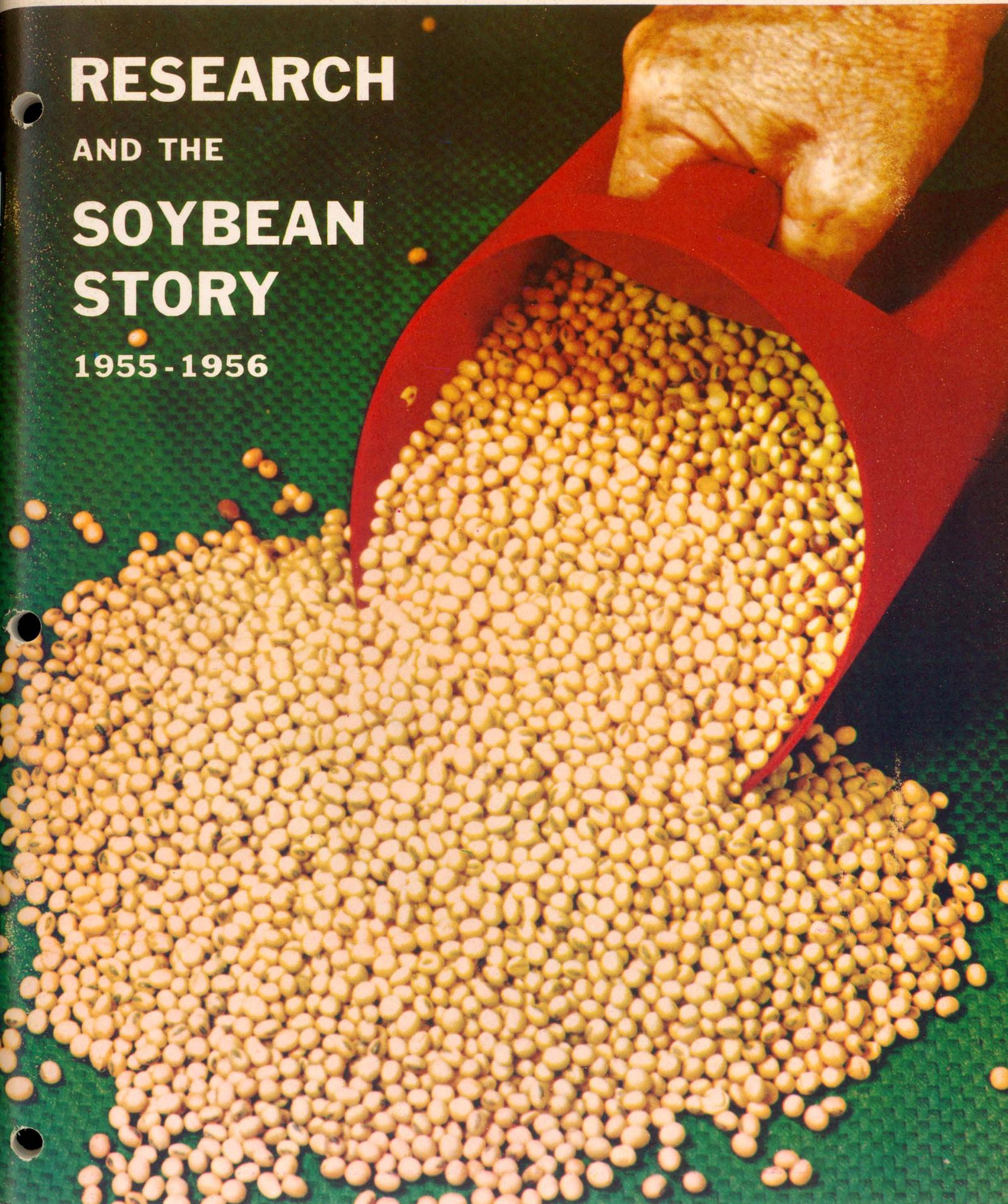


RESEARCH AND THE SOYBEAN STORY

1955 - 1956



ANNUAL REPORT OF THE UNIVERSITY OF MISSOURI AGRICULTURAL EXPERIMENT STATION

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A LEGUME OF LEGEND . . .

by Clyde H. Duncan

The skipper's brow furrowed and one, looking closely, could see a scowl vignetted his features. A mutiny, he knew, wouldn't insure peace of mind on the voyage home!

His uneasiness had been brought about by a hurried inventory of the ship's stores. What he saw in one quick glance—port to starboard—augured no solace for him. Rations were running dangerously low. In addition he detected a look of distrust and uneasiness on the swarthy faces of the crew. This brought to him a long moment of ominous foreboding. He leaned against the bulkhead, but this moment of quick reflection failed to diminish the dizziness at the pit of his stomach.

Lifting his face from his cupped hands he remembered huge stacks of native beans piled high along the sea walls closeby where his ship was anchored. "Shi-yu" and "Ta-tou" he had heard the natives term them.

"Funny names for a bean," he had thought. "A few bags of them aboard might avert disaster . . . avoid mutiny!"

It was then the skipper ordered the Kanaka, who had come on in the Sandwich Islands, as a deck flunky, to go ashore and put aboard a few bags of the beans with the queer names for emergency provender.

But first he had taken from a leathern pouch, hid amongst the folds of his wind-whipped shirt, and suspended on a silver chain from his bull-like neck, a few dirty coins. These he placed in the large palm of the flunky as he quipped: "Go and bargain for a few bags of those native beans." At the same time his left arm swept a wide arc indicating the location of the beans on shore. "Store them in the hold," the skipper admonished. "They will serve well as 'belly ballast' until we can do better."

It was on long sea trips, such as this, that the skipper's problems seemed often to multiply far out of proportion to what they normally should be, he thought, as he scanned the mizzenmast and wondered if the old canvas would weather the storms, or be ripped to shreds on the return joust.

With the thought of a possible mutiny no longer clouding his thoughts, the skipper put his mind to the real and more immediate problem. Where, he wondered, in this long stretch of China coast might he find a cargo for the voyage back to the states? In 1804 Chinese commerce could be likened more to a weathered desert bone than a bonanza.

Shortly afterward, though, success having come their way in the form of pay shipments for the states, the Yankee Clipper's sharp bow and narrow beam were put into the sea lanes bound home. Neither the name of the ship nor the Kanaka who put those first priceless soybeans aboard

from some nameless Chinese port, more than 150 years ago, appear in the nautical records of the day.

Records, if there ever were any of this historic event other than the word of mouth stories from the sailors of the old-time Yankee Clipper ships, have been lost in the insatiable maws of antiquity from whence some of our lore and legend have been preserved in no more permanent form than word of mouth.

The event is important, make no mistake about that! Those few soybeans bought by the skipper in that year of 1804 as a precautionary measure against hunger and possible mutiny, were the first of a long line of such beans to be brought to America. Important, well just how important is a \$75,000,000 annual crop to Missouri alone? So important, we'd say, that its story should be told and re-told in every school house in the land. As the soybean served as insurance against hunger back then for the skipper so has it continued through its history of grandeur. Hunger it allays, of course, in many ways. To the versatile bean's credit, today more than 250 uses have been found for it. In Missouri alone this year were harvested some 47,150,000 bushels of this crop which will outdistance the 1955 crop by 14,000,000 bushels and excel the 10-year average—based on production between 1945 and 1954—by nearly 30,000,000 bushels. In the nation some 462 million bushels of soybeans, or nearly 25 percent above the 1954 record crop, were produced in 1955. Is such a crop important? Most certainly and so is the history behind it.

The skipper's part in the soybean legacy is of comparative recent times when one considers the rich heritage of this legume which stretches back before the days of the Pyramids, some 300 years before the Tower of Babel. Back then, even, the soybean was a legume of legend. A dozen centuries before Solomon fashioned the rare woods and stones of his temple, this bean of the Orient was long ancient.

Some 300 years, almost, before the Messiah trod the lands of Galilee, one finds the first written words of the soybean in "Materia Medica" as recorded by Emperor Shennung. In that ancient writing may be found a description of the plants of China, including the now world renowned soybean.

The name itself, even, is such an ancient thing. One is almost constrained to speak and write of it with great reverence. In China's early history the names of "Shi-yu" and "Ta-tou" were applied to it as the skipper had noted. "These names probably antedate the first authoritative records of the plants," says Edward Jerome Dies in his very delightful and informative little book: "Soybeans, Gold From the Soil."

Dies adds: "To the early Chinese the word 'Shi' meant the salted bean and the word 'yu' alluded to a condiment, and evidently the combination was applied to the plant as well as to the raw bean."

A German botanist, Engelbert Kaempfer, introduced it into Europe in 1712. He had spent a year in Japan from 1691 to 1692. Little interest was shown in the bean, however. Most people in Germany looked upon it more with curiosity than with any serious intent of propagating the plant, or adapting it into the agriculture of that time.

Linnaeus, the great botanist, is credited with making the first really thorough scientific study of the soybean. He used the Greek word "glycine", which means sweet, in referring to all ground nut species of legumes. Since the soybean had very large nodules he termed it *Glycine Max*.

Dies says that botanical history of the soybean was confused owing to an early error by Linnaeus himself in the identification of the legume. The noted botanist in his first edition of "Specie Plantarum" in 1753, described two supposedly different plants, one being called *Phaseolus Max* and the other *Dolichos Soja*. In time, however, the error was corrected. *Soja Max* is the scientific name now generally accepted.

One can only surmise in how many wars this legume, flowering into pod and bean, has provided the main prize as loot and booty, nor how many armies from the dawn of time through the ravages of Genghis Khan to the present day have been fed, and sustained by the soybean. We know that at a very early stage of the world's history it became known as "China's Staff of Life," the bread of the Orient.

So much for the ancient history of this fabulous bean. We come now to events in this our own country in 1804, or shortly after the skipper and his Yankee Clipper ship landed with its renowned cargo. It was only a short time later that James Mease of Pennsylvania became the first one to publicly endorse soybeans, often known then as "Japanese peas" or "American coffee peas." Mease in the writings of that day is reported to have declared that the soybean "was adaptable to Pennsylvania and should be cultivated." This was quite an endorsement for those days and for a bean which seemed to take an unusually long time to catch on, so to speak.

American scientists had perhaps more than any others to do in getting the soybean the recognition it deserved. In 1907 Dr. C. R. Ball of the United States Department of Agriculture, described 23 varieties of soybeans, all that were then known here.

It was in this same year—1907—that a young man by the name of Bill Morse who was that June getting his "sheepskin" at Cornell. He had hardly more than received his Cornell degree than he was given a job under Dr. C. V. Piper of the Bureau of Plant Industry in Washington, D. C. In time Piper was to become internationally famous for his soybean investigations.

This young college graduate didn't wait long for an assignment. Dr. Piper knew a willing hand and an enthusiastic one when he saw one. "I'll

put you in charge of forage crop investigations at Arlington," Dr. Piper announced to Bill Morse one morning shortly after his arrival in Washington. "Arlington," as it was known then was the Federal experimental farm across the way in Virginia, a short distance from the nation's capital.

At "Arlington" the young scientist had a chance to study a dozen, or so, different types of soybeans as they were being experimentally grown. Here was his chance to literally grow up with soybeans.

During these times Morse and Piper became close friends, exchanging ideas and discussing plants, especially those with great and small economic possibilities. Both agreed on the "new bean from China." It had a great future. Both shared in this optimism; but there remained tremendous obstacles yet to be overcome.

"And so for thirty-four years, heedless of material gain or personal honor, shy, modest; but with the repressed intensity of a crusader, Bill Morse carried with steady hand the lamp lighted by Dr. Piper," says Edward Jerome Dies. "By the irony of fate Piper, the Prophet, passed away without tasting the joy of full success that came from their joint labors."

And he adds: "So the work of Bill Morse, the agreeable, easygoing senior agronomist, runs like a bright thread through the whole tapestry of soybean development in the whole of the western world."

The soybean is not really a bean; but no one has yet found a name which fits better. It contains approximately 40 percent protein—twice as much as ordinary beans. Its protein is the only known vegetable protein which has full biological value—equivalent, for all practical purposes to meat, milk and eggs. It contains 20 percent oil. The ordinary bean has practically none.

The soybeans of the ancient Orientals were a far cry from our present-day American kinds. The small leguminous pods of the early ancient varieties bore pods with very small, dull, black seeds. The pods of those ancient varieties were hardly an inch in length.

Today's soybean plants are no longer the short, squatty type, now stand waist high and the pods are as much as 2½ inches long, carrying two or three beans which are as large or larger than ordinary peas. And, instead of being black, the beans developed in the United States are straw yellow, olive yellow, green, brown or black with the most common and valuable being the yellow kind with saddles of black or brown. Research has played an invaluable part in the bean's improvement.

The soybean is an annual summer legume, standing erect with distinct branches. In early growth it resembles the ordinary field or navy bean. "The different varieties range in maturity from very early (about 75 days) to very late (200 days or more)", says W. A. Wheeler in his book: "Forage and Pasture Crops." He adds: "With very few exceptions earli-

ness is correlated with size, the tallest varieties being latest.”

There are many varieties of soybeans. The U. S. Department of Agriculture has made more than 10,000 introductions of soybeans from China, Manchuria, Japan, Korea, Java, Sumatra and India, representing more than 2500 distinct types.

This large collection of varieties has shown wide differences in size, shape, color, composition and quality of seed and in adaptation to soil and climatic conditions in the United States. It is a rule of thumb, however, that the soybeans will grow and thrive anywhere in this country that is suitable for the growth and cultivation of corn. Researchers by improving varieties have literally tailored the variety to the area.

From the standpoint of geography alone, it is interesting that the states which are the top corn producers in the United States are likewise at the top of the list in soybeans harvested. These are the North Central States—including Missouri—which in 1954 produced 90 percent of the total crop and 83 percent in 1955. In these six corn belt states 309,000,000 bushels were produced last year. Of the 48 states, there are 31 which produce soybeans in what might be called commercial amounts.

One can easily observe how soybean production has increased in this country by comparing the soybean record of 1925 with 1955, a span of three decades. In 1925, the acreage devoted to soybeans planted alone was 1,539,000 as compared to 19,669,000 in 1955. For those same years the acreage harvested as beans was 415,000 in 1925 compared to 18,096,000 in 1955. In Missouri in 1955, 26,000 acres were harvested for hay, 26,000 acres were grazed or plowed under, and 1,935,000 acres were harvested for beans alone. As pointed out previously this year's crop of 47,150,000 bushels in Missouri is 14,000,000 above 1955, and 30,000,000 above the average crop based on the period between 1945 and 1954.

