unnatural fatty acids produced by processing and the cyclopropenoid fatty acids, the fatty acids that caused hardening of the butter fat of Harrington and Duncan, is working now to describe the biological effects of such substances. These substances are, in fact, found in the diets of most Americans.[56]

Relatively new additions to the staff and faculty in the Department of Animal Science are Louise Canfield-Sander, who is extending the basic research of the Experiment Station toward the enzymatic mechanisms in the metabolism of vitamin K, and Karen Kubena, whose interests relate to basic and human nutrition.[57]

The unique property of food is that it is required for all human beings. People, if they are able to do so, choose the food they eat. Food is eaten for both nourishment and enjoyment and the food science programs at Texas A&M approach the problems with both aspects in view. Food engineering, methods of preservation, improvement of quality and appearance, development of new technologies and new food products, food microbiology and mycology, and the public health are features of the research and educational efforts in food science and technology. Although all of food science at Texas A&M must directly or indirectly relate to the nutrition of man and animal, not all is directly yoked to nutritional science.

In tandem with the nutritional sciences at Texas A&M, increasingly strong programs of food and feed sciences at Texas A&M provided industrial linkages with the agricultural sciences. The Food Protein Research and Development Center, so designated in 1971, with Karl Mattil as director, was the successor to the Oilseed Products Research Laboratory (1940) and the Chemurgic Research Laboratory (1945) of the Texas Engineering Experiment Station. For over three decades the laboratory has been dedicated to the conversion of seeds to edible protein and oil sources.[58] The names of W. W. Meinke, Bryant Holland, S. P. Clark, Cecil Wamble, W. D. and W. B. Harris, Carl Lyman, Carl Cater, K. C. Rhee, L. A. Johnson, J. T. Lawhon, and E. W. Lusas, in addition to Mattil, thread through one of the longest lines of interrelated researches at the university. Cottonseed (first from the glanded varieties and then the glandless as well), coconuts, peanuts, soybeans, sesame, sunflower seeds, flax, and jojoba were the raw materials for product and process development. The vision of the center, first stimulated by the Cotton Research Committee[59] established by the State Legislature in 1941, was at first Texan in its geographic aim but now seeks to provide protein sources to solve global malnutrition.

Novel protein isolates from animal sources similarly have been developed, in the Departments of Animal Science and of Biochemistry and Biophysics, from milk and blood by the team of C. W. Dill and Wendell Landmann.[60] Dill's laboratory, under contract with the USDA Children's Nutrition Research Center at Baylor Medical College, seeks to preserve human milk without loss of its unique components with biological activity.

Component analyses by L. W. Rooney and his colleagues and students have embodied the combination of nutritional values into new cereal crop cultivars with improved agronomic and processing properties.[61] Rooney's descriptions of sorghum structure, tannin and phytate contents, and effects of processing now form an extensive data base that has linked the sorghum breeding program to nutritional values for both man and animal. His experiments, too, have had international elements as he prepared *ogi*, a Nigerian fermented food, and tortillas from a range of sorghum cultivars.

Microbiology of foods and concerns for the public health, namely, wholesomeness, food-borne illness, and toxic components in foods, have been subjects for investigation by food scientists as well as plant and animal pathologists in a number of units of the Texas Agricultural Experiment Station and the university. The work in two laboratories stands out. For almost 30 years, Carl Vanderzant and his students, first in the Department of Dairy Science and then in Animal Science, have meticulously studied the microorganisms of milk and milk products, meats, aquatic foods, and foods in general.[62] Vanderzant, a native of the Netherlands with a doctorate from Iowa State, built his early career on the effects of bacteria on the spoilage and deterioration of milk products and dairy technology, but expanded that career on extensive studies of microorganisms on meat and seafood and pathogenic organisms on food, particularly *Vibrio parahaemolyticus* and *Yersinia*. His influence has become extensive as he serves on national panels which deal with guidelines, standards, regulations, and requirements associated with microbiological safety of food.

Norman Heidelbaugh, a member of the faculty since 1977 and head of the Department of Veterinary Public Health since 1978, with colleagues A. B. Childers, Timothy Phillips, and others, had launched a program to examine the interactive effects of foods and food systems in human public health.[63] Implications of new technological advances in the food industry, methods of inactivation of viruses and other disease-causing organisms, toxic elements and mycotoxins in feeds that may be consumed by animals, and food hygiene are subjects of investigation by the group in veterinary public health.

Food sciences at the university and in the Agricultural and Engineering Experiment Stations thus have become major strengths in the infrastructure supporting the nutritional sciences at Texas A&M. The opportunities and needs for the nutritional sciences to return the favor are as prevailing. Recent discoveries such as those of significant glycemic effects of processing single foods and that natural human-type diets were less cholesterolemic than equivalent diets composed of purified ingredients, bring food technology and nutritional sciences all the closer in the practical relationship.[64]

Human Nutrition

Research in human nutrition at Texas A&M had its beginnings about 1926 with the appointment of Dr. Jessie Whitacre as Chief of Rural Home Research in the Texas Agricultural Experiment Station.[65] While 1920 has been considered as the year when the United States changed from a rural to urban nation, the population of Texas then remained predominantly rural. Many families were accustomed to a limited number of foods. Cornbread, grits, and sour milk biscuits were the staple foods. Cabbage was the leading commercial vegetable crop. Turnip greens and Southern peas (edible cowpeas) were common field crop vegetables. And canning and drying were the principal means of food preservation.

The initial research, a survey of nutritional status of school children, confirmed the likelihood of widespread poor nutrition in rural Texas around 1927-28. Lacking the means to measure biochemical parameters, which were largely unknown anyway, Whiteacre used body measurements and estimations of the nutritive value of "illustrative diets" as the basis for judging the nutritive and developmental states. According to Whitacre, the diets of whites and Spanish-Americans were likely deficient in calcium and vitamin A; those of blacks were apt to be deficient in calcium, vitamin A, and probably in vitamin C, phosphorus, and iron. The question of caloric adequacy was raised for children above age 12. Tooth decay was widespread and decreased milk and increased sweet foods and processed cereal consumptions were implicated.

Research in the early 1930's attempted to devise an adequate daily diet that would cost only 10 cents. That was never achieved. A "14-cent daily" diet, with its greater variety of foods, meats, fruits, and vegetables, was preferred by Texas rural people. Surveys of eating habits of rural folk in the late 1930's to the early 1940's told of improved conditions: the consumption of almost twice the amounts of dietary milk, butter, eggs, leafy vegetables, and whole cereal preparations as was consumed by the school children of 1927-29. The family records of consumption of protein-rich foods, sources of vitamin A, the "B-complex," and of vitamin C suggested that whites were still better supplied than blacks, owners of farmland were better provisioned than renters, who, in turn, surpassed the landless laborers.

Whitacre carried on her studies of cabbage and cornbread, corn pone and grits, greens and peas, the practical diets of the poor and rural, searching out the effects of cooking, enrichment, storage, variety, harvest period, and place and climate of origin on the vitamin nutrients through the 1950's.[66]

There was wide occurrence of pellagra in rural Texas as well as the South and Whitacre concentrated on the enrichment of cornmeal and grits. Encouraged by Whitacre's findings, the membership of the Texas Home Demonstration Association went to the Texas Legislature and Texas law even now requires the B-vitamin enrichment of corn meal and grits. In retrospect, the plan and the task of Whitacre's researches seem not very far from the efforts to refine the definitions of the nature of malnutrition in the developing world in the 1980's.

Sylvia Cover joined the Home Economics group in 1933 to do foods research, principally research on canning time tables for food safety and on the factors determining B-vitamin contents of meat.[67] But more and more, her attention was turned to the study of the parameters of meat quality, where her contributions were significant and truly seminal.[68] That move left human nutrition research dormant at Texas A&M for most of the time between Jessie Whitacre's retirement, in 1958, and the early 1970's. Irrespective of some studies concluded by a determined Alice C. Stubbs, then head of the Experiment Station's Department of Home Economics,

Dr. Jessie Whitacre, appointed in 1926 as Chief of Rural Home Research in the Texas Agricultural Experiment Station. (Courtesy, Texas A&M University Archives) the principal nutrition research with human subjects was not done at Texas A&M in the 1950's and 1960's, but instead in Pauline Berry Mack's laboratory at Texas Women's University and Mina Lamb's laboratory at Texas Tech University.

Significant programs in human nutrition are now established at Baylor College of Medicine and the USDA Children's Nutrition Laboratory and at the University of Texas Health Science Center in Houston. A new program exists at the University of Texas Health Science Center at San Antonio. Texas Tech University has expanded its program. The Texas Agricultural Experiment Station briefly joined the regional studies, through the work of S. J. Ritchey and Alice Stubbs, on ascorbic acid and vitamin B_6 in preadolescent children (1962-1966)[69] and, under the leadership of Roscoe Lewis, on relationship of food intakes to nutritional health in girls of different ethnic and economic backgrounds (1972-1977).[70] Barbara O'Brien and Raymond Reiser used human subjects in tests of dietary effects on cholesterol and lipoprotein in blood and serum.[71] The work of George Bates included diagnostic methods for evaluating the status of iron nutrition in humans, the absorption of iron as ferric fructose, and the digestive mobilization of iron from foods. More of the basic research and research with animal models is designed to answer specific questions of direct importance to humans. Barbara O'Brien, for example, has directed studies with laboratory animals to investigate the principle that early nutrition may have metabolic imprints.[72] Even subtle variations of such imprinting may affect susceptibility to disease such as atherosclerosis in later life. Karen Kubena has initiated work with animal models to investigate problems of mineral nutrition.

