FIFTY YEARS
IN THE
SERVICE OF AGRICULTURE
1888—1938

BY

The Missouri Agricultural Experiment Station,
University of Missouri

COLUMBIA, MISSOURI
June 21, 1938

[Golden Anniversary]
Fifty Years
In the Service of Agriculture
1888-1938

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Fifty Years
In the Service of Agriculture
by the
Missouri Agricultural Experiment Station
1888-1938

FOREWORD

COMMEMORATING the establishment of the Missouri Agricultural Experiment Station on January 31, 1888, appropriate exercises were held at the University of Missouri, in Columbia, on Tuesday, June 21, 1938.

Some five hundred persons attended the anniversary program. Farmers were present from many Missouri counties, though the date was in the midst of their busiest season. Farm organizations and special enterprise groups were represented by officers and members. State officials, farm paper editors, newspapermen, college presidents and deans, representatives of commercial and industrial groups throughout the state, teachers, and investigators; all these took a day from their crowded schedules and came to make known their interest in the Experiment Station and to pledge anew their support and cooperation.

Many persons who could not come were thoughtful enough to send messages or letters expressing their approval of the work done by the Experiment Station and their hearty good will toward the members of its staff.

In response to the requests of many friends of the Experiment Station, including some who were present at the anniversary exercises and some who were not, a partial report of the event is herewith presented. It is regrettable that space does not permit the presentation of all the addresses and messages that made the occasion memorable.

Supplementing the remarks of those who contributed to the anniversary program, there are presented also (pages 43 to 99) a series of very brief reports by department chairmen of the Experiment Station staff. These reports attempt only to mention those discoveries and techniques by which the Station has made its outstanding contributions to the science and the arts of agriculture.
THE ANNIVERSARY PROGRAM

Tuesday, June 21, 1938

Forenoon
(9:30 until Noon)

Guests were conducted at convenient intervals on tours of inspection of the Experiment Station investigations and equipment.

Afternoon Program
(Beginning at 2:30, in Waters Auditorium)

Presiding --------------------------------------Dean-Elect M. F. Miller
Missouri College of Agriculture

Experiment Station
Objectives and Accomplishments --------------------------------President F. D. Farrell
Kansas State College

Agricultural Experiment
Station Responsibilities
to Farm People ------------------------------------------George Wilkerson
Hughesville, Mo.

Farm People's Use of the
Work of the Agricultural
Experiment Station ----------------------------------------Tom Briscoe
Tipton, Mo.

Industrial Dependence
on Agricultural Research -----------------------------W. A. Cochel, Editor
Weekly Kansas City Star

Fifty Years' Work of the
Missouri Experiment Station ------------------------F. B. Mumford
Dean and Director

Evening Program
(Banquet at 6:30, Tiger Hotel)

Presiding ---------------------------------------------H. J. Blanton
Member Board of Curators
University of Missouri

The Agricultural Experiment
Station and the State -------------------------------Honorable Lloyd C. Stark
Governor of Missouri

Agricultural Research in the
University ------------------------------------------President F. A. Middlebush
University of Missouri

The Work of a Man
(Dean F. B. Mumford) -------------------------------Dean Ernest L. Anthony
Michigan State College

Response --------------------------------------------F. B. Mumford
Dean and Director
Missouri College of Agriculture
REMARKS OF THE PRESIDING OFFICER
BY H. J. BLANTON,
Member of the Board of Curators,
University of Missouri.

THE FAR REACHING EFFECTS of the service rendered to Missouri agriculture and the State at large by the Agricultural Experiment Station were recognized by Mr. Blanton. He contrasted the present popularity of the University in general and the College of Agriculture in particular with the hostility and indifference that prevailed in Missouri even as late as 1895. At that time, Mr. Blanton recalled, the College of Agriculture was assailed and ridiculed by politicians in the legislature and out in the state, while the matter of getting appropriations for the University was beset by formidable opposition. Today, he pointed out, there is such a strong sentiment in every Missouri community for university development that whatever pressure there may be on members of the legislature for adequate appropriations comes from the people instead of from the Board of Curators or the administrative officials of the University. Much credit for this change in sentiment, the speaker said, was due to the very practical and profitable service the College of Agriculture had rendered in every rural community. And now, instead of getting meager appropriations from an indifferent legislature, as once was the case, the Board of Curators and other spokesmen for the University receive an enthusiastic welcome, and all the money that can be spared, when they present their budget to House and Senate appropriations committees.

Referring to Dean Mumford, Mr. Blanton said:

"Dean Mumford is a man all of us know, all of us love, all of us envy. We know him because he has been working for us and with us through forty-three eventful years. We love him because of his attractive personality, his spirit of service and his interest in people. We envy him because of his contributions to better farming, to better thinking and to more intelligent living. In every land under the sun his sound and constructive influence is being felt. From every state in the Union and from the most remote countries on the globe students have been attracted to our College of Agriculture during his administration. And now, full of years and achievements and honors, he is about to transfer his responsibilities to younger shoulders and enjoy his first opportunity to really rest. Fortunately for our needy old world, the good influences a wise man sets in motion continue to function long after he has retired from active service; in fact, they are the only memorials the ravages of time are unable to efface. And so it happens that as a man like this marches into the sunset and hands his torch to a worthy successor he is encouraged and sustained and inspired by knowing that through ages yet to come that torch will continue to burn and light the way to higher human endeavor."
THE AGRICULTURAL EXPERIMENT STATION
AND THE STATE

BY HONORABLE LLOYD C. STARK,
Governor of Missouri

I CONSIDER IT AN HONOR to have been invited here tonight, to join with you in commemorating a half century of usefulness for the Missouri Agricultural Experiment Station. In the past fifty years significant changes have been brought about in farming methods and in the previously neglected field of farm management. Not only the farmers of Missouri but of the entire Middle West are indebted to this University and its Experiment Station for the leadership in this progressive movement.

My subject is “The Agricultural Experiment Station and the State.” It will be the privilege of another speaker on this program to pay the full honors due Dean Mumford as Director of the Experiment Station, a speaker who is likewise eminent in the specialized field of agricultural development. But I can say what every intelligent citizen of Missouri knows, that here again the maxim holds true that “An institution is but the lengthened shadow of a man.” I want to join in felicitating Dean Mumford upon his noteworthy accomplishments.

We have a progressive tradition in this state in the relationship of government to agriculture. Norman J. Colman, the first Secretary of Agriculture, was a Missourian; and it was a Missouri Congressman, Representative Hatch, who was the author of the Federal act which in 1887 created experiment stations in various parts of the United States and provided federal funds for their support.

The following year the Missouri Agricultural Experiment Station was founded. It stands today as one of the foremost of these institutions in the Nation. The results of its work are measurable in the changes and agricultural practices which have resulted.

The Missouri farmer today has a fund of information based on established facts, upon which he can rely with confidence. As a result, systems of farming have been profoundly influenced. It is proper that the Experiment Station should interest itself, not only in the improvement of farming methods, but in the improvement of the rural community and the social life of farm families. The problems of the farm home are as important, in my opinion, as those concerned with farm production.

In recent years we have seen the whole field of land utilization become a national problem. We are facing a period in our agricultural living when the farmers can no longer follow the plans of the pioneer. Agricultural science must contribute to the solution of the problems
arising from changed conditions, and in this the Experiment Station plays an all important role.

INVESTIGATIONS COVER WIDE FIELD

Its investigations must necessarily cover a wide and exceedingly diversified field of activity. I would like to list some of the major contributions it has made, any one of which might serve to justify its existence. Missouri has always been known as a livestock state and the station early interested itself in livestock problems. Under the guidance of Dr. H. J. Waters there was established one of the most fundamental and far-reaching investigations ever attempted, dealing with the nutrition and development of animals.

This has been followed by investigations in cattle feeding, both on pasture and in dry lot, swine feeding and improvement, the influence of good sires in beef production, and, more recently, in the field of reproduction of farm animals. A most substantial addition to the farmer's store of knowledge in efficient livestock feeding and management has been made.

In connection with the investigations in dairy husbandry, I would like to mention the name of Professor C. H. Eckles, who inaugurated that study. These experiments dealt with the factors determining superiority in animals for milk production, a development of proper rations, and the factors determining efficient milk production. During recent years the study of hormones which influence milk production has helped explain the variation of production among individual cows.

I would term this field of inquiry of particular usefulness and one affecting not only the farmer but every consumer of dairy products. Milk has been termed "the perfect food." Every step forward in insuring a pure supply of high grade milk for the public is deserving of the gratitude of every citizen of Missouri. And it is noteworthy that the Experiment Station, not content merely to improve the supply at the source, has also entered the field of dairy manufactures and brought about improvements in ice creams, the manufacture of cheese, and in the handling, cooling and marketing of dairy products.

If you will permit me to digress briefly, I would like to call your attention to an issue which presently will be before the voters of Missouri—an issue that concerns producers of milk and other farm products and the consumers of those products alike. It is the proposal to carry to completion Missouri's system of hard-surfaced roads. It is not enough for us to have trunk roads to carry the through traffic; it is vital to the prosperity of our agricultural areas that they, too, have good farm-to-market roads over which to transport their products.
In view of some of the conflicting statements which have been made for and against the proposed highway improvement program, it seems to me that we might paraphrase the slogan of that earlier campaign and say “Lift Missouri out of the muddle.” But it isn’t a muddled issue for the farmer, and it shouldn’t be for the urban resident either. Let us remember one thing more: If we want good roads in Missouri, and especially farm-to-market roads, we have to pay for them.

I know that you will pardon this interpolation for it concerns something that, in my opinion, is linked closely with the development of Missouri’s agricultural resources.

**GAVE FAR-REACHING BENEFITS**

Turning to the subject of veterinary science, the name of Dr. J. W. Connaway comes to mind in connection with his early work in determining the source of Texas fever in cattle and providing means for the control of the ticks through which it is propagated. That discovery affected the whole southern part of the United States and reflected due credit upon the Missouri institution that made it possible.

Likewise the early investigations in the control of hog cholera have meant a saving of millions of dollars to farmers in Missouri and nearby states. More recently, the war on Bang’s disease has added to the Experiment Station’s laurels, as have discoveries in connection with the diseases of poultry and their control.

Dr. J. C. Whitten was the originator of a series of investigations in the field of horticulture, one in which, as you know, I have a special interest. I am on familiar ground when I mention his researches and those of his colleagues in the rest period of plants, the influence of low temperatures on plant tissue and other studies concerning the hardiness of plants. Investigations on the improvement of varieties, the influence of spray residues and the fertilization of orchards have contributed greatly to the well-being of the fruit grower.

The study of virus diseases and the nutrition of bearing fruit trees, along with pollenization studies, have provided information of great value. These and other basic discoveries are of practical value to all horticulturists in understanding the relationship of vegetative and fruiting processes.

The last legislature appropriated a substantial sum for branch horticultural experimental fields, to study these problems on the different soils and in the different climatic regions of the state. A number of these stations have been established and are proving a wise investment for the people of Missouri. In this connection should be mentioned the insect control investigations, including those dealing with the San Jose scale, the coddling moth and other insects attacking fruits and garden crops. Also, the work in entomology has dealt with insects injurious to field crops, livestock and poultry, and means of combating these various insects have been developed.
I would like to review the complete history of the soil survey, from the time it was established by the legislature in 1905, but time will not permit. We may gain an idea of the magnitude of this task in the fact that about half the state thus far has been covered with detailed soil maps.

With the newfound nationwide interest in soil conservation and prevention of erosion, the Experiment Station has an extensive background on which to cooperate with federal agencies. Of course, crop rotation and scientific fertilization of soil have been studied extensively, with beneficial results for Missouri farmers.

The best proof that the Station is a progressive institution, alert to changing conditions and eager to solve farm problems as they arise, is found in its researches in agricultural economics during the depression years. Cost finding surveys, studies of landlord-tenant relationships, improvement of the soil under tenant farming, surveys of farm management methods, studies of land values, studies in marketing and in land utilization are instances of this valuable research.

The fact that Missouri is, primarily, an agricultural state has been recognized by its state government since the earliest years of its history. I might cite as examples of agricultural activities sponsored by the legislature, responding to the will of the people, the State Board of Agriculture and Agricultural Commissioner, the College of Agriculture, the Agricultural Extension Service, this Experiment Station, the vocational agricultural high schools and the State Fair, which is predominantly an agricultural exposition.

Thomas Jefferson once said, “Cultivators of earth make the best citizens.” Missouri now, more than ever before, has need of good citizens, for they are the bulwark of good government and all that good government stands for—unbiased courts and free institutions.

I think I can speak for the whole body of the citizenry when I say that Missouri is proud of this institution we honor tonight and grateful for the service it has rendered over half a century.

CONGRATULATORY MESSAGE

By Frederick A. Middlebush,
President of the University of Missouri.

The University of Missouri Agricultural Experiment Station has rendered, through the years, far-reaching and distinguished service to the agricultural interests of our State and Nation. This service has been rendered at a minimum cost and in a highly efficient manner. These ends could be achieved only through wise, careful, and far-sighted administration and the most loyal and faithful cooperation on the part of every member of the staff. The results which have been achieved should bring to Dean Mumford and his staff great satisfaction and richly deserved honor. May the next fifty years be as fruitful in constructive progress.
AGRICULTURAL EXPERIMENT STATION
RESPONSIBILITIES TO FARM PEOPLE

BY GEORGE WILKERSON,
Farmer, Hughesville, Missouri.

FOR THIS OCCASION I shall not discuss the genesis of the Land Grant Colleges, the subsequent establishment of the Experiment Stations, and the later addition of the Extension Service, except as proof of the continuing willingness of the National Congress to accept agricultural education and research as a national responsibility.

I shall not attempt to catalogue the achievements of the fifty years of service of the Missouri Station, except to show the nature of the services that are your obligation in the years to come. If during this discussion I shall take some short excursions into the debatable ground of agricultural philosophy, may I have your indulgence.

The willingness of the National Congress to accept agricultural education and research as a national responsibility has continued for over 70 years. It traces to two chief causes. First the far-flung and minutely diversified holdings and use of farm land which condition precludes the possibility of effective research by private initiative.

In my opinion it is not the function of government to perform services for any individual group or industry which they can as well do for themselves.

This philosophy may be at variance with the trend of today but 150 years of national life and progress has proved its soundness and the present stagnation in national progress will not be dissipated until we return to its practice.

Secondly the willingness to accept this national responsibility is based on the universal acknowledgment of the fact that American rural life is a national asset.

RURAL AMERICA’S BEST CROP

"By their fruits ye shall know them." For more than two centuries the best fruit of American agriculture has been the boys and girls, bred and reared in rural America, who taking little with them but the health, character and training acquired in a farm home, have gone to the growing American cities and there taken their places among the social, religious, business and professional leaders of these their adopted communities.

I cannot conceive that the breed of men that has conquered a continent, that has fed and clothed a nation for two centuries, and at the same time sent its sons and daughters to leadership in all the nation’s activities, can fail to produce the leadership that will solve the problems depressing us today.

"Rural life still is a national asset," said Mr. Wilkerson, "and now as never before that fact is uppermost in the minds of national leaders."
The Experiment Station is the research department of the industry. For its efficient functioning there must be the College and the Extension Service. To give it life and usefulness there must exist a fourth side to the structure, that is the constructive cooperation of the people on the land.

This cooperation has not been much publicized but it is the life blood of the whole body of agricultural education and research. Without it the whole thing is purely academic; with no proving ground for the theories investigated, no returns on the investment.

This cooperation is in a way the control factor in the machine. There is an exact parallel in the industrial world. Every great industry has set up a research department and they control it as part of their industry.

Based on their past and present experience in making steel or rubber they have experts in each department in their business, investigating new methods, new uses for their product, better marketing practices, all the manifold problems of any human activity. These new practices are tried in the industry without any interruption of normal production. The good ones are adopted and become standard practice of the industry.

The same results are obtained in agriculture through cooperation. I wouldn't go so far as to say the cooperators are in control, but they get heard from now and then, for the problems are their problems and their solutions can find value only on the land.

**The Station's First Obligation**

The first obligation then of the experiment station is to foster this constructive cooperation. On this count the record of the Missouri Station is good. The attitude of both the college and the people on the farms has led to a very healthful condition in Missouri. To be sure, many Missouri farmers still pose as skeptics on scientific agriculture and as critics of the experiment station and the extension service. Most of them however are following farming and livestock practices which had origin in research work done in Columbia, Missouri.

In proof of this last statement may I briefly catalogue a part of the improvement that has come to Missouri Agriculture through research work at the station.

Starting with soils, Missouri has pioneered in research in soil erosion and its practical control, both by mechanical means and by crop rotation and crop coverage. The increased use of limestone and commercial fertilizers speaks volumes for the work of the soils department and their cooperators. Soil management and erosion control are major factors in the state's farm program.

Crop production in Missouri offers many very striking examples of the rapidity with which new crops and improved varieties can become
standard in the industry through constructive cooperation of the Experiment Station with such farmer controlled agencies as the Missouri Corn Growers Association.

Korean lespedeza is grown on a majority of Missouri farms. Missouri Early Beardless barley is almost as widely spread. Early Premium wheat has become standard. Columbia oats surpasses the combined total of all other varieties. Soybeans have become a major crop. The short rotations involving these new crops and varieties are gaining ground with great rapidity. Research in pasture improvement promises a full development of one of the state's major resources.

In animal husbandry the results are equally significant and the cooperation even more effective. Better sires, graded lambs, hog sanitation, all down the line there has been a steady and valuable improvement. Missouri is practically tubercular free, and contagious abortion is on its way out.

Dairying has gone forward incredibly and Missouri research has been a controlling factor in its development.

Agricultural engineering has many results to add to the picture of improvement.

Horticulture is a major activity in the state and the research work in this department has been an invaluable adjunct in its development.

And this brings us to insect pest control. Perhaps this offers the outstanding illustration of cooperation by Missouri farmers. When it became apparent from the research surveys of the Department of Entomology that Missouri was about to suffer a very serious infestation of grasshoppers in 1938, steps were taken to meet the menace.

We have quite a Governor in Missouri. He is a farmer, and a cooperator. At his instance there is an insect pest control committee in every county in Missouri, on which committees every municipal township in the State is represented. And at last reports cooperation had scored a new high.

So it is pretty hard for any Missouri farmer to live on a Missouri farm and not do something that had its genesis at the Experiment Station. He almost has to kill a few grasshoppers, or raise a little lespedeza or vaccinate a pig or two.

IMMENSITY OF SERVICE

The question proposed on your program is: "What are the responsibilities of the Experiment Station to the people on the farms?"

Most of these responsibilities are indicated in the record of achievement which I have presented to you. It is your responsibility that constructive work in finding the answers to recurring problems in Missouri Agriculture shall as in the past go on in good times and in bad times, and you don't have to solve the riddle of the universe or find a short cut out of the depression. The problems of the Experiment
Station are the problems of seed time and harvest. Of better cultural practices and better land use. The control of all the scourges that work in opposition to man’s best efforts on the land. The solution of these problems adds up into a lot of man’s-size jobs and calls for the best brains the college can develop. 

These are duties it takes years of study and training to assume, and years of intensive and whole-souled work to achieve results. It is a career for the chosen few whose talents can here find dedication to the advancement of the greatest of all the arts and sciences. It is work for specialists and we have them on the job.

In all times of stress throngs of dilettante swarm in the market place and in legislative halls, with panaceas for relief. The background of most of these self appointed Moseses is so meager in technical training and in information that they do not even know that their visionary panacea has been tried with dismal failure in some previous emergency in the world’s progress toward better things.

The greatest responsibility of the Station and of the College to the people on the farms and to the American Nation is to see to it that no hunting for short cuts out of this deplorable depression shall interfere with the steady forward march of agricultural education and research.