The yield per acre nationally has “skyscrapered” as indicated by the yield of 11.7 bushels of beans per acre in 1925 as compared to 20.1 bushels of beans per acre in 1954.

All of this has been the result of improved seed strains and improved planting, cultivating, harvesting and crop rotation programs and methods. During the past 20 years an almost unbelievable amount of research on soybeans has been conducted by various state and federal experiment stations, and trade and industrial organizations. The main objective in all this research has been the growing of improved oil producing soybeans, and more per acre. In this area of research the Missouri Experiment Station has long been active, and with vastly productive results.

Right here in our own Missouri, we find that the soybean's history has been an illustrious one and the same men who did so much to popularize Korean lespedeza were just as active in popularizing the soybean. These, of course, include such of the University of Missouri Field Crops Department as W. C. Etheridge, Charley Helm, L. F. Williams, and J.

Ross Fleetwood in the earlier as well as the later days.¹

Unfortunately, the two former have passed on, but we have left Dr. Williams and Fleetwood who can attest to some of the early pioneering in popularizing the legume. Fleetwood, who is Extension Professor of Field Crops, in recounting early experiences with the bean says that today in Missouri it has grown into a "man-sized crop," and for proof points to the fact that last year (1955) 1,953,000 acres of soybeans were harvested, producing 35,154,000 bushels, an average of 18 bushels per acre, worth a total of \$73,823,000.

"In 1955, the total value of soybeans produced in Missouri was exceeded only by corn, hay, cotton and wheat, and as a cash crop they were exceeded only by wheat and cotton," Fleetwood says.

He points out that since the end of World War II the soybean acreage has been expanded 250 percent, or nearly 1¼ million acres. This acreage is more than equal to the required reductions in corn, wheat, cotton and tobacco.

Fleetwood claims that the full economic significance of this points up to making a practical and profitable use of "adjustment acres" which is difficult to assess. He concludes it is not hard to see that substitution of this crop for those in economic distress substantially reduced economic pressures on many Missouri farmers.

It is a fact that a thing which becomes important in our lives, assumes historical interest for us. What is the origin of this crop? Who brought it in? How did it develop? All these, and other questions are of greater interest since the crop is grown on so many farms and has assumed such a big role in our everyday "pocket" money.

A search of the files of the Missouri Agricultural Experiment Station does not reveal the first introduction of soybeans into Missouri. However, a report in 1909 notes the receipt of some one half dozen varieties from the U. S. Department of Agriculture for testing.

A report for 1910 of the Missouri station includes this statement: "Owing to the fact that this station never (has) secured good results with soybeans for seed, that planting in rows for seed production had not been thoroughly tried, the different varieties were sown in rows to test this method of seeding."

This note indicates first that testing started some time prior to 1910 and second, a good reason why early bean production in the state was confined to hay production.

Fleetwood feels that it may be coincidental, but the development of

¹Credit is due for much material used in this article to J. Ross Fleetwood, Extension Professor of Field Crops; Dr. Merle E. Muhrer, Professor of Agricultural Chemistry, and Dr. L. F. Williams, Associate Professor of Field Crops, all of the University of Missouri.

the soybean in Missouri came at a time when the limestone supply in our soils was beginning to reach a low enough level that red clover was failing on many farms.

“Thus, this legume crop offered a hay to replace red clover and the early work was with so-called hay varieties of the soybean, such as Wilson, Ebony, Laredo, Sable and Virginia,” Fleetwood concludes.

Even as late as 1930 the acreage used for hay was 296,000 as compared to 152,000 acres devoted to grain. A rather large percentage of this “grain” acreage was devoted to production of seed of the hay varieties. The Oriental origin of the crop is shown in a 1909 listing of varieties on test, including To ho, Shinto, Manchu, Pingsu, Peking and Ito san.

In the period following world War I the experimental and Extension Division work on limestone began to bear fruit with red clover and alfalfa acreages beginning to increase. However, it was the introduction of Korean lespedeza, another Oriental crop, which really put the “knock out” to soybeans for hay.

From 1920 to 1940, a period of 20 years, the experimental work on soybeans was greatly accelerated. The breeding program produced varieties such as Boone, Illini, Chief and Arksoy, all of which carried more and improved oil, yielded and stood better.

These higher yielding varieties plus the increased yields due to liming stimulated grain production. As grain, beans were produced in larger quantities, the processors came in and markets began to expand.

Perhaps the most notable in this region being the A. E. Staley Manufacturing Company, at Decatur, Ill. The elder Staley long claimed identification with the soybean in this country, going as far back as 1873 when his father attended a Methodist conference in North Carolina, and returned home with a small parcel of soybeans given him by a missionary then recently returned from the Orient.

Staley then six or seven years of age, planted these seeds and from then on his interest in the plant never waned, and he claimed—as a result of having planted the seeds—to being the first ever to put soybeans in the soil on this continent. He went on from there to found and head what is today one of the nation’s largest concerns based largely on soybeans.

By the end of World War II some 7,200,000 acres of soybeans were harvested for grain in Missouri while less than 90,000 acres were cut for hay.

Fleetwood says that research played a big role in the introduction of soybeans, developing a place for the crop in the state, breeding desirable varieties and working out management and fertility practices. Certainly in the case of the soybean, as in so many other instances, research has paid off to the tune of “seventy times seventy.” Money invested in soy-

bean research has brought returns beyond all comprehension.

"As time 'marches on,'" Fleetwood says, "insects and weeds especially harmful to soybeans have become established, thus the present program of research has had to be expanded to include special work on these problems. The new varieties currently used, such as Clark, Perry, Dorman and Lee are good yielders."

They stand well, resist shattering and produce beans of excellent oil content and quality. They are, however, subject to certain diseases and weed control is a major problem. Thus, breeding for disease resistance, weed and insect control offer the most promise of making this "wonder" crop even more wonderful.

To what uses has this magic plant from the Orient been put? As stated before, some 250 different products are now being made from it. These products are made from either crude soybean protein, crude soybean oil or what is termed "in the trade" as soybean products meaning such items as baked soybeans, puffed soybeans, steamed soybeans and soybean sprouts.

Some of the common soybean products include: soy flour, soybean flakes, soybean oil meal and soybean pellets, all used in animal feeding. For human consumption the list is a long one, but includes oil for oleomargarine, diabetic foods, frozen desserts, mayonnaise and salad dressings, soy cereal, confections, candy ingredients, chocolate extender, nut meats, meat loaves, sausage components, prepared dry mixes, puddings, soups and countless dozens more. The list is legion.

Soybeans have filled an unparalleled place in the agricultural research of the nation being only partially approached in this regard by another legume—the peanut. Dr. Merle Muhrer, head of the Agricultural Chemistry Department of the University of Missouri, says that the soybean is a good crop for Missouri farmers because research workers have found many uses for all its products.

"When this crop was first introduced," says Dr. Muhrer, "it was used as a forage or hay crop and the bean was valuable only as seed to produce next year's crop. Today the picture, due to research, has changed. Now the bean seed is so valuable that the plant is seldom cut in the immature stage for forages, but allowed to mature and the seed harvested as a major cash crop. This cash crop has replaced many acres of corn and wheat thus greatly relieving our surplus of these crops. Our surplus of corn and wheat would be a much greater burden to our economy if research had not found the value of a replacing crop, the soybean."

Dr. Muhrer says that the oil from the soybean is very versatile, being useful both as food oils and as paint oils. "This was the first dual purpose oil discovered with great possibilities in both directions," he says. However, much research was necessary and is still indicated for developing these possibilities. "For example", Dr. Muhrer says, "soybean oil in stor-

age may develop unpleasant flavors that make it undesirable for food. Research has made progress in correcting this difficulty.”

Taking paint for instance, soybean oil has both desirable and undesirable qualities. It is immune to the yellowing that is objectionable with linseed oil paints. However, it does not dry as rapidly as the linseed product. Research has indicated that a new chemical treatment can cut this drying time without affecting its desirable properties.

The soybean is high in oil content, about 20 percent, but is much higher in protein, about 40 percent. The protein of raw soybeans was not good animal feed because the animals could not efficiently utilize the protein from the untreated beans or raw meal.

“Through research,” says Dr. Muhrer, “it was found that soybeans contained an antitrypsin enzyme that interfered with animal utilization of the bean protein. Later it was discovered that this inhibitor could be destroyed by heat.”

Heated soybean meal is excellent feed for animals. This research discovery has made the protein more important than the valuable oil from soybeans. Therefore, the price of soybeans remains high, because of the great usefulness of the products of the beans discovered by research.

Dr. Muhrer points out that the production of soybean meal has increased so greatly in the past few years that it is more than double the production of any other feed protein source and is 50 percent of the total protein supply today.

Our great feed industry of 80 million tons annually would not be possible now without soybean meal, our scientists think. Soybean oil meal has a current value of 400 million dollars per year as feed. Increases in high protein concentrates in the past 20 years has been due mostly to the development of soybean oil meal as a feed source.

Nutrition research has revealed the nature of the animal protein factor that made tankage and meat scraps superior to the vegetable proteins, such as soybean protein. Scientists can now supplement soybean oil meal and even make it superior to tankage, or meat scraps, as a source of protein for farm animals.

The broiler industry increase, as well as other increases in livestock production, has been made possible by improved and more abundant feed sources. The increased protein supplies provided by soybeans, and research findings of how to make this protein high quality, have been the keys to the increased production of meat animals.

This increase in high quality human food at a reasonable price has raised our standard of living and made possible a well fed, increased consumer population.

Even with the great amount of research which has gone on and is going on today, there is evidence aplenty, the scientists say, to indicate

a real need for more research on the soybean's possibilities. In addition to its role as a forage, an oil and a protein, there are other products in this bean that could be used if we find what they are, and know how to make use of them. Research alone is our hope for these developments.

It is a proven fact that soybeans contain unknown growth factors. Is there another unknown vitamin hidden here that we may find by research? Possibly so, and how important is this factor to our national health problem?

Soybeans contain biologically active components of hormone nature. An active estrogen has been found here, but its importance has not as yet been determined. An antihormone as well as an antienzyme has been discovered in soybeans. "These may be important biological balancers, and much more research is needed," concludes Dr. Muhrer.

Soybeans are a good source of the lecithin phosphatides that are finding widespread use in foods, feeds and pharmaceuticals. These findings create new markets that keep the price high and the demand good. The farmer is producing a crop that industry can convert into products that the consumer can use to increase his standard of living.

There is no surplus of high living standards. The soybean fits snugly into the program of research, and we ever need research on new crops that may prove useful to industry and the consumer.

In the whole annals of chemurgy there are no more illustrious chapters than those devoted to the soybean, whose history antedates the Holy Writ and is lost in the sagas of antediluvia. Legume of legend, be that as it may it has winnowed a way into our daily lives. It has become a part of our national existence. And so, the soybean which found its way to our shores by way of a Yankee Clipper ship back there in 1804, thanks to a discerning skipper, has made us richer by far than it found us. And thanks to research at our own Missouri Experiment Station, and others, we have improved the soybean, found hundreds of uses for it, and made it possible for it to add many extra millions of dollars to the coffers of agriculture. In the case of soybeans, as in so many other instances, research was the "golden key."

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Agricultural Chemistry

M. E. Muhrer, Chairman

Hemorrhagic Condition In Farm Animals

M. E. Muhrer, Wm. R. Thomas

OBJECTIVES

- A. Maintenance of the bleeder strain of swine.
- B. Study the hemostatic properties of a blood plasma extender.
- C. Study of the Anti-hemophilia factor in swine blood.
- D. Study of the relationship between blood volume and body condition in swine.

RESULTS

A. Maintenance of the Bleeder Strain of Swine:

The Missouri Agricultural Experiment Station has the only strain of hemophilia-like swine on which any experimental work has been recorded in the literature. This hemophilia condition has been compared physiologically and biochemically with canine and human type hemophilia and has been found to be similar to these diseases. As a result, this herd affords an excellent opportunity to do original research and help in the advancement of knowledge in this important phase of biochemical and physiological mechanisms. Because of the limited space, funds and personnel the bleeder herd has been kept to the bare essential minimum in number. Pigs from the bleeder herd have been used jointly in fermented feed studies. The breeding system involves the use of bleeder males and carrier females. In this way the apparently normal sows will produce bleeder pigs. The male is the only mature bleeder that needs to be kept with this system. Therefore, the possible loss of mature animals from hemorrhage is kept at a minimum.

B. Hemostatic Properties of a Blood Extender:

Dextran is one of the more recent blood extenders developed in this country. Blood substitutes or extenders are used in plasma replacement therapy. Its primary function is the restoration of blood volume and osmotic balance following shock, trauma or wounds resulting in extensive blood losses and diminished blood pressure. Dextran, a strategic substance in war time, is presently being stockpiled in

the event of a national disaster. The practical production and use of Dextran has been one of the major projects of the Northern Utilization Laboratory. Our experiments were designed to test the effect of Dextran on hemorrhagic animals. The mechanisms of blood coagulation were studied by use of saline bleeding time, adapted prothrombin time and fibrin precipitation time determination. The tests were repeated on as many animals as were available in the bleeder herd.

The results indicate that Dextran does not beneficially increase the coagulability of blood. Actually, our results indicate that Dextran is a mild anti-coagulant. Thus Dextran therapy would be used in the prevention of thrombi development and other conditions associated with hypercoagulability of blood. In view of these findings, whole blood or plasma therapy would be indicated to increase blood volume before surgery or when hemostasis is a problem. Dextran could be used successfully as a blood extender however, when hemorrhage is not a problem. In the situation just described, Dextran would be superior to whole blood or plasma because it would lessen the danger of thrombosis or intravascular clotting. Due to the fact that Dextran is a natural fermentation product it may be produced commercially in quantities sufficient to meet the growing demand. In addition, it may be stored for extensive lengths of time without fear of either decomposition or loss of therapeutic value.

C. Study of the Anti-hemophilia Factor in Swine Blood.

Some progress has been made on the isolation of the biologically active form of the anti-hemophilia factor. Along with the isolation and assay of A.H.F. has gone a chemical characterization of this plasma fraction of swine blood. Previous work in this plasma factor has been reported by Dr. Muhrer of this University working in conjunction with Dr. K. M. Brinkhous and F. C. Morrison Jr. of the University of North Carolina as reported in the Federation Proceedings of March, 1952. At that time the A.H.F. component of swine plasma was reported to be 1½ to 2 times the concentration found in human plasma. Chemical characterization of the A.H.F. includes sep-

aration of the A.H.F. from the plasma by dialysis. This tentatively suggests that the A.H.F. is a low molecular weight polypeptide. The dialyzed fraction was subjected to acid hydrolysis and upon chromatographic analysis was found to be composed of several fractions, probably amino acids, that as yet have not been identified.