Human nutritional research at Texas A&M received incremental extension with the establishment of the College of Medicine and the initiation of investigations of sociological forces in human nutrition in the Department of Sociology. Arriving in 1976, David N. McMurray of the Department of Medical Microbiology and Immunology brought with him considerable experience and data relating to cellular immune responses in undernourished children out of the Tulane University-International Center for Medical Research project in Cali, Colombia.[73] McMurray extended his studies to the mechanisms by which specific nutrients alter immune responses and the evaluation of the significance of immunological alterations induced by diet on resistance to infectious diseases.[74]

William Alex McIntosh of the Department of Sociology is contributing to the literature now on social support mechanisms and the diet of the elderly[75] and is focusing new research on adolescent food behavior.

Academic Programs in Nutritional Science

Undergraduate and graduate courses in animal nutrition have been taught at Texas A&M University since 1937. Nutrition courses received their clear biochemical base upon the appointment of Paul Pearson as professor of animal nutrition in 1937 and Bernard S. Schweigert as associate professor in 1946. It was an academic need in 1937 that brought the infusion of biochemistry into nutrition research at Texas A&M. It was the amalgam, a decade later, of academic and Experiment Station units that gave academic programs in biochemistry and nutrition a force in graduate instruction that for another decade and a half was unmatched by anything else then at Texas A&M.[76]

The M.S. degrees in biochemistry and in nutrition have been awarded since 1948, the Ph.D. since 1953. A total of 148 M.S. degrees and 118 Ph.D. degrees in Animal Nutrition, in Biochemistry and Nutrition, and in Nutrition have been granted through December 1984.[77] An uncounted number of M.S. and Ph.D. degrees also have been awarded in Biochemistry, Poultry Science, and Animal Science to recipients whose research concentrations were closely related to animal and human nutrition and nutritional biochemistry.

The role of the College of Agriculture at Texas A&M took on a pivotal dimension in 1969 upon the strategic development of a professional graduate program leading to the Master of Agriculture degree. The Master of Agriculture degree program is institutionally oriented in contrast to the traditional disciplinary or subject matter orientation of graduate degrees. At this writing, the total number of M.Agr. degree graduates since 1969 has mounted to 1,000.[78] More than 90 of these emphasized applied nutrition and are employed in institutional management, dietetics, feedlots, feed mills, and poultry and pork production units. More than 25 students of L. M. Schake alone thread the management organizations of feedlots in the United States. One senses an even larger impact yet to come.

The first institutional designation that emphasized nutritional science occurred with the establishment of the Department of Biochemistry and Nutrition in 1947. That special emphasis of mission was lost, however, in 1966 when the department was redesignated as the Department of Biochemistry and Biophysics[44] and general agreement was reached that courses and faculty members in nutritional sciences would be allied with the faculties of Animal Science and Poultry Science as well as of Biochemistry. Courses in nutritional pathology were in the College of Veterinary Medicine. Enrollments in courses in nutrition, however, continued to rise. Over 2,000 students took such courses in the academic year 1982-83.

A renewed institutional focus in nutritional sciences occurred as Texas A&M University included studies in nutrition as a frank purpose in its Statement of Institutional Role and Scope in 1978. The university, pleading the case that little distinction could be made between animal and human nutrition, requested and received authorization from the Coordinating Board, Texas College and University System, in 1980 to redesignate the M.S. and Ph.D. degrees in Animal Nutrition to Nutrition.[78] As it did that, the Coordinating Board also issued an inherently contradictory caveat that though Texas A&M University may have strong separate programs both in nutritional science and in food science, an academic program in "foods and nutrition" was proscribed for Texas A&M. A combined program of food science and nutritional science was judged to fall under the rubric of home economics, and an academic program in home economics was outside the "role and scope" of Texas A&M. An undergraduate option emphasizing nutrition and dietetics in food science and technology was dropped. A new approach and a new curriculum were devised under the leadership of Christine Meiners, Wendell Landmann, C. R. Creger, and Edward Harris. Texas A&M was able to establish its strength in nutritional sciences with the Coordinating Board and was granted the authority in 1982 for a B.S. degree program in Scientific Nutrition. Texas A&M University, for the first time in its history, was able to provide the full range of academic programs in the nutritional sciences, from baccalaureate to professional to doctorate.

The development of a College of Medicine at Texas A&M University in 1976 increased both the opportunity and the imperative for the academic and research efforts in the nutritional sciences. An accredited internship in clinical and applied nutrition was made available in 1981 for professional master's degree students at Texas A&M by the Scott & White Memorial Hospital and Clinic and the Olin E. Teague Veterans' Medical Center at Temple. And the fact that over one-third of the current Texas membership of the American Institute of Nutrition, the principal professional society in the nutritional sciences, are faculty and staff members of Texas A&M University and the Texas Agricultural Experiment Station raises the expectations that the faculty and scientific supports for academic excellence in basic nutrition can flourish again.

A long-missing academic base for fundamental studies related to human nutrition is now in place at Texas A&M.

The Right to Know

The right of the public to know was inherent in the Land-Grant concept and the establishment of the state agricultural experiment station. It was an unquestioned principle in the unwritten code that guided the early research of the Texas Agricultural Experiment Station.[11] The results of each experiment were carefully documented in a bulletin from the station and in agricultural magazines. A pattern of "field days" that began with the "meetings of farmers and ranchers" called at the end of the feeding tests carries on today. But scarcely is there anything now that compares with the Annual Ranchers Roundup at Sonora in the early part of the century.

George Fraps was diligent in his records and writings, publishing more bulletins of the Texas Agricultural Experiment Station than any other person. Others were also prolific in their writings. But none surpassed the perseverance and attention to detail in the record for public knowledge as John H. Jones, who joined John M. Jones and the Texas Agricultural Experiment Station in 1936. John H. Jones coordinated and assiduously reported the results of each feeding test in a Cattle Feeder Series and a Lamb Feeding Series and then in hundreds of Experiment Station Progress Reports. These Feeder series and Progress Reports and numerous articles by the Joneses in agricultural magazines were both the record and the telling of the research.

In ways not quite like those with other lines of agricultural research, there was—and still is—the direct flow of science-based information from researcher to the public. Animal husbandmen, prior to World War II, fed and tested and learned the intricacies and worth of each feedstuff, each processed form, and each mixture under farm conditions. The Joneses, Burns, Hale, and Sherwood developed a studied depth of understanding that only long experience can bring. Their experiments sought to answer specific questions: "Is there any difference in the feeding value of 41-43 percent protein cottonseed meal and 28 percent protein whole pressed cottonseed cake?" "Should sorghum grain be ground for cattle feeding?"[79] The answers were to form the experiential base guiding farm livestock production in Texas. The answers were provided to producers through direct communication but more often through the county agricultural agent's office or through mailings out of College Station.

The principles of a new animal agriculture began to fall into place at the end of World War II. By 1946, all of the nutritionally important amino acids had been identified. All but one (B_{12}) of the nutritionally important vitamins had been discovered. All but one of the economically significant mineral requirements of animals had been identified. The importance of microorganisms in the gastrointestinal tract was recognized in vitamin synthesis, and in the synthesis of protein in the ruminant. The National Research Council had published its first "Recommended Nutrient Allowances for Domestic Animals." A new strategy for transfer of science-based technology developed. As an industry supporting agriculture, the feed manufacturing industry of Texas was cast as a modern means of applying technology.

Feed formulation and feed manufacturing soon formed an infrastructure that would undergird a revolution in animal agriculture in Texas and the United States. The decision makers in the new technology came to be trained nutritionists and consultants employed by the industry, micronutrient suppliers, poultry producers, and the feedlots. And their key contacts came to be the nutritional scientific community and its institutions. Scientists at Texas A&M played a significant interactive role, though parts of the institutions at College Station, dedicated as they were to farmers and ranchers, were ideologically not well prepared for the entry into a university-industrial relationship.[80] Time would soften even those reservations.

The first Texas Nutrition Conference[81] was held on April 8, 1946, sponsored by the School of Agriculture and organized under the chairmanship of Paul B. Pearson. The conference was held annually for more than three decades with Russell Couch the perennial chairman after Paul Pearson left the university in 1949.

At the first conference, Leo Norris of Cornell University and Paul Phillips of the University of Wisconsin spoke of animal needs for B vitamins and mineral supplements. I. W. Rupel, only recently arrived at Texas A&M from the University of Wisconsin, recounted his classic experiments in the use of urea for dairy cattle. George Edds noted the interrelationship of chemotherapy, pharmacology, and nutrition, but he could not yet predict the revolution that would follow with the addition of drugs to feeds in the 1950's. Carl Lyman pointed toward the importance of protein sources and the effect of processing. Evidences of yet unidentified factors were related. But though "quality" in feedstuffs was recognized, it was not readily defined.