Equal opportunity through education is the genius of America. Fulfillment of that ideal was the course charted by a sane people at a sane time in their career. On that course in a few decades we have gone farther toward the betterment of mankind than any people in the world’s long history. That course leads to better opportunity for our children’s children. On that course we have come from small beginnings to magnificent maturity.

It is your responsibility and mine to see that no short-term program, undertaken in desperation, shall swerve us from this true course of our destiny.

The mind of man can conceive of no other road to equal opportunity than enlightenment. By education and enlightenment trends can be put in motion that can do more than legislation can ever do; that is, cause people to want to do things right.

We must keep the land so that the land will keep us and all generations of men. We must keep all the values of American rural life, for these values are the foundation of America’s history as they must be the basis of America’s future.

I believe that the Missouri Experiment Station and the men who have led its thoughts during the fifty years of its service have had a profound and saving influence on Missouri agriculture.

Practices in harmony with sound agriculture are in operation on thousands of Missouri farms.

It is with regret that we see the director of the station, our beloved Dean Mumford, retiring after years of service that show a net
result of outstanding growth and development in Missouri's College of Agriculture, its Experiment Station, and its Extension Service.

It is with joy that we welcome his successor. May he meet his obligation to keep the high standards of this institution high. We know Dr. Miller. We know that his work during the years has been one of the prime factors in the development we have witnessed in the service of this institution to Missouri Agriculture.

On behalf of the Cooperators of Missouri, Dean Mumford, you have our thanks for a work well done.

Dr. Miller, on behalf of all the farmers of Missouri I pledge you a growing cooperation in the work you are to do.

THE FARM PEOPLE'S USE OF THE WORK OF THE AGRICULTURAL EXPERIMENT STATION

BY TOM BRISCOE,
Farmer, Tipton, Missouri.

PROBABLY NO FARMER IN MISSOURI is more appreciative of the work of the Missouri Agricultural Experiment Station during the last half century than I am, and I dread to think what our system of agriculture would be today in our great state if it were not for the findings of our own and other experiment stations throughout the country.

Our Experiment Station is financed by State and Federal appropriations. I have looked up the Federal appropriations and I quote the amounts and purposes given. The Hatch Act, passed March 2, 1887, provided an annual appropriation of $15,000 to establish, in connection with the Land Grant college in each state, an agricultural experiment station for the purpose of promoting scientific investigations and experiments respecting the principles and applications of agricultural science.

The Adams Act of March 16, 1906 provided an additional $15,000 annually for each state for conducting original researches or experiments bearing directly on the agricultural industry in the United States.

The Purnell Act of 1925, gave to each state, in addition to the $30,000 provided by the Hatch and Adams Acts, $20,000 for the year ended June 30, 1926 with an annual increase of $10,000 a year, for experiments and investigations bearing directly on the production, manufacture, preparation, use, distribution and marketing of agricultural products, and such economic and sociological investigations as
have for their purpose the development and improvement of the rural home and rural life. The total Federal aid to the agricultural experiment stations will at maturity of the Purnell Act amount to $4,320,000 annually.

So much for the financing of our agricultural experiment stations.

The Missouri Experiment Station as an institution has been charged with the responsibilities above mentioned.

We are indebted to our Experiment Station for our present efficient crop rotations, approved methods of cultivation, the new crops which are introduced to fit changing economic and climatic conditions, new and improved varieties and seed, approved fertilizer practices, and the present efficient methods of livestock production and management.

If the individual farmer is to adapt and maintain permanent systems of profitable agriculture, he cannot accept "parrot" instruction, he must know the why and wherefore, the reason for doing things and the ultimate effect of his agricultural practices on the entire farm enterprise.

TEACHINGS BUILT ON FACTS

Leading and progressive farmers know that all experiment station teachings and recommendations are built upon facts, and through the years, we find such farmers accepting these facts and putting them into practice without hesitation. It is to this class of farmer that we in turn owe the general adoption of these sound practices by the majority of farmers who adopt them only after seeing them in practice in their home communities.

We are well acquainted in Missouri with the corn, oats, wheat and clover rotation—the result of experiment station findings. This same institution brought to us the small grain—Korean rotation, barley, soybeans and many others. As progressive farmers we apply lime and phosphate to our soils in Missouri. Why? Because our Experiment Station has found and demonstrated to us the need and value of such practices.


The progressive livestock producer and poultryman feed balanced rations, the former using protein supplements for different classes of livestock, the latter for growth and efficient production and again we do these things because of Experiment Station results.

We terrace land, because nineteen tests from five different experiment stations show that the annual loss of soils on terraced land is 3 tons per acre, whereas on unterraced land the soil loss is 17 tons.
Our Missouri Experiment Station tells us that the annual soil loss on a 4% slope is 20 tons per acre on land in continuous corn, whereas the soil loss is only 3 tons where a rotation of corn, wheat and clover is followed. Therefore our progressive Missouri farmer follows the proper rotation.

Another reason why we farmers in Missouri use such a rotation and many of us keep a good sized acreage in sod is because our Experiment Station results show that land of a 4% slope will lose 7 inches of top soil in 50 years planted to corn continuously and if in a rotation of corn, wheat and clover it would take 368 years to lose this top soil, and 3000 years if in bluegrass sod.

**Farmers Believe in Station**

Our Missouri Experiment Station has proved that soil losses on land in grass are negligible, while the losses on land in grain or fallowed are as follows: wheat 10 tons per acre, corn 40 tons per acre, and land fallowed 60 tons per acre per year. Therefore we take these truths and adjust our farming systems accordingly.

Our Experiment Station here at Columbia conducting a 5-year-old experiment conclusively has shown sound rotations increase farm efficiency. It shows that the corn yield from continuous cropping is 19 bushels per acre as compared to 41 bushels per acre in a four-year rotation of corn, oats, wheat and clover. It shows 17 bushels of oats as against 28 bushels in the rotation, and 10 bushels of wheat when grown continuously as against 24 bushels in the same rotation.

With my own Experiment Station teaching me these truths, I naturally try to follow all its recommendations.

Let’s turn to livestock. We have been shown again and again the value of purebred sires. Results at the Missouri Experiment Station show that lambs sired by purebred rams weighed 60 pounds at 3 months, while lambs sired by scrub rams weighed 56 pounds at 4 months, that the value of the first group was $4.38 per head as against $2.52; yet many Missouri farmers never use a purebred ram.

Again, in the case of beef cattle, Experiment Station results show that the cost of feed per 100 pounds gain was $5.00 on animals from scrub dams and sires, $4.18 on animals from scrub dams and registered sires, and only $3.75 from high grade dams and registered sires.

The average daily gain on the other hand showed 1.25 pounds for the scrub, 1.75 pounds for the second group and 1.91 pounds for the third group. Naturally I keep high grade cows and use good registered bulls.

I want to mention just a few of the things on my farm for which the Experiment Station is directly responsible. I have 30 miles of well constructed terraces, several well constructed rock dams, several grass waterways, 500 acres limed, 250 acres good sweet clover, 20 acres alfalfa, 100 acres Korean lespedeza, 90 acres of corn planted
on contour with terraces, 10 acres Atlas sorgo for silage, 75 head good grade Hereford cows, 2 good purebred Hereford bulls.

I could go on and on, bringing out the many truths our experiment stations have brought to the American farmer, but the only way by which we farmers can benefit from these teachings is to put them into practice.

In a paper of this kind we cannot but mention the agency largely responsible for bringing these truths out in the country to the farmer—the Extension Service. All of its teachings and demonstrations are based 100% upon the findings of our Experiment Station.

In closing, I would mention again, that without the findings of our Missouri Experiment Station during the last half century, most of us would not be following the countless efficient methods on our farms, and we take our hats off to our Missouri Experiment Station on this, its Fiftieth Anniversary.

Waters Hall, named in honor of Dr. Henry J. Waters, director of the Missouri Experiment Station from 1895 to 1909. In this building are located the offices and smaller laboratories of the Departments of Field Crops and Poultry Husbandry, the Seed Testing Laboratory, and the administrative offices of the Agricultural Extension Service.
INDUSTRIAL DEPENDENCE ON AGRICULTURE

BY W. A. COCHEL,
Editor, Weekly Kansas City Star.

AGRICULTURAL EXPERIMENT STATIONS are provided with federal funds collected from all citizens. Although devoted primarily to research of immediate value to farmers the results secured are used as a basis for industrial development. There is latitude under the various acts of Congress to use federal funds for almost any problem which confronts farmers. Anything which results in the development of a better and more profitable system of farming has a direct influence on industrial development. The packing industry, the dairy industry, the poultry industry, the textile industry, the milling industry, the soap industry, the fruit and vegetable industries are entirely dependent for volume of business upon the farm production of both raw and finished products. Manufacturers of farm machinery, farm home equipment, fertilizers, insecticides and farm equipment base their operations on prospective production of farm commodities.

Transportation agencies depend upon agricultural production for a considerable proportion of their business in moving farm crops and livestock to central points and returning manufactured goods to the farms. The various exchanges which handle livestock, grain, hay, fruits, vegetables, poultry and dairy products flourish or wane with the ups and downs of farm marketings.

The agricultural experiment stations in their efforts to increase the efficiency of the farmers by better use and management of soils, higher yields of crops, increased production from livestock, prevention of loss from insects and diseases and improvement of the grade and quality of all farm products contribute directly to the volume of business of industries directly dependent upon agriculture.

The training which men get in research work at the experiment stations opens up a wide field of opportunity for employment in industrial establishments. In this way they contribute to the efficiency of the personnel of industrial employees. One of the chief difficulties which those who direct research work in the stations have to meet is the maintenance of a well trained working staff. When a research worker establishes a reputation for outstanding ability in his work, executives of industrial establishments are apt to offer better inducements not only in remuneration, but of more importance, better facilities for broader and more significant work in his chosen field. Much of the research now carried on by large industrial establishments is directed by men whose training was secured in investigational work at experiment stations.
Frequently problems under investigation not only have a bearing upon volume of production of raw material for industrial organizations but upon the improvement of the quality of the finished product.

**Research Benefits Many Fields**

Millers are directly concerned with the types of wheat developed by plant breeders. They study not only the percentage of protein but the quality of the protein which may insure flour of greater value in the making of bread.

Packers utilize the information gained in experimental feeding of livestock because of the possible influence of feeds not only in effective dressing percentages but the quality of the meat, the color and melting point of fats and the influence exerted in the process of curing and refining of meat.

Fruit and produce dealers make use of all possible information available in the effects of soil treatment upon color, shipping and storage of the product.

Wholesale dealers in dairy products give particular attention to color, vitamin content and hardness of fat in the milk which they distribute. Herd management as determined by station investigators is a dependable source of information by which the wholesomeness as well as sanitary quality of dairy products are determined.

Manufacturers of fertilizers, insecticides and fungicide consider the work done at experiment stations and substations essential to the mixing of materials and for trying them out under field conditions before they can be offered for sale with full confidence of effective use.

Practically all biological products used in the treatment of diseases among livestock and human beings trace back to research work done by experiment stations frequently in cooperation with other agencies. If these products are not directly the result of station work they are worked out upon the principles which station workers have devised and perfected.

The manufacturers of soap and paint furnish a market for non-edible fats and oils produced on the farms. They also use edible fats which have the peculiar properties which are needed in the manufacture of their products.

The development of plastics from animal and plant sources, the production of lumber substitutes, paper and fuel oils are infant industries which may have a potent influence upon farm practices in the future. The agricultural experiment stations have a wide field of investigation along these lines.

Farm machinery manufacturers take the results of investigation of soil erosion or conservation of soil moisture as the starting point for the building of implements to put this information into use. The terracing and ditching machines in the humid districts and the basin
lister and tillage tools used in the sub-humid sections of the country are the direct result of station investigations which have to do with control of soil moisture.

Agricultural research designed primarily to improve systems of farming ramify into many places which those in charge have not anticipated. It frequently happens that the most competent research worker does not have the desire even if he were otherwise qualified to extend his activities beyond the immediate field in which he specializes. The large industrial organizations supplement the research workers by directly applying the facts which they have discovered or disclosed to practical use. The coordination of research findings with industrial problems frequently gives a finished product that is of real value both to industry and to agriculture.

EXPERIMENT STATION OBJECTIVES AND ACCOMPLISHMENTS

BY F. D. FARRELL, President, Kansas State Agricultural College

NOTWITHSTANDING man's many admirable qualities he has some serious defects. One of the most serious is that his knowledge is often inadequate to his needs. It has been known for a long time that man's inadequate understanding of the forces with which he must contend is one of his greatest handicaps.

William Shakespeare, who died in the year 1616, made one of his characters say that man is "most ignorant of what he's most assured" and that, because of his ignorance, he "plays such fantastic tricks before high heaven as make the angels weep."

Nearly three centuries later a somewhat facetious, but nevertheless suggestive, view was expressed by an American humorist, Josh Billings, I believe. He said, "The difficulty is not so much that we know so little as that we know so many things that aren't so."

Knowing none too much and knowing at least some things that aren't so, we all need the services of institutions that will help us to find the truth. This probably is no more true of farmers than of any other fraction of the population. But truth for the farmer is of special significance to society for the reason that society as a whole is peculiarly dependent upon the farmer. If the farmer "plays fantastic tricks before high heaven" he is not the only sufferer. "The angels weep" not only for him but also for everybody else.

It is the function of scientific research to help to free man from his bondage to ignorance; to provide truth in place of superstition and misunderstanding. Essentially, this function comprehends the objectives of the agricultural experiment station.
Truly scientific research is a comparatively new activity. Until quite recently man sought solutions to his problems through argument and through appeal to authority. This is illustrated by an old legend. It is said that for years ancient philosophers argued about the number of teeth in a horse's mouth. There was much oratory. Authorities were quoted in support of divergent beliefs on the subject. The arguments went on and on, year after year, but got nowhere. Finally, somebody had a truly scientific inspiration. He settled the argument in a thoroughly scientific manner. He went into a stable and counted the teeth in the horses' mouths.

The instance is legendary, of course. But it is enlightening nevertheless. Right now there are millions of us twentieth century Americans who argue about questions that can be answered only by research, by actually finding out the facts. Millions of us know "things that aren't so" about the climate and the weather, about prenatal influences in man and in farm animals, about the soil and plants and insect pests, about prices and money and credit, about education, and even about government and politics!

Man's need for the results of scientific agricultural research increases as the agricultural difficulties of his environment increase. When America contained hundreds of millions of acres of rich, virgin soil, the farmer disposed of his soil problems largely by running away from them. The ancient Maya people in Central America and Mexico are said to have followed this practice for hundreds of years. When there was no more virgin soil available to them, they became impoverished and weak and were easy prey to their enemies. That ended their remarkable civilization. So far as we know they had no agricultural experiment stations. If they had had these useful institutions their civilization might possibly have persisted to the present time.

**Farmers Saw Need For Science**

When the United States was a century younger than it is now, farmers from the old agricultural districts on the Atlantic seaboard overflowed in great waves onto the rich lands of the Mississippi Valley. As the Valley filled up and as there was no similar region to which to migrate, the farmers became increasingly aware of their need for science in coping with the agricultural problems of their environment. Their need gave rise to the land-grant colleges three quarters of a century ago, and to the agricultural experiment stations a half century ago. It is important to recognize that the agricultural experiment stations were established deliberately to find out agricultural facts—"to count horses' teeth"—and to interpret the facts and disseminate them throughout the agricultural community.

The State of Missouri occupies a prominent place in the history of the agricultural experiment stations. William Henry Hatch, a Mis-
souri member of the National House of Representatives, as chairman of the House Committee on Agriculture and Forestry, sponsored a bill that bears his name and that was the first act of Congress to provide Federal aid for the agricultural experiment stations. It was the Hatch Act of March 2, 1887.

Even before the passage of the Hatch Act, agricultural research work had begun in a small way in Missouri as in several other states. Soon after the Hatch Act became a law, the State of Missouri accepted its provisions and in 1888 the Missouri Agricultural Experiment Station was formally established.

It would require much more time than is available to mention and comment upon all the notable accomplishments of the Missouri Agricultural Experiment Station. But I shall mention a few achievements of fundamental importance not only to the farmers of this state but also to farmers generally and to the public. It is gratifying to note that many of these achievements have occurred during the incumbency of several members of the present staff of the station, notably Dean F. B. Mumford and Professor M. F. Miller, who soon will succeed the dean. It would be difficult, if not impossible, to overstate the value of the services of these men and their associates at the Missouri Agricultural Experiment Station.

If I were required to describe in one sentence a notably distinctive feature of the work of the Missouri Station, I should say that the Station consistently has pioneered in research upon agricultural fundamentals. The Station has engaged successfully in the search for fundamental truths about soils and plants and animals and about various other subjects of basic importance to agriculture.

More than 20 years ago, when the now all-too-familiar expression, "soil erosion," was scarcely heard of, the Missouri Station was engaged in a comprehensive study of the fundamentals of the subject. The Station's work on the relations of vegetative cover to soil erosion has become classic. The results of this work are perhaps the most reliable guide now available for use in the nationwide program of soil erosion control. Among other facts, this research has proved that...
by varying the nature of the vegetative cover of a tract of land we may cause the average runoff of rainfall to range from as little as 12 per cent to as much as 31 per cent; and that we may cause the annual loss by erosion of surface soil to range from as little as one-third of a ton to the acre to as much as 41 tons to the acre. These discoveries are of profound practical significance. They are invaluable for disabusing people’s minds of “things that aren’t so” about soil erosion and for guidance in the development of programs to conserve the last refuge of the human race—the soil.

Comparable pioneering work has been done at the Missouri Station in the study of soil colloids and of base exchange in the soil solution; and also in the study of the fundamentals of the conservation and improvement of the supplies of soil nitrogen and of organic matter in the soil.

In the study of field and orchard crops, the Station has done much fundamental pioneer work. In this area, the Missouri research in plant genetics is particularly noteworthy. The work of Dr. Stadler and his associates in the use of X-rays and of ultraviolet radiation to induce mutation in plants, reaches to the very foundations of plant breeding and crop improvement. It has brought world-wide fame to the Missouri Station. It is contributing vastly to the increase of man’s power over the forces of his environment with which he must contend.

A PIONEER RESEARCH PROJECT

More than 30 years ago, when the knowledge of animal nutrition was essentially chaotic, the Missouri Station was conducting fundamental research described as an “inquiry into the composition of the carcasses of cattle at different ages, different stages of development and in different conditions of fatness, or an attempt to ascertain to what use steers of different ages, on different rations and in different conditions of fatness put their food.” This research produced a great body of fundamental data, anatomical, physiological and chemical, on the subject of beef cattle nutrition. Continuance of the work with many improvements and refinements of technique, has produced a steady flow of practically useful and scientifically stimulating facts regarding beef making. This one pioneer research project, like each of several other projects of the Missouri Station, probably is worth more in dollars and cents to the American farmer each year than the support of the entire Station has cost during the past half century.

As you all know, Missouri is an important dairy state. It is said that when the Department of Dairy Husbandry was established at the Missouri Station at the turn of the present century, its inventory consisted in a “small herd of Jerseys, a cream separator and a churn.” But the Department had at least one asset not shown on the inventory: it had C. H. Eckles, an original and stimulating thinker
whose influence upon research on dairy animals became world-wide. Eckles and his associates and his able successors at Missouri have brought floods of light into the hitherto dark places of dairy cattle development and nutrition. This work, like so much of the other work of the Missouri Station, is fundamental. It involves normal growth standards, energy metabolism, milk secretion, the influence of nutrition upon the composition and quality of dairy products and other fundamentally important subjects. Recent studies of the role of hormones in udder development and milk secretion, reveal possibilities for the improvement of the dairy industry that were not even imagined a half century ago.

These are only a few of the accomplishments of the Missouri Agricultural Experiment Station. And even these few are inadequately described. Research work through the years upon problems of soil conservation and improvement, plant improvement, animal breeding, feeding and management, the control of insect pests and diseases of plants and animals, and more recently, upon the economic and sociologic aspects of agriculture, is making contributions of increasing value. My brief comments regarding a few typical accomplishments may suggest something of the value of the Missouri Station to the State and the Nation.