D. Determination of Blood Volume in Swine.

Blood volume has been determined in swine while drawing blood for other purposes. The method presently employed uses a dye, and dilution technique. This method is to be correlated with a radioactive P³² tracer technique for blood volume estimation. It is believed that a very fat animal has a relatively low blood volume. Therefore, the blood volume determinations are being correlated with back fat determinations being made by the Animal Husbandry Department of this University. Present indications are that there exists an inverse relationship between blood volume per unit body weight and body weight. Tentative data to support this contention follow:

Pig No.	Wt. in lbs.	Blood Volume in ml.	Blood Volume in ml/100 g. body wt.
1	43	1883	9.65
2	61	1732	6.53
3	59	1750	6.70
4	51	1585	6.85
5	65	1740	6.65
6	215	4905	5.00

(Project 56)

Spectrographic Service

E. E. Pickett, Bobby E. Hankins, Charles Strobel, and Samuel Koirtiyoham

Publications connected with this project usually are written by the departments or projects submitting the samples to the Spectrographic Service for analysis, with suitable acknowledgment usually made for the analytical work, so that no publications ordinarily arise out of the Spectrographic Service itself, except in the rare instances wherein special analytical methods are developed, publishable in themselves, in connection with the analysis of samples submitted by other projects.

The purpose of the Spectrographic Service is to analyze samples submitted by other Experiment Station projects, on approval of the Director, by appropriate methods, usually optical or instrumental, using methods already existing whenever possible, and to develop suitable methods when necessary. (Project 76)

Biochemical, Physical and Physiological Aspects In Natural and Artificial Breeding

D. T. Mayer, F. M. Orsini, J. T. Smith

The chief or overall objective of the research under this project was the accumulation of fundamental knowledge, through chemical, biochemical, physiological, and metabolic procedures, which would provide a basis for understanding the mechanism involved in the more critical reproductive processes, including fertilization and cold shock. The objectives related to this overall concept stressed during the past year are listed below:

A. A biochemical study of the spermatozoa and ova of laboratory animals and farm animals. Instead of a downright chemical analysis, we were more concerned with the isolation and characterization of these cells.

B. Through metabolic and physiological studies to obtain information of aid in understanding (1) storage changes in spermatozoa, (2) seasonal variations in physiological characteristics of the semen of farm animals, and (3) the methods whereby diluter constituents aid storage or prevent changes in spermatozoa.

C. The development of procedures for the evaluation and study of spermatozoa and ova of farm animals.

REPORT OF PROGRESS:

A. Evaluation of Sperm Concentration by the Hemocytometer Methods.

There has been developed an improved method for the accurate determination of spermatozoan concentration using the hemocytometer method described for counting blood cells. Although utilized in this laboratory for a number of years with success, the method had never been published nor had any critical study been made of this method. The literature gave no specific recommendation of the type of fluid best suited for hemocytometer determination of sperm concentration until 1952 when George described a new eosin-containing fluid for counting red blood cells.

Since the fluid developed both by Mayer and George were eosin-containing fluids and had proved to give reliable results, a study of eosin-containing and non-eosin-containing fluids was made.

In addition to ascertaining the accuracy of the two eosin and non-eosin fluids, the surface tension, refractive index and the pH of the fluids were measured in order to see if any of these physical characteristics of the fluids were responsible for their behavior as counting fluids.

The results showed that a high statistically significant difference in the number of spermatozoa countable by the eosin-containing and eosin-free

fluids existed. Approximately 20 to 25% less sperm were countable by the eosin-free fluids than by the eosin-containing fluids of Mayer and George.

When these fluids were compared on the basis of their physical characteristics (pH, surface tension, and refractive index), the results just cited were not explainable on the basis of a different pattern in these characteristics. However, the lowest surface tension and the highest pH values were obtained for the eosin-containing fluids.

B. Egg Yolk as a Diluter Constituent.

For a number of years this laboratory has studied the effects of egg yolk and its isolated constituents in diluting media for the spermatozoa of farm animals. If we were to actually know the physical, physiological and chemical requirements for the storage of spermatozoa, it was necessary to discover the active factors in the biologically and chemically heterogeneous mixture comprising egg yolk. In previous reports a description of the research on certain isolated constituents of egg yolk has been given. These reports included a discussion of phospholipids and lipoproteins as factors in egg yolk which protected the spermatozoa of farm animals against cold shock. Further study showed that in cold shock, aerobic glycolysis, anaerobic glycolysis and respiration were decreased to a marked degree and that the detrimental changes in metabolism could be prevented either by the phospholipids (lecithin and/or cephalin) or by lipoprotein complexes containing these phospholipids. However, evidence had accumulated suggesting other factors in egg yolk which were possibly necessary for storage and which had an influence on the metabolic activities of these cells.

The object of the study made during the past year was the determination of the effect of egg yolk upon certain enzymes involved in metabolic activities of mammalian spermatozoa.

The Warburg technique was used in the measurement of metabolic activities and of enzymatic activities. The results of numerous experiments with egg yolk showed that it stimulated the activity of their succinic, malic, and glyceraldehyde-3-phosphate dehydrogenases. This was true whether washed or unwashed spermatozoa were utilized in the experiments. Stimulation of dehydrogenase activity was believed to be beneficial to the survival of spermatozoa during storage at 5° C. Interestingly, a comparison of heated and unheated milk (heated milk has been used in diluting media instead of egg yolk) showed that the former also stimulated dehydrogenase activity. The latter failed to do so and is actually spermicidal.

Fractionation of the egg yolk showed that the dehydrogenase-stimulating factor in egg yolk was associated with the acetone soluble portion. The acetone soluble fraction could possibly contain cholesterol and/or carotene or complexes of these substances, hence pure cholesterol and carotene were tested. It was found that cholesterol stimulated the succinic dehydrogenase activity but inhibited both malic and glyceraldehyde-3-phosphate dehydrogenase activity. On the other hand addition of carotene to sperm suspensions stimulated succinic and malic dehydrogenases and gave variable effects upon the third dehydrogenase cited above.

C. The Effect of Washing upon the Dehydrogenase Activity of Bovine Spermatozoa.

The literature pertaining to spermatozoan physiology contains numerous references to the detrimental effects of excessive dilution or washing with water or dilute aqueous solutions. Workers in England and New Zealand reported a decrease both in respiration and fructolysis upon excessive dilution. Earlier work at the Missouri Station under this project had suggested that excessive dilution or that washing might be removing soluble enzymes from the cells and thereby influencing metabolism. Subsequent investigations were based upon this suggestion and the influence of washing four times with physiological saline upon dehydrogenase activity was observed.

The results, briefly, showed that washing (1) stimulated succinic dehydrogenase activity 24% above that of the unwashed cells, (2) stimulated malic dehydrogenase activity 16% above that of the unwashed cells, and (3) markedly inhibited glyceraldehyde-3-phosphate dehydrogenase activity.

It is concluded that the third dehydrogenase is soluble and easily removed from spermatozoa and should be added to the diluting medium of washed spermatozoa. Stimulation of the two dehydrogenases may be attributed to the removal of inhibitory enzymes during washing. Results of experiments with DPN supported this hypothesis.

D A Seasonal Variation in the Succinic Dehydrogenase Activity of Bovine Spermatozoa.

It has been observed for a number of years that a seasonal variation in semen quality exists. This variation in quality has been reflected in lower volume, lower motility, decreased survival and an increased percentage of morphologically abnormal forms.

Initial experiments upon the effects of washing spermatozoa upon dehydrogenase activity uncovered the fact that the results differed in specimens col-

lected in different seasons. A detailed study of the dehydrogenase activity of bull spermatozoa throughout the years was made. (Project 81)

Analytical Services

E. W. Cowan, C. W. Gebrke, L. D. Haigh, Frank Johnson, Joseph Bevirt, E. L. Wood, Billy Ray Smith, Wayne Freeark, and T. A. Burns.

OBJECTIVES:

- A. To conduct analytical research work on the various research projects submitted by the several divisions of the College of Agriculture and related agencies.
- B. To develop new fundamental chemical methods related to any of the above projects.
- C. To conduct routine analytical control work for the University, Agricultural Stabilization and Conservation Commission, and the citizens of the state.
- D. To conduct a basic research program in agricultural chemistry and related fields. This will be done in cooperation with various cooperating departments and agencies.

SAMPLE PREPARATION:

In addition to the chemical analyses in the Station Laboratory, the following number of samples were processed through the Station Laboratory Sample Preparation Room:

2572 fertilizer samples were recorded, ground and mixed for various chemical analyses.

1380 miscellaneous samples of fertilizer, feeds, feces etc. were recorded and processed for analyses.

1302 limestone samples were recorded, dried, pulverized and mixed for chemical analyses.

REAGENT PREPARATION:

Approximately 70 carboys (12 gallons each) of standard reagent solutions were prepared by the personnel of the Station Laboratory. The preparation of each carboy of standard solution required an average of 10 analytical checks to assure proper normality, specific gravity, pH, etc.

REPORTS OF ANALYSES:

A report of analysis was made of each sample analyzed by the Station Laboratory. During 1955 over 15,000 analytical averages were computed, checked for accuracy, and reported. (Project 132)

Unrecognized Factors or Proper Proportions of Amino Acids Required By Poultry

A. G. Hogan, Osmund Laerdal, B. L. O'Dell

OBJECTIVES:

- A. To determine what proportions of some of the critical

amino acids are most suitable for the chick.

- B. To obtain additional evidence as to whether there are any more unrecognized vitamins.

The chicks were White Leghorns in most cases, and within one day after hatching they were weighed and divided among the experimental groups. In order to conserve space, the dietary constituents were always included in the rations in the same amounts. Various sources of protein were used and generally cerelose was the source of carbohydrate and was used to make a total of 100 percent.

It is a common opinion that if the protein in a chick ration is deficient in an essential amino acid, the deficiency is not remedied merely by increasing the amount of protein. As an example it can be assumed that a ration contains 25% of protein, and that this protein provides 1.5 gram of the critical amino acid, A. In order to grow at the optimum rate it would be necessary for this amount of protein to supply 2.4 grams of amino acid A.

One might suppose the same result could be accomplished by raising the amount of protein to 40% of the ration, and supply 2.4 grams of the amino acid in that way. However, some assert that as the amount of the protein is increased, the amount of the critical amino acid that will be required rises in direct proportion, in order to get the optimum rate of growth. If that is true the optimum rate of growth would not be attained by raising the amount of protein to 40%. This is a problem of considerable practical importance, and an attempt was made to learn more about it.

The conclusion is that when a protein is mildly deficient in an essential amino acid, the deficiency can be remedied, at least almost entirely, by supplying more protein. Relative to unrecognized vitamins, the simplest explanation is, there are no unrecognized vitamins required by poultry, and the chicks from hens on one of the diets such as Diet 27 should grow as rapidly as did those from hens on any other diet.

(Project 137)

Mineral Content of Blue Grass and Lespedeza Grown in Missouri

E. E. Pickett, C. W. Strobel, and B. E. Hankins

About 50 samples of lespedeza and associated soils were collected from the same unfertilized plots in 1950, 1951, and 1952, and analyzed for copper, cobalt, zinc, iron, manganese, boron, and the macronutrients. Supplies of copper, zinc, iron, manganese and boron were found to be generally adequate for animal feeding as well as for good growth of the

forage itself. However, the cobalt content of several samples from Marshall silt loam was low each year.

The analysis of the alfalfa collected in 1954 was nearly completed. Much of this alfalfa was quite deficient in cobalt. These results are somewhat surprising but have been checked repeatedly. The matter is most important and should receive further study.

The samples of corn and soils collected in 1955 were partly analyzed. An interesting inverse correlation between molybdenum and nitrate content was found. A graduate student has begun further study of this finding for thesis credit. It is likely that molybdenum deficiencies will be found.

The wheat collected in 1954 was analyzed for major elements and partially for minor elements. No very interesting results were noted.

(Project 147)

Relation of Ionic Concentration to Stability of Evaporated Milk

C. W. Gehrke and Billy Ray Smith

OBJECTIVES:

- A. Broadly, to obtain fundamental information of a physico-chemical nature on the activities of cations and anions in milk and processed milks. Basic knowledge of this type would be of great value in understanding complex changes such as the commonly observed phenomena in processed milks of fat separation, tricalcium citrate and phosphate salt precipitation, gelation, and protein instability.
- B. More specifically, to seek knowledge concerning the distribution of the inorganic components of milk between the ionic, dissolved-complex, and colloidal phases.
- C. In what way these systems are changed by the application of heat, and at different pH's.
- D. Finally to determine the relationship of these findings to date on the heat stability of the protein.

The research work on this project has not continued at the rapid pace of the past two years due to lack of outside or grant funds. However, a certain amount of fundamental research is in progress and this is reported below.

Since July 1955 studies have been made on the exchangeability of phosphate and calcium ions in milk to anion and cation exchange resins by RCTM (resin contact time method) developed in the Missouri laboratories.

In work on the removal of phosphate ions from milk, mixtures of the free base and chloride forms of the resin were used (Amberlite IR4B-NH₂, and IR-4B.NH₃+Cl). The mixture contained 7 ml. of

the free base and 23 ml. of the chloride form of the resin. This mixture held the pH of the milk constant at 6.8 over the contact times used. With 10 seconds contact 40% of the phosphate in milk was exchanged and after 10 minutes contact only 44% of the phosphate was exchangeable. When skim-milk was heated at 120°C. at 15 lbs in for 30 minutes the amount of exchangeable phosphates was decreased by 12.5% for all contact times, and holding of the heat treated milk at 44°F. for 48 hours did not change appreciably the available phosphates. The heat treatment caused an irreversible change in phosphate exchangeability. Experiments were conducted using the strongly basic anion exchanger IRA-400-Cl to remove phosphates, and it was found that the pH of the milk was maintained constant at pH 6.6, and about 50-60% of the total phosphates were available. These studies will be continued in more detail.

Experiments were conducted on the removal of calcium by IRC-50-K-H from a quaternary solution containing Ca++ 20 meq/l., Mg++ 9 meq/l., K+ 40 meq/l., and Na+ 22 meq/l. This experiment was conducted to determine the exchangeability of Ca++ ions from a quaternary solution similar in cationic composition to milk. Also, different amounts of resin were used in the study (10 to 40 ml. of resin). It was found that 99% of the calcium was exchanged from this solution by 30 ml. of IRC-50-K-H at pH 6.8 in 20 seconds and in 30 seconds by 15 ml. of resin. These data show that ionic calcium is quickly removed from a true solution.