The first conference in 1946 was attended by less than 50 people. By the mid-1950's attendance peaked at over 300. Stepping up to the podium were the nation's outstanding scientists and feed industry people who in their own right had worked scientific wonders.

The conclaves in 1949 and 1950 buzzed with discussions that the newly discovered vitamin B_{12} would henceforth be a key ingredient in poultry and swine feeds. That was coupled with the discovery that certain antibiotics stimulated the growth of "normal" animals. Feeds could now be formulated which actually increased efficiency of animal production above that described as normal and expected.

The conferences in the 1950's were in the main directed to refinements in poultry and swine feeds. Progress with ruminant animals was slow but certain during the first half of the decade, but 1955 recorded the early experiments with diethylstilbestrol in cattle feeds, extending the concept of "above normal" productive rates to ruminant meat animals.

The Food Additive Amendment to the Food, Drug and Cosmetic Act was passed in 1958, and the conference in 1959 had overtones of problems that would be shared henceforth. Commercial development of new chemical additives slowed. The conferences at the end of the decade, however, emphasized other technical highlights: Ratios of production energy to protein became the basis of precision formulation of poultry rations. The reevaluation of ruminant feeds, hinting at the effects of processing feeds, coupled with improvements in the control of diseases and parasites and automation in management were concepts that built the modern feedlot industry.

The 1964 conference turned to other essential facets of the technology of feed manufacturing—integration of operations, plant management, and quality control. Problems of transportation were added in 1965. The conference in 1965 accented the use of sorghum, reflecting the emergence of the sorghum belt as a distinguishable area of the United States.

With the passage of time, however, the flow of innovative findings waned. New networks of information developed. The animal nutritional sessions of the Texas Nutrititon Conference were discontinued in deference to the consolidated Animal Agriculture Conferences and more dispersed formats. In its time, though, the Texas Nutrition Conference had performed the magnificent service of bringing to Texas industry the scientific developments of a nation.[82]

Specialists and county agricultural agents of the Texas Agricultural Extension Service obviously carried with them a certain knowledge of feeds and feeding of livestock. The first specialist, however, to concentrate in beef cattle nutrition was Uel Dee Thompson, who came to College Station in 1948 from service as a county agricultural agent. Though swine and poultry production and cattle feeding were industrialized, range and pasture production of sheep and cattle and, at first, the dairy industry maintained more traditional technologies. Needs remained that could not be met by the industrial infrastructure. By the mid-1960's, trained nutritionists were employed as animal science specialists. T. D. Tanksley, Jr., was awarded a Ph.D. in nutritional biochemistry while serving as a swine specialist, and his appointment was extended to teaching and research. Gilbert Hollis (Ph.D., Purdue University) was appointed area swine specialist at Lubbock in 1966. Appointments that followed were W. B. Thomas and Robert Cohen as swine specialists; Byron J. Greiman, Dixon Hubbard, L. M. Schake, John C. Parrott, and John McNeill, successively, as beef cattle specialists in Amarillo; Dennis Herd as beef cattle specialist; William Smith as livestock specialist at Vernon, Randall Grooms at Overton, Robert Rupp at Weslaco, and Larry Boleman at Bryan; Chris Woelfel as dairy cattle specialist at College Station, Alfred G. Lane at Stephenville, E. M. Sudweeks at Overton, and Thomas White at Dallas; and Douglas Householder as horse specialist.[83] The concept of support of professional nutritionists was carried on by L. M. Schake, who in 1969 developed the Plains Nutritional Council, which serves the beef cattle industry with current membership of some 125.

Better food throughout the year, and thereby improved nutrition, was the goal of Extension home economics work at its inception. At the turn of the century, fruits and vegetables were available only through a short harvest period. The aim of those early Extension activities was to extend usefully the time vegetables were available.[84]

Believing that the best way for farm women to accept a new idea was through their daughters, Edna Trigg was appointed in 1911 by the U.S. Department of Agriculture to supervise the "Girls Tomato Clubs" in Milam County. She taught the girls tomato culture and ways of using tomatoes. She also taught and applied the new home method of preservation—canning in metal cans. Mrs. Trigg, after 1915, moved to Childress and then to Denton County, taught canning schools, and taught girls and women to solder the can, handle a pressure cooker (which for some was a

As Supervisor of the "Girls Tomato Clubs," Edna Trigg taught farm daughters how to preserve food in metal cans. She is honored by a plaque at the Milam County Courthouse. (Courtesy, Texas A&M University Archives.)

frightening experience), and save the garden produce and meat for another day. "Canning Clubs" were formed in counties across Texas, with training by home demonstration agents and volunteer demonstrators.

The entry of the United States into World War I was the impetus to step up the work under the heading of Emergency Food Conservation Work. Home demonstration agents cooperated with the Texas Department of Rural Organization in supervising community canning plants. After the war, the emphasis of the home demonstration program was placed on the attempt to increase fruits and vegetables in the diets of farm families. Through the pioneering efforts of Lola Blair, the first Extension foods and nutrition staff specialist, emphasis was placed on the well-stocked pantry and the family food supply. As drought and depression struck their double catastrophes of the 1930's, a federal emergency meat canning program directed through the Extension Service salvaged cattle from drought-stricken areas and people were fed. The community canning centers in the 1930's served not only as a means of preserving food but as a medium of distributing the excess meats and vegetables throughout the community.

The depression of the 1930's passed. Extension home demonstration work turned to greater emphasis on proper nutrition education. A guide for the selection of foods was developed with the assistance of Dr. Jessie Whitacre. During World War II, the foods recommended in the guide were embodied in a Texas Food Standard. The standard was adopted by the Texas Nutrition Council and was a principal guide in Texas for the decade that followed.

The Extension component of nutritional sciences emphasized first food production for home consumption and then the elements of conservation, nutrition, and storage. These features remained characteristic of the foods and nutrition programs of the Extension Service throughout its history, although the emphasis varied through the decades.

After World War II, the process of freezing food began to displace canning and drying as means of preservation. Armed with the more complete knowledge of the nutrients required by humans, Extension food and nutrition specialists turned to the family food budget, and the selection of "nutritious" and high-quality foods to meet the requirements for nutrients. But in the 1960's a series of events occurred on the national scene that set new directions for nutritional science and education in the Extension Service.

Professional and lay communities were shocked and alarmed when a report from a Senate Subcommittee investigation and a television documentary ("Hunger in America," CBS) highlighted hunger and malnutrition in the United States. Congress, in June 1967, authorized the Secretary of Health, Education and Welfare to undertake a comprehensive survey of the incidence and location of hunger and malnutrition. Surveys were carried out in ten states, including Texas, from 1968 to 1970, and the findings were that a small but significant proportion of the population in Texas and the other states was malnourished or at a high risk of developing problems.[85] The result was Congressional action. A $10 million special appropriation to the U.S. Department of Agriculture was made for a six-month special project for nutrition education of low-income, high-risk families. The Expanded Nutrition Program was launched in 11 counties in Texas in which there were high concentrations of poverty. This new and added educational program, which taught homemakers in their homes, was initiated in January 1969, using a network of program assistants and program aides who were taught first by the professionals. Within a year, 21,000 families had been enrolled. And hundreds of thousands of poverty-struck homes later, the program continues today, though at a reduced level.[86]

The foods and nutrition program of the Extension Service started the decade of the 1970's with some emphasis on family health and nutrition.[86] The principal thinking was directed to prevention of deficiency diseases. The donated food and food stamp program provided new avenues for Extension education in 1971. Expanded and innovative methods of reaching larger numbers of people were tested in 1973. The flow of circular letters, newsletters, and direct mail was markedly increased. "Mulligan Stew," a television series targeted for youth, was released.

By the mid-1970's, food preservation returned as a subject of emphasis. A back-burner item for two decades, interest in home food preservation and preparation returned as inflation flowered and a "back to basics" trend emerged. Renewed interest developed in breast-feeding of infants.

As the decade closed and the 1980's moved in, fears and worries emerged that degenerative diseases—heart disease, high blood pressure, cancer—were somehow related to diet.[87] An unprecedented interest in weight control dominated nutritional concerns of consumers. Diet-health relationships became a central issue. "Thin is in" was the vogue. New diseases—anorexia nervosa and bulemia—were written about. Food popularists had their day. And physicians prescribed diets to control diabetes, heart disease, and hypertension. The change in public interest in nutritional knowledge and science during the decade was astonishing. The right to know what was going on in nutritional science became a public and political issue.[88]

The first Extension staff specialist in foods and nutrition was Lola Blair.[89] Principal staff specialists in foods and nutrition who served since were Grace I. Neeley (1935-1942), Louise Mason (1935-1966), Maeona Cox (1936-1966), Marie Tribble (1946-1983), Elizabeth Barnard (1968-1969), Frances Reasonover (1947-1979), Sally Springer Coble (1968-1977), Jimmie K. Ullom (1969-1971), Karen Kreipke Walker (1971-1974), Cass Ryan Crowe (1971-1982), and Rose Postal (1979-1983). They were all dedicated workers, and some were evangelistic, deeply concerned for the welfare of rural families first and then people everywhere.