The intellectual and spiritual significance of scientific research projects deserves special mention. We have not said all that should be said when we have mentioned the economic value of scientific work. The discovery and announcement that the earth is not flat had great economic importance. But it had even greater intellectual and spiritual significance. It affected profoundly the minds and the spirits of human beings. So it is, in greater or lesser degree, of the results of all scientific research. Whether the scientist studies the stars or the soil, the heavens or the earth, his findings may have immense cultural value. There is potentially as much genuine culture in understanding a pig or a strawberry as there is in understanding a star or a piece of fine statuary. The significance of scientific agricultural research is not limited to its economic importance. Its value in freeing our minds of the incubus of “things that aren’t so” and in increasing our understanding of the world in which we live, of course, incalculable; but it certainly is very great.

**HAS DIFFICULT RESPONSIBILITY**

In fulfilling its function—to find the truth about the multifarious problems of agriculture—the agricultural experiment station has a difficult but inescapable responsibility. It is responsible first of all to the agricultural community. But it is no less certainly responsible to the general public, by which it is owned and supported. It is a responsibility of the agricultural experiment station to seek the truth about agricultural problems, no matter where the quest leads; and,
having found the truth, to proclaim it without bias, fear or favor and in intelligible terms. Not infrequently the truth is painful to certain interests, sometimes to certain agricultural interests. But it must be told if the experiment station is to merit the respect and confidence of the public.

In discharging its responsibility to find the truth and to proclaim it, the experiment station has achieved its greatest accomplishment. It has established itself as an institution to which any citizen may go for unbiased, disinterested, reliable information about the problems of agriculture. Such an institution is a precious public possession. It is noteworthy and gratifying that such an institution is maintained on a constantly rising plane of usefulness by an average contribution of a few cents a year by each farm owner and each other taxpayer. I am confident that most of you who live in this state would be astonished to learn how small a part of your annual tax bill is contributed to the support of the Missouri Agricultural Experiment Station.

The Missouri Station has been unusually fortunate in the continuity of its administration. Most of its 50 years of existence has been covered by the directorships of two men, the late Henry Jackson Waters and Dean F. B. Mumford. Dean Mumford, now “full of years and honors,” has been director for about 60 per cent of the half century since the Station was established. No small part of the distinguished success and favorable world-wide reputation of the Missouri Station must be attributed to the continuity and stability of its administrative leadership.

The people of Missouri, indeed the people of the entire nation, may well be proud of the Missouri Station. Its function is to serve the public by contributing to the understanding and the solution of the problems of agriculture. It has not faltered in the pursuit of that objective. It has kept the faith.

Fifty years from now, when most of us are dust, there probably will be a celebration of the centennial of the Missouri Station. On that far distant day the celebrants no doubt will cite instances of even greater accomplishments than may be announced today. But it is virtually certain that in doing so they will point to the foundations laid during the first half century as having made possible the accomplishments of the second 50 years.
Fifty Years in the Service of Agriculture

Fifty Years of Agricultural Experiment Station Work

By Frederick B. Mumford,
Director of the Missouri Agricultural Experiment Station.

The rapid progress of agricultural education is in many respects one of the most remarkable and significant developments in the educational history of the United States. This development is the more remarkable in that it represents to some extent a protest against the earlier educational philosophies. The colleges of agriculture were organized to provide a type of education and of service which existing institutions did not provide and whose educational ideas were not deemed worthy of the attention of the so-called literary colleges of the 1860’s.

In so far as the early educational philosophies still control the administrative procedures of a considerable number of educational institutions of influence and authority, these colleges of agriculture continue to represent a type of education not yet accepted into full fellowship by the more conservative institutions of higher learning. It is therefore still true that the colleges of agriculture have continued to develop in spite of and not because of any considerable enthusiasm on the part of educational ideologies which have been inherited from the past.

The colleges of agriculture owe their existence to the federal government whose generous contributions to their support have continued in increasing appropriations as these institutions have more and more completely justified the visions of the founders. Following the lead of the federal government in establishing these institutions, each of the several states has generously provided additional funds for their support. There is abundant evidence that the colleges of agriculture have been generally successful in convincing the appropriating bodies of the essential values of the type of education and service rendered. It is therefore of some importance in considering the probable future relations of government to education that if possible we discover the reasons for the progress of these institutions. It seems to the writer that we must recognize the fact that the fundamental motive in the establishment of these institutions was service to agriculture and rural people. In all the hearings before Congress and in all the arguments before State legislatures, emphasis has been placed upon the fact that these institutions are organized for the purpose of training students to succeed in a rural environment. True, the Morrill law clearly envisioned an education for the industrial classes, including not only agriculture but mechanic arts. However, all the subsequent important appropriations for these institutions have been
for agriculture through the agricultural experiment stations and agricultural extension services.

The agricultural experiment stations were established to solve the problems of agriculture by means of scientific research. It is still true that governments are willing to support these institutions with enthusiasm if they have been true to the trust imposed upon them in the beginning and if they can demonstrate that they have rendered a real service to the agricultural industry and to rural people.

The second reason for the continuing support of appropriating bodies is, that the colleges of agriculture, the extension services, and particularly the agricultural experiment stations have proved through the years that they do and can render the service originally contemplated. It has become more clearly apparent as the years go by that the agricultural experiment stations not only serve agriculture and rural people but have made important contributions and accomplished significant services to all firms and corporations dealing in agricultural commodities or whose market is chiefly among farm people. Perhaps no type of institution has been so generally approved by farmers, chambers of commerce, bankers, industrial organizations and manufacturers as have the institutions devoting themselves to agricultural research. It is now fully recognized by all students of our national economy that service to agriculture is in the interests of the public welfare, and many have supported the colleges of agriculture on this theory.

The Morrill fund made available by Congress in 1862 provided for the establishment of colleges of agriculture and mechanic arts for the education of industrial classes. It did not provide for agricultural experimentation.

**EARLY YEARS WERE DIFFICULT**

The first twenty-five years following the establishment of these colleges of agriculture were years of controversy, criticism and of disappointment on the part of those people who were supposed to be the beneficiaries of this type of education. These institutions were a disappointment both to the administrators and to the farmers who had builded high hopes upon the value of these colleges for solving the increasingly troublesome problems of agriculture.

These early years in the history of the colleges of agriculture must be regarded as unsuccessful. Sincere efforts on the part of those in charge to make them efficient failed to satisfy the friends of agricultural education.

Looking back over the development during these years, it is now apparent that the major reason for the failure of these institutions was, that there was no adequate body of knowledge which could be organized, systematized, and put in teachable form. It was not until the establishment of the agricultural experiment stations, made
possible by the Hatch Experiment Station Act of 1887, that such knowledge began to accumulate. As a result of the work of the agricultural experiment stations, we may now credit the beginning of the success of all agricultural teaching, including extension teaching, to the work and progress of the agricultural experiment stations.

The agricultural experiment station and its work are fundamental to successful college teaching and are essential to a successful agricultural extension program. This fact is clearly recognized by the administrators of land-grant colleges at the present time. If, therefore, the agricultural experiment station is in fact the very foundation of all the other activities of the land-grant colleges, it is of primary importance that these institutions continue to utilize the highest skill and techniques of modern scientific research for the solution of agricultural problems. While these institutions are founded for the express purpose of serving agriculture, it does not follow that they are not at the same time making great contributions to science as such; but the primary function of these institutions is service to agriculture.

This definite relation to agriculture and rural life is exceedingly important. Every grant of money to agricultural experiment stations made either by Congress or by the individual state has been given on the basis of the need of agriculture and farm people for such service. The funds have not been made available for general education or for the advancement of science per se. The evidence is very clear that the justification for the expenditure of public funds for these purposes is to be measured by the extent of their services to agriculture.

The Missouri Agricultural Experiment Station was actually established by the University Board of Curators on January 31, 1888. Previous to this action and before the biennial meeting of the Missouri General Assembly, Governor Albert P. Morehouse had accepted the federal grant providing $15,000 annually for agricultural experimentation. The general assembly of Missouri did not give its assent as required by law until the regular meeting of the legislature in 1889. The resolution accepting these grants for the Experiment Station was dated June 11, 1889 and reads as follows:

"Be it resolved by the General Assembly of the State of Missouri, assembled in first regular session since the passage of the within named Act,

"That the assent of the State of Missouri is hereby given to the purposes of the grants set forth in the Act of Congress hereinbefore in this resolution set forth."

This federal law, known as the Hatch Act, must be regarded as the beginning of an entirely new governmental policy of far-reaching consequence and destined to exert a profound influence on the growth and development of colleges of agriculture; on the methods and practices of agricultural enterprise; on the utilization of scientific research in
a primary industry; and to exercise a significant influence on all education in the United States.

MISSOURI SUPPLIED DISTINGUISHED LEADERSHIP

It is of more than passing interest to Missourians that this legislation bears the name of Colonel William H. Hatch of Hannibal, Missouri, a Missouri Congressman whose vigorous support of this legislation is largely responsible for its passage. He was ably supported by Honorable Norman J. Colman, another Missourian, the first Secretary of Agriculture and a man of wide influence in the early history of agricultural development in this country.

The establishment of the Experiment Station at the University in 1888 was not the beginning of agricultural experimentation at this institution. As early as 1886, the University published results of a study of the composition, structure, and distribution of soil types collected in Missouri. In 1859, a leaflet was published on the fruit-growing possibilities of south Missouri. A test of varieties of farm crops was reported in 1870. Horticultural experiments were reported in 1877; feeding of live stock in 1882; veterinary researches in 1885; and results of experiments in agricultural chemistry in 1886.

So great was the interest of the administration of the University in these reports of experiments that from 1876 to 1886, nineteen agricultural bulletins were printed in the annual catalog of the University. These reports covered the whole range of agricultural enterprise. Two of the most important were reports by Dr. Paul Paquin relating to diseases of the domestic animals and by Dr. J. W. Sanborn on feeding for lean meat.

These bulletins and reports were issued by the University authorities before any serious consideration had been given to the establishment of a division to be known as the Agricultural Experiment Station. They are undoubted evidence of the great interest in research and its importance even in a College of Agriculture.

The first director of the Experiment Station was Dr. Paul
Schweitzer, who held this position for six months, from February 1 to July 5, 1888.

Dr. J. W. Sanborn was appointed director on July 5, 1888. He remained in the position of director for about one year. He was responsible for the establishment of the soil experiment field which bears his name. His administration was tempestuous. He was a man of decided opinions and of uncompromising disposition. An item in the Columbia Missouri Statesman at the time reports that “Professor J. W. Sanborn, dean of the agricultural college, appeared before the board in his own behalf and was given a respectful hearing but to no purpose, and by resolution he was removed from any and all connection with the University, his removal to take effect at once.”

It is interesting to note in this connection that the first dean of the College of Agriculture, Dr. George C. Swallow, was likewise dismissed. The June 23, 1882, issue of the Columbia Missouri Statesman reports a meeting of the Board of Curators at which meeting “the chair occupied by George C. Swallow, Professor of Agriculture and Natural History and Dean of the College of Agriculture, was declared vacant after July 1, 1882.”

The Missouri climate was apparently very unhealthy for agricultural deans in the early history of the College of Agriculture. On the retirement of Director Sanborn the Board of Curators appointed Dr. Edward D. Porter of the University of Minnesota to direct the affairs of the Experiment Station beginning in 1889. He continued until his death on January 5, 1894.

The College of Agriculture was established at the University of Missouri in 1870, after a long and bitter struggle in the Legislature. The delay of eight years after the passage of the Morrill Act in establishing the College at Columbia seemed to be due primarily to the feeling on the part of the friends of agricultural education that a college of agriculture could not be successful if associated with the University of Missouri. This antagonism persisted after the establish-
ment of the College of Agriculture and was a factor of great difficulty and embarrassment to the University for many years.

It is difficult to understand the intense antagonism of the farmers, horticulturists, and leaders in agricultural thought in Missouri to the College of Agriculture in its early history, unless we keep in our minds the bitterness of the struggle antedating the establishment of the College of Agriculture at the University. While the Morrill land-grant was available in 1862, it was not until 1870 that the legislature finally located the College of Agriculture at the University in Columbia.

The establishment of the College of Agriculture at the University was hailed with satisfaction by the administration of the institution, but it was only the beginning of the bitter struggle and continued turmoil centering around the College of Agriculture and later the Experiment Station. The bitterness of this struggle persisted for many years and greatly affected the work and progress of the Agricultural Experiment Station. It may be truthfully said that the first twenty-five years of the history of the College of Agriculture and of the Experiment Station for seven years of that period was a time of bitter and violent criticism of the institution by representative farmers of Missouri. This criticism was leveled primarily at the University on the assumption that the reason the College of Agriculture was failing to meet the high level of excellence which the people of the State had believed possible in the beginning was in some manner the fault of the University. The friends of the College of Agriculture failed to realize that the land-grant itself provided a very modest income to the institution, that the income of the University was very small, and that conditions generally in the State and in the University were not favorable for the development of an institution having the ideals and ideas essential for its development. It seemed that the authorities in charge of the institution were attempting to give to the farmers an education that they thought the farmer ought to have and failed, according to the farmers, to give the kind of an education that the farmer wanted and believed necessary.
It was assumed by the friends of the Experiment Station that so large a sum as $15,000, available under the Hatch Act, would immediately result in a solution of the many, many problems of the farmer, the orchardist, the live stock breeder, and the poultryman. One criticism of the time stated that the experiments had been confined to corn and were managed in such a way as to be utterly useless so far as any increased knowledge was hoped for. It was also emphasized that $9,000 had been expended for this and other useless experiments and that the director of the experiment station had permitted $6,000 of the $15,000 appropriated to be forfeited at the end of the fiscal year because the workers in the Experiment Station did not have enough initiative to plan helpful experiments.

As a result of these criticisms the Board of Curators met on Friday, July 11, 1888, and provided for a re-organization of the Missouri Agricultural Experiment Station. The chief purpose behind this re-organization seemed to be to make the Experiment Station an integral part of the College of Agriculture and closely associated with the teaching program. Before this re-organization there was an apparent attempt to set up a separate division known as the Agricultural Experiment Station. This policy of close coordination of the college teaching program and research has been successfully followed for the entire fifty years of the institution. This likewise has come to be the policy in all but a very few of the institutions of the United States. Such a plan of organization benefits both the station and the college and is particularly effective in the training of scientific workers for the station staff.

There is evidence in the history of the Agricultural Experiment Station and the College of Agriculture that the University was very sincere in its efforts to make the College of Agriculture serve the purposes for which it was established.

A famous episode in the history of the University of Missouri in 1886 was the changing of the name on the official catalog of the University from its legal name established by the Missouri General Assembly to the name "Missouri Agricultural College and University." President Laws decreed that this should be its name forever after. This action by President Laws was wholly illegal, since the Legislature had designated its name to be "University of Missouri." Naturally, this action raised a storm of protest even more violent than the criticisms of the friends of agricultural education, and the action of Dr. Laws was overruled by the Board of Curators; and the next catalog appeared under the rightful and legal name "University of Missouri." This action on the part of President Laws is significant only in that it appears to have been another gesture on the part of the administration of the University to demonstrate its real interest in the development and progress of the College of Agriculture.
The passage of the Hatch Act in 1887, appropriating $15,000 to the University of Missouri for agricultural research, was hailed as one of the outstanding events in the history of the University itself. This seemed at that time to be a very large sum of money and aroused the expectations of the friends of the College of Agriculture and caused them to demand even greater service from the institution. For a number of years, from 1889 to 1895, the criticism of the institution continued, and very bitter criticism was leveled at the institution because of the failure of the College of Agriculture to succeed and the Experiment Station to solve the problems of the farmer. As the result of all this criticism, it was repeatedly demanded that the College of Agriculture be separated from the University. This culminated in an attempt in the Legislature in 1895, when the House of Representatives passed the Murray Bill, for the complete separation of the College of Agriculture from the University by a vote of 78 to 42. Fortunately, this bill did not prevail in the Senate, being defeated by a vote of 12 to 19.

In 1895, the Board of Curators appointed Dr. Henry J. Waters, a graduate of the College of Agriculture of the University of Missouri, as Dean and Director of the College of Agriculture. His wise administration may be regarded as the beginning of a very gradual change of sentiment on the part of interested people as to the value of the College of Agriculture and to make the institution one of value to the agricultural interests of the State. Probably for the first time the College of Agriculture took into its confidence the agricultural leaders of the State and attempted to acquaint them with the ideals and purposes of the institution, the difficulties surrounding its development, and the ultimate possibilities if appropriately supported.

**NOTABLE RESEARCH PROJECTS**

Some of the notable research projects of the Agricultural Experiment Station were initiated during the administration of Dr. Waters. He held the position of director for fourteen years. During that time there was developed a real appreciation of the value of scientific research as a means of solving agricultural problems and the development of an agricultural curriculum that came nearer to providing the type of education that the farmers and horticulturists of the State believed essential.

His administration, coming as it did at the beginning of 1895, after the bitter struggle in the Legislature to separate the College of Agriculture from the University, was attended with great difficulty; but his wise leadership and fine spirit had a profound influence upon the work of the Agricultural Experiment Station. He resigned, after fourteen years as Dean and Director, to accept the presidency of the Kansas State Agricultural College in August, 1909. His going was a real loss to the University of Missouri.
FIFTY YEARS IN THE SERVICE OF AGRICULTURE

DR. HENRY J. WATERS
Director of the Missouri
Agricultural Experiment Station
1895-1909
President Richard Henry Jesse, who had taken a very real personal interest in the development of the Agricultural Experiment Station, was retired in 1907. His successor, Dr. A. Ross Hill, was even more interested in the progress and development of agricultural research. He had a real vision as to the value of research and from the beginning gave his enthusiastic support to the Agricultural Experiment Station.

Upon the resignation of Dr. H. J. Waters in 1909, the present director was appointed Dean of the College of Agriculture and Director of the Agricultural Experiment Station.

The growth of the Agricultural Experiment Station, because of larger resources and the eminent investigators constituting the staff of the Missouri Experiment Station during recent years, is notable. The Station has been particularly fortunate by reason of the fact that the key positions of the institution have been occupied by able men, actuated by the true scientific spirit and having an intimate knowledge of the agricultural problems of the State. They have been retained in their position through a long series of years, so that the Station has been able to maintain a continuity of policy that is significant.

One of the most unfortunate situations that can develop in any Experiment Station is frequent changes of the station staff. Those experiment stations in the United States that have accomplished most have been those in which the principal administrative officers and the investigating staff have been continued in their positions and protected in their activities through a sufficient period of time to make it possible for them to make substantial contributions in their several fields of intellectual enterprise.

It is not my intention, nor indeed is it possible to present adequately in this brief paper a functional history of the Missouri Agricultural Experiment Station. It has consistently followed the policy of utilizing the highest developed methods of science for the solution of farm problems. Its research is no less fundamental by reason of the fact that its objectives have been in a sense utilitarian. After all, there is no logical distinction between research in the applied sciences and research in the so-called pure sciences. The methods of science are the same in either case; the needs for fundamental research are identical. The only difference is in the motivation.

Knowledge Is Widely Used

The Missouri Agricultural Experiment Station has not only made notable contributions to the science of agriculture based on the most careful and fundamental research, but it has gone a step farther and developed a technique for the utilization of such knowledge. After all, it is how knowledge is utilized that determines its real value to the public welfare. The experiment station workers have not been content to make observations and accumulate data; they have definitely investigated the application of this knowledge to the agricultural
enterprise. This is no doubt one reason for their widespread popularity.

It is not only important that an experiment station should be manned with able investigators and with the highest type of scientific apparatus and equipment, but it is even more important that the problems selected be worthwhile. It is exceedingly important that the energies of an experiment station be devoted to the most worthwhile problems of agriculture. It is comparatively easy to dissipate the generous appropriations of Congress and the States in research of little value. The number of important problems crying for solution is so great that wasting our resources on inconsequential and less important investigative enterprises is little short of tragic.