The ionic calcium content in raw skimmilk at pH 6.2 was found to be 28 mg %.

It has also been found that different ratios of the K+ and H+ form of the resin will hold the pH of the milk constant at different pH values over the contact times normally used. A series of RCTM studies have been started using resin mixtures to hold the pH of milk at 7.4, 6.8, 6.2, and 5.8 over the RCTM range. Also, RCTM studies will be started on the exchangeability of C++ and PO₄ ions from skimmilk adjusted to different pH values, then subjected to different heat treatments. The ionic Ca++ and PO₄ levels in the milk and rate constants of exchange for these ions will then be calculated. (Project 148)

Critical Nutrients in Guinea Pig Nutrition

A. G. Hogan, B. L. O'Dell, W. O. Regan, and
E. R. Morris

OBJECTIVES:

- A. Mineral Composition of Diet and Calcification of

- Soft Tissue. The relative value of potassium, sodium magnesium, and calcium received major attention.*
- B. *The Wrist-Stiffness Syndrome. Value of natural products and certain sterols including stigmaterol.*
- C. *Nutrients Required for Optimum Growth. The value of antibiotics and various fresh vegetables were investigated.*

The addition of potassium and magnesium tends to alleviate the injurious effects of a high phosphorus diet and apparently both elements are required for optimum results. However, of the two, magnesium has the greater effect on growth and the prevention of deposits. Both cations increase the base balance and the urine pH. Sodium appears to be as effective as potassium and the combination of sodium and magnesium supports a rate of growth equal to that of potassium and magnesium.

The addition of calcium to a high phosphorus diet decreases mortality and raises the urine pH. It has little effect on growth and if anything increases the incidence of soft tissue calcification and abnormal tooth development. Magnesium prevents the overgrowth of teeth and apparently plays an important role in the regulation of calcium phosphate deposition. On a diet that contains 1.7% calcium and 1.1% phosphorus the magnesium requirement is between 0.13 and 0.31% and is probably met by 0.2% of magnesium.

As was shown by balance studies, a high intake of phosphorus decreased the calcium balance and created a negative balance of potassium and magnesium. Normally guinea pigs excrete a high proportion of the waste calcium and magnesium by way of the kidneys, but on a high phosphorus diet the proportion in the urine is greatly reduced. This results from a marked reduction in the absorption of these elements. When the animals consume a large quantity of phosphorus, a larger amount passes through the intestine unabsorbed and no doubt carries with it the calcium and magnesium in the form of their insoluble phosphates. The phosphorus intake had no effect on the percentage of endogenous fecal phosphorus but of course the absolute amount increased with intake.

The arthritic-like syndrome in guinea pigs is dual in nature. The calcium phosphate deposits and stiffness of the hind quarters can be prevented by magnesium but wrist-stiffness is unrelated to the mineral composition of the diet. Wrist-stiffness can be prevented by fresh spinach and fresh alfalfa, but blended or canned spinach was inactive. Whole oranges or orange peel were the most potent natural products tested. However, oranges appeared to be

more effective in the females than in the males. Raw cream and cabbage were ineffective. As in the case of the potent foods, the plant sterol, stigmaterol, was effective against wrist-stiffness in females but not in males. None of the active substances would cure stiffness in adult animals.

Cabbage, particularly in the raw state, stimulates the growth of guinea pigs in a striking manner. Other green feeds, such as alfalfa and spinach have little or no stimulating effect. Cooked cabbage retains a large measure of the activity, but slow drying of uncooked cabbage results in loss of activity.

Contrary to literature reports, we have found aureomycin to be nontoxic for the guinea pig. In fact, aureomycin tends to stimulate growth slightly. It has been used in the colony diet for over a year without ill effects and it appears to have held infections to a minimum. (Project 149)

Maternal Nutrition and Congenital Abnormalities in Infant Rats

A. G. Hogan, B. L. O'Dell, and Robert Craghead

OBJECTIVES:

- A. *To study the effect of various types of physiological stress on malformations in the newborn rat.*
- B. *To investigate the effect of maternal nutritional deficiencies on the anatomy and function of the brain and other tissues.*

REPORT OF PROGRESS:

In these studies of the effect of stress on the incidence of anomalies in the newborn rat, different types of diets have been used: the highly purified type of casein diet, No. 2901; a practical type, No. 2704; and a semi-purified, No. 2530. The practical type diet has been used primarily in studies involving food additives, drugs, hormones and toxins. The purified diet has been used chiefly to study the effect of protein source and level while the ration 2530 has been used to produce a vitamin B₁₂ deficiency.

For the most part the experimental animals have been adult albino rats originally obtained from Texas A and M College. For comparative purposes a few Wistar strain rats have been used. To study the effect of a supplement during gestation only, the vaginal smears were made and the date when sperm were found is called day zero in the gestation period.

Most of the animals were housed in Schweitzer Hall, but, in an attempt to eliminate possible disease factors and established microflora, a colony was maintained in a Veterinary Farm Building. These

animals came directly from Texas A and M College.

Tissues for histological study were removed from either newborn rats or more commonly from 18-day embryos obtained by laparotomy. The tissue were fixed in Bouin's solution, sectioned in the usual manner, and stained with hemotoxylin and eosin. (*Project 151*)

Rumen Culture

J. S. Baumstark, G. B. Garner, and M. E. Muhrer

OBJECTIVES:

- A. *Continuation of the study to elucidate the principles involved in the regulation of the growth of rumen microorganisms.*
- B. *Study of amino acid and protein synthesis in the rumen.*
- C. *Study of changes occurring in artificial rumen that would improve a ration for non-ruminants.*

RESULTS:

Corn silage obtained in Northeast Missouri (unaffected by drouth was extracted with water. Extraction was accomplished by soaking over night under anaerobic conditions and then pressed to exude the liquid. The extract was divided into approximately equal portions. One portion was concentrated by vacuum to a semi-solid form until 44.78 gm. of extract was proportional to 1 pound of original silage. The second portion was treated with Norit-A and allowed to set overnight. The Norit-A was then removed by Sharples centrifugation. The Norit-A was next treated with 80% Ethanol and the eluate subjected to vacuum distillation in order to remove the alcohol. Final concentration of this fraction was such that 14.6 ml. of extract was proportional to 1 pound of original silage.

During the first experimental period rumen samples were drawn for volatile fatty acid determinations. The control ration (Hay) and the Norit-A eluate supplemented ration gave an average figure of 8.33 MEQ per 100 cc of rumen fluid while the water extract supplement gave a value of 10.16 MEQ per 100 cc of rumen fluid.

Microscopic examination indicated an increased number of protoza to be present in the treated animals. Not only were the numbers increased but also the protoza seemed to be larger. The rumen fluid appeared more colloidal in the treated animals. By tripling the amount of Norit-A eluate per sheep to give an equal concentration of total acids it was found that the volatile fatty acids had increased to only 9.3 MEQ per 100 cc of rumen fluid. From the feeding trial data one observes little difference in the

coefficient of digestibility for nitrogen or cellulose in the case of the water extract even though the above volatile fatty acid picture was observed. When the Norit-A eluate was fed the coefficient of digestibility for cellulose was markedly increased while there was no appreciable change in the coefficient of digestibility of nitrogen. This substantiates the finding in artificial rumen studies reported last year.

Further studies on the chemical composition of these extracts were started. Chromatograms of the volatile acid protion by Butanol-Ammonia system indicate at least four fractions. Steam distillation from the concentrations of the initial extract was found to contain 5-6 fractions which correspond to C₂-C₆ fatty acids. Further studies on these and other fractions are now progressing to elucidate the principles involved. (*Project 152*)

Role of Hormones in Biochemical and Physiological Activities of the Reproductive Organs

D. T. Mayer, V. Rathnasabapathy, Henry Bredeck, A. Gawienowski, V. B. Reddy, and M. Melicevic

Two different phases of reproductive physiology related to litter size in swine are included in this investigation:

1. The determination of the relative importance of ovulation rate, efficiency of implantation and of embryonic mortality as factors affecting litter size.
2. The possibility of increasing the sensitivity of the uterus to respond by greater distention with increased embryonic number and/or weight with exogenous progesterone.

In Phase I of this investigation, 27 cross-bred gilts were mated during the period from August, 1955, to October 25, 1955, to unrelated boars. These gilts were slaughtered on the 55th day subsequent to mating, at which time the following observations were made and data obtained: (a) length of the vagina, cervix, body of the uterus, uterine horns and fallopian tubes, (b) intrauterine spacing of the embryos, (c) weights of the embryos, (d) length of the embryos, (e) sex ratio of the embryos, (f) weight of the ovaries, (g) the number of corpora present on each ovary and the corpora weights. In addition, gross physiological and anatomical abnormalities are being studied and the effect of heredity (inbreeding) and environment on ovulation rate, fertilization, and embryonic survival is being observed.

In Phase II of this investigation a second group of 27 gilts were bred to unrelated boars. These 27

gilts were divided into 4 groups which were injected with a progesterone-estrogen mixture in the ratio of 1000:1 (50 mgms of progesterone and 50 mcg. of estrone or 25 mgms. of progesterone and 25 mcg. of estrone) as follows:

- Group I. 5 gilts received the hormones from the 4th day of gestation to the 13th day.
- Group II. 7 gilts treated with the hormones from 14th to 23rd day of gestation.
- Group III. 8 gilts treated from 24th to 33rd day of gestation.
- Group IV. 7 gilts treated from 34th to 43rd day of gestation.

All of the treated animals were slaughtered on the 55th day of gestation and a detailed study of the reproductive organs as cited above is being made.

Another group of 30 non-bred gilts of the Landrace x Poland x Duroc cross were slaughtered at 200 pounds body weight during August and September, 1955. The relative development of the reproductive organs, age of maturity, and genetic control of reproductive capacity are being studied in an attempt to observe the possible relationship between the measurable phenotypic traits of the individuals with ovulation rate and other reproductive characteristics in order to develop methods for the more efficient selection of breeding animals. (*Project 223*)

Nutrients in Grains, Forage Crops and in Rations of Ruminants Before and After Fermentation in an Artificial Rumen By Rumen Microorganisms

By *Laura M. Flynn*

OBJECTIVES:

- A. *Statistical analyses of data showing percentages of zein in 164 samples of corn grain varying in their content of crude protein.*
- B. *Statistical analyses of data showing composition and yields of leaves, stalks and shelled grain from corn harvested in 1953, to find whether changes in hybrids, in plant population, and in levels of added nitrogen caused significant differences in plant composition and in yield.*
- C. *Conversion of laboratory data on composition of 1954 drouth corn forage to dry basis, and calculation of yields of nutrients.*
- D. *Determination of carotene in corn forage from hybrids K-1639 (yellow grain) and US 523-W (white grain) grown at three levels of added nitrogen; study*

of changes in carotene and dry matter in forage when grain production is prevented.

- E. *Investigation of changes that occur in amino acid distribution in rumen contents from fistulated sheep fed semi-synthetic rations containing purified proteins.*
- F. *Investigation of optimum amino acid distribution of poultry rations.*

Hybrids US 523-W and Kansas 1639 were planted at three levels of added nitrogen on the South Farm. When the corn silked, shoots on half the plants were "bagged" to prevent grain development. Both hybrids produced excellent yields of grain and the forage was cut September 1st, when the kernels were dented. This was considered a desirable stage for ensiling the forage. The plants were weighed as cut, stripped into leaves, stalks, shucks and grain and the separate parts weighed before storage. The forage was packed at once in tight 50 lb. lard cans containing ample dry ice to displace the air and chill the plant tissues quickly. The cans were placed in frozen storage within an hour of cutting and kept at 0° F. until ground for assay.

As each sample was removed from storage the frozen tissues were divided into two lots. One was dried in a forced draft oven at 60° F. for feed analyses. The other was ground in the frozen state with dry ice thru a Hobart Mill. Each frozen ground sample was mixed thoroughly, then stored at -35°C. until tested.

Dry matter was determined on each sample and the frozen samples were assayed for carotene by the Moore and Ely method.

Under the conditions of the experiment no marked difference is apparent between the carotene contents of the two hybrids. One notes however that the leaves contain most of the carotene in the plant. The leaves from plants which did not produce grain were higher in dry matter as harvested, and lower in carotene.

An analysis of variance was made on the carotene in leaves, to find whether there were significant difference resulting from difference in hybrids, nitrogen, the presence of ears, and interactions between these variables. The only significant differences came from the lack of grain development. Using Student's *t*-test on the data, $t=5.979^{**}$. Lack of normal grain development is paralleled by low carotene in the leaves. Leaves high in dry matter are low in carotene.

It was found that prevention of grain production caused an increase in dry matter in the leaves of corn forage.

The high dry matter in the leaves of corn plants which had not produced grain was accompanied by

a marked decrease in carotene content.
(Project 212)

Forage Poisoning Caused by Drouth

G. B. Garner and M. E. Muhrer

OBJECTIVES:

- A. *To develop a test to predict whether or not forage would be toxic.*
- B. *Investigate the effect of ensiling on toxicity of forages.*
- C. *Study physiological effects of high nitrate and investigate ways of counteracting these effects.*

The use of diphenylamine (0.5% in 80% Sulfuric Acid) continued to be of quantitative value in screening samples. If the test was negative the forage was believed to contain less than toxic amounts of nitrate. This test was found to be sensitive to moisture content. The test failed to distinguish approximately 0.3% Potassium Nitrate equivalent when 75-80% moisture was present. It would be desirable to have slightly greater sensitivity. Samples that were found to be positive to diphenylamine were analyzed quantitatively by a microbiological method. (Project 247)

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Agricultural Economics

O. R. Johnson, Chairman

Effect of Development of Local Industries Upon Rural Income

Frank Miller

The data presented in a manuscript show that 79.3 percent of the farm families in the five southwestern counties of Missouri have less than \$2,500 money income. Approximately 79.4 percent of the farms are smaller than 180 acres. More than one-third of the total number are smaller than 50 acres. Almost two-thirds of the families living on these small farms received more income from other sources than they got from the sale of farm products.

Intensive enterprises such as small fruits and vegetables can be grown successfully in this section of Missouri, but they are not emphasized on most farms. The marketing system is not developed to provide a ready outlet for fruits and vegetables, except to processors. The returns are low in proportion to the income that could be obtained through sale for fresh table use.