The group now that provides leadership in Extension foods and nutrition are Jennie Kitching, Assistant Director for Home Economics, Mary K. Sweeten, Marilyn A. Haggard, Dymple C. Cooksey, Carol Suter, Guillermina Valdez, and Alice Hunt. They are increasingly called on to provide nutritional information that goes far beyond the range of knowledge required of their predecessors. The demands on them and their colleagues on the county scene are escalating. Nearly half (45 percent) of the effort in home economics now is in foods and nutrition.

The human nutrition programs of the Agricultural Extension Service, aided by those in the university and the Agricultural Experiment Station, are a powerful force in nutrition education in Texas. But they remain limited in what they can accomplish. Extension nutrition programs are dealing with a science that remains caught up in controversy because the data are still insecure. Long-term responses to nutritional education are uncertain.[90] Food faddism and nutritional misinformation remain widespread. These educational programs can also be buffeted by advertising and other media campaigns, the attempts to set national policy, and even political philosophy. And they have been so buffeted.[91]

The challenge to the system of nutritional education is that its content be placed in perspective. To this end periodic reviews of scientific knowledge are being written by each of the Extension foods and nutrition specialists.[92] The institutional response to the need for perspective, evident a decade ago, was the organization of a section on human nutrition within the 28th annual Texas Nutrition Conference in 1973.[93] For two years human nutrition was a part of the Texas Nutrition Conference, but in 1976 it became a "stand alone" conference sponsored by the College of Agriculture. The Texas Human Nutrition Conference of 1982 was the tenth consecutive year of bringing together national and international nutritionists on the Texas A&M campus. Students, Extension personnel, professional nutritionists, and faculty members are able to relate to research in both the national and international scientific communities. The conference is now the longest continuing series on human nutritional science in Texas.

Impact and Triumph

The history of nutritional science in the Texas Agricultural Experiment Station and the Texas Agricultural Extension Service and at Texas A&M University reveals results of significant impact. Important contributions are these:

1. Decades of experience with the feeding qualities of the unique crops grown in Texas and the Great Plains, which formed the groundwork for a massive beef cattle feedlot industry and an efficient, productive poultry industry.
2. George Fraps' painstaking development of an extensive data base which provided knowledge of the production energy of feedstuffs for poultry and swine production.
3. The discovery of the effects of dietary antibiotics which, along with the information on productive energy, formed keystones in the modern technology of poultry production.
4. The confirmation in the 1930's that phosphorus was the limiting nutrient in cattle production in South Texas, a demonstration that ranks with the control of the cattle tick, both keys to the economic future of the cattle industry in South Texas.
5. The development of a modern complex of nutritional research in Texas which forms an essential scientific support for the high payoff researches in animal and plant agriculture.
6. The renewed researches in human and basic nutrition which can now form additional bases for strength in Extension programs in the nutritional sciences in Texas.
7. The promulgation of the principles of food preparation in the 1920's and 1930's, which had a tremendous impact on the health of rural people, and the intellectual catalysis of animal agriculture in the 1950's and 1960's through the Texas Nutrition Conferences and consulting arrangements form outstanding illustrations of the importance of the transfer of knowledge and technology.

Demonstrated, too, was the important principle that it is the research located at a university that supports and involves training of people who are needed in our increasingly technology-dependent agricultural economy.

The impacts and triumphs of research in animal nutrition in Texas, on the surface, seem less milestone events than the dramatic successes of research leading to hybrid sorghum and the breeding of modern wheats and cottons, the discovery of the means to control Texas fever, or possibly even the codification of the principles of soil conservation practice. Save for a couple of striking discoveries—those of restrictive phosphorus deficiences in the forages of South Texas and of the effects of antimicrobial substances placed in the diets of intensely produced animals—the achievements of nutritional science at Texas A&M were aggregate achievements and can be best appreciated by contrasting the technologies of animal production now to those of 25 years ago. They sometimes came at the end of years of persevering research and data gathering. They often came as individual discoveries which were incorporated into the technology nearly as quickly as the discovery was made. But they were substantial nonetheless.

Nutritional sciences at Texas A&M and in the Texas Agricultural Experiment Station contributed powerfully to the technologies of animal agriculture in Texas. They will be indispensable for further developments in the future. Economic forces and production costs will demand even greater efficiencies of animal production systems and, hence, of feed formulations. The nutritional complexities of animal production on rangelands and forages require solution. Nuritional studies will be required to fit new plant cultivars into efficient use in the decades ahead. New feed resources will become available as biotechnological and genetic approaches overcome the problems of pests and diseases and availabilities of water. Nutritional studies on aquatic animals are needed for the further development of aquaculture. And the products of biotechnology promise new dimensions which we can only guess. The possibilities of introducing new genes of economic importance into animals, of immunological control of the animal's own hormones to alter reproduction, lactation, and growth, of modification of ruminal microflora, and of the biotechnologic production of all of the amino acids for supplements in animal diets offer potentialities as exciting as at anytime in our history.

Research and knowledge in fundamental and human nutrition will also be imperative for academic, research, and Extension purposes. Nutritional sciences now have new meanings for the agricultural and food sciences and medicine.[94] Nutrition is the interface that links the activities of agriculture to human and animal health and disease-related issues. That point cannot be overlooked at Texas A&M University. The linkage of nutrition and food science will determine whether appropriate technologies are in place to convert plant and animal resources to quality food products. Nutritional concerns have often dictated issues important to food production. Policies regarding nutrition of people have broad, often permanent economic and societal implications and that fact dictates very careful evaluation of nutritional information. A scientific capacity to do that in the Land-Grant university is essential.

There has been no strong tradition or facility at Texas A&M for extensive nutritional research on human subjects. But that historic role should be no barrier to future research and education. Some research with humans must surely be done there in the years ahead. The social aspects of nutrition can only be investigated in human populations. Extensive strength, however, can and ought to be fostered at Texas A&M in the fundamental science related to human nutrition. Controversies regarding human nutrition abound in Texas as elsewhere. The strength in food sciences requires concomitant strength in nutritional science. Serious scientific questions regarding bioavailabilities and interactions of nutrients provide opportunities for significant research. The relationships of diet to cardiovascular diseases, cancer, and neurological integrity have both academic and practical importance. And a significant potential to contribute substantially to the national community of nutritional science exists in the agencies and departments at Texas A&M University.

Given the nurture and encouragement that such potential demands, nutritional sciences at Texas A&M University will surely record new chapters of triumph and impact.

NOTES

1. An important contribution toward the sociological understanding of science is Thomas S. Kuhn's *The Structure of Scientific Revolutions,* 2nd ed., enlarged (Chicago: University of Chicago Press, 1970). Kuhn proposed the notion of a paradigm as what the members of a scientific community share, a combination of world view together with the experimental techniques and theories required to research and conceptualize natural phenomena in appropriate terms. The agricultural experiment stations, early on, tended to turn to models that reflected local and common goals and approaches shared by the research community within the experiment station. That kind of normal research pattern seems to have had much of the force of a paradigm as do the more universal paradigmatic choices of today.

2. See *Beef Cattle Investigations in Texas, 1888-1950,* Texas Agricultural Experiment Station Bulletin 724 (September 1950).

3. The identification of the more than 40 specific chemical substances which are dietary requirements—amino acids, vitamins, carbohydrates, and inorganic elements—had largely been accomplished by 1940. The major exceptions were folacin, vitamin B_{12}, and selenium and the scarcely critical chromium, nickel, and vanadium which appear to have biological functions. See Elmer Verner McCollum, *A History of Nutrition* (Boston: Houghton Mifflin Co.; Cambridge, Mass.: The Riverside Press, 1957) for a history of classical nutritional science.

4. See Henry C. Dethloff, *A Centennial History of Texas A&M University, 1876-1976,* vol. I (College Station: Texas A&M University Press, 1975), p. 222; see also Irvin M. May, "The Origins and Development of the Texas Agricultural Experiment Station: 1888-1892," *Panhandle Plains Historical Review* 49 (1976): 55-79.

5. *Texas Farm and Ranch,* 1 July 1889, p. 11.

6. Raymond Reiser and P. K. Raju, "The Inhibition of Saturated Fatty Acids Dehydrogenation by Dietary Fat Containing Sterculic and Malvalic Acids," *Biochemical and Biophysical Research Communication* 17 (1964): 8.

7. Fraps' papers repeatedly noted the "starch values" of Otto Kellner (*Die Ernährung der Landwirtschaftlichen Nütztiere,* Berlin: Paul Parey, 1905, 10th edition, 1924) and the estimates of productive energy values by H. P. Armsby (*The Nutrition of Farm Animals,* New York: The Macmillan Co., 1917) and his successors at Pennsylvania State University.