The agricultural experiment station workers of the United States have been amazingly industrious. No group of scientists have ever accumulated so vast a volume of data. Much of this has been interpreted and the results applied in the public interest. But there is in the vaults of agricultural experiment stations of the United States a volume of undigested scientific data too voluminous to contemplate. There is great need—perhaps it is the greatest need of agricultural experiment stations at the present time, that we develop a particular type of investigator whom we may call an agricultural philosopher. Men like Darwin who can utilize the investigations of a great number of researches and from these results formulate laws and generalizations which may have a profound influence upon science and the agricultural industry.

The mistake is often made that the large institution, and the rich experiment station, is making the greatest contribution to the science of agriculture. This is a grave error and certainly should not be made by scientists who supposedly have the ability to evaluate scientific research. The size of an institution has no relation to the quality of research.

The rapid development of agricultural experiment stations in the United States was the result of a real demand for a type of research which the existing institutions had not supplied. It was clearly a recognition of the value of scientific research for the solution of agricultural problems. The results from the work of the agricultural experiment stations can not be fully evaluated at the present time, but such results as can be envisioned have clearly demonstrated that the agricultural experiment stations actually achieved the wise purpose of utilizing science for the service of agriculture.

The beginning of agricultural research also made possible successful colleges of agriculture. College teaching in agriculture began to assume the exactitude of accurate scientific knowledge rather than the opinions of scientists on the one hand or practical farmers on the other. It rapidly resulted in a complete change in the attitude of farmers toward agricultural education and the value of scientific re-
search. Where before farmers were critical, suspicious, and scornful of book learning and of institutions responsible for such learning, their attitude was one of appreciation. At first this was a grudging acceptance of the facts of science as reported by the experiment stations. This skepticism in the minds of farmers has come to be little less than enthusiasm, appreciation and gratitude, which in itself is eloquent testimony to the work of these institutions. All this has greatly increased the demand for more and more research and the solution of more and more difficult problems.

The effect of the establishment of agricultural experiment stations has had a profound influence upon all research. It has stimulated research in all lines. The experiment stations, through their scientific investigations, have dignified the calling of agriculture and have given to the farmer an intellectual background and basis for his thinking that can not easily be measured.

Not only have these results come directly from the activities of the agricultural experiment stations, but all college teaching of agriculture and all agricultural extension work is based upon the work of the agricultural experiment stations. The work of these agencies is vitalized and constantly renewed through the effective research of experiment stations.

Another very great contribution made by the agricultural experiment stations, which is not in the nature of college teaching or extension work, is in the many services that have been developed based upon scientific techniques, such as the manufacture of vaccines and serums, inoculating materials for legumes, laboratory services in lime determinations for fertilizing purposes, diagnosis of diseases—both plant and animal—and a wide range of technical services requiring the accurate skill of investigators.

**FEDERAL-STATE RELATIONS**

There is growing concern on the part of some, who place a high value on State's rights and on local initiative, over the increasing influence of the federal government in the administration of Agricultural Research and Extension. This concern is based on the assumption that any administrative procedures which suggest a greater degree of federal control are to be regarded as undesirable.

Federal domination of education of any kind is generally looked upon as inimical to our traditional ideas of democracy in the United States. There is some evidence that federal influence is increasing. It is desirable that the whole subject be given more attention on the part of the States and that an attempt be made to define this tendency and if possible to determine the extent of this influence. It may be that it is not a matter of such importance as to justify the concern of State administrators. On the other hand, there is some evidence that local initiative is discouraged. There is undoubtedly a disposition
on the part of some State legislatures to limit sharply, and in some instances decrease, funds for agricultural education as federal funds to the States are increased. This is a very serious matter and will do more than any other one thing to hasten federal domination. If this is adopted as a policy by some States, those States will most certainly be dominated by the federal influence. As State funds for agricultural education are diminished for any reason or any pretext whatsoever, the administrators of the State institutions will be driven straight into the arms of the federal government and must necessarily accept a certain amount of administrative control by the federal departments.

The federal government has never yet appropriated money to the States without exercising a certain amount of supervision and control. If, therefore, we accept federal funds for agricultural education we must at the same time accept federal administration. I think we need have no fear for the present of any serious increase in federal control of the larger institutions receiving adequate funds from the State legislatures. The weaker States will more and more necessarily look to Washington for funds and will also necessarily submit to more and more federal influence.

The administration of the federal laws providing funds for agricultural experiment stations is an excellent example of a type of federal relation which has been generally successful and satisfactory to the States. The Office of Experiment Stations has exercised a minimum of regulation and has encouraged local initiative. There is no reason to believe that this policy will be abandoned in the future.

In conclusion, it seems very clear that science can make a great contribution to agriculture. Agricultural research has been more effective than any other single agency in solving the many perplexing problems with which the farmer has to deal. The contributions to be made to agriculture in the future from the work of scientists can not be envisioned with any degree of certainty at the present time, but some ideas of the possibilities for service to agriculture are suggested in the famous prophecies of Sir James Jeans in his book "The Universe Around Us." I quote:

"As inhabitants of the earth, we are living at the very beginning of time. We have come into being in the fresh glory of the dawn, and a day of almost unthinkable length stretches before us with unimaginable opportunities for accomplishment. Our descendants of far-off ages, looking down this long vista of time from the other end, will see our present age as the misty morning of the world's history. . . . By what light we have, we seem to discern that the main message . . . is one of hope to the race and of responsibility to the individual—of responsibility because we are drawing plans and laying foundations for a longer future than we can well imagine."
Mumford Hall, occupied since its completion in the fall of 1923 by the administrative offices of the College of Agriculture and Agricultural Experiment Station, the agricultural library, the publication offices, and the Departments of Animal Husbandry, Agricultural Economics, Rural Sociology, and Soils. On March 1, 1930 this building was named by the Board of Curators of the University in honor of Dean and Director Frederick B. Mumford.
BRIEF REPORTS OF THE WORK OF THE
EXPERIMENT STATION

By Department Chairmen

WITHIN THE FIFTY PAGES immediately following are mentioned some of the outstanding accomplishments of fifty years.

The difficulties inherent in such condensation are the more apparent when it is remembered that not infrequently a single annual report of the Agricultural Experiment Station, recording the progress made in current investigational projects, fills a hundred pages.

Leaving unnamed the investigators who have devoted the best years of their lives to make these results possible, omitting many notable services and discoveries, and describing inadequately the few discoveries that are mentioned, the following reports can give only a sketchy idea of the scope and importance of the Experiment Station's contributions to agriculture and rural life.

It goes without saying, also, that many important services have been rendered to agriculture by other schools and colleges of the University of Missouri, working with and through the Experiment Station. Notable contributions have been made by the department of botany of the College of Arts and Science, including many important investigations relating to poisonous or noxious plants and to the identification and control of plant diseases. The department of zoology has been similarly helpful in relation to wildlife problems. The demand for condensation in this hasty appraisal of the work of the Experiment Station has, no doubt, resulted in other regrettable omissions.

In addition to the contributions made to agriculture and rural life through carefully planned research, the Agricultural Experiment Station maintains a flow of timely service which represents instant and continuous response to the daily, specific problems of farmer and homemaker. Staff members of the Experiment Station receive and answer by mail more than 100,000 questions a year.

In its fifty years the Experiment Station has published 285 research bulletins, 397 bulletins, and 198 circulars in original editions and has supplemented these by a large number of reprints.

Other service projects, some of which are mentioned in the departmental reports on succeeding pages, include the following: seed testing laboratory, inspection and analysis of commercial fertilizers, manufacture and distribution of legume cultures, testing soils for their need of lime, testing limestone samples, official testing of dairy cows, diagnostic service on diseases of animals and poultry, agglutination testing for Bang's disease in cattle, and agglutination testing for pullorum disease in chickens. For many years, also, the Station made and distributed anti-hog-cholera serum.
Who Will Become Director of the Missouri Agricultural Experiment Station

September 1, 1938
AGRICULTURAL CHEMISTRY

THE MOST IMPORTANT DUTY of the chemists of the Agricultural Experiment Station, throughout its entire history, has been that of exact measurement. Farmers must know how much of each kind of plant food is in the soil, how much calcium and magnesium in outcroppings of limestone, how much of each type of fertilizer is needed for each crop and each field. They must know how much protein, fat, carbohydrate, and mineral is produced in each crop; how much meat, wool, milk, or eggs can be obtained from a definite amount of feed. The importance of accurate quantitative analyses has been recognized from the beginning, and the very first investigations made at the Missouri Station were of that nature.

ANALYSES OF SOILS AND CROPS

One of the early investigations of this kind was a study of the soil and its composition and the effects of additional plant food upon the composition of the crops produced. Both rich and poor soils were subjected to chemical analysis supplemented by measurements of the plant foods contained in the field crops and vegetables grown on these soils.

Another series of investigations involved minute analyses of many products then largely allowed to go to waste on the farm, including corn fodder, corncobs, straw, and similar materials. Each was studied as a source of animal nutrients with especial reference to its feeding value when used with various concentrates and supplements. Analyses were also made to determine the stage at which corn fodder should be cut to obtain the greatest feeding value.

A study was made of the corn plant, including a chemical determination of the composition of the grain, cob, leaves, stems, husks, and roots, as well as the green and dry weights of all parts of the plant studied separately. The timothy plant was subjected to similar study, in order to discover the stage of growth at which it produced its highest yield, was most palatable to livestock, and gave the greatest feeding value.

SUGAR BEET INVESTIGATIONS

When Missouri farmers, in the Nineties, became greatly interested in the possibility of growing sugar beets as a commercial crop, the Experiment Station began a series of experiments to determine the adaptability of Missouri soils for this purpose. Although the crop was readily grown in this state, chemical analysis of the beets and the soils in which they were grown revealed that certain essential qualities of soil and climate were lacking and that production of this crop, therefore, could not be profitable in Missouri. Four publications of the Station reporting these studies were circulated throughout the
state, saving thousands of farmers from making unwise investments in this enterprise.

**STUDIES IN ANIMAL NUTRITION**

It was also in the Nineties that the Experiment Station began a series of studies on the composition of the flesh of beef steers, which later expanded in 1907 into experiments on the use of food by beef cattle. This continued for thirty years and yielded a vast amount of basic information which has since been quoted in books on animal nutrition and in scientific papers in every language. Discoveries were made giving answer to such problems as the comparative cost of gains and quality of meat produced by cattle on scant, medium, and full feed; how fat is distributed under various conditions; the energy cost of fattening; the effects of retarded growth; and the maintenance requirements of beef cattle. All feeds were weighed and analyzed, the slaughtered animals were separated into various commercial cuts and anatomical parts, and each cut, portion, and organ analyzed to determine all possible effects of each method of feeding.

These studies also determined the quality of meat produced by various methods of feeding, what portion of the total carcass is contained in each of the several cuts, and the weight and composition of the meat in each of these cuts. Thus was developed a wealth of information that has proved to be of great value to the producer, seller, and consumer of beef. Related studies with dairy cattle and hogs gave equally valuable information on the maintenance requirements of these animals, as well as on the cost and composition of their products.

**INSPECTION OF FERTILIZERS**

For more than forty years the Experiment Station has administered the Missouri Fertilizer Control Act, a law requiring the sampling and chemical analysis of all fertilizers offered for sale in the state. The chemists of the Station, with their exact measurements of the various plant foods contained in every fertilizer formula registered for sale in the state, have detected and reported shortages in plant food content, thereby safeguarding the farmers' purchases of this important commodity. Fertilizer sales in Missouri range from one to one and a half million dollars a year, and under the watchful eye of the Station chemist farmers may expend this huge sum with the assurance that the fertilizers purchased are correctly labeled and that they actually contain the values indicated.

Coordinating the constant sampling and analysis of fertilizers with the results obtained from their use in growing crops on the various soil types throughout the state, the Experiment Station was at all times able to advise changes in practice and in the selection of fertilizer formulas that would give farmers larger returns from their use.
Manufacturers, appreciating the fundamental value of this information, have been glad to cooperate with the Station by preparing and offering for sale the kinds of fertilizer that are most profitable to the purchaser.
DETERMINING THE ESSENTIAL NUTRIENTS

Within recent years the investigations carried on by the chemists of the Experiment Station have been directed toward the solution of the fundamental problems in animal nutrition, particularly the determination of the nutrients essential for a complete life cycle. Approaching this problem through a study of the vitamins, amino acids, and minerals, the Missouri investigators have developed a technique for the preparation of purified nutrients including protein, fat, carbohydrate, minerals, and isolations of several vitamin supplements. Some of the latter are as yet unnamed, though their respective functions in preventing certain nutritional diseases have been clearly demonstrated. Much work has been done with chicks and knowledge is being developed that will eliminate some of the hazards that now interfere with poultry production.

One of the most notable of the recent contributions in this field was the discovery of a new vitamin, now known as the anti-dermatitis vitamin. Its identification was an important step in explorations of the still uncharted field of nutritional requirements not only of domestic animals but of man himself.

AGRICULTURAL ECONOMICS

WITH THE ORGANIZATION of a department of farm management in 1910, the Missouri Experiment Station began a statewide study of farm records and cost accounting. This work has been continued without interruption to the present time, with steady expansion of its scope to cover all farm enterprises and various farming systems throughout the State. These studies have not only served a very practical purpose by assisting farmers in their own record keeping and in the planning of their business enterprises, but have also developed a vast body of knowledge on the cost of farm operations under widely varying conditions. The resultant accumulation of knowledge has been of great value in much of the research of the Station in related problems.

FARM MANAGEMENT SURVEYS

One of the early investigations in agricultural economics was a farm management survey covering 725 farms in the northwestern part of Johnson county, Missouri. The field work of this project was undertaken in the summer of 1913. Complete survey records were taken on a solid block of farms, and these records were later analyzed to determine the farm management principles that gave best results in a general farming area. Similar surveys were made in succeeding years, covering a beef cattle producing area in Saline county and a
cash grain farming area in Dade county. At the same time the Ex-
periment Station began an extensive study of landlord-tenant rela-
tionships with the purpose of improving farm lease contracts from
the viewpoint of equitable division of expense and income and also
from that of encouraging good farm management practice.

More recent surveys have studied farm management in relation to
income in the various types of farming areas of the State, in relation
to land utilization in Nodaway and Callaway counties, and in relation
to earnings as influenced by farm improvement in Nodaway, Atchison,
and Linn counties.

**COST FINDING SURVEYS**

A detailed enterprise survey was conducted in 1918 in cooperation
with the department of dairy husbandry to determine the cost of produc-
ing milk in the St. Louis, Kansas City, and St. Joseph milk
sheds. The following year the Station undertook a five-year study
of the costs of various methods of fattening beef cattle on Missouri
farms. In this study the Station enjoyed the cooperation of the Bureau
of Agricultural Economics of the United States Department of Agri-
culture.

Cost finding studies were extended in later years to cover the cost
of producing various crops, costs of using tractors and work stock,
farm machinery and equipment costs, and family living costs.

**MARKETING AND PRICES**

In the field of marketing and prices the first important studies made
were those having to do with the developing of a Missouri farm price
index. This work was begun in 1923. Another study conducted soon
after this had to do with the economics of the strawberry industry
with particular reference to costs of production and marketing, and
the market agencies which handled the Missouri strawberry crop.
Other marketing studies include the factors involved in buying Mis-
souri cream, an analysis of the pig survey, the marketing of stock
hogs, the cost of marketing livestock by truck and rail, cooperative
livestock shipping associations, new markets for Missouri butterfat,
the cooperative marketing of fruits and vegetables in the St. Louis
market, factors affecting sweet potato prices, and progress reports
on growth of livestock trucking and the development of cooperative
marketing agencies.

**LAND ECONOMICS**

Important contributions have been made by the Missouri Station to
our knowledge of land economics and farm finance in this State.
Studies in this field include a series of reports on the Missouri farm
real estate situation, emphasizing particularly trends in the price of
farm lands; the accuracy and flexibility of rural real estate assess-
ment; studies in land values; the Missouri farmer's tax position; studies in types of farming and land use; tax delinquency studies; farm mortgage debt situation; and land classification for agricultural purposes.

**LAND UTILIZATION**

Within the past two years a further study has been inaugurated under the general direction of the Land Use Committee of the Experiment Station. This study has to do with a determination of the productive possibilities of pastures and pasture crops in Missouri. This is in connection with the pasture farming programs being encouraged by the Experiment Station on Missouri lands where much of the acreage must be devoted to pastures.

**PRACTICAL APPLICATIONS**

A brief summary of the practical application of the work of the Experiment Station toward the solution of the farmer's own problems in agricultural economics may be made as follows:

Farmers learned not only the method of keeping records and cost accounts but were informed as to the utilization of such records in replanning their enterprises for greater economy and efficiency.

Results of the cost finding surveys gave farmers a yardstick for judging the comparative economy of their own operations and also called their attention to the various elements entering into the costs of production.

The landlord-tenant surveys resulted in general improvement of the lease forms widely used in the state and led generally to a fairer distribution of income from landlord-tenant agreements.

The farm management surveys have not only pointed out in each successive era the factors essential to successful farm management, but also enabled farmers to coordinate capital, labor resources, and available land to best possible advantage.

Studies of actual land sales enabled the Station to develop an index showing the movement of Missouri farm land prices from 1820 up to date, and to keep farmers and others informed concerning the composite farm real estate situation.

The work done by the Station in cooperative marketing has given guidance to farmers' cooperative marketing associations, notably livestock shipping associations and produce exchanges. These studies have also aided in the development of laws properly safeguarding farmers' cooperative marketing organizations.

Studies in land utilization have been of service in developing new uses for lands unsuited to agricultural production and private ownership, eventually leading to the establishment of a comprehensive program for the development of forests and other uses for lands not suitable for farming.
ONE OF THE EARLIEST PROJECTS of the Missouri Agricultural Experiment Station was one on the draft of farm wagons as affected by height of wheel and width of tire. The results of the first work done in 1896 and 1897 became more or less classic and were used extensively by designers and manufacturers all over the world to produce the broad-tired wagons of easier draft. This discovery was confirmed and the work brought up to date by a series of tests twenty-five years later.

THE DURABILITY OF FENCE POSTS

A study to determine the effect of various preservatives and treatments on different varieties of post timber was started in 1913 and is still being carried on. The study has brought out some very important facts. It has shown that treatment of the less durable varieties of wood will not make economical posts; also, that treatment of the more durable varieties may not add sufficiently to their usefulness to warrant the cost of the preservative treatment. White oak, black locust, white walnut and sassafras respond best to treatment and may give three to four times the service of untreated posts.

SOIL CONSERVATION

At the beginning of terracing in Missouri the terraces were made small, and much difficulty was encountered with breaking because of a lack of capacity. The difficulty in securing proper size came from lack of efficient equipment for doing this special work. A new standard was adopted which called for a 10-foot channel width and a 20-foot ridge with a height of at least 16 inches. A machine was designed which enables one man to build one mile of this standard terrace in one day. In addition, this machine is provided with an attachment designed to keep a large per cent of the top soil in formerly barren channels. Thus the Experiment Station has set a new standard for terraces, and provided a means for constructing them economically.

CONTOUR FURROWING FOR PASTURES

The ordinary plow has been until recently the standard machine for contour furrowing. The objections to this method, however, have been many. (1) A large amount of pasture is destroyed; (2) a double strip of sub-soil is exposed, making a difficult problem in seeding; (3) this process results in a great deal of erosion. The Missouri Experimental Station has produced a machine which lifts the sod and turns a furrow in the sub-soil, lowering the sod covering into the furrow and onto the ridge formed. Little, if any, grass is lost, and practically the same water-holding capacity is secured. This method has greatly increased the interest in this important practice.
Erosion Control Structures

The excessive cost of permanently constructed terrace outlets for preventing overfall erosion made this improvement almost prohibitive. The experimental work of the Missouri Station has provided a thin-section structure at a cost of about one-fourth the cost of previous structures of equal size. Over one hundred such structures were built during the past year, and have been giving excellent service. The structures have greatly stimulated terracing by providing an economical plan for building protected outlets.