The following objectives are included in this report:

- A. *To determine the principal causes of low farm incomes in southwestern Missouri.*
- B. *To measure the influence of industrial development upon agriculture in communities when non-farm or farm product processing industries have been located in the community.*

The original plan was to obtain data from several towns where industries had been established to

determine the extent to which factory work is contributing to the incomes of families who live on inadequate farms. Funds are not available to carry out this plan. However, some data on this phase of the industrial development problem will be obtained in ten Ozark counties under Project 44, Land Resource Investigations. (Project 111)

How Young Families Get Started in Farming

Frank Miller and Melvin Blase

OBJECTIVES:

- A. *To determine types of farm businesses, amounts of investments, and procedures that have been used in establishing successful farm businesses in selected areas of Missouri.*
- B. *To trace the development of successful operating units for the purpose of determining types of training and extent of family or other financial assistance operators have had.*
- C. *To discover procedures that have been used successfully to enlarge inadequate farm businesses and to finance families who have become established in farming.*

Records have been obtained from 175 farmers who have started farming since 1945. The information gives the age, previous experience, educational training, method of starting, beginning net worth, original and present farm organization, major changes, and closing net worth of each operator.

This information is being used to determine relationships between such factors as initial capital, training and experience, type of business, family assistance, and rate of capital accumulation.

The analysis is not complete enough to draw conclusions at this time.

(Project 279)

Efficiency of Livestock Marketing in Missouri

Charles Cramer, Elmer Kiehl, and Durward Brewer

Data on daily salable receipts of livestock at the livestock markets in Kansas City, St. Louis and St. Joseph have been tabulated. Indices of daily fluctuations of receipts have been computed. Cooperative arrangements have been developed with representatives of the stockyards company at Springfield in addition to those at Kansas City, St. Joseph and St. Louis. During March and April, 1956, receipts data will be obtained from the Springfield market and will be tabulated in the same manner as the other receipts data.

In addition, a series of questionnaires prepared for use in obtaining information from livestock truckers, order buyers and dealers, and commission firms have been pre-tested and revised. During April and May, 1956, livestock truckers, order buyers and dealers, and commission firms will be interviewed to obtain information on what institutional factors, if any, contribute to daily fluctuation in receipts at markets. *(Project 7)*

Seasonal Price Patterns and Their Effects on the Economy of Various Livestock Feeds

J. C. Grady

We have continued to assemble the basic materials including prices on feed grains and supplements as well as the prices of the classes of livestock that consumes these grains. This accumulation of basic material constitutes part of the background information necessary to interpret price movements and changes in production. No detailed analysis of this material has yet been completed for publication. Emphasis is placed on feed grains and supplements that have their origin on Missouri farms and their distribution in Missouri and adjacent states. We are also including the recording of prices of livestock, grade and classes, that constitute the chief consumers of these feed grains. Most of these livestock classes are major sources of income on Missouri farms. With the change indicated in personnel assignment we are hoping that more concentrated attention can be given to a study of these data and

their meaning to farm producers.

(Project 12)

A Study of Grade-Price Quotations for Eggs and Poultry

John D. Miller and J. N. Smith

OBJECTIVES:

- A. To appraise the use and adequacy of price-grade quotations as they reflect the actual prices paid producers, and prices paid in the central markets.
- B. To learn the buying practices and services rendered by marketing agencies as they relate to pricing poultry products.

Field work on both objectives, which was the work plan for this year has been completed but limited to a study of eggs. *(Project 67)*

Costs and Returns in Producing Corn

O. R. Johnson, Stanley Spangler, and Clay R. Moore

OBJECTIVES:

- A. To summarize cost and yield data of corn on Putnam and Mexico soils for crop years of 1953, 1954, and 1955.
- B. To summarize data to determine the response of crops to fertilizer carry over from the preceding corn crop.
- C. To summarize data on the effect of factors other than fertilizer on corn yields. Such as date of planting, rate of planting and preceding crop grown on land.

Seventy-six (76) farm survey records secured to date on 1955 crop year. About sixteen (16) more records to be taken.

(1953) Ninety one records were taken in 1953. Costs per acre for machinery and labor in growing the corn crop were \$12.61. Cost for harvesting and cribbing were \$8.16 per acre. Results of the increase in corn yields from the lower levels of fertilizer applications were profitable. Medium to heavy applications were hard to justify and appeared unprofitable in 1953. The year 1953 was much too dry for maximum corn production.

(1954) Ninety three records taken in 1954. Due to the extreme heat and drouth corn yields averaged only about 5 bushels per acre regardless of the amount of fertilizer used. The only factor checked other than climate affecting yields this year was date of planting. The late planted corn escaped being at a critical growing stage during the worst drouth and heat period. This year (1954) data were secured on other crops that were planted on the fields that

were in corn in 1953 to check the response of fertilizer carryover.

(1955) Seventy six records secured to date.

Much of the 53 and 54 data are already summarized. Such as hours of labor required for each farm operation in growing the corn crop; plowing, discing, etc. The various numbers of livestock kept on each farm. The acres of the different crops grown on the farms. A summarizing of all costs in the growing of a corn crop.

One third of the records are secured from farmers using low levels of fertilization, one third on farms using moderate level of fertilization and one third from farms using high rates of fertilizer application.

It is hoped this information may be useful to farmers and others working with them by serving as a guide in determining rates of fertilizer application, planting rates and time of planting as they affect corn yields.

(Project 110)

Consumer Acceptance and Preference for Meat and Meat Products

B. H. Frame, J. C. Grady, O. R. Johnson, and Elmer R. Kiehl

The first group of experiments involved the use of laboratory taste discrimination panels to compare eating differences among carcasses of various grades. Preliminary comparisons were made between grades, between carcass weights, and between both grades and weights. Short loin and top round steaks from 20 cattle were used. The four top federal grades and carcass weights ranging from Average Prime to Average Commercial were in the tests. The results showed a very surprising lack of association between number of judge discriminations and the grade and/or weight "distances" between the samples.

Large-scale field tests of consumer preferences were postponed in order to explore these results further. Twenty short loins from 20 cattle were purchased in the lower third of each of the four top federal grades. Also 20 short loins were obtained in the weight range 480 to 510 and 20 in the range 650 to 710 in the low Choice grade. One-half of the steaks from the 20 Prime short loins were used in trios with one-half of the steaks from the 20 Good loins. Likewise, the Small Choice and Large Choice loins, and the Choice and Commercial loins were compared. The other steaks were used to compare 10 Prime short loins with the other 10 Prime short loins, etc. In general, discriminations *within* grades were almost as frequent as for trios *between* grades. The pro-

portion of discriminations within the Large and Small Choice groups actually exceeded the proportion of discriminations between those groups. In an ideally effective grading system all 20 pairs of Choice and Commercial or Prime and Good loins should be discriminated between. Actually, significant discrimination was found for 7 of the 20 pairs of Choice and Commercial, and 11 of the 20 pairs of Prime and Good loins. As a corollary to segregating different products, there should ideally be no discriminations between pairs of loins of the same grade. Actually, significant discriminations between pairs of loins within a grade ranged from only 2 of 10 pairs in the Good grade to 7 of 10 pairs for the Commercial grade.

Analysis of variance of Warner-Bratzler shear measurements of every loin tasted indicated that the mean shear values of Choice and Good significantly exceeded that of Prime. The greatest variance of shear values within a grade was for Commercial.

The experiment results support the hypothesis that consumers cannot discriminate better between loin steaks from different present federal beef grades than between steaks within those grades. This hypothesis challenges ideas long held about grading. It is possible that the results do not apply to the population because of the test methods used or the smallness of the sample of carcasses. Tests were conducted January-June, 1955.

A pilot study for future large-scale consumer field testing was conducted simultaneously. A sample of 41 Columbia households received pairs of loin steaks for seven weeks. Two replicates were given of each of the following comparisons: Prime and Good, Choice and Commercial, Large Choice and Small Choice, Commercial and Small Choice, Commercial and Large Choice, Prime and Commercial, Prime and Small Good. Certain socio-economic characteristics of households were obtained. Several matters of methodological interest were explored including the use of schedules printed on mark-sense punch cards.

The second group of experiments involved testing the same hypothesis with a sample of 266 households in Metropolitan St. Louis (Missouri side). Every household received two pairs of frozen steaks per week for three weeks. Ratings of each steak on a scale developed by the Quartermaster Corps were obtained. Two replicates were made of each of three comparisons: Prime and Good, Choice and Commercial, Choice and Choice. Two adults tasted and gave preferences in each household. Respondents were not informed as to the grade of steaks or the possibility of replicates.

Careful product control was maintained. Both short loins were purchased from 126 carcasses grading in the lower third of the grade and weighing 550 to 600 pounds. Identity of every steak as to grade, carcass, and loin position number was maintained from the cutting laboratory to the household.

Tests were conducted September-October, 1955. Analysis of the results is just beginning.

Six steaks from each of 14 cattle in each of the six grade groups were reserved for laboratory panel testing. Thus there is an excellent opportunity for comparing the results of consumer and laboratory panels. This tasting will begin in February, 1956. (*Project 86*)

Missouri Land Use

Frank Miller

OBJECTIVES:

- A. *To determine the effects of soil treatments upon yields and the cost of producing crops.*
- B. *To determine the extent of shifts from such crops as corn, wheat and spring seeded grains to hay and pasture crops.*

Data obtained on Putnam soils in Central Missouri show that yields of corn can be increased from 25 bushels to 80 bushels per acre by fertilizing according to soil tests. Soybean yields can be increased from 18 bushels to 28 bushels; wheat yields from 17 bushels to 32 bushels; and hay, from one ton to three tons.

The increase in yield has reduced the cost of producing corn from 84 cents to 58 cents a bushel at recent prices for fertilizer, wages and costs of operating farm equipment.

In the 1920-24 five-year period, farmers in the Northwest Meat Producing Area of Missouri harvested an average of 62.3 million bushels of corn from 1.9 million acres. In the 1949-53 period, an average of 58.4 million bushels were harvested from 1.3 million acres. The average declined approximately 600,000 acres, or 31.6 percent. Production went down about 3.9 million bushels, or 6.3 percent. Yields increased from 33.3 to 43.8 bushels per acre.

The wheat acreage declined 41.6 percent. The oat average increased 7.4 percent, and the hay acreage 15.5 percent.

Soybeans became an important commercial crop between these two periods. The acreage was not reported in the 1920-24 five-year period. In 1949-53 an average of 3.4 million bushels were harvested from 157,780 acres.

Similar information on acreage and production of crops has been obtained for each type-of-farming area in the State. (*Project 44*)

The Farm Real Estate Price Problem and Assessment Situation

Frank Miller

The work has been guided by the objective which is to develop standards, manuals and procedures that can be used to improve assessment practices.

During the year, 797 land transfer and assessment records have been received from six counties. The data show that the upward adjustment in assessed valuations in some counties to bring the general level into line with valuations in other counties has not corrected local assessment inequities: In Macon County, the assessment of farm land that was transferred by warranty deed in 1955 varied from 11.9 to 90.3 percent of the market price. The assessed value of town real estate varied from 7.5 to 82.2 percent of its sale value. (*Project 61*)

Farm Business Analysis

O. R. Johnson, Stanley Spangler, C. R. Moore

Data were used from 51 records in this farm business analysis. The average capital investment per farm was \$86,966 of which 64.1 percent was in land, buildings, and other improvements; 22.5% in livestock; 7.9 percent in machinery and equipment; feed and supplies made up 5.5 percent. The average total cash receipts were \$45,704; feeder cattle contributed \$32,085, and hogs \$9,750. These farms sold 144 head of fat cattle, and 180 head of hogs per farm in 1954. (*Project 112*)

A Study of Cotton Marketing in Missouri

J. W. McKinsey, Kenneth Blase, David Harrington

Work during the past year has consisted of processing and partial analysis of data collected for the three marketing seasons reported in earlier reports. The data have been processed through I.B.M. methods, relating average local market prices to central market evaluations for the different classes of cotton. Analysis is incomplete.

The analysis to date has been an attempt to discover the degree to which local markets reflect price differentials for quality that are registered by the Central Market at Memphis, and to discover the basic factors affecting both the general level of prices in the local markets as compared to that of the central markets, and the differentials not explainable by quality differences. Analysis by multiple correlation has failed to yield meaningful results to date.

No patterns have emerged. Apparently here are factors other than size of lot, quality of cotton, central market evaluations, and transportation costs which influence local market prices for cotton in Missouri, and these likely have different influences in different local markets in different seasons, and at different times of the season. Additional methods of analysis are being explored. (*Project 65*)

Measuring and Appraising Impact of Agricultural Price and Income Policies

B. H. Frame, Frank Miller, J. C. Grady, John D. Miller, O. R. Johnson, Gordon Nance, Elmer Kiehl, S. F. Whitted, J. W. McKinsey

We are continuing the accumulation of price information for farm products of significance to Missouri agriculture. We have also continued our review of developments in the price support and production control programs. In addition we have reviewed debates in Congress and elsewhere pertinent to these problems. We have also participated in regional committee deliberation in the price policy field and in the specific development of sub-projects in which this station has participated.

SUMMARY:

1. Price support programs that keep prices of the commodities concerned above the world price level have been major factors in creating agricultural surpluses in certain fields.
2. Such supports do not encourage the optimum allocation of resources.
3. They tend to place the users of such supported products at a disadvantage.
4. They encourage the ignoring of cost of production in determining production programs and resource use.
5. They reduce needed flexibility in the Agricultural economy and postpone voluntary adjustment by individual firms.
6. Price support programs have not proved satisfactory mechanisms by means of which the redistribution of income may be achieved. They have increased incomes of low cost producers who do not need this assistance and have not provided adequate supplementation to incomes of low volume, high cost, operators.
7. Up to this point the conclusion is unavoidable that policies so far followed have not proved adequate production adjustment programs nor have they significantly relieved the economic status of low income farm families. On the other hand they tend to retard production adjustments where

input-output relations would indicate desirable shifts.

We are in process of appraising cost of such programs. This appraisal is quite complex and will require a considerable amount of time and concentrated attention because it will involve not only input-output relations for the products concerned in the support and adjustment program but will require an examination of the impact of these programs on activities not directly involved. (*Project 115*)

Marketing of Meat and Meat Products

Elmer R. Kiehl, Robert J. Reid

The general objective of this study was to identify price behavior patterns pertaining to the various levels of the distribution system for beef. These observed price behavior patterns have been evaluated in terms of the degree to which the group of firms at each level adjusts to price changes resulting from short run changes in cattle marketings. It should be recognized that this study was based on a rather short time period and during a particular phase of the cattle production cycle. The observed price behavior patterns are as follows:

- (1) An apparent increase in "derived demand" at the live animal level seemed to have occurred during decreasing animal marketings. This increase in derived demand may be associated with the efforts of meat packers to maintain volume, and the lag in response in increasing prices at the retail level.
- (2) There was considerable variation in the wholesale prices paid by retail stores for the same grade of beef.
- (3) At any given time, there seemed to be no significant difference in the average reported wholesale prices between different packers.
- (4) Wholesale prices of beef responded to changes in live animal prices in about two weeks.
- (5) Retail prices of beef between stores within the same town showed a high degree of association over time. There was less association between the retail prices reported by stores in different towns.
- (6) Retail prices of beef responded to changes in wholesale prices in about four to five weeks.
- (7) Retail beef prices are slower to respond during periods of increasing prices than during periods of decreasing prices.