8. See G. S. Fraps, *Composition, Digestibility and Energy Values of Some Human Foods,* Texas Agricultural Experiment Station Bulletin 680 (1946); G. S. Fraps, *The Composition and Utilization of Texas Feeding Stuffs,* Texas Agricultural Experiment Station Bulletin 461, rev. ed. (1947). See also Gerald F. Combs and G. L. Rosomer, "A New Approach to Poultry Feed Formulation," *Feed Age* 5, no. 3 (1955): 50-58.

9. Hubert Schmidt, *Feeding Bone Meal to Range Cattle on the Coastal Plains of Texas,* Texas Agricultural Experiment Station Bulletin 344 (1926).

10. E. B. Reynolds, Jr., *Methods of Supplying Phosphorus to Range Cattle in South Texas,* Texas Agricultural Experiment Station Bulletin 773 (1953).

11. A. B. Conner, *Forage Crops in Northwest Texas,* Texas Agricultural Experiment Station Bulletin 103 [circa 1908], p. 8. See also J. Roy Quinby, *A Triumph of Research . . . Sorghum in Texas* (College Station: Texas A&M University Press, 1971), pp. 4-5; J. W. Carson and G. S. Fraps, *Commercial Feeding Stuffs,* Texas Agricultural Experiment Station Bulletin 141 (Austin: Austin Printing Company, 1911).

From the beginning, Experiment Station researchers asked questions regarding: (1) the practical application of feeding tests to ranchers, (2) what were the practical methods of winter-feeding steers and would this be profitable, (3) what Texas feedstuffs would give best results for the costs, and (4) could unimproved Texas steers be fattened with profit.

These questions were answered in unsophisticated comparisons of various feed rations principally involving cotton products, silage, and molasses without benefit of economic analysis. See *Feeding Experiment,* Texas Agricultural Experiment Station Bulletin 6 (1889) and F. A. Gulley and J. W. Carson, *Feeding Experiment,* Texas Agricultural Experiment Station Bulletin 10 (1890). By 1916, Fraps' research had begun to substantiate Conner's thesis eight years earlier. See a brief mention in *The Production Co-Efficients of Feeds,* Texas Agricultural Experiment Station Bulletin 186 (Austin: Von Boeckmann-Jones Co., Printers, 1916).

12. Texas Agricultural Experiment Station, *Annual Report: 1913*, p. 69.

13. John C. Burns, *A Test of the Relative Values of Cottonseed Meal and Cottonseed Hulls on Fattening Cattle*, Texas Agricultural Experiment Station Bulletin 153 (1912); Texas Agricultural Experiment Station, *Annual Report: 1914*, pp. 23-25; John C. Burns, *Feeding Baby Beeves*, Texas Agricultural Experiment Station Bulletin 198 (1916); Paul M. Lucko, "A History of the Department of Animal Science at Texas A&M," M.A. Thesis, Texas A&M University, 1975, p. 32.

14. *Progress Report, Substation No. 7, Spur, Texas*, Texas Agricultural Experiment Station Bulletin 218 (1917).

15. The best historical survey of this topic remains Robert S. Curtis, *Cottonseed Meal: Origin, History, Research for Farmers, Stockmen, College Students and Research Workers* (Raleigh, N.C.: The Robert S. Curtis Publishing Co., 1938).

16. The physiological conversion of carotene to vitamin A was first reported by Paul Karrer, *Helvitica Chimica Acta* 12 (1929): 1142.

17. Lubbock *Avalanche-Journal*,[n.d.] April 1958, Paul Marion Scrapbooks, private possession. See also Paul T. Marion and Alvis Bilberry, interview with Irvin May and R. D. Lewis, 9 July 1976, pp. 27-37. Archives, Texas A&M University.

18. John K. Riggs, interview with Irvin May and R. D. Lewis, 2 April 1976. Archives, Texas A&M University.

19. See John K. Riggs and Donald D. McGinty, "Early Harvested and Reconstituted Sorghum Grain for Cattle," *Journal of Animal Science* 31 (1970): 991 et seq.

20. Fred Hale, *Cottonseed Meal as a Feed for Hogs*, Texas Agricultural Experiment Station Bulletin 410 (1930). Hale made a major contribution to science by pointing out that teratogenic effects occurred from maternal vitamin A deficiency as well as deformation through inheritance. See Fred Hale, "Pigs Born Without Eyeballs," *Journal of Heredity* 24 (March 1933): 105-106.

21. The laboratory, a wooden structure a mile away from the campus center, remains in use today as the Biochemistry Field Laboratory.

22. See Carl M. Lyman, K. A. Kuiken, and Fred Hale, "Essential Amino Acid Content of Farm Feeds," *Journal of Agricultural and Food Chemistry* 4 (1956): 1008-1013.

23. Henry C. Dethloff, *A Centennial History of Texas A&M University, 1876-1976*, vol. I (College Station: Texas A&M University Press, 1975), pp. 217-225.

24. Paul B. Pearson authored more than 40 papers resulting from his researches at Texas A&M. Examples are: Paul B. Pearson, "The Nicotinic Acid Content of the Blood of Mammalia," *Journal of Biological Chemistry* 129 (1939): 491-494; Paul B. Pearson, "Studies on the Metabolism of Pantothenic Acid in Men and Rabbits," *American Journal of Physiology* 135 (1941): 69 et seq.; B. S. Schweigert, Paul B. Pearson, and Marvin Wilkening, "The Metabolic Conversion of Tryptophan to Nicotinic Acid and to N-methylnicotinamide," *Archives of Biochemistry* 12 (1947): 139 et seq.; H. O. Kunkel and P. B. Pearson, "Magnesium in the Nutrition of the Rabbit," *Journal of Nutrition* 36 (1948): 657-666.

25. Raymond Reiser, oral history interview with Irvin May, 24 November 1975, edited and revised. Archives, Texas A&M University.

26. See Raymond Reiser, M. J. Bryson, M. J. Carr, and K. A. Kuiken, "The Intestinal Absorption of Triglycerides," *Journal of Biological Chemistry* 194 (1953): 131 et seq.

27. The intensity of some of the arguments may be perceived in papers such as Raymond Reiser, "Oversimplification of Diet: Coronary Heart Disease Relationships and Exaggerated Diet Recommendations," *American Journal of Clinical Nutrition* 31 (1978): 865-875.

28. See Herman F. Beckman, Sara M. Bruckart, and Raymond Reiser, "Laboratory Culture of the Pink Bollworm on Chemically Defined Media," *Journal of Economic Entomology* 46 (1953): 627-630; Erma S. Vanderzant and Raymond Reiser, "Studies on the Nutrition of the Pink Bollworm using Purified Casein Media," *Journal of Economic Entomology* 49 (1956): 454-458; and Erma S. Vanderzant, Dundappa Kerur, and Raymond Reiser, "The Role of Dietary Fatty Acids in the Development of the Pink Bollworm," *Journal of Economic Entomology* 50 (1957): 606-608.

29. Personal observations. See also L. R. Richardson and John V. Halick, "Studies on Feed Spoilage," Texas Agricultural Experiment Station Bulletin 879 (1957); L. R. Richardson, Jackie Godwin, Stella Wilkes, and Martha Cannon, "Reproductive Performance of Rats Receiving Various Levels of Dietary Protein and Fat," *Journal of Nutrition* 82 (1964): 257-

262; Luther R. Richardson, John L. Martin, and Sharon Hart, "The Activity of Certain Water Soluble Vitamins after Exposure to Gamma Radiations in Dry Mixtures and in Solutions," *Journal of Nutrition* 65 (1958): 409-418.

30. James Russell Couch, oral history interview with Irvin May, 2 June 1976, with addenda. Archives, Texas A&M University.

31. The seminal research demonstrating a growth-promoting effect of antibiotics was announced in 1950. A source of pure vitamin B_{12} and a source of vitamin B_{12} contaminated by chlortetracycline (aureomycin) were fed to chickens, and the antibiotic-laden preparation produced a marked increase. Subsequent experiments verified the effects to be those of the antibiotic. See J. R. Couch and H. L. German, "Vitamin B_{12}, APF Concentrates and Dried Whey in the Nutrition of the Growing Chick," *Poultry Science* 29 (1950): 754.

32. The subjects of the over 300 refereed scientific papers published by J. R. Couch and his students range from fundamental nutritional biochemistry to practical feeding practices. Examples are C. R. Creger, R. H. Mitchell, R. L. Atkinson, and J. R. Couch, "The Effects of Different Protein and Energy Levels on the Growth of Turkey Poults," *Poultry Science* 39 (1960): 1350-1354; A. A. Kurnick, B. L. Reid, and J. R. Couch, "Trace Elements in Poultry Nutrition–a Review," *Soil Science* 85 (1958): 106-116; J. R. Reed, Jr., R. L. Atkinson, and J. R. Couch, "Dried Whey as a Source of Unidentified Factors of the Growing Chick," *Journal of Nutrition* 43 (1951): 501-513; R. L. Jacobs, J. F. Elam, J. Fowler, and J. R. Couch, "An Unidentified Growth Factor Found in Litter," *Journal of Nutrition* 54 (1954): 417-426; M. M. Rahman, R. E Davis, C. W. Deyoe, B. L. Reid, and J. R. Couch, "Role of Zinc in the Nutrition of Growing Pullets," *Poultry Science* 40 (1961): 195-200; G. L. Feldman and J. R. Couch, "Studies on the Oxidative Metabolism of the Chick Embryo, I and II," *Poultry Science* 39 (1960): 517-523; J. R. Couch, J. H. Trammell, and C. R. Creger, "Computer Programmed Least-Cost Diets for Turkey Poults for the First 3 Weeks," *Poultry Science* 48 (1969): 2086-2097.