Building Improvements

The departments of agricultural engineering and dairy husbandry of the Missouri Station have cooperated in the development of plans for dairy structures. Plans for milk houses to suit all needs, from those of the small dairy farm selling milk in bulk to those of the more specialized dairy that retails its products direct, have been developed. Blue prints and bulletins issued by the Station have aided hundreds of farmers with these problems.

Sanitary and efficient hog production years ago demanded a change in housing equipment. The departments of agricultural engineering and animal husbandry at the Missouri Station designed an individual hog house and furnished plans to the farmers of the State, enabling them to realize enormous saving in the number of thrifty pigs saved at farrowing and fattened to marketable size.

Improvement of Farm Homes

The Missouri Station has made valuable contributions on four phases of farm home improvement. The wells in one community of one hundred farms were tested and from this study plans were made for giving needed protection to farm water supplies. Pumps and pressure systems have been tested and recommendations made to farmers through bulletins published.

Considerable experimental work was done in an effort to simplify construction and reduce the cost of sewage disposal systems. Twenty septic tanks were under observation for a number of years. Plans were published and a large number of homes have been improved as a result.

Several types of individual farm lighting systems were tested and the results were published in bulletin form. This work is still being used where individual plants are the only means of supplying the farm home with electricity.

Several plans for low-cost farm homes have been developed by the Missouri Station to suit Missouri conditions. These plans have found considerable use throughout the State. Remodelling plans, also, have been published and have filled a need.
Contour furrows made by a furrowing plow developed at the Missouri Station. This machine lifts the sod and turns a furrow in the sub-soil, lowering the sod covering right-side-up into the furrow and upon the newly formed ridge. Little if any grass is lost.

Terracing machine developed at the Missouri Experiment Station and now widely used in the Middle West. With this machine one man can build in one day a mile of standard terrace with a ridge 20 feet wide and 16 inches high and a channel 10 feet wide. The machine also keeps a large percentage of the top-soil in formerly barren channels.
Much work has been done in adapting electricity to farm jobs and in developing new uses for electricity in agriculture. The Missouri Station was a leader in the development of electric hotbeds. It is believed that the first electrically heated hotbed in the United States was put into service in St. Louis County, Missouri, as a result of work done at this Station. Electricity is now accepted as one of the standard means of heating hotbeds.

The Missouri Station has also done notable work in adapting electricity to such jobs as feed grinding, silo filling, hay hoisting, and chick brooding. An outdoor electric brooder developed at the Station is now being manufactured in the State and is widely used.

Efficiency in Use of Farm Machines

Considerable data have been collected on the cost of power, labor, and machinery. This information has enabled farmers to select sizes and types of machines better adapted to their individual needs, and to use and manage their machines and power units more economically.

Animal Husbandry

At the time of the establishment of the Missouri Experiment Station, the farms of the State were producing vast quantities of cheap roughage and pasture. With bad roads and limited methods of transportation, the conversion of these products into cash was a major problem. The early work of the Experiment Station, therefore, was directed toward the purpose of developing methods of utilizing cheap roughage and pasture with livestock, thus enhancing its cash value. Marketing roughages and pastures through cattle netted a significant saving. Two, three, and four-year-old steers were in general use for grazing and feeding, at that time, but this left the heifers of the annual calf crop to be used as breeding cows or otherwise disposed of. Heifers of the above ages were not as satisfactory for grazing and feeding and were penalized on the market. A study of the practice of spaying heifers developed a satisfactory technique for the operation and the practice proved profitable under certain conditions.

Balanced Rations

Feeding home-grown grains and hay was a logical use of these crops. With tightening economic conditions, it became imperative that more efficient feeding methods be employed. At this time, certain grain by-products were placed on the market at attractive prices. Without a knowledge of their constituents, many difficulties in feeding these were encountered. Investigations begun in 1896 by the Ex-
periment Station demonstrated that less feed was required per unit of gain and that a better finished product could be produced if rations were fed in a properly balanced form. Any of the common hays, grains and by-products could be used if the proper combinations were employed to balance the ration. Methods that were at first only experimental gradually became widely used practices.

FEED PREPARATION

Surplus grains were most logically marketed by feeding to livestock in the area of production. But it was known that much of the small grains such as wheat and barley passed through the animals undigested. The Missouri Station, therefore, studied the value of cooking, grinding, and other methods of preparation of grains, with special emphasis on the feeding of swine, since most of the concentrated feeds at that time were being fed to hogs. Finding that cooking grains and warming feed and water for swine were not profitable, the Station saved farmers much useless labor and expense by publishing this information. Under certain economic conditions, grinding was found to be profitable.

EXPERIMENTS WITH TYPES AND BREEDS

A problem arose in the production of hogs since there was a demand for lard as well as for lean meat, and there was a general belief that either could be produced by a given method of feeding. Seeking a factual answer to this question, the Experiment Station found it more economical to feed animals of different types rather than to feed the same type of hog by different methods in an attempt to produce two diverse products. The "battle of the breeds" among beef cattle breeders had raged since about 1875. The proponents of the various breeds loudly proclaimed their merits. Experimentation and practice indicated the relative merits of the various breeds and that each of the generally used beef breeds had certain characteristics which particularly fitted it to meet a given set of conditions. With the publication of this and other information, developed by impartial investigation, the breed war gradually subsided and interest was directed to the use of the breed best suited for the particular conditions of farm or locality.

GOOD SIRES

Quality in animals has always been important. Improvement by the use of good purebred sires has been demonstrated and emphasized time and again by the Experiment Station. Much work has been done with sheep and substantiated with other farm animals. Specific information in this field has stimulated a more careful selection of herd sires and encouraged breeders to produce the kind of sires needed for improving commercial livestock on the average farm at a price that the business warrants.
Normally Missouri ranks about third among the states as to numbers of hogs produced. It was logical, therefore, for the Experiment Station to make extensive studies of the pork producer's problems.

With cheap lands producing good crops of corn this grain was largely used to make hogs ready for market. As feeds increased in price, however, it was realized that cheaper methods of production were necessary. Early investigations demonstrated that corn was deficient in protein and mineral matter and that when supplements furnishing these nutrients were fed with corn, gains were not only more rapid but more economical. In these studies various supplements such as tankage, wheat shorts, soybean, cottonseed or linseed oil meal, dairy by-products, fish meal, etc., were compared and their relative value and manner of use determined.

But even with such improvements in the ration, methods of still cheaper production were sought. A liberal use of pastures offered possibilities so that extensive pasture investigations were conducted demonstrating that pastures may reduce the amount of concentrates required in producing fat hogs.

Following early discoveries at the Missouri Station showing the advantages of supplementing corn with protein and minerals in rations for hogs, still greater economy was sought in a series of pasture investigations. It was found in these experiments that pastures may reduce by as much as 50 per cent the amount of concentrates required in producing fat hogs.
required from 15 to as much as 50 per cent in producing fat hogs. The relative values of different forage crops were determined. Studies were made, also, of amount and kind of grain giving best results on the various pasture crops. These investigations have widely increased the use of pastures in Missouri, particularly in recent years when pastures have been an important factor in promoting swine sanitation.

While corn is usually the principal hog feed, other grains may at times be used more economically. The Missouri Station has compared wheat, barley, oats, rough rice, hominy feed, and other corn substitutes, thus making an intelligent choice of these feeds possible, especially in seasons of corn shortage.

Swine investigations have not been limited to fattening hogs, but experiments have demonstrated the nutritive requirements of brood sows during the gestation and suckling periods as well as the feed requirements for weanling pigs. The Station has studied different methods of feeding, particularly the self-feeding of hogs and the hogging down of finishing crops like corn. Pork producers have taken advantage of the facts brought out by these studies and have materially reduced production costs.

Studies made some years ago at the Missouri Station were helpful in clarifying the understanding of producers and packers on the fattening of pregnant sows for market. Farmers had learned that pregnant sows fattened more rapidly than open sows, but such animals were heavily docked by the packers because of waste in slaughter and a supposed impairment of quality. By subjecting this problem to experimental study the Station found that pregnancy has no detrimental effect upon the meat of the animal, though slaughter losses increase as pregnancy advances.

**Retarded Growth**

Customs as well as conditions prevalent in Missouri until some years ago had encouraged the practice of growing animals before attempting to fatten them. In some of the poorer pasture regions and in all areas during unfavorable seasons, the scarcity of feed contributed to these conditions. Retardation of growth of the young animals frequently resulted. To what extent such conditions affected the ultimate to be realized from these animals was long a subject of conjecture. Investigations at the Experiment Station revealed the fact that young animals gain weight more economically than older ones. Mild retardation of growth of young animals was found not as serious to the later development of the animal as some had assumed. Animals fed a good ration except deficient in quantity maintained the ability to grow even after the age of normal maturity.
Drought Seasons

The drouths of 1934 and 1936 called for substitutes for more commonly grown feeds, and in this emergency the Experiment Station came forward with information that aided farmers in making the utmost use of roughage, grain, and fall pasture, and in handling drought crops. Molasses already much used also found attention and wide use made of it throughout the State. Thousands of acres of barley pasture were sown and used and a high value of drought-stricken stover was realized.

Silage Added to Farm Feeds

With the increase in the use of ensilage came new problems in the fattening of cattle. Farmers were having some difficulties with unthriftiness of fattening steers on a ration of corn and silage. The Experiment Station studied the use of silage in the regular feeding program, in rations for cattle, sheep, and horses. Results encouraged the use of silage not only for cattle but demonstrated its possibilities for sheep and horses. The now generally recognized improvement in the value of silage and corn by use of a nitrogenous roughage or concentrate was also demonstrated through Station investigations.

Preparation of Corn

Corn has been and still is a standard ration for fattening livestock. It has been fed as broken ear corn, shelled corn, ground corn, and corn and cob meal, and many opinions as to the relative merits of various methods of feeding have existed. Bulletin 150 of the Missouri Experiment Station dealing with the preparation of corn has become a standard work on the subject. Increased gains on cattle produced by shelling or grinding have been evident, but with hogs to follow cattle to utilize the waste it has been demonstrated that big steers could utilize broken ear corn or shelled corn most advantageously under ordinary conditions.

Met a War Emergency

The World War also brought a demand for carcasses of good size but not necessarily carrying a high degree of fatness. The need for grain as human food during that period suggested the possibility of putting enough finish on cattle with legume hay, corn silage, and nitrogenous supplement to make them meet the market demand. During that period the degree of finish which could be attained by rations of this sort was tested and the results given to the public with consequent important savings to both producer and consumer.

Cattle Feeding Experiments

During the last twenty years a gradually increasing demand for lighter cuts of choice meat have indicated the necessity of fattening cattle at an early age. Taking up the various methods available for
meeting this demand with profit to the producer, as well as convenience and saving for the consumer, several systems adapted to conditions existing in the various sections of the State were studied. Creep feeding calves while nursing their mothers, produced at 8 to 10 months very desirable cattle at market weights of 600 to 750 pounds, methods of fattening yearlings to produce a fine quality beef for market in late summer or fall weighing 850 to 1000 pounds were demonstrated, and the feeding in dry lot for the last 30 to 60 days of a feeding period was found advantageous under many conditions. Each of these systems, on certain farms and under certain conditions serves well to meet the market demands and conserve the resources of the farm, at the same time affording a dependable source of income with maximum use of home-grown feeds.

Both pasture and dry lot feeding of cattle were common on Missouri farms in the early years of the Experiment Station. Differences of opinion concerning shelter for fattening cattle were prevalent. In a series of experiments the Missouri Station found that inexpensive open sheds were effective in saving feed and providing the necessary protection for the animals. This type of shelter has come into wide use on Missouri farms.

**NUTRITIONAL INVESTIGATIONS**

A series of investigations starting in 1923 have resulted in many discoveries of value to all phases of animal production. These studies were instrumental in developing a new laboratory technique for isolating specific nutrients in purified form, thus making it possible to determine the effect on the animal of withholding from the diet any single nutrient or combination of nutrients.

An intensive study of vitamins revealed the fact that vitamin B is composed of several factors, each performing its own specific function in growth and development. The Missouri Station identified two of these factors as vitamin G and vitamin B1. The former, as lactoflavin, is present in large quantities in milk and the latter is found in the outer coverings of cereal grains. This Missouri discovery and similar experiments at other stations have been of value not only in feeding farm animals but also in selecting suitable diets for man.

To the general knowledge that an animal on an extremely heavy diet does not utilize feed as economically as one receiving somewhat less feed, the Missouri Station was able to add much quantitative data of importance to livestock producers. It was not known at what level of feed consumption the most efficient and economical utilization was secured. In answer to this problem the Station found that most efficient utilization occurs considerably below maximum consumption, yet it is often economical to feed above or below the point of greatest efficiency, depending upon the specific purpose for which the animal is being grown or fattened.
REPRODUCTION IN FARM ANIMALS

Information of immense value to livestock producers not only in this State but throughout the world has been developed in a series of investigations in the field of reproduction in farm animals. The normal processes of reproduction, including the sexual cycle in both male and female of several species have been subjected to minute and prolonged study.

A deficiency of minerals, vitamins, or protein in the ration was found to have a marked influence on the sexual cycle, inasmuch as the entire body of the animal was affected by such deficiency. The sexual cycle was found to be influenced unfavorably by either overfatness or poor condition. Among the practical results of this investigation was a better understanding and a wider utilization of the value of green pasture for pregnant or lactating females, since animals on such pasture, though receiving only a limited amount of grain, seldom suffer from a deficiency of any of the known essential nutrients.

The Experiment Station has endeavored to determine those factors that affect favorably or adversely efficient production on the livestock farm. Some twenty years ago the Station demonstrated that the breeding of swine at a relatively early age had very slight, if any, detrimental influence on the breed so long as the sows were well fed and properly handled; that it was the suckling that caused the sow to lose weight, and little or no drain on the gilt’s system was evidenced during pregnancy, provided she received good care. Undue postponement of first mating was accompanied by frequent cases of barrenness or difficult parturition.

In recent years the livestock breeding investigations have been in the direction of understanding and influencing the fertility of animals. Certain facts have been learned, notably information about the master gland, or pituitary, and its effect on reproduction. Use has been made of the biological tests for pregnancy, and during recent years farmers have been able for a small fee to have their mares tested according to these methods. It has been rather forcibly demonstrated that fertility in the male varies all the way from low in some individuals to very high in others. Methods for measuring the level of fertility are in the process of development and these can be employed to test any particular sire. The frequency with which the sire can be used has been studied and the Station is prepared to make recommendations in this problem.

Great variation in the breeding ability of rams and the failure of certain rams to come into breeding condition until late in the summer or early fall have been observed. Protecting such rams from the extreme heat of the summer months has tended to prevent this seasonal decline in fertility and has kept them satisfactory for such earlier use.

Certain facts concerning the females of farm livestock have been brought to light. Work done at the Missouri Station has demonstrated
the approximate time of ovulation in the ewe, the sow, and the mare. With considerable success methods have been devised whereby animals have been induced to come into heat. Economy of gains of lambs has been correlated with foetal membranes of varying types, showing the latter to be a fair index of what may be expected of the lamb. A higher breeding efficiency and additional criteria for a more critical basis for judging the suitability of individual livestock for breeding purposes have been the goals, and these facts offer aid in this direction.

Young experimental cattle on the Missouri Experiment Station pastures. To meet the market demand for lighter cuts of choice meat, the Station has investigated many available methods for fattening cattle economically at an early age. Three plans found particularly well adapted to conditions in different sections of the State have been widely accepted by Missouri farmers.

Artificial insemination or mechanical breeding has recently been given attention, and already information pertaining to methods of collection, storage, and distribution of seminal materials have been made available to Missouri breeders.

**Protection and Use of Work Stock**

Investigation has assured farmers that brood mares, under proper conditions on the average farm, are highly efficient as farm power and
also produce their own replacements, provided mares receive proper management just prior to and following foaling.

While horses and mules have long been a practical source of furnishing farm power, their maintenance on expensive feeds during the winter months when little use could be made of them has been a problem. Some method of wintering the work animals cheaply without impairing their usefulness for the next working season was needed. The Experiment Station demonstrated the limits of the use of some cheap roughage as oat straw or fodder when supplemented with a limited amount of corn and linseed oil meal as an efficient and economical winter ration. Repeatedly work animals were wintered with a minimum expense consistent with the proper thrift of the stock, and the published reports made these savings possible on Missouri farms.

Since the production of work animals on the farm seemed the logical way of obtaining replacement animals, the problem arose as to how such growing animals should be fed for economical production of desirable work stock. As the result of Station studies on the normal growth and development of the draft colt and the factors influencing these, economical and desirable systems of draft colt production have been definitely formulated and widely adopted. This Station has, along with other investigators and horse producers, found that horses can be economically produced by the maximum use of cheap roughages and pastures and limited grain. Although the colts developed largely on cheap roughages and pastures may not grow as rapidly or look as well as the grain fed ones, they become eventually just as desirable as work animals. Colts produced by heavy grain feeding on the one hand or limited use of grain on the other show little or no difference when they are five years old.
DAIRY HUSBANDRY

THE EARLIEST EFFORT of the Missouri Agricultural Experiment Station in 1888, to discover facts important to dairy farming was the initiation of the keeping of dairy milk records on the Station herd, then consisting of five cows. This practice has been continued without interruption to the present, the Station herd now consisting of 185 cows of three breeds. The great volume of records thus accumulated, including data on feed consumed, milk and butterfat produced, age, weight and condition of each cow, has become the basis of many important discoveries.

These records have been used to answer the question: "Why do cows of the same general appearance vary so widely in their ability to produce milk and fat?" Working on this problem, the Missouri Station 25 years ago made the now classic discovery that the superior cow is not the one with the best coefficient of digestion, but the cow having large capacity for using food above the maintenance requirement and actually using this extra food for milk production.

VITAMIN DISCOVERIES

An intensive study of the pigments of milk—carotin in the milk fat and lactochrome in the whey—was begun in 1906 and became in time the foundation for progressive discoveries in this and many related fields. Building upon the results of this study, later research at the Missouri Station revealed that carotene is the provitamin A and that lactochrome is vitamin G.

REDUCING MAINTENANCE COSTS

Successive experiments, each building upon the foundation laid by earlier discoveries, brought all this accumulated knowledge to bear on the intensely practical problems having to do with growth in dairy cattle, the development of "normal" standards of growth, the nutrients required for growth and maintenance, and the nutrients required for milk and butterfat production. These experiments developed the knowledge that the more perfectly balanced the ration fed to dairy cows, the less the waste, the greater the growth rate, the earlier the maturity, and less the overhead maintenance expense per unit product; and hence the more economical the productive process.

Proceeding from this point, later researches at the Missouri Station developed methods for accurately estimating live weight, condition, efficiency, and profitableness in dairy cattle.

AIDS TO BREEDING AND SELECTION

Long study of the factors influencing yield and composition of milk have resulted in discoveries of immediate value in relation to breeding, herd management, feeding, and in the care and marketing of dairy products. Studies of the increase of milk production with age showed
High-producing cows in the Jersey and Holstein herds of the Missouri Agricultural Experiment Station, developed by the slow but economical process of fifty years of steady improvement through the use of proved sires, carefully selected young bulls, rigorous culling and selection, control of disease, correct feeding, and good management.

The present Experiment Station Jersey herd consists of approximately 60 head. Thirty cows in milk at the average age of 3½ years, have official records averaging 8819 pounds of milk containing 517 pounds of butterfat.