An analysis was made of the retail price relationship of 16 retail cuts of Choice grade beef reported by 11 stores over a 26 week period. Using the average price for all cuts as an index base of 100, the following relationship was found:

CUT	INDEX
Round Steak (bone-in)	132.7
Rump Roast (bone-in)	107.0
Sirloin tip	147.8
Sirloin steak	126.7
Porterhouse steak	145.8
T-bone steak	145.5
Club steak	125.7
Heel of round	108.3
Ground beef	61.3
Blade chuck roast	76.6
Arm chuck roast	89.3
Plate beef	45.0
Rib roast	105.5
Brisket (bone-in)	41.7
Brisket (boneless)	68.5
Neck (boneless)	73.5

This relationship varies slightly from store to store and over time. Changes in price relationships over time were small but fairly frequent for some stores. While many stores are apparently guided in a general way by a percentage markup system, they do not adhere rigidly to such a guide.

It is believed that considerable meat moves directly to Missouri consumers through non-federally inspected slaughterers in the state. An exploratory study is being initiated of their distribution and pricing policies, sources of supply, buying practices, margins, and processing efficiency. A sample of custom slaughterers has also been drawn. Each will be interviewed personally. (Project 150)

Change in Demand-Supply Relationships of Dairy Industry in Missouri

*J. N. Smith, S. F. Whitted, G. E. Hanman,
E. L. Tipton*

OBJECTIVES:

Ascertain the extent and direction of the development of the dairy industry in Southeast Missouri and ascertain the extent and direction of the development of the dairy industry in Northeast Missouri.

Study of Southeast area—data collected and tabulated. Some preliminary findings by the survey of this 34 county area are summarized.

In this area there are 7 plants producing American Cheese, 8 producing butter, 29 producing ice cream, and 54 estimated daily maximum capacity of over 3 ½ million pounds of milk. This compares with an average daily production of about 1 ¼ million lbs. in this area. The number of milk cows has been increasing in this area, but not at as rapid a

rate as for the entire state so that today it contains a smaller proportion of the total than in 1920 (1920, 22%—1954, 19%). (Project 167)

Study of Northeast area—data collected and tabulated. Some preliminary findings by the survey of this 22 county area are summarized. In this area there are 2 plants producing American cheese, 4 producing butter, 16 producing ice cream, and 17 producing bottled milk.

These plants have an estimated daily maximum capacity of about 1 million lb. per day. The average daily production is about the same. The number of milk cows has been increasing in this area, but not at as rapid a rate as for the entire state so that today it contains a smaller proportion of the total than in 1920 (1920, 17%—1954, 14%). (Project 167)

Problems of Grain Marketing and Storage

*B. H. Frame, J. W. McKinsey, Kenneth Blase,
David Harrington*

Data collected from the 44 terminal and the sub-terminal grain firms in Missouri was transferred to IBM cards for use Regional Analysis and analysis at this station.

Schedule NCM-10-B-2 drafted by the NCM-10 sub-committee, of which this station research worker was a member, was used to collect data from a random sample of country elevators in Missouri. Data have been collected from 107 country elevators. The schedules have been coded and sent to the Iowa Station for IBM processing.

Additional data on receipts of grain in the terminal markets in Missouri have been secured for the years 1945-1954 in compliance with the work plan NCM-10. (Project 179)

Impact of Expansion of Milk Distribution Areas Upon Competitive Practices and Patterns of Distribution

*B. H. Frame, S. F. Whitted, Quentin Banks,
G. E. Hanman, E. L. Tipton*

Schedules were taken on randomly selected retail outlets located in every town with a population of 200 or more in an 8 county area in Southeast Missouri. Identical schedules were taken simultaneously in Western Kentucky and Southern Illinois. These schedules were designed to discover store characteristics, facilities for and methods of handling milk, and attitudes toward various types of promotional activities. This is an area of deficit milk production so that a great deal of milk is imported and an excellent opportunity is afforded to study

various competitive situations. No stores were found which did not sell milk and the majority of them had excellent facilities for handling it. Until recently some communities in Southeast Missouri were without adequate milk supplies.

Schedules were also taken from all the major firms in the state which operate milk vending machines. These 44 firms serviced 802 coin operated machines and sold approximately 8 million pounds of milk through them in 1954. An attempt is being made to determine what proportion of these sales constitute milk consumption in excess of what would have taken place without the use of the machines. (*Project 199*)

Feasibility of Retail Distribution of Frozen Meats

Elmer Kiehl, R. C. Maxon, V. J. Rhodes, Edwin Jaenke

Convenience outranks all other considerations in the popularity of frozen meats among households with frozen storage space. "Convenience" appeared in 58% of the responses to the question "What do you like about frozen meats?" Other responses in order of their frequency were "economy," 16%; "more tender," 8.4%; "no spoilage problems," 8%; "better flavor," 5%; "could buy in larger quantities," 3%; and miscellaneous reasons, 3.5%. About 7.5% of these households stated they did not like frozen meats.

The meat products tested by the consumer panel were delivered to the households in frozen form bi-weekly for 3½ weeks. In the final questionnaire taken from the panel members, this situation was posed, "It might be more convenient for your grocer to sell frozen meat in packages which are not transparent. Would you be willing to buy it that way?" The initial response to this situation was, "Yes," 12%; "No," 80%; "Maybe," 7%; and "Don't Know," 1%. When asked to comment upon the question, over 50% of the comments indicated an unwillingness to purchase meat products sight unseen. Another 33% of the replies were in opposition to "blind packaging" without any specific reasons stated.

In asking the panel members to comment upon their satisfaction with the frozen delivery of the meat products tested, 80% were satisfied, 13% expressed no preference, and 7% said they would have preferred to have received the products in fresh form. These percentages are almost an exact duplication of the responses in the previous paragraph. It indicates a large consumer satisfaction with frozen meat products but at the same time indicates that con-

sumers have some hesitancy in purchasing frozen meats without prior inspection or a very firm assurance of quality and satisfaction. (*Project 215*)

Economic Significance of Pork Grades

V. J. Rhodes, Elmer Kiehl

All interviewers involved in this study observed an almost universal awareness of excess fat in the comments of the consumers and their intent to select for leanness.

The difference in outside fat in the pictures used in the store survey of ham slices trimmed to one-fourth and one-half inch external fat seemed to be compensated by a difference in marbling. It was observed that many consumers chose the one-half inch trim as the leaner slice because of this difference in marbling.

The grade A picture standard was too lean to obtain sufficient A's without exercising a "liberal" interpretation of the standards. This suggests that the existing ham standards need to be subjected to review.

CONCLUSIONS:

Most consumers visually preferred leaner pork. The A and B₂ ham slices and blade chops were usually enough different in internal fatness that consumers detected the difference and chose the leaner. This indicates that the difference in ham grades is large enough to be detected and that such grades could be developed for ham and blade chops. A preference at equal prices for leaner pork will doubtlessly be reversed with sufficiently high price premiums on the leaner. There is no good way to estimate those premiums except by sales tests.

There was an inconclusive division of opinion about eating preferences. The aversion to fat is probably so great in relation to eating differences that the latter *probably* has a negligible influence on repeat-sales.

Differences in internal fatness of loin and rib chops were too small to be consistently detected. (*Project 216*)

Consumer Preference for Egg Quality

J. D. Miller, L. D. Bender

OBJECTIVES:

To determine by sampling what proportion of the consumer population detects noticeable difference between two or more grades of eggs.

On March 1, L. D. Bender was hired and assigned to this project on a full time basis. Work has

been done in the general areas of drawing a sample, preparing a schedule, and interviewing.

The sample was drawn using the stratified area approach in which areas of an average income were isolated and samples drawn from each area. After isolating the areas, an eye count was taken of all households. From the addresses obtained in this manner a predetermined number of households for each area was selected on the basis of a fifty percent refusal or non-contact rate. A total of one hundred forty-nine households was selected in this manner.

Each home was visited and the cooperation of the housewife enlisted. An attempt was made to contact each housewife if they were not at home on the first visit, either by making another trip or by telephoning. From the sample of one hundred forty-nine, a total of fifty-eight cooperators was enlisted.

The research being carried out in Columbia is in the nature of a pilot study. The following various measures of preference needed to be tested: (1) a rating scale, (2) unaided responses, (3) rank order, (4) on hand or actual purchases. Considerable difficulty was encountered in providing a schedule adapted to unaided responses. The final schedule was flexible in the area of unaided responses, and a simple shorthand method was devised for recording this information.

One extra person was hired to help with the interviewing, and was given rigid instruction on the use of the schedule and the nature of the interview situation. Part of the instruction was in the nature of a pre-test of the schedule in natural interview situations.

Arrangements were made for securing eggs from the Department of Poultry Husbandry. Factors pertaining to egg weight, shell color, shell texture, and yolk color were held constant as far as possible. The only variable was that of interior quality. This was obtained by using eggs which were originally AA grade with the above prerequisites. A, B, and C grades were obtained from the AA grade by use of heat and/or holding. These eggs were stored in a cooler where a half day supply was obtained by the interviewers.

The first of the three interviews began on Monday, April 9, and continued through that week. Appointments were made with the cooperators (by telephone) prior to the interview. Fifty-four of the original sample of fifty-eight cooperators were interviewed during this week. Since three interviews for each cooperator is needed to complete the study, no conclusions can be reached at this stage of the study.

(Project 228)

Extent of Use of Farmer's Cooperatives—Services Performed—Problems Confronted.

John D. Miller

Field schedules have been taken in Callaway and Saline counties. One hundred usable schedules have been obtained in both counties. These schedules were taken to gather the data needed.

A mail questionnaire was sent to the cooperatives in four counties to be studied in order to ascertain the services performed for farmers. Most replies were deemed inadequate necessitating a personal interview with each cooperative. Personal interviews were begun during the reporting period.
(Project 254)

Adjustment in Farm Organization in Dairy Farming Areas in Missouri

B. H. Frame, O. R. Johnson, O. E. Miller

OBJECTIVES:

The general objectives are to develop factual information that can be used as a guide in adopting and carrying out farm programs, and to provide the economic information needed by individual dairy farmers in making adjustments in their businesses to meet changing demand and technological developments.

The Project was organized July 1, 1955. The month of July was occupied with selecting the area in which to get farm records and the method to select the farms from which to obtain the records.

Grundy County was selected for the study because of its high butterfat sales. During the months of August and September we interviewed the farmers selected and obtained the beginning of the year inventory, January 1, 1955. At this time we had 89 farms cooperating, of which 27 farms had no dairy product sales, 16 farms were engaged in Grade A milk production and the remaining 46 farms were selling Grade C Milk or cream of which the requirements are nearly the same. January 1, 1956 we started interviewing the farmers the second time to get the expenditures, income and end of the year inventory. The second interview was completed February 3, 1956 and after this we had 81 farms cooperating, of which 16 was Grade A, 25 was Non-dairy and 40 was in Grade C and Cream production. The decline in number of farms participating was due to farms changing ownership, and therefore changing in tenancy, farm sales due to health, and farm sales to go to other occupations. The records are in the process of being summarized now.

(Project 256)

Marketing Missouri Vegetables

B. H. Frame, J. C. Grady, J. W. McKinsey

Most of the work done to date has been with secondary data. The information taken from secondary sources has consisted of the following:

- A. *Determining the total value of vegetables produced in the state during the past five years.*
- B. *Determining the leading vegetable producing counties.*
- C. *Determining the most important vegetables produced in the state by leading counties.*
- D. *Determining the beginning and ending dates of harvest by products.*
- E. *Determining what states produce and market the same products at the same harvest period as Missouri.*

Other work has consisted of compiling a list of vegetable growers in the state from which a sample of 75 or more will be taken. A schedule has been prepared and pretested for outdoor production and a schedule for crops produced under glass is being prepared. It is anticipated that at least half of the schedules on outdoor production will be taken in St. Louis county and over half of the under glass

schedules will be taken in Jackson County. The population of vegetable producers indicates that well over half of the producers of outdoor production are located in St. Louis County while over half of the under glass producers are located in Jackson County.

Effect of Drouth and Government Programs on Dairy Farmers

S. F. Whitted

Material concerning government programs, both state and federal, which influence the incomes of dairy farmers has been gathered together in preparation for writing the chronological summary of these programs. Preliminary planning of the means of collecting the data and of statistical analysis to assess the effect of the drouth on dairy farm incomes in Missouri has been carried out. This preliminary work will be of value should it become possible to pursue this project further at some future date.

(Project 264)

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Agricultural Engineering

M. M. Jones, Chairman

Forage Harvesting, Storage and Feeding

D. B. Brooker, M. M. Jones, J. S. McKibben

SUMMARY OF RESULTS:

1. Maximum unit lateral pressures of 125 to 150 pounds per square foot will occur temporarily at a depth of from one to two feet below the silage surface during the filling operation.
2. At depths below the two foot level of silage the unit lateral pressures relax to approximately 100 pounds per square foot.
3. A single unit pressure curve for the total depth of silage changes constantly during the silo filling operation but soon after the silo is filled becomes practically a vertical pressure curve of about 100 pounds per square foot from the two foot depth down to the six-foot depth.
4. The overturning moment caused by the lateral stresses in wheat silage harvested with a flail-type chopper is expressed by the equation $Y = 33.40X^{2.202}$. These moments are slightly lower
5. The average concentrated lateral loads caused by the packing tractor ranged from 135 to 190 pounds at the silage surface. The horizontal load on the silo wall two feet below the surface is not affected appreciably by the tractor.
6. A lateral concentrated load of 200 pounds at the surface caused by the packing tractor is recommended for design purposes.
7. The 4-inch concrete wall panels, reinforced and supported by pilasters ten feet on center, showed no sign of weakness during the first year. The technique presented for the construction of above ground silos requires a comparatively small amount of labor and a minimum of skilled labor and special equipment not available on the farm. The concrete wall and test panel made up one wall of the experimental silo. One-half of the other wall was of concrete block and concrete

pilaster construction. The other half was of oak planking spiked to pressure treated creosote posts. Cost data for the three types of wall construction are as follows. The concrete slab-pilaster wall cost of construction is about \$4.64 per foot of wall length. The figure for concrete block construction is about \$5.00 per foot of wall, and the figure for the creosote post-oak plank wall is about \$2.50 per foot. All these figures are for a wall 6 feet high. (Project 138)

Midway Farm Improvement

J. S. McKibben, M. M. Jones, C. L. Day, T. O. Hodges,
R. P. Beasley

OBJECTIVES:

- A. *Reservoir at Southwest Corner of Farm.* This reservoir has been practically completed and a water stage recorder is installed to be used in determining inflow and outflow and evaporation and seepage losses. This reservoir cost is about \$3000.
- B. *Terraces and Waterways.* Waterways are about completed, 4940 linear feet having been completed this year. There are over 2½ acres in the waterways. An improved system of laying out and the constructing cut-and-fill terraces with considerable correction for uneven topography has been developed and a little more than 3½ miles of such terraces have been built. A few remaining terraces will be finished as weather and crops on the land will permit. The value of the terraces and waterways on a basis of customary contract prices would be about \$1600.
- C. *Sign, Entrance, Roadways, Cattle Guards.* Good progress has been made on these. The sign is ready to be erected, the entrance cattle guard is done and most of the roadways are graded. Some crushed rock is yet to be applied to some roadways to make them usable in wet weather, and two more cattle guards are to be constructed. The 26-acre pasture has been fenced, as well as lots around the feeding area at the barn. The value of these improvements is approximately \$2250.
- D. *Hay Storage and Feed Structure, Machine Shed, Grain Storage and Handling Building.* The hay storage and feeding barn was completed during the year and has been in use for several months. In conjunction with the building, lots, chutes and scales have been built or installed. The machinery storage building has been designed and most materials are on order. It is to be constructed as rapidly as resources will permit. The

construction of the grain storage and handling building will be postponed for at least a year. The hay storage and feeding barn cost about \$5000.