33. See C. R. Creger, M. A. Zavala, R. H. Mitchell, R. E. Davies, and J. R. Couch, "Organic and Inorganic Supplements in a Purified Type Diet for Chicks," *Poultry Science* 41 (1962): 1928-1931; C. R. Creger and L. B. Colvin, "The Transference of 89_{Sr} from the Shell to the Developing Chick Embryo," *Radiation Research* 32 (1967): 131-136; C. R. Creger, R. L. Atkinson, and J. R. Couch, "Fat Levels in the Diets of Turkey Breeders," *Nutritional Reports International* 2 (1970): 1-8; C. A. Bailey and C. R. Creger, "25-Hydroxycholecalciferal-1-hydroxylase Activity in Heat Stressed Laying Hens," *Poultry Science* 61 (1982): 586-588.

34. See R. L. Atkinson, J. W. Bradley, J. R. Couch, and J. H. Quisenberry, "The Calcium Requirements of Breeder Turkeys," *Poultry Science* 46 (1967): 207-214; K. K. Krueger, R. L. Atkinson, J. R. Couch, and W. F. Krueger, "Biotin and Early Poult Growth," *Poultry Science* 55 (1976): 497-501; R. L. Atkinson, K. K. Krueger, J. W. Bradley, and W. F. Krueger, "Amino Acid Supplementation of Low Protein Turkey Starting Rations," *Poultry Science* 55 (1976): 1572-1575.

35. T. M. Ferguson, R. H. Rigdon, and J. R. Couch, "A Pathologic Study of Vitamin B_{12}-deficient Embryos," *American Medical Association Archives of Pathology* 60 (1955): 393-400; T. M. Ferguson, C. H. Whiteside, C. R. Creger, M. L. Jones, R. L. Atkinson, and J. R. Couch, "B-Vitamin Deficiency in the Mature Turkey Hen," *Poultry Science* 40 (1961): 1151-1159; D. H. Miller, J. W. Bradley, and T. M. Ferguson, "Effect of Vitamin A and Protein Levels on Growth and Semen Quality of Turkeys," *Poultry Science* 56 (1977): 1086-1091.

36. Texas Agricultural Experiment Station *Annual Report: 1915* (Austin: Von Boeckmann-Jones Co., Printers, 1916). See Ross M. Sherwood, "History of the Poultry Department at Texas A&M College," ms. [n.d.]. Archives, Texas A&M University.

37. The following are typical of John Quisenberry's papers: J. N. Taylor, B. B. Bailey, and J. H. Quisenberry, "A Comparison of the Costs and Effects of Range and Confinement Rearing of Egg Production Type Pullets Fed All-Mash and Mash and Oats," *Poultry Science* 39 (1960): 1484-1490; R. R. Kari, J. H Quisenberry, and J. W. Bradley, "Egg Quality and Performance as Influenced by Restricted Feeding of Commercial Caged Layers," *Poultry Science* 56 (1977): 1914-1919.

38. R. W. Colby, F. A. Rau, and J. C. Miller, "The Effect of Various Antibiotics on Fattening Lambs," *Journal of Animal Science* 9 (1950): 652.

39. H. O. Kunkel, Leonard V. Packett, Jr., Marcus Hoelscher, and J. H. Bridges, "Chlortetracycline Supplements in Self-Fed Rations for Lambs," *Journal of Animal Science* 15 (1956): 770-780; Leonard V. Packett, Jr., T. D. Watkins, Jr., and H. O. Kunkel, "Influence

of Dietary Chlortetracycline on Incidence of Urinary Calculi in Sheep," *Proceedings of the Society for Experimental Biology and Medicine* 97 (1958): 860-863.

40. H. O. Kunkel, R. W. Colby, and Carl M. Lyman, "The Relationship of Serum Protein Bound Iodine to Rates of Gain in Beef Cattle," *Journal of Animal Science* 12 (1953): 3-9; J. L. Fletcher, R. R. Shrode, and H.O. Kunkel, "Serum Alkaline Phosphatase and Gain in Brahman Cattle," *Journal of Animal Science* 15 (1956): 1119-1124; E. C. Stutts and H. O. Kunkel, "Reduced Glutathione Concentration in Relation to the Age and Weight of New Hampshire and White Leghorn Embryos," *Poultry Science* 37 (1958): 914-924.

41. See John C. Reagor and H. O. Kunkel, "Relationship Between Tolerances Toward Insulin and Ruminal Epithelial Development in Lambs," *Journal of Animal Science* 28 (1969): 364-368.

42. See "Alamo Switchgrass," "Nueces and Llano Buffelgrass," and "Verde Kleingrass," Texas Agricultural Experiment Station Leaflets L-1774 (1979), L-1819 (1981), and L-2070 (1983); W. C. Ellis, "Determinants of Grazed Forage Intake and Digestibility," *Journal of Dairy Science* 61 (1978): 1828-1840; W. C. Ellis, J. H. Matis, and Carlos Lascano, "Quantitating Ruminal Turnover," *Federation Proceedings* 38 (1979): 2702-2706; W. C. Ellis, J. H. Matis, K. R. Pond, C. E. Lascano and J. P. Telford, "Dietary Influences on Flow Rate and Digestive Capacity." In F. M. C. Gilchrist, ed., *Herbivore Nutrition in the Sub-Tropics* (Pretoria, R.S.A.: A Donker, 1983).

43. Hagen Lippke, "Forage Characteristics Related to Intake, Digestibility and Gain by Ruminants," *Journal of Animal Science* 50 (1980): 952-961.

44. The change in the name of the Department of Biochemistry and Nutrition to the Department of Biochemistry and Biophysics was approved by the Coordinating Board, Texas College and University System, on July 18, 1966. Approved at the same time was a new B.S. degree in Biochemistry and a new M.S. degree in Biophysics. Approval of the request for the Ph.D. degree in Biophysics was delayed and the university has not since requested the program.

45. See T. D. Tanksley, Jr., and D. A. Knabe, "Researchers Outline Amino Acid Digestibilities of Some High-Protein Feedstuffs and Use in Swine Diet Formulations," *Feedstuffs*, 27 December 1982, pp. 16, 29-31; Robert A. Easter and Thomas D. Tanksley, Jr., "A Technique for Re-entrant Ileocecal Cannulation of Swine," *Journal of Animal Science* 36 (1973): 1099-1103; B. W. Cousins, T. D. Tanksley, Jr., D. A. Knabe, and Teresa Zebrowska, "Nutrient Digestibility and Performance of Pigs Fed Sorghum Varying in Tannin Concentration," *Journal of American Science* 53 (1981): 1524-1537.

46. See P. G. Gibbs, G. D. Potter, R. W. Blake, and W. C. McMullan, "Milk Production of Quarter Horse Mares During 150 Days of Lactation," *Journal of Animal Science* 54 (1982): 496-499; C. E. Anderson, G. D. Potter, J. L. Kreider, and C. C. Courtney, "Digestible Energy Requirements for Exercising Horses," *Journal of Animal Science* 56 (1983): 91-95.

47. L. M. Schake, F. M. Byers, and K. L. Bull, "Energy and Economic Evaluation for Corn and Grain Sorghum Processing for Cattle," *Energy in Agriculture*, vol. 1 (1982): 185-195; L. M. Schake, P. W. Ljungdahl, and R. C. Egenolf, "Establishing and Operating Inter- and Intrafirm Comparisons for Feedlots," *Journal of Animal Science* 49 (1979): 1168-1175; G. G. Guittierez, L. M. Schake, and F. M. Byers, "Whole Plant Grain Sorghum Silage Processing as Lasalocid Effects on Stocker Calf Performance and Rumen Fermentation," *Journal of Animal Science* 54 (1982): 863-868.

48. F. M. Byers, "Nutritional Factors Affecting Growth of Muscle and Adipose Tissue in Ruminants," *Federation Proceedings* 41 (1982): 2562-2566.

49. David P. Hutcheson, N. A. Cole, and J. B. McLaren, "Potassium Addition to Receiving Diets of Transported Feeder Calves," *Proceedings of the Western Section of the American Society of Animal Science* 29 (1978): 400-402.

50. C. E. Coppock, P. A. Grant, S. J. Portzer, Adrian Escobosa and T.E. Wehrly, "Effect of Varying Ration of Sodium and Chloride on Responses of Lactating Dairy Cows in Hot Weather," *Journal of Dairy Science* 65 (1982): 552-565; J. A. Fernandez, C.E. Coppock, and L. M. Schake, "Effect of Calcium Buffers and Whole Plant Processing on Starch Digestibility of Sorghum-Based Diets in Holstein Cows," *Journal of Dairy Science* 65 (1982): 242-249.