The Holstein herd now numbers 90 head. Forty females in milk have official records averaging 12,431 pounds of milk containing 471 pounds of butterfat at the average age of 3½ years. In 1910 Missouri Chief Josephine, one of the earlier cows in the Station herd from whom many of the present high producers are descendants, produced 26,861.5 pounds of milk containing 740.5 pounds of butterfat, which established her as the second highest producing cow in the world. She was exhibited on various agricultural trains and it is estimated that more than 100,000 people viewed her. Stories concerning her appeared in practically all American and in many foreign papers. In 1935 a great grandson of old "Jo", Campus Aaggie Segis Sultan, led all sires in America with an index, according to the Holstein-Friesian Association, of 24,180 pounds of milk and 873 pounds of butterfat on his first seven daughters.

that about one-fourth of the increase in production is due to increasing body weight and about three-fourths to the growth and development of the udder with the recurrence of pregnancy. Investigations of the rise and decline of milk secretion with age and dam-and-daughter comparisons have enabled Missouri investigators to formulate conversion factors reducing to a common basis of mature equivalents the production records of cows of all ages. This knowledge is of paramount importance in our understanding of the inheritance of milk secretion and in the breeding of better dairy animals.
In a series of experiments on growth and development the discovery was made that the energetic efficiency of productive processes in the dairy cow tends to be independent of body size. These investigations also revealed that the amount of feed required for maintenance increases with body weight; not in direct proportion, but in the proportion of the 0.73 power of body weight. This means that a 1400-pound cow eats, not twice as much feed for maintenance as a 700-pound cow, but only 73 per cent more.

**Milk Secretion Studies**

During the last ten years much work at the Missouri Station has been devoted to a study of the hormones which influence milk production. Discoveries made in this field still further explain the variation

![Diagram indicating in outline the Missouri hypothesis that differences in productive ability of individual dairy cows are largely due to the regulation of the endocrine glands by the pituitary. Missouri investigators have found that the mammogenic hormone secreted by the pituitary influences the growth and size of the udder, while the lactogenic hormone of the pituitary directly stimulates milk secretion. These workers and others have found, also, that the pituitary influences milk secretion indirectly by means of its thyrotropic and adrenotropic hormones which increase respectively the secretion of thyroxine and the adrenal cortical hormone. These hormones have been found to influence the composition of the blood and its rate of flow to the mammary gland. The pituitary also influences the metabolism of carbohydrate, fat, and protein.](image-url)

in milk production among individual cows; for it now appears that differences in production are due in large part to the interaction of the hormones of the pituitary and other endocrine glands in stimulating the growth of the udder, in stimulating the secretory epithelium
of the gland, in stimulating the metabolism of various precursors of milk in the blood, and in speeding up the circulation of the blood.

To secure information on the precursors of milk, Missouri investigators have measured the volume of the blood and plasma in cows, they have determined the relation of the leucocytes to lactation, and have compared the constituents of arterial and venous blood. They have set up apparatus to measure the volume of blood flowing through the udder. These studies have demonstrated, for one thing, that the gross efficiency of the mammary gland is more than 90 per cent; that is, the energy expended in transforming the blood precursors into milk is somewhat less than 10 per cent of the total energy transfer.

The milk secretion investigations of the Missouri Station have been productive of new knowledge of great value to medical science concerning the mammary gland, the hormones of the endocrine glands, and the precursors of milk. Because of its basic significance this work has been aided by grants aggregating $25,000 from the American Medical Association, the Rockefeller Foundation, and similar agencies.

**Dairy Manufactures**

In the field of dairy manufactures, investigations have led to many improvements in ice creams and sherbets through better proportioning of the ingredients, through new methods of processing, and through regulation of storage and serving temperatures. Similar improvements have been made in the manufacture of cottage cheese and in the preparation of whipped cream. Better methods of handling, processing, and marketing of dairy products have been developed, adding to the incomes of dairy farmers day by day in year-round routine throughout the entire State.

**Growth and Development**

A notable series of studies on growth and development with special reference to domestic animals was undertaken by the Missouri Agricultural Experiment Station in 1926 and to date has resulted in the publication of forty-six bulletins comprising a total of 1910 pages. This project, centering in the department of dairy husbandry has had the cooperation of three other departments of the Experiment Station: animal husbandry, poultry husbandry, and agricultural chemistry.

Prior to the integration of the growth studies of these four departments into a single investigational program, data on growth and development had been accumulating at the Station for more than twenty years; much of this data being a by-product of other investigations, the immediate object of which had been to solve practical problems. Data on the growth of dairy cattle and swine had accumulated as a result of efforts to determine the most economical age for breeding these animals. Data on the growth of cattle, horses, and
swine had accumulated as the result of research to determine the most economical rations for the production of meat, milk, and power.

With the establishment of the integrated program of fundamental research in this field it was decided to correlate the several growth projects, which had been carried on primarily for the purpose of solving practical problems, into one of much wider scope for the purpose of obtaining a better insight into the phenomenon of growth and formulating quantitative laws of growth, especially as they relate to farm animals. In this study, therefore, the Missouri investigators have brought together the quantitative data on growth accumulated during the twenty-odd years prior to 1926 and have supplemented these data with other obtained here and elsewhere, and have interpreted so far as possible all the facts thus obtained.

The discoveries and interpretations made thus far in carrying out this ambitious program of research have attracted the favorable comment of scientists in all parts of the world and have won for the Missouri Station the important support of the National Research Council and the Herman Frasch Foundation of New York City. The grants made to the Missouri Station by the latter organization in recognition of the importance of its contributions to the knowledge of growth and for the purpose of encouraging the continuation of these studies have covered a ten-year period from 1929 to date and have reached a total of $121,000.

ENTOMOLOGY

RESEARCH IN ENTOMOLOGY was first seriously undertaken at the Missouri Agricultural Experiment Station in 1895, seven years after the establishment of the Station. Prior to this, insect pests of agriculture and their control in Missouri had been given much serious attention, notably in the work and nine annual reports of C. V. Riley, State Entomologist with the Board of Agriculture from 1868 to 1875. Worthy of note also is the fact that as early as 1844 the University of Missouri offered instruction in entomology. It was not until 1894, however, that the three departments of entomology, zoology and botany were created as separate departments.

From the very beginning the entomological work in the Agricultural Experiment Station was developed on the well demonstrated principle that insect pests are the farmer's worst enemies. Since the early development of agriculture in Missouri the major insect scourges, with their varied habits, and life cycles, have created problems which farmers would have been unable to solve without the aid of the Experiment Station.

It was in the early Nineties that the accidental introduction into Missouri orchards of the San Jose scale from eastern nurseries
threatened to destroy Missouri's vast orchard interests. In that day practically nothing was known about insecticides and spray machinery so that our present highly-developed chemical warfare against insect pests has been largely developed as the result of Experiment Station research during the last forty years. San Jose scale is now of little importance in well-kept Missouri orchards.

**LIVESTOCK AND POULTRY PESTS**

Investigations in this group of insect enemies have been directed especially at the blood-sucking flies, horse bots, ox warbles, mites and lice of livestock, and the lice and mites of poultry. Their breeding habits, methods of spread, distribution, extent of damage to the host, and practical methods of control have been worked out and made available to the livestock and poultry producers of the State. As a measure of the extent to which Missouri farmers are applying the results of these investigations, some 20,000 farmers in 1937 had over 80,000 horses and mules treated for bots, and practically every successful poultryman in the State is following recommendations on control of lice and mites.

**FIELD CROP INSECTS**

Years of careful study of the large group of major insect scourges of the field crops have resulted in the development of control practices which are saving Missouri farmers millions of dollars each year. In 1916, wheat growers lost six million bushels of wheat worth nine million dollars. To prevent the annual recurrence of this staggering loss the Experiment Station, basing its recommendations on twenty years of study of the life cycle of the Hessian fly, developed control measures applicable to every climatic zone in the State. These measures have been almost universally accepted by wheat growers and have practically eliminated Hessian fly as an important pest in Missouri.

The chinch bug has long been one of the State's most destructive crop pests, periodically building up its numbers to become a scourge. However, methods developed for predicting outbreaks and for controlling its infestations have largely eliminated this pest as field crop enemy No. 1 in drouth seasons in Missouri. The unprecedented outbreak of 1934, involving 69 of the 114 counties, was very effectively controlled. Close to 20,000 farmers used over a million gallons of creosote and gas tar in maintaining 6,000 miles of barrier, which protected nearly a million acres of corn.

Grasshoppers, though not an annual menace in Missouri, have become in very recent years a major crop scourge. Here again, the Experiment Station has successfully attacked the problem on the basis of its years of research in the feeding and breeding habits of the pest.
Statewide surveys and use of poison bait are enabling the farmers to cope with the present widespread outbreak.

Methods developed at the Experiment Station for predicting outbreaks of the chinch bug and for controlling its infestations have been widely utilized. In one recent year 20,000 Missouri farmers used more than a million gallons of creosote and gas tar to maintain 6,000 miles of barriers, thereby protecting a million acres of corn.

**GREENHOUSE INSECTS**

Missouri has a large acreage under glass and a very important greenhouse industry, which is especially susceptible to insect damage. Twelve months in the year both tropical and native insect pests find in the greenhouse conditions ideal for their development as destroyers of growing plants. Very early in its history the Experiment Station recognized this as a problem of great importance to Missouri and inaugurated research which has resulted in the development of an effective prevention and control program.

**HOUSEHOLD INSECT PESTS**

In studying the life cycles of the insect pests of the household and developing measures for their destruction, the Experiment Station has rendered service of the utmost importance, for these pests threaten not only man's property and comfort but also health and even life
itself. Control methods based on Experiment Station research have proved effective not only in preventing property damage and physical discomfort, but have also checked the spread of disease and have made important contributions to medical science.

**Orchard and Garden Pests**

Fruits, vegetables and nursery stock are intensive crops and, at times, are subject to unusually heavy insect damage. The grower of intensive crops, on the other hand, can afford to go to much greater expense in protecting them against insect damage than the producer of less valuable crops. It is against orchard and garden insects that chemical warfare is most extensively used. Special efforts have been made, with a considerable degree of success, to control the major insect pests of orchard and nursery, including the San Jose scale, tree borers, codling moth, leafhoppers, plant lice, leaf miners, and the tarnished plant bug. Research at the Experiment Station has also developed methods of chemical warfare that are very effective in the control of insect pests of potato and melon crops.

An effective method for trapping the apple worm. A band of corrugated paper, chemically treated, is placed around the bole of the apple tree a few inches above the ground. Saturated with Beta Naphthol and engine oil, the band kills all worms that collect beneath it to pupate. As many as 1300 worms have been taken by Experiment Station workers from beneath a single two-inch band.
FIELD CROPS

THE FINAL PURPOSE OF RESEARCH in field crops is the conservative use of farm land for good production at low cost. For many years studies in the efficiencies of crop production at the Missouri Experiment Station have been directed toward this end. Old crops have been improved by methodical breeding; new crops have been introduced; both old and new have been subjected to experimental culture and designed systems of management; the responses of crop plants to ecological environments have been observed; and contributions to the science of plant genetics have been made.

CORN

A selective process to find and improve the productive kinds of corn, and to eliminate the unproductive, has been carried on in Missouri for many years. It has proceeded by (a) sectional tests of varieties for the adjustment of plant type to soil type, (b) the development of higher productivity in the adapted types, and (c) the promotion and increase of the improved varieties or strains. The good results are that each broad section of Missouri now mainly grows the general type of corn best suited there.

WHEAT

Efforts to find the best wheat for Missouri led first through a long initial period, 1905-1917, of testing commercial varieties. More than 200 differently named samples were tried in representative sections. Next the Station tested in greater detail the few highly productive varieties discovered by the earlier comparisons in this large list. Then began a program of wheat breeding by hybridization and selection. The more important results of these consecutive processes are (1) a fine strain of Michigan Wonder, yet unequalled for average yield on fertile well-drained land in Missouri, and now composing about half of our whole wheat crop, (2) the recognition of the wide adaptation and excellent performance of Fulcaster, and (3) the development by selection of Missouri Early Premium, a variety distinguished by its extremely early maturity. In the earliness of this last named variety farmers are finding the solution for some of the difficulties involved with wheat farming in Missouri. Earlier ripening wheat assures better success of legumes and grasses sown in this crop; it gives greater safety from late rains or early droughts, from late epidemics of rust, and from late spring insects; and it makes possible easier harvesting and better prices. Missouri Early Premium is also particularly suitable for the short rotations, as wheat-lespedeza, wheat-soybean hay.
WINTER BARLEY

Similar search for superior strains of winter barley adapted to Missouri conditions led to the development of Missouri Early Beardless, a winter barley that has proved of immense value to the farmers of the State during recent years. This new barley was accorded immediate and widespread acceptance by farmers because of its strategic values in furnishing early and abundant fall pasturage, in supplying excellent feed grain by late spring, in serving more efficiently than any other grain as a nurse crop, and in taking the place of corn on land withdrawn from row crops for purposes of soil conservation. In only seven years from the date of its introduction this barley is now well established as a factor in Missouri agriculture.

OATS

By the introduction of the Fulghum variety and the development of the Columbia, the Missouri Station made decisive improvement in the oats crop of Missouri. In combining the qualities of earliness, efficiency as a nurse crop, and ability to produce high yields, either of these varieties far surpasses any other kind of oats ever grown in Missouri. Both are widely popular. Columbia now represents much more than half the total oats crop of Missouri and is rapidly gaining favor in adjoining States. The degree of improvement added to Missouri oats by the development of the Columbia variety has seldom been equalled in other crops by plant breeding in the United States.

SOYBEANS

The soybean crop was introduced to Missouri farmers in 1920, by the Missouri Experiment Station, following several years of research with the plant. It soon became popular and is now grown on about 600,000 acres annually. Today the soybean covers a great area of Missouri medium upland, much of which is incapable of producing any other legume hay crop economically. Nearly all of the crop is used for cattle feed.

In a long-time effort toward improvement of soybean varieties the Experiment Station seeks to continue the vigor, the wide vegetative adaptation, and the excellent hay plant qualities of the Virginia variety with the yellow color of seed in some of the more productive seed-bearing varieties. More than fifty such hybrids have been produced here and are now in the ninth generation. At least six of them are highly promising. These dual purpose varieties—yellow-seed Virginia, capable of good yields of hay or of the desired commercial yellow seed—are likely to become a very large part of the Missouri crop.

LESPEDEZA

Korean lespedeza first came to Missouri in the winter of 1921, when a 2-ounce packet of the seed was sent to the Missouri Experiment Station.
Station by the Division of Forage Crops and Diseases, United States Department of Agriculture. For the next six years, at the Missouri Station, Korean lespedeza was the subject of carefully planned experimentation, covering the essential phases of its production and utilization. In the winter of 1927 seed was sent in 5-pound lots to thirty Missouri farmers, with instructions for planting and use. In ten years from that date Korean lespedeza was growing on 115,338 Missouri farms. Thus in a period of sixteen years a handful of seed from the other side of the world was found useful here by experimental study and promoted to a commanding place in Missouri agriculture, to the great benefit of many thousands of farmers. This is a striking example of the services of the Missouri Experiment Station.

A broad ability has qualified Korean lespedeza for its position. The plant is suited to our climate and grows well on all our land, reaching success in even the infertile places where nothing else has flourished. It gives abundant yields of highly nutritious feed, particularly in pasturage from May to October, thus covering the period when bluegrass and other native grasses are in a low state of utility. Its dense growth protects the soil from erosion during August and September. It is easy and cheap to produce, as it volunteers in the spring from its own seed, and is generally resistant to drought.

**COTTON**

The first study of cotton production by the Missouri Experiment Station was conducted on Lintonia sandy loam, near Kennett, during the period 1912 to 1923. The important results of this early work were: (1) the discovery of the adaptation of Cleveland and Acala varieties to medium fertile, well drained soils, and (2) that cotton yields on these soils could be increased efficiently through the use of fertilizer, by planting at a heavy rate to insure a good stand, and by systematic crop rotations.

Under the high prices that prevailed from 1918 to 1923, cotton culture spread rapidly to the north and into the hands of inexperienced growers. A more thorough study of cotton production was then undertaken on all the important soil types of southeastern Missouri and has continued to the present time. The first important facts discovered in these studies were: (1) the excellent adaptation of Trice and Delfos varieties to rich heavy soils, (2) the value of close spacing as an easy and simple means of increasing acre yields, and (3) the efficiency of moderate applications of potash fertilizer in controlling black rust. By 1928 these measures for increasing cotton yields had been adopted by the more progressive growers. Since that time, however, the superiority of new varieties including Stoneville 4A, 4B, 5 and 5A, and D. P. L. 11A was discovered on the Station’s Southeast Missouri experimental field. These new varieties have excelled the
old varieties in yield, quality of staple, boll size and storm resistance. They are rapidly filling the Missouri cotton acreage.

NEW ROTATIONS

The growing need in Missouri in recent years for an abundant supply of feed produced at low cost, for year-round protection of the soil against erosion, and for greater safety against drought, insects and diseases, has created a widespread and difficult problem. The development of a series of 1-year rotations—two crops on the same land annually—was the solution offered by the Experiment Station.

Wheat and lespedeza in one of the several one-year rotations developed at the Missouri Experiment Station. Here is diversification on the same unit of land within a single growing season. This plan has been designed, proven, and widely accepted as a symbol of a new efficiency in the conservative use of the land for good production at low cost. It largely eliminates the use of the plow, reduces labor requirements, and increases total production of nutrients. It combines grain production and livestock farming with minimum capital investment and maximum economy in soil conservation.

These rotations are wheat-lespedeza, winter barley-lespedeza, oats-lespedeza, rye-lespedeza, early wheat-soybean hay, winter barley-soybean hay, and rye-soybean hay. They are all highly productive in terms of total annual returns per acre; they afford practical means of erosion control and if correctly utilized are beneficial to basic
fertility; they can be grown cheaply and with a minimum of plowing and other machine labor; and they have a high degree of safety from ordinary crop hazards.

**Utilization of Heavy Clay Bottomlands**

In Missouri's total area of alluvial land, approximately 1,500,000 acres is represented by Wabash clay and similar heavy soils. These soils contain a high potential fertility but on account of their physical properties they are exceedingly difficult to till, and consequently their actual output is meagre. The problem here was to develop methods by which the essential fertility of such "gumbo" land could be efficiently utilized in crop production. Accordingly in 1929 an experiment field was established at Elsberry, on an extremely heavy phase of Wabash clay. The field has been conducted in cooperation with the Division of Cereal Crops and Diseases of the United States Department of Agriculture. Seven years of experimental study there have

![Rice growing on the Elsberry experimental field. This crop yielded 100 bushels per acre. The investigations carried on here by the Missouri Agricultural Experiment Station and the United States Department of Agriculture on Wabash clay soil have revealed new possibilities for the utilization of the so-called gumbo soils of Missouri. Results of nine years work indicate that this soil, under proper management, produces heavy yields of rice, wheat, soybeans, and barley.](image-url)
gained valuable information, applicable to similar heavy land in any part of Missouri.

Rice and soybeans have regularly been grown with high success on these heavy clay bottomlands, the yield and quality of the former being seldom exceeded by rice crops elsewhere in the United States. The two crops may be grown on the same field in a two-year rotation. Rice culture is thus shown to be a practicable means for the more efficient use of a part of the heavy bottomland area of the State that has long been unprofitable under Corn Belt systems of farming.

**PLANT GENETICS**

For the promotion of still further progress in plant breeding, the Experiment Station carries on fundamental studies in plant genetics. Since the methods of plant breeding now in use are direct applications of the discoveries made in earlier studies of genetics, it is not too much to expect that other important advances may originate from the studies now going on. Fundamental discoveries made by Missouri investigators in the complex and difficult subjects of mutation, the mechanism of heredity, and polyploidy have attracted the attention of geneticists in many lands and have secured for Missouri the benefit of important grants of funds from national research foundations and valuable cooperation with the United States Department of Agriculture.