- E. *Water System.* Water under pressure has been piped to points of need around the farmstead. An 8000-gallon reinforced concrete reservoir has been built to supply the pressure water system with water pumped from the deep well. A very successful frost-proof cattle waterer tank of small size has been designed and built below the pond in the northeast corner of the farm. No ice was formed on the water during the winter of 1955-56 even though temperatures dropped to near zero. The water system cost about \$1000.
- F. *Basic Soil Treatments.* Basic applications of rock phosphate and lime are being made as they can be worked into the cropping system. With intensive cropping, it is difficult to schedule these applications at times when they can be worked into the soil. (Project 274)

Corn Production Studies—One-Year Rotations, Small Grain and Irrigation

R. P. Beasley, J. S. McKibben, R. B. Curry

OBJECTIVES:

- A. *To determine the effect of irrigation on such factors as crop yield, quality, germination, maturity date, decomposition of crop residues and crop handling methods in intensive one-year rotations.*
- B. *To determine irrigation methods best adapted to the production of crops in intensive rotations.*

REPORT OF PROGRESS:

- A. Plans have been completed for a detailed study of rotations under different handling methods, and different levels of irrigation. In the first year of the study the first series of plots were handled as follows:
 1. Wheat for silage, corn for silage.
 2. Wheat for silage, corn for grain (harvest when dry).
 3. Wheat for silage, corn for grain (dry in storage).
 4. Wheat for grain (dry in storage), corn for grain (dry in storage).
 5. Wheat for grain (dry in storage), corn for silage.

On this series of plots three levels of irrigation were proposed, low level (no irrigation), medium level of irrigation and high level of irrigation. Due to weather conditions and operating conditions only two levels, irrigation and no irrigation, were maintained.

On the other set of proposed plots of the same corn-wheat rotation, the crops were to be handled in the following manner:

1. Wheat for grain (dry in storage), corn for silage
2. Wheat for grain (dry in storage), corn for grain (dry in storage)
3. Wheat for silage, corn for grain (dry in storage)

Because this was the initial year of this study and because the wheat had not been planted the previous fall on this set of plots only the corn portion of the rotation was conducted.

Two moisture levels were maintained insofar as weather conditions permitted.

Both series of plots were given a uniform application of mixed fertilizer. However, the basic soil nutrient deficiencies had not been corrected which accounts for the low yields obtained. Soil samples have been taken to determine the basic treatment to be applied to the individual plots.

In both series of plots, the corn plots to be irrigated were irrigated on August 1-3 and on August 22-26. Two inches of water was applied each time.

The following corn yield results were obtained:

I. Corn (silage after wheat)

Irrigation	(tons/A)	9.89	6.15
No Irrigation	(tons/A)	6.95	4.07
		<u>2.94</u>	<u>2.08</u>

(Differences in yield in each replication are significant at the 1% level.)

II. Corn (grain after wheat)

Irrigated	(bu/A)	55.88	58.50	53.43
No Irrigation	(bu/A)	34.50	16.64	32.28
		<u>21.38</u>	<u>41.86</u>	<u>21.15</u>

III. Corn yield on series of plots where corn was not preceded by wheat.

A. Corn (silage)

Irrigated	(tons/A)	10.24	11.19
No Irrigation	(tons/A)	10.05	8.57
		<u>.19</u>	<u>2.62</u>

(Differences in yield are not significant probably because no crop immediately preceded the corn and the moisture supply was therefore not seriously depleted.)

B. Corn for Grain

Irrigated	(bu/A)	74.81	65.74	73.10	65.96
No Irrigation	(bu/A)	45.87	35.69	36.72	35.25
		<u>28.94</u>	<u>30.95</u>	<u>36.38</u>	<u>30.71</u>

(Differences in yield in each replication are significant at the 1% level.)

A variation of the moisture content of the grain at time of harvest indicates that the irrigated corn matured earlier. At harvest, the moisture content of the irrigated corn was 33.4 percent and that of the non-irrigated corn was 39.0 percent. (Project 2)

Machines and Methods for Intensive Rotations

M. M. Jones, C. L. Day, J. S. McKibben, D. B. Brooker

OBJECTIVES

- A. Explore the possibilities of using a one-year rotation of two major crops such as wheat and corn.
- B. Use intensive crop rotations on Midway farm for experimental work with tillage, seeding, harvesting and crop drying and storage methods.

REPORT OF PROGRESS

A crop of wheat and a crop of corn was successfully grown on a small acreage during 1954. The wheat yielded 56 bushels per acre and the corn 76.25 bushels per acre on irrigated plots and 39.5 bushels per acre on non-irrigated plots.

A cropping plan was worked out and put into effect on the Midway farm to enable studies to be made of tillage, and other farming operations. This research project was reorganized, however, and the work is now being done under Project 272. Project 42 was closed out, and final report submitted on June 8, 1955.

(Project 42)

Soil and Water Conservation Management

R. P. Beasley, M. M. Jones, J. S. McKibben, Ernest Smerdon, D. D. Smith

OBJECTIVES:

- A. To determine under full soil treatment, best terrace spacing, grade, channel capacity and treatment, and extent to which point rows may be eliminated for the major soil areas in Missouri.
- B. To determine the effect of terraces on power, labor, and machine costs in crop production and on crop yields.
- C. To investigate new designs of water management structures with a view to improving them and reducing their costs.

Improvements have been made in the methods of layout and construction of terraces to reduce their curvature and make them more nearly parallel. This has resulted in terraces that are easier to farm and has reduced the number of point rows between them.

Eight additional terraces have been constructed by this method on three different areas. In addition one diversion channel and an oversize terrace which serves as a field road have been constructed.

These terraces were constructed using two types of equipment working simultaneously on them. A 3-4 plow tractor with a 1-3/4 cubic yard scoop and a T-9 track-type tractor with a 4 cubic yard scoop.

In the study of the effect of terraces on

crop yields following is a tabulation of yields secured at the McCredie farm in Callaway County and at the Christy farm in Andrew County in 1955.

Location	Crop	Yield-bu. per acre	
		Terraces	Without Terraces
McCredie	Corn	67	63
Christy	Corn	71	66

In neither case was the yield difference significant. The contour area without terraces on the Christy farm had rather serious rill erosion and quite an uneven stand. The stand on the terraced area was more uniform. Weeds were a problem on both areas.

Hydraulic tests have been conducted on scale models of a number of designs of a sliced-inlet type of entrance for tube overfall structures. Research Bulletin #599 has been published giving the results of preliminary tests. Additional tests have been conducted to determine specific dimensions for inlets giving the most desirable flow characteristics.

(Project 43)

Farm Buildings and Equipment Design

J. C. Wooley, T. O. Hodges, J. S. McKibben

The objective of this project is the design and development of plans for farm buildings and equipment to meet the needs and conditions of the state.

Major emphasis during the past year on this project has been on the development of buildings and equipment for the Agricultural Engineering farm. While these buildings and equipment are primarily of an experimental nature, it is expected that the majority of them will be applicable to many Missouri farms. Plans of these buildings and equipment will be made available to Missouri farmers through the Missouri Plan Service as seems advisable. Several projects have received attention during the past year as reported below. Detailed plans are available for most of these structures and equipment.

- A. *A Self-feeding Hay Barn.* This barn features the pole type construction, which is quite popular in Missouri, and embossed aluminum roofing which should furnish trouble-free service over a long period of time, and also should promote winter and summer comfort for animals within the unit. The unit consists fundamentally of a center core for chopped hay, surrounded by loaf-feed lot including cutting gates, corrals, etc.
- B. *Feed Lot Arrangement.* The arrangement of the ing and eating areas for animals could be utilized on any average size stock farm in Missouri. The outstanding features of this particular layout are the utilization of the barn for a holding pen so that additional pen space is

not required for this phase of cattle working. The sliding cut-off gates, working in conjunction with swinging gates, permit complete ease in handling of cattle through the holding chute, over the scales, through the working chute, or up the loading chute.

- C. *Plans for Machinery Storage Building and Shop.* This particular building was designed to fit the needs of about a three or four tractor farm. Special features of the building include clear-span construction and a lower wall on one side of the building, where high head clearance is not needed, for drop-off type implements. The locations of the pole supports on this side of the building are such that a row of implements can be placed on either side of the poles, fully utilizing all of the space without interference from supports and also, so that no piece of equipment is ever made inaccessible by being behind another. The plan offers the advantage of freedom of use generally associated with open-type machine sheds, while at the same time giving the protection of a closed building.
- D. *Horizontal Silo.* Plans were developed for a 16 x 60 foot horizontal silo with various types of wall construction and the silo was built during the past year. Details of this silo are reported in Project 136 on forage handling and feeding.
- E. *Feeding Gate For Horizontal Silo.* A plan in the Missouri Plan Service was revised to include a platform for animals to stand on while eating. This feature prevents the animals from pushing the gates out of position.
- F. *Bucket Transport and Lift Unit.* To conserve time and labor in transporting and dumping mixed concrete, even into forms a considerable height from the ground, a special four-cubic foot transport and lift was designed and built for use on a three-point tractor hitch. It was used to real advantage in construction of the horizontal silo and other smaller concrete jobs about the Agricultural Engineering farm. It makes an excellent companion tool for a concrete mixer of about four cubic yard capacity or smaller. Many farms could make good use of such a transport and lift. (Project 71)

Influence of Climatic Factors on Shelter Requirements of Cattle

R. E. Stewart, J. C. Wooley, T. O. Hodges, H. G. Yeck

OBJECTIVES:

- B. *Effect of Infra-red to Ultra-violet Radiation on Vari-*

ous Animals.

D. Housing Requirements of Young Cattle as Indicated by Effect of High Environmental Temperature on Growth and Other Criteria.

B. The principal effort on this objective has been directed toward study of climatic reactions of the rabbit, to establish analogous behavior to cattle. Temperature reactions were studied in the range 9°-40°C.

It was found that rabbits resemble European-evolved dairy cattle in being intolerant to temperatures above 27°C and tolerant to low temperatures; in developing a marked rise in respiration rate at 21°C, in rectal temperature at 27°C, with associated declines in food intake, thyroid activity, milk production; and in convergence of skin, hair and air temperatures at 40°C with rectal temperature 41°C.

Food intake in rabbits declined from 110 grams at 24°C to 3 grams at 37°C. Respiration rates followed an S-shaped course, increasing from 80 per minute at 21°C to 400 per minute at 40°C. Pulse rates increased from 100 at 24°C to 150 at 35°C. Skin temperatures increased from 36°C at 21°-27°C ambient to 41° at 40°C. Thyroid activity declined from 13 empirical units at 10°C to 1.2 at 35°C.

Rabbits growing in 28°C chamber had 0.6°C higher rectal temperature, 41% lower thyroid activity, 10% lower heat production, 33% lower food consumption, 17% lower body weight than those in 9°C chamber. Males were heavier in 9°C, females heavier in 28°C. Male per female body weight ratios at 28°C declined from 100 percent at 50 days to 82 percent at 350 days of age; in 9°C male per female ratios declined from 115 percent at 75 days

to 105 percent at 350 days. Mature weight was about 17 percent greater in the 9°C than those at 28°C. Pulse rate at 28° was 15 percent higher than at 9°C. Respiration rates at 28° increased from 115 per minute at 75 days to 125 per minute at 350 days; at 9°C there was little difference with increasing age.

D. Calves were installed in the Psychroenergetic Laboratory at a very early age and maintained under constant temperature. There were two groups: One group of nine calves was held at 50°F air temperature, and the other group of nine calves was held at 80°F. A third group was given open shed housing, subject to normal weather variations.

Three breeds of beef calves have been used in these tests: Shorthorn, Santa Gertrudis, and Brahman, all females.

The work of this objective has been concerned with the effect of temperature on growth rate of young cattle. The growth rates appear to be affected considerably by the environmental temperature, with a considerable difference in breeds. The calves were matched as well as possible at the start of the testing, and the testing proceeded for over a year.

The results are significant. First, the Shorthorn breed thrived much better at 50°F than at 80°F. The Brahmans seemed to do slightly better at 80°F, while the Santa Gertrudis (a breed derived from crossing Shorthorn and Brahman) did slightly better at 50°. An unexpected result was that the Shorthorns held at constant 50° temperature grew better than those that were housed in regular open shed housing. To a lesser extent this was also true of the other breeds. These results are indicated in Table 1, following.