51. G. T. Schelling, S. E. Koenig, and T. C. Jackson, Jr., "Nucleic Acids and Purine or Pyrimidine Bases as Markers for Protein Synthesis in the Rumen," *1980 Protein*

Symposium, Oklahoma State University, Stillwater (1980), pp. 1-9.

52. Robert R. Stickney, John H. Hesby, Robert B. McGeachin, and W. A. Isbell, "Growth of *Talapia nilotica* in Ponds with Differing Histories of Organic Fertilization," *Aquaculture* 17 (1979): 189-194; Robert A. Winfree and Robert R. Stickney, "Effects of Dietary Protein and Energy on Growth, Feed Conversion Efficiency and Body Composition of *Talapia aurea*," *Journal of Nutrition* 111 (1981): 1001-1012; William L. Yingst III, and Robert R. Stickney, "Effects of Dietary Lipids on Fatty Acid Composition of Channel Catfish Fry," *Transactions of the American Fisheries Society* 108 (1979): 620-625.

53. Chaim Hershko, Gary Graham, George W. Bates, and Eliezer A. Rachmilowitz, "Non-Specific Iron in Thassalemia: an Abnormal Serum Iron Fraction of Potential Toxicity," *British Journal of Haematology* 40 (1978): 255-263; Nakao Kojima and George W. Bates, "The Reduction and Release of Iron from Fe^{3+} Transferrin $CO_3{}^{2-}$," *Journal of Biological Chemistry* 254 (1979): 8847-8854; Nakao Kojima, Diane Wallace, and George W. Bates, "The Effect of Chemical Agents, Beverages, and Spinach on the *in vitro* Solubilization of Iron from Cooked Pinto Beans," *American Journal of Clinical Nutrition* 34 (1981): 1392-1401.

54. See Edward D. Harris, "Copper-induced Activation of Aortic Lysyl Oxidase *in vivo*," *Proceedings of the National Academy of Sciences, USA* 73 (1976): 371-374; James E. Balthrop, Charles T. Dameron, and Edward D. Harris, "Comparison of Pathways of Copper Metabolism in Aorta and Liver," *Biochemistry Journal* 204 (1982): 541-548.

55. Jeffrey D. Falk and Joseph J. Nagyvary, "Exploratory Studies of Lipid-Pectin Interactions," *Journal of Nutrition* 112 (1982): 182-188.

56. Randall Wood, Fred Chumbler, and Rex. D. Wiegand, "Effects of Dietary Cyclopropene Fatty Acids on the Octadecenoates of Individual Lipid Classes of Rat Liver and Hepatoma," *Lipids* 13 (1978): 232-238; Randall Wood, "Geometrical and Positional Monoene Isomers in Beef and Several Processed Meats." In *Dietary Fats and Health*, AOCS Press, Champaign, Ill. (1983).

57. Louise M. Canfield and Ulku Ramelow, "Vitamin K-Dependent Carboxylase: Evidence for Semiquinone Radical Intermediate," *Archives of Biochemistry and Biophysics* 230, no. 2 (May 1, 1984): 389-399.

58. The mimeographed publication "Presentations and Speeches Related to Oilseed Proteins," an undated publication of the Food Protein Research and Development Center, Texas Engineering Experiment Station, is a compilation of 277 publications through 1977 which chronicle the activities of the center. The current international view of the center can be seen in publications such as J. M. Aguilera and E. W. Lusas, "Review of Earlier Soya-Protein-Fortified Foods to Relieve Malnutrition in Less Developed Countries," *Journal of the American Oil Chemists' Society* 58 (1981): 514-520.

59. The Cotton Research Committee consisted of the presidents of the University of Texas at Austin, Texas Tech University, Texas Women's University, and Texas A&M University for the purpose of supporting additional research on cotton fibers and textiles, cottonseed products, and the economics and cultural aspects of cotton production. The committee was redesignated as the Natural Fibers and Food Protein Committee and includes wool and mohair as well as cotton as the subject of supported research.

60. Wendell A. Landmann, Charles W. Dill, and Charles R. Young, "Nutritive Value of Globin-Amino Acid and Complementary Globin-Cereal Mixtures," *Journal of Nutrition* 110 (1980): 2254-2262.

61. See M. N. Khan, L. W. Rooney, D. T. Rosenow, and F. R. Miller, "Sorghums with Improved Tortilla Making Characteristics," *Journal of Food Science* 45 (1980): 720-725; J. O. Akingbala, L. W. Rooney, and J. M. Faubion, "Physical, Chemical and Sensory Evaluation of Ogi from Sorghum of Differing Kernel Characteristics," *Journal of Food Science* 46 (1981): 1532-1535; D. H. Hahn, J. M. Faubion, S. H. Ring, C. A. Doherty, and L. W. Rooney, "Semiautomated *in vitro* Analysis of Sorghum Protein Availability via Pronase Hydrolysis," *Cereal Chemistry* 59 (1982): 132-136.

62. The range of research publications can scarcely be indicated by listing a few selected publications. Some, which in the judgment of the author are more important, include Carl Vanderzant and Ranzell Nickelson, "*Vibrio parahaemolyticus*—A problem in mariculture," *Journal of Milk and Food Technology* 36 (1973): 135-139; Carl Vanderzant and R. Nickelson, "A Microbiological Examination of Muscle Tissue of Beef, Pork, and Lamb Carcasses," *Journal of Milk and Food Technology* 32 (1969): 357 et seq.; M. O. Hanna, D. L. Zink, Z. L. Carpenter, and C. Vanderzant, "*Yersinia enterocolitica*-like Organisms from

Vacuum-packaged Beef and Lamb," *Journal of Food Science* 41 (1976): 1254-1256; D. L. Zink, J. C. Feeley, J. G. Wells, J. C. Vickery, W. R. Roof, G. A. O'Donovan, and C. Vanderzant, "Plasmid-mediated Tissue Invasiveness in *Yersinia enterocolitica*," *Nature* 283 (1980): 224-226.

63. See Norman D. Heidelbaugh, "Public Health Implications of Intermediate Moisture Food Technology," *Journal of the American Veterinary Medical Association* 171 (1977): 196-199; A. B. Childers, Norman D. Heidelbaugh, Z. L. Carpenter, G. C. Smith, and Scott White, "Technologic Advances in the Food Industry: Their Influence on Public Health," *Journal of the American Veterinary Medical Association* 175 (1979): 1291-1296. As an example of fundamental research in the Department of Veterinary Public Health, see Timothy D. Phillips, Bohdan R. Nichay, Susan L. Neldon, Leon F. Kubena, Norman D. Heidelbaugh, Eric C. Shepherd, Aaron F. Stein, and A. Wallace Hays, "Vanadium-induced Inhibition of Renal Na^+, K^+-Adenosinetriphosphatase in the Chicken after Chronic Dietary Exposure," *Journal of Toxicology and Environmental Health* 9 (1982): 651-661.

64. See Lucille Hurley, *Developmental Nutrition* (Englewood Cliffs, New Jersey: Prentice-Hall, 1979), 335 pp.; Barbara Cooney O'Brien and Raymond Reiser, "Cholesterolemic Responses of Rats to Human-Type Diet Ingredients," *Journal of Nutrition* 112 (1982): 1490-1497.

65. Alice B. Stubbs, History of Home Economics Research, Texas Agricultural Experiment Station. Unpublished ms., April 7, 1975. Archives, Texas A&M University.

66. See Jessie Whitacre, Alice Willard, and Katherine Blunt, "Influence of Fiber on Nitrogen Balance and on Fat in Feces of Human Subjects," *Journal of Nutrition* 2, no. 2 (1929); Emma E. Sumner and Jessie Whitacre, "Some Factors Affecting Accuracy in the Collection of Data on the Growth in Weight of School Children," *Journal of Nutrition* 4, no. 1 (1931); Kathreen Thomas, June Pace, and Jessie Whitacre, *Effects of Enrichment on the Thiamins, Riboflavins and Niacin of Corn Meal and Grits as Prepared for Eating*, Texas Agricultural Experiment Station Bulletin 753 (1952); Mary Futrell, Earline Weddle, Ethel Grimes, and Jessie Whitacre, "Calories and Essential Amino Acids in an Experimental Diet," *Journal of the American Dietetic Association* 34, no. 11 (1958).

67. Sylvia Cover, Barbara A. McLaren, and P. B. Pearson, "Retention of the B-vitamins in Rare and Well-Done Beef," *Journal of Nutrition* 27 (1944): 363-375; Sylvia Cover, Esther M. Dilsaver, and Rene M. Hays, "Retention of B-vitamins in Beef and Veal after Home Canning and Storage," *Food Research* 14 (1949): 104-108.

68. Sylvia Cover and Robert L. Hostetler, *An Examination of Some Theories about Beef Tenderness by Using New Methods*, Texas Agricultural Experiment Station Bulletin 947 (March 1960).

69. Ritchey, S. J., "Metabolic Patterns in Preadolescent Children. XV. Ascorbic Acid Intake, Urinary Excretion and Serum Concentration" *American Journal of Clinical Nutrition* 17 (1965): 17 et seq.