**STUDIES OF PASTURE IMPROVEMENT**

Broad research in pasture improvement is conducted by the Missouri Experiment Station in cooperation with the Division of Forage Crops and Diseases, United States Department of Agriculture. In studies on the management of grazing Sni-A-Bar Farms, at Grain Valley, also is a valued cooperator.

Studies at Sni-A-Bar, begun in 1931, have compared controlled grazing with uncontrolled grazing to find the relative effects of these practices upon the persistence and productivity of bluegrass. This experiment is developing a superior system of pasture management. A more efficient utilization of the grass and the increased productivity of the whole pasture are expected to result.

Comparisons of feed production by rotation pastures and cultivated crops have revealed valuable facts which are now being used by Missouri farmers. Thus it has been found that on medium upland a continuous 6-month spring and summer pasture of wheat and lespedeza will double or treble the average feed production by corn on the same kind of land. A particularly valuable and popular result of this study of rotation pastures was the development of a year-round pasture system, a method of feed production now widely used on Missouri farms.
General view of pasture improvements plots of the Missouri Experiment Station at Columbia. These plots have been set up to study the response of different pasture species to various environmental factors. Kentucky and Canada bluegrass, Bermuda grass, and orchard grass are here grown under varying degrees of moisture and are cut at varying heights. Measurements are made also to determine the soil temperature under the sod in each plot.

Outlying Experiment Fields

In addition to the studies of crops at Columbia, a system of local experimentation in representative sections has been developed. Outlying experiment fields are now placed near Sikeston, Elsberry, Cuba, Cabool, Green Ridge, Grain Valley, Bolivar, Unionville, Paris, and Tarkio. And beyond the systematic studies conducted at these centers, numerous small tests are located every year with farmer cooperators.

This type of research proceeds by a special method and arrives at a special value. It limits and localizes a problem and seeks a quick practical solution, capable of immediate use. A large part of the whole body of technical knowledge in crop production, given to farmers by the Missouri Experiment Station, has been gathered on these outlying fields. Local subjects such as the adaptation and improvement of cotton varieties, the utilization of heavy clay bottomlands, crop systems
for the Ozarks, and the adaptation limits of winter barley, can be studied efficiently only in the place where the application is to be made.

SEED TESTING AND SEED IMPROVEMENT

The seed testing laboratory, conducted cooperatively by the Missouri Experiment Station and the Bureau of Plant Industry, of the United States Department of Agriculture, serves the farmers of Missouri and ten neighboring States in the free analysis of farm seeds. In 1937 the laboratory analyzed 5,265 lots of commercial seed for Missouri farmers and seedsmen, and 328 lots for other states.

In addition to this general service the seed testing laboratory has two special uses. It is an essential, cooperative agency for seed analysis under the administration of the Missouri State Seed Act by the State Department of Agriculture. It is also one of the means by which standards of seed quality are discovered and maintained through the state-wide seed improvement program conducted by the Missouri Corn Growers' Association.

This association of farmers was organized in 1903 to promote the production and distribution of improved seed corn. It carried on its original limited purpose until 1919 when the scope of work was broadened to include the improvement of all farm seeds. The Association program covers the inspection, testing, certification, and listing for sale of superior farm seeds produced by its members. Any Missouri farmer is eligible to join this organization. The great value of the organization results from the service it renders all farmers by promoting the production and distribution of good seed for their use. Any farmer in the State, at any time, can learn through the Association a reliable source of good seed officially tested and recommended for his conditions. The majority of all farmers in the State are repeatedly reached in this way.
HOME ECONOMICS

A PROGRAM OF RESEARCH to help solve the many and varied problems of the homemakers of Missouri was first undertaken by the Missouri Agricultural Experiment Station in 1909.

Gwynn Hall, in which are located the experimental laboratories of the Department of Home Economics. Here are conducted the investigations in nutrition, in the utilization of Missouri-grown products, in meat cooking, in textiles and clothing, and in other phases of family economics.

FOOD PREPARATION

Food preparation plays a most important part in the science of homemaking, since cookery processes influence the nutritive value, palatability, and cost of food. Investigation in this field by the Missouri Station was begun in 1909.

Several years work was done on the use of Missouri soft wheat flour in light bread, proving that bread of excellent quality and volume can be made from Missouri flour. Recipes and methods have been developed and published for the use of the housewife.

Food preparation studies have also covered the following problems: cooking temperatures for various foods, chemical and physical factors involved in cake making, vegetable cookery, the use of various fats in cookery, stability of mayonnaise, and meat cookery.
During the past ten years a work has been done on meat cookery, as a part of the Cooperative Meat Investigations. Methods of roasting, broiling, and cooking by moist heat have been studied on beef, lamb, and mutton of various cuts, grades and conditions; fresh and cured pork; and fresh and frozen veal. These studies have determined the chemical composition of raw and cooked meat and of the drippings, the effect of the cooking methods on the palatability and cost of the meat as served, and the fuel consumption. The palatability of the meat has been measured subjectively and its tenderness has been measured mechanically.

The results of these investigations have been published for use in home and institutional kitchens and have helped to revolutionize meat cookery.

The outstanding conclusion has been that high temperatures have no place in meat cookery, since the higher the temperature the greater the cooking losses of the meat and the greater the fuel consumption; also, the higher the cooking temperature the lower the palatability, particularly tenderness and juiciness.

**NUTRITION**

Research in the field of nutrition has been conducted along three main lines; basal metabolism, dietetic problems, and vitamin studies. In addition to the determination of the basal metabolism of a large number of university students under normal conditions, special studies have been made on the effect of external temperature and of coffee on metabolism.

Dietary studies of Missouri state hospitals for the insane have been made. Work has been done on the value of milk in the diet for children, on the psychology of child nutrition, and also on a nutrition problem with negro children. The growth promoting qualities of some fruit and vegetable juices used in infant feeding have been studied.

Investigations have been made on the vitamin content of a number of Missouri food products, including the effect of storage and preparation. This type of investigation is important since the nutritive value of food products is known to vary markedly not only with methods of cooking and storing, but also with soil and climate. Among the foods studied were wheat cereals, apples, spinach, green beans, rhubarb, sweet potatoes, and eggs.

Studies of the influence of the rations of the hen upon certain nutritive qualities of eggs have been made. It has been found that the vitamin A content of eggs is greatly influenced by the amount of vitamin A in the rations. To insure an appreciable amount of vitamin D in egg yolks, it must be supplied in the ration of the hen or she must have access to direct sunshine. Since eggs constitute an important item in family diets at all seasons of the year and are of
primary importance in special diets, anything that can be done to enhance their value is beneficial to producer and consumer alike.

Recent investigations in the vitamin field with the discovery of new factors and new methods of assay have led to a study of the flavin and vitamin \( B_6 \) content of eggs. The carotenoid pigments and iron and copper content of the eggs used in vitamin studies have been investigated also.

The effects of a diet consisting of cornbread made of white cornmeal, fat salt pork, and sorghum molasses, on young growing rats have been investigated. This diet is common among underprivileged families in some sections of the State. It was found that such a diet is very unfavorable to normal health and growth. The addition of milk to this diet, however, entirely overcame its deficiencies.

Soybeans have long been an important food in the Orient. In this country the cultivation of the soybean is increasing, but the crop is used principally in cattle-feeding; therefore a study of the nutritive properties of a variety of soybean has been made by the Missouri Station. In this study it was found that the soybean may safely constitute as much as 60 per cent of the diet if properly supplemented with natural foods such as rice, eggs, milk and vegetables. With the present need for cheap, nutritious food such information concerning the supplementary relationships among foods is very valuable.

**TEXTILES AND CLOTHING**

Investigations in the field of textiles and clothing were started in 1920 with a study on the hygiene of women’s underwear and this was followed by a practical piece of work on the wearing qualities of hosiery.

Beginning in 1927, most of the recent investigations are textile studies on plain-weave cotton fabrics. Studies have been made to determine the changes in the physical properties of these fabrics when subjected to various laundering methods and to body wear. One comprehensive study included a comparison of the effect on fabrics after a series of washings by two commercial methods and one home method and ironing by the commercial method and the hand iron and small home rotary ironer.

In another study fine muslins were made into a large number of nightgowns of three sizes. Forty-eight of these garments were worn out by 24 women. The additional garments were laundered but not worn. Comparisons of the effect of body wear and wear from laundering were made.

In addition to these, two unrelated research studies were made: One on the cost of clothing for college girls in Missouri and another, on the cost of homemade and ready-made layettes.
Organization in 1930 of work in family economics as one of the basic fields of home economics led to research in this very important phase of family life. In the comparatively short period since this work was begun, three major types of studies of value to families in solving their economic problems have been made, namely, (1) problems of homemakers as buyers, (2) problems of household production, and (3) incomes and expenditures of families.

The problems of the homemaker as a buyer were studied in an investigation of the buying habits of 460 Missouri homemakers with reference to their information concerning, and use of, present-day market guides. The variation of qualities of products marketed under particular brands was investigated. An evaluation of advertising from the standpoint of the consumer was carried out. More recently the problems of rural and city homemakers in buying textiles and clothing have been studied with particular reference to qualities desired in these articles.

The economic responsibilities of families at various income levels in Moberly and Columbia, their expenditures for major items, and their financial status at the end of the year have been investigated. Comparisons have been made of these facts for families dependent upon different sources of income.
HORTICULTURE

IN NO FIELD OF INVESTIGATION has the Missouri Experiment Station enjoyed a greater degree of popular interest and cooperation than in that of horticulture. With the founding of the College of Agriculture in 1870, horticultural teaching and experimental work was established with the support of the Missouri State Horticultural Society, which even then, in its twelfth year, was a strong organization.

For the various problems confronting the producers of horticultural crops the Experiment Station orchards, gardens, and greenhouses have been the proving ground. Here fruit and vegetable varieties possessing special adaptation to Missouri conditions, greater resistance to weather hazards and plant diseases, or products of greater utility have been developed.

IMPROVED VARIETIES

Scores of commercial varieties of fruits have had their origin in Missouri. Among these are the apples known as Missouri Pippin, Gano, Huntsman's Favorite, Payne's Keeper, Nixonite, Lawver, and White Winter Pippin. The Missouri Mammoth quince is another Missouri product. Such plums as Gold and Missouri Apricot had their origin here. Among Missouri grapes are the Herman Jaeger, Jacob Rommel, Samuel Miller, and Henry Wallis.

Much of the earlier horticultural work at the Missouri Station was accomplished under the personal supervision of the late Dr. J. C. Whitten, for twenty-three years chairman of the department of horticulture. This great teacher and investigator was able to direct the labors of his colleagues and assistants so wisely that they not only solved many of the fundamental problems of horticulture but won international recognition for their institution and their State.

EARLY INVESTIGATIONS

One of the earlier investigations which made an important contribution to basic horticultural knowledge was a study of the rest period in plants. This involved six years of continuous work, and the results when reported in five research bulletins of the Experiment Station became the basis of further important discoveries here and at other stations.

In another investigation begun in 1904 and completed in 1913, the Missouri Station went deeply into the subject of the killing of plant tissues by low temperatures, being the first in the United States to apply laboratory experimentation to the problem of hardiness in plants. Though completed twenty-five years ago the report of this investigation remains a standard reference on the sensitivity of the tissues of horticultural plants to low temperatures and the means of increasing the resistance of such tissues to cold.
Years of carefully recorded observations on trees and vines maintained under different systems of pruning at the Missouri Station have justified the announcement of certain fundamental principles that have been highly profitable to orchardists and grape growers throughout the State.

Whitten Hall, in which are located the offices and indoor laboratories of the Departments of Horticulture and Entomology. The building was named by the Board of Curators of the University in honor of Dr. J. C. Whitten, shortly after his death, which occurred on June 5, 1922. Dr. Whitten had served for 23 years as head of the Department of Horticulture in the College of Agriculture and Experiment Station.

These investigations have shown that any kind of pruning is a dwarfing process and that heavy pruning reduces yields, lowers the
resultant net income of the orchardist, and shortens the life of the tree. Unless pruning is light and used chiefly as a corrective measure, it may do more harm than good. These findings have become the basis of recommendations now generally followed, namely; that fruit trees in general should be allowed to assume their natural shape, with pruning confined to the judicious removal of dead, weak, crowded, or rangy branches.

Experiments with grapes indicated that the single-trunk and Y-trunk Kniffin systems are most economical under Missouri conditions, and that generally vines pruned to 40 or 50 buds will give the best average yield and maintain the best balance between growth and production.

**Spraying**

Important economies for the fruit grower resulted from a Missouri experiment on the preparation of oil emulsions as sprays for fruit trees for the control of San Jose scale. This experiment resulted in the development of a cold-mix emulsion that proved to be both cheaper and more satisfactory than emulsions previously used by fruit growers.

**Spray Residues**

Coming to the assistance of apple growers faced with the dilemma of using enough spray to protect their fruit from insects without leaving too much on the apple when marketed, the Experiment Station has carried on investigations which indicate that spray insecticides do not have as acute toxic effects on higher forms of life as had been supposed. So important was this work that it aided in the initiation of more extensive research on this problem by the United States Public Health Service, which undoubtedly will be of far-reaching importance to the apple industry.

**Virus Diseases**

Discoveries of the utmost importance in all phases of plant industry have been made by the Missouri Station in a highly specialized study of the virus diseases, which are transmitted from plant to plant by some agency so obscure and minute that neither the highest-powered microscope nor even a porcelain filter can trap it. Developing a technique for the isolation of a purified proteinaceous fraction of the juice of diseased plants, the Missouri Station has crystallized and recrystallized this fraction any number of times without impairing its infective power. After being inoculated into a healthy plant the protein acts as a disease producing agent and, at the same time, stimulates the production of more of itself in the living plant. This is truly a new concept in the theory of disease. Since Pasteur's time it has been taken for granted that all diseases other than the so-called physiological diseases are caused by organized bodies, such as bacteria, fungi, and protozoa. The Missouri experiments have opened up a new field and instituted a new mode of attack on virus diseases; conse-
sequently more rapid progress toward their control can now be expected.

FERTILIZATION OF TREES

The Missouri Station was one of the first to discover the fact that nitrogen fertilizers, to have most profitable effect on fruit trees, must be applied in the fall between late September and early November. Later investigations also revealed that there is much more latitude in the optimum date of application in the fall than in the spring. Use of nitrogen fertilizer was also found to be helpful in reducing the early dropping of newly set fruit.

Investigations at the Missouri Station have shown that the application of nitrogen fertilizers to apple orchards in the fall between late September and early November not only increases the amount of bloom the following spring but is also helpful in reducing the dropping of newly set fruit. Other investigations with reference to pollination have shown that certain varieties of apples are especially valuable as pollinizers when interplanted with varieties that produce only scant amounts of pollen.

In a study of the shedding of non-setting flowers and immature fruits of the apple, Missouri investigators have found that several of the commercial varieties most generally grown in Missouri exhibit four waves of dropping of young fruit. These waves occur at intervals of approximately 12 to 14 days and apparently are controlled by hereditary factors. It was found that the first two of these waves can be
greatly minimized by proper cross-pollination and by the use of commercial nitrogen fertilizer. The two later waves, sometimes called the “June drop,” have been found to be responsive to branch and trunk ringing at the time of full bloom.

Further experiments, dealing especially with the problem of biennial bearing, have shown that nitrogen fertilizers applied in the fall of the “on” year and in the spring of the “off” year are most effective in correcting this habit. At the same time it was found that still further improvement results when fertilization is combined with judicious fruit thinning, when the set is heavy, and by pruning following the crop year.

**Nutrition of Bearing Trees**

A great deal of fundamental knowledge concerning the nutritional requirements of bearing apple trees, together with a new understanding of the movement and storage of food reserves within the various parts of the tree prior to the setting and development of fruit, has been discovered by Missouri investigators. These discoveries have enabled growers to apply the right kind and quantity of fertilizer at the right season to get maximum results for their investment. Fruitfulness and its regularity, these experiments have revealed, are conditioned largely by the production of food reserves, and by their distribution and utilization within the tree. Several series of investigations have been completed, each adding much to basic knowledge on the seasonal changes and quantitative distribution of carbohydrates, nitrogen, and mineral substances in various parts of the apple tree. Somewhat a similar study has been made on the cherry.

Among the important new knowledge developed in these experiments was the discovery that fruit setting is typified by a marked increase within the fruiting spur of all active soluble forms of carbohydrate and nitrogen, which are translocated to flower and embryonic fruit. Much new light on the relation of vegetative growth to the development and ripening of fruit in the apple came, also, with the Missouri discovery that approximately 30 to 40 leaves are required per apple to supply sufficient carbohydrates for the proper development of the fruit. With increasing number of leaves up to 40 per apple the fruit not only attained larger size but it increased in richness of the acid and sugar content. This information is of great value in view of the fact that, according to a survey made in the major orchard areas in the state, subnormal size is responsible for a large proportion of cull apples.

**Pollination Studies**

All of the apple varieties common to commercial plantings in the State have been studied intensively in respect to their pollination requirements. These studies have proved a profitable guide to orchardists, pointing the way to more regular setting of fruit by means of
interplanting with varieties that are highly efficient in the production of pollen. The varieties found most useful as pollinizers among those grown commercially in Missouri are the Delicious, Jonathan, Golden Delicious, Ben Davis, and Gano. These varieties head the list as producers of abundant and effective pollen.

**Strawberry Investigations**

To aid the strawberry growers in their choice of fertilizers, as well as in the time and quantity of the applications, the Station has conducted long-continued investigations in the nutritional requirements of the fruiting plants. It has been found, when moisture and temperature are not limiting factors, that the number of flowers formed and the size of the berries depend on the nutritional reserves within the plant and the fertilizer applied during the preceding fall and that they are not nearly so much affected by the supply of nutrients in the soil at the time of fruiting.

**Physiological Studies**

Since the production of fruit is closely linked with the initiation and maintenance of sexual reproduction in plants, the Experiment Station has made intensive studies in this field. Among the many important additions to knowledge resulting from this investigation was the discovery that the length of the day (photoperiod) is one of the most potent factors in initiation of flower development. Evidence was also found indicating that there is a specific flower-producing hormone in plants and that this functions independent of the nutritional state of the plant. The interesting knowledge has been developed, also, that during the period of flower development vegetative growth is slowed down (photoperiodic inhibition) and that, as a result, nitrogen and carbohydrates accumulate, there is increased enzyme activity, and respiration rate, and an increased concentration of carotinoid pigments. These and other basic discoveries made in the course of the investigation are of practical value to all horticulturists in enabling them to understand the relation of the vegetative and fruiting processes, for only through such knowledge can they hope to influence these processes with resultant profit to themselves and to humanity at large.

**Work with Vegetables**

A great deal of experimental work with vegetables has been undertaken and completed by the Missouri Station, following much the same course as the investigations with trees and vines. Among the most important of the resultant gains for the home gardener and truck grower have been the development of disease resistant varieties of cabbages, tomatoes, watermelons, and sweet corn. All known varieties of these plants have been tested and the most promising have been improved by selective breeding, with the result that at the present
time there are available varieties that can be grown successfully on infected ground, where non-resistant sorts would be a complete failure.

Seed treatment investigations for both Irish and sweet potatoes have aided materially in establishing production on a permanent and profitable basis. Recent studies on soil temperatures for the commercial production of greenhouse cucumbers are encouraging, and producers are adapting suggestions profitably.

Other outstanding benefits to vegetable growers have resulted from the Missouri Station's experiments with fertilizers for vegetable crops, with especial attention to Missouri soil and climatic conditions. These studies have shown that very frequently the method of application is just as important as the kind and amount of fertilizer used. Great economy for the grower and a better product for the consumer have resulted from these investigations.

POULTRY HUSBANDRY

DURING THE TWENTY-SEVEN YEARS that the Missouri Experiment Station has had a department assigned specifically to the problems of the producer, seller, and consumer of poultry products great advances have been made in this field. Based on the discoveries of the research worker, more efficient and economical methods have been developed for the selection and management of the breeding flock, for hatching and brooding, for growing the young stock, for housing and feeding the laying flock, and for marketing poultry products.

HOUSING THE FLOCK

One of the early investigations was a study of the principles of poultry house construction with especial reference to Missouri's climate. This study resulted in the construction of a building of original design, embodying the features of several former designs found most desirable in a strictly practical survey of Missouri conditions; a square, well lighted house with straw-filled loft and open south front; a house well ventilated but without drafts, economical but affording ample head room for the attendant; a durable house, simply constructed and easily cleaned, and with no dark corners.

The first building of this design, 20 feet square, was built on the University Farm in 1915 and was put into immediate use, housing 125 laying hens. Records kept on this flock indicated that the new design offered definite advantages in relation to the health of the flock, economy of maintenance, ease of operation, and increase of egg production. Consequently it was recommended for general use with the result that it has become standard equipment on many thousands of Missouri farms. Flocks transferred from the ordinary, old-type struc-
tures to houses of the new type on farms of hundreds of record keeping cooperators over a period of many years have shown an increase in annual egg production of 20 eggs per hen with no greater outlay for feed or labor.

**FEEDING**

Through investigations of protein supplements for poultry rations, the Missouri Station years ago made the discovery that adequate protein supplements roughly doubled the volume of egg production as compared to that obtained from feeding grain alone. The earliest of these experiments indicated that this was true only with proteins of animal origin, but later studies resulted in the additional discovery that vegetable proteins, notably the by-products of the soybean so widely grown in Missouri, gave equally good results with the addition of a very small amount of salt and bonemeal.

In another experiment the discovery was made that dried milk products were equally efficient as liquid buttermilk or condensed buttermilk in securing gains in milk feeding poultry for market.

Research with baby chick rations involving the use of milk products led to the development of a feeding formula containing dried milk
which is now widely followed by farm poultry raisers, feed mixing plants, and commercial poultrymen. This formula has been an important factor in reducing losses of chicks in brooding and also has resulted in more rapid growth and development of young stock with consequent savings in the cost of replacements in the laying flock and in the production of broilers for the early market.

**CARE OF CHICKS**

In studying the relationship that exists between the date of maturity and total market value of eggs produced, Station investigators found decided advantages in early hatching, full feeding, and special summer care of the pullet flock. As a result of recommendations based on these discoveries, Missouri poultry raisers are now very generally maturing their pullets at a much earlier date than formerly and are realizing greater profits because of the greater proportion of eggs produced in fall and early winter when prices are comparatively high.

Also by studying the growth of chickens under normal conditions, the Station has found that chickens hatched early grow much faster when young than do those that are hatched late. However, retarded growth when young is offset by accelerated growth later on. Eventually chicks hatched at a later date attain the same weight as do those hatched early. From these studies it was learned, also, the chicks of smaller size are less seriously retarded by periods of extreme heat. From this series of investigations the Station has developed standards of growth by which poultrymen are safely guided in solving the chick management problems for every condition.

**MARKETING PROBLEMS**

Much work has been done by the Missouri Station on the problems connected with egg marketing. One of the most important of the investigations in this field was a study of the rate at which eggs cool under various conditions and the effect of the rate of cooling on their market value. This led to the designing and widespread adoption of cooling equipment for farms and egg buying establishments throughout the State. By maintaining quality at a high level from farm to consumer, many thousands of dollars have been added annually to the amount received for Missouri eggs and their position on the eastern markets has been greatly improved.

A study was made of consumer preferences for egg yolk color and shell color in New York City. Tabulation of the results revealed unwarranted market discrimination against eggs which did not have pale yolks or which were brown-shelled. The report of this study led to changes in the descriptions of market standards favorable to the type of eggs normally produced in Missouri and other Mid-western states.

More recently, in attempting to reduce the losses due to eggs reaching the market in dirty condition, the Experiment Station has completed an investigation of the factors influencing the production of
clean eggs. Even under favorable production practices fully 7 per cent of the eggs marketed have been classified as dirty and subjected to heavy market penalties. Moreover, it was believed that washing eggs led to rapid reduction of interior quality. In their attack on this problem, Missouri investigators discovered that dirty eggs can be completely cleansed in a 1 per cent solution of sodium hydroxide (lye water) and that after being thus handled they maintain their interior quality in storage just as well as naturally clean eggs.

**OTHER EXPERIMENTS**

One of the widely quoted, fundamental discoveries of the Missouri Station resulted from an investigation instituted nearly twenty years ago and centering around the utilization of carotinoid pigments by the fowl. The discovery that the principal yellow pigment utilized by the fowl is xanthophyll made possible an understanding of the control of yolk color in the production of market eggs by limiting the amount of xanthophyll in the ration. The investigation also explained the fading of the shanks of yellow skinned hens after long-continued laying, thus providing knowledge that has been widely utilized in the culling of farm flocks for the retention of heavy layers.

Other research by the Missouri Station of recognized economic and scientific importance has included studies on the feed purchasing power of eggs, factors influencing the hatchability of eggs, the egg weight of the domestic fowl, incubation and brooding temperatures, factors in successful turkey production, and environmental factors influencing egg production.
RURAL SOCIOCY

RESEARCH IN THE SOCIAL PROBLEMS of the rural home and community has been definitely organized as a separate department of the Missouri Agricultural Experiment Station only since 1926. In this short period, however, the department has investigated a number of basic problems and has been able to assemble and interpret in published form a considerable body of knowledge highly useful to community leaders, ministers, teachers, legislators, and similar groups whose services are important to the rural family and community. This work has been closely coordinated with that done by other state and national agencies interested in similar situations.

RURAL POPULATION

Some of the earliest projects were designed to determine the sources, changes, and composition of the rural population of Missouri. An analysis of this population from the first settlements to the present, by areas, counties, townships, and villages, developed a knowledge of the human make-up of the State and its sub-divisions, together with gain or loss in population by decades. These surveys provided a body of useful population data which indicated the status of the farmer class in the total situation and were a sound basis for further research in rural life.

COMMUNITY ORGANIZATION

The study of some ninety rural communities which had pursued a plan of general community development resulted in the formation of a plan of community organization which is applicable to Missouri conditions and is now being used successfully by a number of communities. This plan established a rational program for rebuilding the rural social structure, the need for which had been created by rapid and far-reaching social changes. Upon this basis, the Missouri Standard Community Association was used by extension workers and community leaders in many Missouri counties to organize neighborhoods into unified groups interested in building a richer and more permanent country life.

COMMUNITY TRENDS

Through a three-year experiment a plan was developed whereby rural communities could determine their growth or decline and their efficiency in the services rendered their citizens. Score cards measuring school facilities, health, public service utilities, commerce, and religious and civic interests provided indices to local committees for establishing trends. The cooperation of these collaborators made the project a continuous one which created leadership by a group of persons with a knowledge of the community status and needs.
Several communities have been studied to determine the economic and social conditions relating to the life of rural young people with the view of finding out their occupational preferences and attitudes, and determining the extent to which organizations in these communities had been meeting their needs. These surveys pointed out a desire on the part of young people for more recreational facilities and will be a useful tool for local leaders in their endeavor to stimulate further interest in local organizational activities.

Levels of Farm Family Living

Investigations have been made concerning differences between levels of living of farm families residing on marginal land with poor roads and inferior institutions and families living on productive land with improved transportation and better institutions. The relationship of factors associated with an adequate standard of living have been used by state and national agencies in establishing a richer home environment for farm families. Households have been instructed in the use of forms for recording expenditures and incomes and have been furnished with yearly summaries of their business.

Rural Churches in Missouri

A study of 3,000 rural churches was made in an effort to determine the conditions under which some churches appear to be prospering and others declining. The inclusion of such factors as church size, frequency of services, attendance, and ministerial tenure made it possible to ascertain the degree to which these organizations are fulfilling the religious and social needs of the community. The facts established by this report have been used extensively in the training of ministers and have served church leaders of the state as a basis for rural religious programs.

The Libraries of Missouri

The Experiment Station, by a state-wide survey, made known the conditions under which library facilities are available to farm families. This investigation was most comprehensive and included a study of the location of libraries, number of books, extent of use of library facilities by farmers, and the extent of the development of circulating libraries as a loan service to rural communities. The Missouri State Library Commission has made extended use of the facts assembled in this study in administering and planning their program of work.
SOILS INVESTIGATIONS

IN NO PHASE of the farmer's business does he need the assistance of minute and exhaustive research more constantly than in his utilization of the resources stored within the soil. With some two hundred types of soil variously distributed and intermingled and constantly changing, on 275,000 Missouri farms, the responsibility of the Experiment Station in supplying such assistance is boundless in scope and unending in its continuity. Here is a field of knowledge in which generalities are not acceptable, for the man who would use his land wisely and maintain it well must have information exact and specific for the soil types, topography, cropping systems, and degree of erosion represented on his own farm.

THE SOIL SURVEY

One of the early projects dealing with soils was inaugurated in 1905 under the name of the soil survey. This project was developed through the efforts of Dr. C. F. Marbut, who later became a world figure in the science of soil classification. Cooperation was early established with the United States Department of Agriculture and under this cooperative plan half of the counties of the State have been covered with detailed soil surveys. In addition, a reconnaissance soils map of the State has been published, together with a descriptive bulletin, and this has been followed by a key to the various soil types of the State. In 1934, in cooperation with the Federal Soil Conservation Service, an erosion map of the State was prepared. During the last two years work has been in progress in developing methods of land classification based on the soils and other physical features of the land. Land classification maps have been completed for two counties and others are in process of classification. However, much is yet to be done to complete a satisfactory land inventory of Missouri.

THE OUTLYING EXPERIMENT FIELDS

In 1907 the State Legislature made a small appropriation to the College of Agriculture for the purpose of conducting experiment fields on the important soil types of Missouri. This appropriation has been continued and expanded until experiments have been conducted on most of the important soil areas of the State. These experiment fields give first hand information as to the best systems of soil management on the different soil types, particularly with reference to manuring, fertilizing and liming. Although there are many soil types which have not been reached, these experiment fields represent more than one-half of the total agricultural area of the State, and it is upon the results of these experiments that most of the recommendations regarding soil management are made. Outgrowths of these experiments are the widespread use of legumes in Missouri agriculture and the
development of a very considerable use of lime. The annual use of lime has increased from practically nothing twenty-five years ago to a total of about 375,000 tons in 1937. It is through such far-flung investigations as those of the soil experiment fields that the soil management practices of Missouri farmers have been greatly influenced.

**CROPPING SYSTEMS AND SOIL TREATMENTS**

Sanborn Field, one of the oldest experiment fields in the United States, and the oldest west of the Mississippi, was established in 1888, and this year (1938) represents the fiftieth harvest from this field. Investigations on this field have established fundamental principles for cropping systems and soil treatments. The yields of those plots which for fifty years have been conducted under continuous cropping systems, with individual crops such as corn, wheat, oats and hay, have shown most profound declines as compared with yields of the same crops in rotations. Likewise, the long continued use of commercial fertilizer and farm manure has shown the two methods of treatment to be almost equally effective in maintaining yields where the applications have been in large quantities. The soil of these individual plots with widely varying treatments during a half century of time is being subjected to a critical physical, chemical and biological study which should provide much valuable information.

**SOIL EROSION**

One of the investigations in which the Missouri Station has pioneered is that dealing with erosion losses under different cropping and cultural systems. This investigation inaugurated in 1917 and maintained continuously since that time, provided the first quantitative data dealing with erosion losses under farm conditions. It was large-

The original plots of the world's first scientific experiment for the measurement of the runoff and soil losses under different cropping systems and cultural practices. Established at the Missouri Experiment Station in 1917, this investigation has supplied much of the early data and long-time averages now generally accepted as basic in soil management and erosion control teaching.
ly as the result of these investigations that the federal erosion experi­ment stations were established in many parts of the country and the beginnings of a national program of soil conservation were made. The interest thus created has been carried throughout the State by the Extension Service and marked development in soil conservation has taken place among the farmers. At the present time these in­vestigations are being conducted both at Columbia and at the Federal Soil Conservation Experiment Station at Bethany.

**Organic Matter in the Soil**

Much attention has been given to the organic matter level of soils under Missouri agriculture. These investigations cover the influence of climate, cropping systems, tillage practices, and the effects of individual crops upon the content of organic matter in the soil. In general, they have shown that in the climatic zone in which Columbia is located, the rather warm climate so encourages a rapid decay of organic matter that it is not practical to maintain a very high content of organic matter under ordinary agricultural practices. At the same time these investigations have demonstrated that with the long growing seasons, in this climatic zone, it is very simple to provide a large organic matter turnover during one round of a good cropping system. Since it is the decomposition of organic matter within the soil that is important in maintaining productivity, and since the long growing seasons make possible a large organic matter turnover, it is this turnover that is of paramount importance rather than the level to which the organic matter of the soil may be maintained.

**Soil Colloid Investigations**

A field of investigation in which the Missouri Station has assumed considerable leadership has to do with soil colloids, and their relations to soil properties. Work inaugurated in this field in 1920 and continued to the present has revealed the relationship of colloids to soil acidity, to ionic exchange, to soil structure, to soil absorption, and to plant nutrition, and by so doing has established principles of far-reaching importance. More recent investigations on the mineralogical nature of the colloid complex of the soil have provided a new means of approach to an understanding of the chemical and physical factors thus influenced.

**Investigations with Legume Organisms**

A type of research which has been given much attention during the last twenty years is that dealing with nitrogen fixing organisms associated with legume plants. The results of these studies have shown the very important relationships of calcium to nitrogen fixation and the fundamental importance of this element in legume crops used for
animal forages. Accompanying this investigation there has been developed a service project for supplying cultures of legume bacteria to Missouri farmers. Distributing as much as 100,000 of such cultures yearly, this project has had a far-reaching influence on the growing of legumes in Missouri.

Sanborn Field, established in the fall of 1888 by Dr. J. W. Sanborn, director of the Missouri Experiment Station (1888-1889). Established to test the long-time effects of rotations as compared to continuous cropping, both with and without the application of manure, this field has been in continuous operation for fifty years.

OTHER LINES OF SERVICE

A number of other lines of investigation have given, or are giving fruitful results. Among these are studies of fertilizer usage on individual crops, the use of small amounts of very finely ground limestone to take the place of the standard but more costly applications, the development of practical methods of making artificial manure, and the fertilization of pastures. These, along with service projects in testing soils and limestones for farmers have supplied much usable information to the people of the State.
WORK IN VETERINARY SCIENCE at the Missouri College of Agriculture was inaugurated prior to the establishment of the Experiment Station in 1888, but was stimulated to more productive activity by the enlarged means available under the latter organization.

Fifty years of continuous investigations in this field at the Missouri Station have made contributions of inestimable value to the livestock industry of Missouri, and have developed knowledge of fundamental importance even beyond the borders of the State and Nation. Some of these discoveries aided in the establishment of concepts in disease control that were new not only in veterinary practice but in the entire field of medicine.

PLEURO-PNEUMONIA IN CATTLE

Early in its history the Missouri Station did an important service for the State and the animal industry of the entire nation by its prompt and effective participation in the eradication of pleuro-pneumonia from cattle herds near Fulton, Missouri. Cooperating with the veterinary service of the U. S. Department of Agriculture this dangerous European cattle disease was rigidly quarantined and quickly eradicated. No spread of the disease occurred from this infected area.

MADE BLACKLEG VACCINE

The Missouri Station was the first institution in America to produce and make available to the cattle raisers a preventive vaccine against blackleg in calves in conformity with newly discovered French methods. Prior to this work the cattle industry in Missouri suffered enormous losses annually from this disease.

PRODUCED SMALLPOX VACCINE

The Missouri Station produced and distributed to the medical profession the first smallpox vaccine made west of Boston. Special laboratory facilities were provided by the Station for this purpose.

CONTROL OF TEXAS FEVER IN CATTLE

One of the most important lines of research undertaken at the Missouri Station was carried on by Dr. J. W. Connaway in the department of veterinary science in cooperation with Dr. Mark Francis of the Texas Experiment Station, for the purpose of determining the cause of Texas fever in cattle, and devising methods for its control. The work was interrupted for a time by the resignation of Dr. Paquin, but was resumed later by Drs. Connaway and Francis who confirmed in a practical and convincing way the findings of the Federal Bureau of Animal Industry that Texas fever was transmitted by a definite
species of cattle tick. Moreover, extensive experiments were instituted to determine the feasibility of destroying the ticks upon the living cattle. The good results derived from these early experiments pointed the way to the adoption of the dipping process in an extensive cooperative program between all of the Texas fever infected states and the Federal Bureau of Animal Industry to eradicate this disastrous cattle plague from the United States.

BIOLOGICAL STUDIES OF THE FEVER TICKS

In a study of the movements of the southern cattle ticks, facts of practical value in the control of the disease were discovered; namely, that the tick is highly sensitive to light and travels away from the direction of the sunlight. Moreover, that upon a grassy pasture the distance traveled is but a few inches from the point where dropped from the infested cattle host—at farthest not more than four feet and that a narrow unused lane suffices to prevent the spread of the infection to adjoining pastures.

It was determined also by experiments at the Missouri Station that the Texas fever ticks lost their power of transmitting the disease when grown upon the horse. Additional experiments, in cooperation with the Alabama Experiment Station, demonstrated that the fever ticks grown on the mule likewise lost their power to reproduce Texas fever in cattle.

The Missouri Station, cooperating with the Mexican Agricultural Society, carried out experiments with several species of cattle ticks to determine the cause of "ranilla," a cattle disease simulating Texas fever. A species of Mexican cattle ticks, later identified as of the same species as those producing Texas fever in the United States, produced all the symptoms of Texas fever and ranilla in the Missouri Station experiments—other varieties of Mexican ticks failed to cause disease in the cattle. The inference drawn from this research was that ranilla and Texas fever are identical diseases.

IMMUNIZATION OF CATTLE AGAINST TEXAS FEVER

Researches of great economic importance, namely, experiments to develop methods of immunizing cattle against the disease were carried on originally in cooperation with the Texas Experiment Station, and extended in cooperation with the Mississippi Station, and with cattle breeders and ranchmen in California and other states. By means of this method valuable breeding cattle from non-infected territory were made immune and could be shipped with safety into Texas fever infected territory.

IMMUNIZATION OF SWINE AGAINST CHOLERA

The Missouri Station was the first among the state experiment stations to establish a laboratory to put to extensive scientific and practical tests anti-hog-cholera serum, and to demonstrate its effec-
tiveness in the field in protecting swine against hog cholera. This early inauguration of the application of this discovery resulted in saving millions of dollars to Missouri farmers. For some twenty years the Station manufactured and distributed to Missouri farmers at cost fresh, tested serum to facilitate the prevention of this disease.

**INFECTIOUS ABORTION OR BANG’S DISEASE**

The Missouri Station was also one of the earliest in the United States to conduct intensive researches into the various phases of infectious abortion (Bang’s disease) in cattle and swine. In the work at this station it was discovered that aborting sows would react in the same manner as cattle to the blood test for Bang’s disease and that the diagnosis in swine herds could be made by this specific test. This station was one of the first to advocate and emphasize the eradication of Bang’s disease by blood testing and segregation of the infected animals. This plan of eradication is now in progress throughout the country under a cooperative project between the U. S. Bureau of Animal Industry and the Livestock Sanitary departments of the various states for the purpose of eradicating this disastrous disease.

**DISEASES OF POULTRY**

Some other discoveries of importance are those relating to diseases of fowls. It was discovered that in the disease of turkeys known as blackhead the initial lesions occurred in the ceca, and experiments were made to determine whether the removal or ablation of these organs would prevent the disease. The results of these experiments demonstrated that cecal ablation, that is, the separation of the ceca from the main gut by ligature, protected turkeys from ordinary exposure to blackhead disease. It was thus shown for the first time that by surgical interference a serious infectious disease of fowls could be prevented.
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