70. Alice B. Stubbs and 23 others, "Patterns of Food Intake and Nutritional Health in Preadolescent Girls—Demographic, Clinical and Anthropometric Methods," *Southern Cooperative Series Bulletin 226* (August 1977).

71. Barbara Cooney O'Brien and Raymond Reiser, "Human Plasma Lipid Responses to Red Meat, Poultry, Fish and Eggs," *American Journal of Clinical Nutrition* 33 (1980): 2573-2580.

72. Barbara Cooney O'Brien, Raju Pullarkat, Jerry Darsie, and Raymond Reiser, "Delayed Responses in Rats and Mice to Early Postnatal Diets," *Journal of Nutrition* 109 (1979): 989-998; Barbara Cooney O'Brien, David N. McMurray and Raymond Reiser, "The Influence of Premature Weaning and the Nature of the Fat in the Diet During Development on Adult Plasma Lipids and Adipose Cellularity in Pair-Fed Rats," *Journal of Nutrition* 113 (1983): 602-609.

73. David N. McMurray, "Cellular Immune Changes in Undernourished Children." In *Nutrition in the 1980's: Constraints on Our Knowledge* (New York: Alan R. Liss, 1981), pp. 305-318; David N. McMurray, Ronald R. Watson, and Marcos A. Reyes, "Effect of Renutrition on Humoral and Cell-Mediated Immunity in Severely Malnourished Children," *American Journal of Clinical Nutrition* 34 (1981): 2117-2126.

74. David N. McMurray, Patricia A. Beskitt, and Stephen R. Newmark, "Immunologic Status in Severe Obesity," *International Journal of Obesity* 6 (1982): 61-68; David N. McMurray and Elizabeth A. Yetley, "Immune Responses in Malnourished Guinea Pigs,"

Journal of Nutrition 112 (1982): 167-174; Mirta A. Carlomagno and David N. McMurray, "Chronic Zinc Deficiency in Rats: Its Influence on Some Parameters of Humoral and Cell-mediated Immunity," *Nutrition Research* 3 (1983): 69-78.

75. W. Alex McIntosh and Peggy A. Shifflet, *The Impact of Social Structure and Social Attachments, Future Time Perspective, and Changing Food Habits on the Nutrient Intake of the Elderly*, unpublished report, Texas A&M Research Foundation, College Station, 1981, 100 pp.

76. A recapitulation of the doctoral degree programs at Texas A&M University may be seen in Curtis Eric Schatte, *Doctoral Degree Programs at Texas A&M University*, The Graduate College, Texas A&M University, 1970, 42 pp. Through 1963, faculty members in the Department of Biochemistry and Biophysics had supervised 55 recipients of the Ph.D. degree. The Department of Chemistry then ranked second with 38, and the Department of Entomology third with 33.

77. Records of the Graduate College, Texas A&M University.

78. Personal observations. Files of the Office of Dean, College of Agriculture, Texas A&M University, 1980-1983.

79. The inherent desire that research on livestock feeding answer the questions that might be posed by farmers and ranchers is reflected in the catechetical structure of *Beef Cattle Investigations in Texas, 1888-1950*, Texas Agricultural Experiment Station Bulletin 724 (September 1950).

80. A certain adversarial relationship between the fledgling feed industry and Texas A&M was created with the passage of the Texas Feed Stuff Law of 1905, which gave the administration of the law to the Texas Agricultural Experiment Station. Suspicious of industrial motives and supportive of consumers, those responsible for administration attempted strict enforcement. In the early 1950's, a highly placed administrator earnestly raised the question of the propriety of doing research which "would likely" increase costs to the farmer by involving the feed industry. But, at the end of the decade of the 1950's, a mood of mutual confidence existed between the people at Texas A&M University and the feed industry.

81. Some of these thoughts on the Texas Nutrition Conference were stated by H. O. Kunkel in an unpublished address, "The 25th Anniversary of the Texas Nutrition Conference," at College Station on October 7, 1970. Proceedings of the Annual Texas Nutrition Conference were available to the author from 1946 onward.

82. The Proceedings of the Annual Texas Nutrition Conference in 1960 listed the conference as a production of the Departments of Animal Science, Biochemistry and Nutrition, Poultry Science, College of Agriculture, Texas A&M University, the Texas Feed Control Service, the Texas Agricultural Experiment Station, and the Texas Agricultural Extension Service in cooperation with Texas Grain and Feed Association, Fort Worth, and Midwest Feed Manufacturers Association, Kansas City, Missouri.

83. Derived from personnel records, Texas Agricultural Extension Service, College Station.

84. The efforts related to foods and nutrition in the Texas Agricultural Extension Service during its first four decades were described by Kate Adell Hill, *Home Demonstration Work in Texas* (San Antonio, Texas: The Naylor Company, 1958). The terms "county-home demonstration agent" and "home demonstration work" are superseded now by the terms "County Extension Agent–Home Economics" and the "home economics program."

85. *Ten-State Nutrition Survey, 1968-1970*. U.S. Department of Health, Education and Welfare, Publication No. (HSM) 72-8130 (1981).

86. Unpublished annual reports to the U.S. Department of Agriculture by the Texas Agricultural Extension Service, 1970 through 1982. Office of Director, Texas Agricultural Extension Service.

87. A review of the controversies may be found in Kristen McNutt, "Dietary Advice to the Public: 1957 to 1980," *Nutrition Reviews* 38 (1980): 353-360.

88. Some measure of the effects of nutritional information on people may be found in the Nationwide Food Consumption Survey, 1977-78, U.S. Department of Agriculture, and the Texas Dietcheck, 1980. See E. M. Pao, "Nutrient Consumption Patterns of Individuals in 1977 and 1965," *Family Economics Review*, Spring 1980, pp. 16-20; "Summary Report of the Dietcheck Program Conducted by the Texas Agricultural Extension Service," Texas Agricultural Extension Service Report, 1980.

89. Personnel records, Texas Agricultural Extension Service, College Station. See also Kate Adell Hill, *op. cit*.

90. Scientists of the Baylor College of Medicine and The Methodist Hospital, Houston, Texas, were joined by staff members of the Texas Agricultural Extension Service in a recently completed long-term (3-year) longitudinal study of the effects of instruction given to a free-living population of people on diet modification and plasma cholesterol. The conclusion was reached that nutritional education and support must be continuing to be effective. See Rebecca S. Reeves, John P. Foreyt, Lynne W. Scott, Robert E. Mitchell, James Wohlleb, and Antonio M. Gotto, Jr., "Effects of a Low Cholesterol Eating Plan on Plasma Lipids: Results of a Three Year Committee Study," *American Journal of Public Health* 73 (1983): 873-877.

91. An era of controversy in the conduct of nutrition research and the formulation of national nutrition policy began in 1977, with the publication of the Senate Select Committee on Nutrition entitled *Dietary Goals for the United States*, which was a presumptive prescription for what the public should eat to avoid "the epidemic of killer diseases." Radical in manner, *Goals* was acclaimed in one camp and decried by others. Nutrition research became a political issue and the 1977 Farm Bill authorized the creation of a center for human nutrition in the U.S. Department of Agriculture. The center was created in 1978 and in 1980 issued the *Dietary Guidelines* in concert with the Department of Health and Human Services. The *Dietary Guidelines*, considerably more moderate in tone than the *Goals*, advised Americans to "eat a variety of foods; maintain ideal health; avoid too much fat, saturated fat, and cholesterol; eat food with adequate starch and fiber; avoid too much sugar; avoid too much sodium; and if you drink alcohol, do so in moderation." See William J. Broad, "News and Comment, Nutrition Research: End of an Empire," *Science* 213 (1981): 518-520. Sensing its inspiration from the source that yielded the *Goals*, agricultural commodity groups in Texas expressed deep concern for the economic dislocations that widespread adoption of the *Guidelines* would have. Extension education would be caught between the position of the center and economic concerns.

Political support for the USDA Human Nutrition Center ran its course with the election of the Ronald Reagan administration (W. J. Broad, *loc. cit*). The USDA administrative unit for nutrition was ordered closed in July 1981. The scientific questions, however, remain unresolved and the public policy debate continues. See R. A. Stallones, "Ischemic Heart Disease and Lipids in Blood and Diet," *Annual Review of Nutrition* 3 (1983): 155-185, for a review.

92. Unpublished reviews written included: Carol B. Suter, "Maternal and Infant Nutrition Update;" Guillermina G. Valdez, "Nutrition and the Adolescent;" Mary K. Sweeten, "Nutrition and Hyperactivity;" Marilyn A. Haggard, "Effectiveness and Safety of Very Low Calorie Protein Formula Diets;" Dymple C. Cooksey, "The Bioavailability of Food." All, Texas Agricultural Extension Service, 1982.

93. C. R. Creger, personal communication, 1983.

94. Robert B. Rucker, "New Frontiers in Agricultural Science—Nutrition," unpublished manuscript presented at the Annual Meeting of the American Association for the Advancement of Science, Detroit, Michigan, 27 May 1983.

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