Average Monthly Gain (pounds per day) of Beef Calves Under Three Environmental Conditions

	50°F.			80°F.			Open shed - Outside		
	SG	Sh	Br	SG	Sh	Br	SG	Sh	Br
Nov. 1954	1.22	1.53	1.35	1.00	1.17	1.20	0.59	1.38	0.90
Dec.	1.85	1.63	1.58	1.65	1.30	1.70	1.14	1.60	1.30
Jan. 1955	2.35	2.56	1.80	2.34	1.35	2.26	1.58	1.49	1.55
Feb.	2.54	2.51	2.20	2.50	1.55	2.46	2.25	1.82	1.74
Mar.	2.31	2.06	2.14	2.11	1.13	2.14	1.86	1.59	2.08
Apr.	2.14	1.93	1.84	2.01	1.63	2.40	1.89	1.87	1.74
May	2.25	1.72	1.55	1.58	1.48	1.39	2.11	1.68	1.87
June	1.98	1.70	1.64	1.75	1.18	1.12	1.62	1.56	1.60
July	1.45	1.28	0.82	1.27	1.12	1.33	1.26	0.90	1.15
Aug.	1.41	1.17	0.98	1.09	1.05	1.05	1.52	1.21	1.31
Sept.	1.92	1.45	1.38	1.98	1.27	1.04	1.92	1.77	1.43

SG = Santa Gertrudis

Sh = Shorthorn

Br = Brahman

(Project 66)

Environment Requirements for Farm Animal Shelters

M. D. Shanklin, R. E. Stewart, J. C. Wooley, C. N. Hinkle, T. O. Hodges

OBJECTIVES:

A. *Moisture Production of Dairy Stables.*

B. *Young Calf Housing.*

C. *Insensible Weight Loss Measurements.*

D. *Partitional Calorimeter and Radiant Cooling.*

E. *Effect of Solar Radiation on Shelter Requirements of Cattle.*

Ventilation requirements with variable stable temperatures were determined in the Psychroenergetic

Laboratory, using two groups of lactating Jersey and Holstein cows. Four diurnal temperature changes were employed: 10°-40°F, 40°-70°F, 70°-100°F, 60°-110°F. The rate of stable heat dissipation dropped and the rate of stable moisture dissipation increased with increasing stable temperatures. This concurs with previous constant temperature results.

The average temperature of the diurnal cycle was found to be satisfactory for use with previous constant temperature ventilation exchange data in order to predict most of the daily heat and moisture dissipation rates. The diurnal values were generally above the constant temperature values. Only during the extreme range of 50°-110°F cycle did the daily rate of moisture dissipation differ notably from that of previous constant temperature data. The differences between the rates of heat dissipation for the diurnal and for constant temperature tests were greatest for the 10°-40°F cycle. However, instrument errors during the 10°-40°F cycle may have produced this result.

Air-conditioning requirements from one two-hour period to the next within a day were found to change. Moisture dissipation rates changed most within the high temperature diurnals and least within the low temperature diurnals. The moisture load increased about 35 percent over the daily average moisture dissipation rate during the two-hour period following the 100°F temperatures of the 70°-100°F cycle and even more during the 60°-110°F cycle. This would mean that added ventilation or dehumidifying equipment would be necessary at certain times of the day in stables having temperature cycles such as these two high-temperature diurnal cycles if low relative humidity is desirable in the stable.

Structural heat storage was found to be of major importance in determining ventilation requirements in stables with varying temperatures, making hour-to-hour heat dissipation calculations impractical.

Calves were installed in the Psychroenergetic Laboratory at a very early age and maintained under constant temperature. There were two groups: One group of nine calves was held at 50°F air temperature, and the other group of nine calves was held at 80°F. A third group was given open shed housing, subject to normal weather variations.

Three breeds of beef calves have been used in these tests: Shorthorn, Santa Gertrudis, and Brahman, all females.

Studies included measurements of the effect of type of bedding, cleaning frequency, and bedding temperature on the moisture produced by the calves

housed at 50° and 80° in the Laboratory.

A comparison was made of stable moisture production (pounds water per calf per hour) where one day of litter is accumulated and where six days are accumulated. In the 50°F test room the average increase in moisture between one-day and six day cleaning frequencies was found to be 0.063 pound water per calf per hour, with the greater amount of moisture given off after six days of litter had accumulated. In the 80° test this difference was found to be, on the average, 0.20 pound water per hour per calf. Thus it is seen that significant amounts of moisture are vaporized into the stable air where cleaning is delayed, moisture which invariably causes trouble in young stock housing.

A study was made of the effect of cleaning frequency on stable heat dissipation. In the 80° test room (TR) the average heat difference between one-day accumulation and six-day accumulation was found to be about 230 Btu per calf per hour, showing the significant amount of sensible heat added by fermentation of the litter. In the 50° test room the average heat difference was 96 Btu per calf per hour, with greater heat added with six days accumulation of bedding.

(Project 136)

Equipment and Procedures in Spraying for Brush and Weed Control

D. B. Brooker, R. E. Larson, J. D. Crumpacker

Soybean Weed Control Equipment Studies. The use of rolling and smoothing devices as an aid for pre-emergence applications of herbicides were tested for the fourth year. The studies were conducted in conjunction with herbicide pre-emergence studies. The herbicides included in this study were CIPC, DNSP (amine), NaPCP, CDEA, CDAA and CDEC at what were considered to be optimum rates. The roller and smoothing device was the same as developed in the previous two years of this study. The tests were run at four locations—Weed Research Field, Lincoln University Farm, Elsberry Experiment Area and Wise Brothers farm. The results of these studies show no significant advantages for rolling or smoothing.

Rotary Hoe Studies. Studies were run to determine the effectiveness of the rotary hoe as a method of weed control in soybeans. The results of this study show that using the rotary hoe in combination with cultivation and/or the chemical treatment increases the yields over cultivation only. There was also indication that the rotary hoe will reduce yield

if used when the beans are as much as eight inches tall.

Post-Emergence Methods of Application of Herbicides.

The comparison of boom, drop and skid mountings as method of application of postemergence herbicides for weed control in soybeans was continued for the third year. The above methods of mounting were studied in conjunction with a number of herbicides. These were 2,4, -D, Dalapon, CMU, DNBP, and diesel oil. The equipment studied this year was the same as previous years with one exception. The drop mountings used single 110° nozzles this year as compared to two 80° nozzles in previous years. In general the results show the drop method to be slightly better than the other two. The skids are considerably poorer as reflected by the yields. In weed control the drops give results about equal to the skids and both are considerably better than the boom method. The advantage of using the drops was particularly evident in the application of Dalapon. This chemical lowered yields an average of ½ with booms and skid applications as compared with the drops method. This reduction in yield was primarily through delaying maturity.

Brush Control. The study of brush control methods and equipment was continued through observing the results of treatments applied in 1954. Defoliation ratings for the treatments were as follows:

Basal Knapsack	96.8%
Basal Handgun	97.2
Notch Oil Can	73.4
Cut and Stump	60.0
Foliage Handgun	94.2
Foliage Boomless Nozzle	67.3

The results are equal to or improved over those of 1954 in all cases but one, that being the C&S treatment in which the results are based on resprouting only. Resprouting was not considered in the results for the other treatments.

As a result of the 1954 findings, work was continued in an attempt to develop the use of the boomless nozzle for use in controlling brush. The effort this year was toward improving the tower and the mounting design and to determine the proper application rates and concentrations. The material of the tower was changed from steel to aluminum to reduce weight. For convenience of building, standard sections of television mast were incorporated in the design. An unsuccessful attempt was made to counterbalance the tower such that it would be free standing and not subject to all the minor ground variations transmitted through the tractor. The results indicated this might be feasible with the light weight tower but it would require additional work on the

design of the method of counterbalancing and dampening. The effort to determine the proper rate for this method of application was primarily an attempt to reduce the volume required. Treatments were applied at 15, 20, and 30 gallons per acre. (Project 153)

Tractor Fuel Losses in Storage

D. B. Brooker, C. L. Day

This phase of research work on above ground gasoline storage was begun July 19, 1955, at the Agricultural Engineering farm in order to study the loss of quality and quantity of gasoline under farm storage conditions in relation to storage tank color, pressure vents, tank shades, and the addition of chemical surfactant. The study was concerned only with summer storage.

Eight tanks were used in this storage study. Six tanks were set in the sun and two were shaded. The unshaded tanks had their longitudinal axis in an east-west direction. Each tank had a length of five feet, a diameter of three feet, and a capacity of approximately 300 gallons.

Two of the tanks were equipped with pressure-vacuum release valves set to "pop off" at a pressure of 3 pounds per square inch. The remaining tanks were equipped with common hinged fill caps.

Two of the tanks were equipped with a shade which was constructed of aluminum sheeting. An air escape area was provided so that warm air could not be trapped and held around the tanks.

Two of the tanks contained a chemical surfactant added at the rate of 80 parts of surfactant per million parts of gasoline.

Two of the tanks were painted red; one of the tanks was painted aluminum; and the others were painted white.

Evaporation Loss. Evaporation losses over a three week storage period in the various tanks, determined by subtraction are shown in the following table:

Tank	A1	A2	A3	A4	A5	A6	A7*	A8
Loss, Gallons	8.0	4.7	5.2	4.2	5.3	7.7	1.1	2.0

*A7 developed a slight tank leak five days prior to conclusion of the experiment. (Project 224)

Grain Drying

D. B. Brooker, C. L. Day

OBJECTIVES:

To study operating characteristics of grain and ear corn drying systems, with emphasis on the distribution of air in the grain mass.

REPORT OF PROGRESS:

Approximately 1700 bushels of wheat, 700 bushels of combine grain sorghum, and 550 bushels

of ear corn were dried with natural air.

The table gives a summary of these drying operations.

Summary of Crop Drying on the Agricultural Engineering Farm in 1955

Grain	Bushels	Original Moisture Content (%)	Final Moisture Content (%)	Ventilation Rate (cfm per Bushel)	Days Drying Time	Electrical* Costs-Cents per Bushel
Wheat	1700	17.0	13.0	1.5	10	0.85
Grain Sorghum	700	30.0	13.5	6.0	31	12.0
Ear Corn	510	33.0	16.0	6-10	26	5.7

*Electrical energy figured at 3.0 cents per KWH.

(Project 225)

Farm Water Supplies

T. O. Hodges, M. D. Shanklin, M. L. Esmay,
M. M. Jones

In general it has been found that (a) slow sand filters can be depended upon to give some reduction of turbidity and bacteria, depending upon how well the filters are maintained; (b) that the clogging of filters and the frequency of servicing is directly related to the turbidity of the influent; (c) that the turbidity of pond water varies considerably even within the same general farming area; and (d) that slow sand filters cannot be depended upon to consistently produce pure water without disinfection.

Frequency and amount of servicing required are important factors in the operation of sand filters; and since rate of clogging of filters increases with increased turbidity, it is important that water in a pond be as clear as possible before entering the filter. Two commercial pressure-type filter units have been installed on farms of cooperators near Columbia, and they are under observation. Recorded data include water quality (turbidity and bacteria) before and after treatment, the quantity of water filtered between servicings, the effectiveness of the filters with various head losses, and maintenance requirements. Plans have been made to study factors in watershed and pond management as they affect turbidity of pond water. (Project 155)

Benefits of Supplemental Irrigation on Improved Pastures

R. P. Beasley

Seven irrigations were made on irrigated plots after lambs were weaned. Two inches of water was applied at each irrigation.

RESULTS:

1. Irrigation increased carrying capacities from one and one-half to three and one-half times.
2. Irrigation of plots provided continuous grazing during this period, while it was necessary to re-

duce stocking rates and for a few short periods remove lambs entirely from non-irrigated plots.

3. Periodic applications of nitrogen in addition to the basal treatment (250# 8-24-8) during this period did not result in increased forage production as measured by total pasture days.

4. Severe parasite infestation developed in all lots. The infestation was severe enough to make evaluation of pasture production on the basis of lamb gains inconclusive. Frequent drenching and continuous access to phenothiazine salt did not prevent an eight percent death loss due to parasites. (Project 226)

Use of Surface Runoff for Irrigation

R. P. Beasley, Ernest Smerdon, D. D. Smith

Seepage from a 16 acre clay-blanketed reservoir has averaged 0.93 inches per month during the last five years. Evaporation from the reservoir has averaged 74 percent of that from a Weather Bureau pan located 25 miles west of the reservoir. Preliminary data from a pan near the reservoir site indicate a pan loss eight percent higher than that of the pan located in Columbia 25 miles away.

Study of runoff records for the last 14 years from the 154 acre watershed of slowly permeable soil indicates the minimum 25 year frequency runoff should equal about 2 inches. The 0.21 inches recorded during 1954 appears to be the minimum amounts to be expected once in a period of over 1000 years. Irrigation of pastures in 1955 increased rainfall runoff 1.07 inches or 81 percent. (Project 227)

Distribution and Application of Irrigation Water

R. P. Beasley, V. C. Jamison, D. D. Smith,
J. D. Hildinger

OBJECTIVES:

To determine adaptability and efficiency of surface and overhead method of applying water on Mississippi

river bottom soil and to test the use of newly developed plastic devices for distribution of water to furrows.

SUMMARY OF SIGNIFICANT FINDINGS:

The absorption rate with furrow irrigation is not as high as with sprinklers because only part of the furrow area is in contact with the furrow stream. Minimum absorption rates with furrow application were about 60 percent of the sprinkler rate and average rates 66 percent. Losses by evaporation and lateral leakage during five sprinkler irrigations averaged 17 percent of the pumped amounts. Sprinkler plots which absorbed 0.6 inches more water out-yielded furrow plots by only 8 bushels per acre. Three inches of absorbed irrigation water on sprinkler plots resulted in a yield of 117 bushels per acre in comparison to a non-irrigation yield of 99 bushels per acre. (Project 265)

Water Management in Producing Cotton

R. B. Curry, A. H. Miller, R. P. Beasley

Arrangements have been made to obtain infor-

mation on present irrigation well installations during the 1956 growing season. A complete physical description of the well will be obtained as well as information on yield drawdown, and sand pumpage.

Due to the limited funds and lack of technical personnel it was not possible to set up plot studies this past year to study irrigation and drainage techniques.

Arrangements have been made for cooperative studies with land owners who are using different methods of irrigation and different degrees of land leveling. Information on initial cost, labor requirements, operating costs, efficiency of irrigation and yield variation will be obtained for different methods of irrigation. Information on the effect of different degrees of land preparation on the improved efficiency of irrigation and drainage will also be obtained. These studies will be made during the 1956 growing season. (Project 271)

CORN PRODUCTION IN INTENSIVE ROTATION WITH SMALL GRAIN

J. W. ALLEN R. B. CURRY C. L. DAY J. S. MCKIBBEN ALBERT MILLER D. B. BROOKER M. M. JONES

TABLE I

Summary of Results of Plot Studies on Intensive One-year Rotation of Wheat and Corn in 1955

Crop Handling	Irriga- tion	Production Costs								Yield/A tons or bu.	Crop Value/A	Net per Acre Crop Rotation	
		Tractor	Imple.	Fuel	Labor	Seed	Drying	Fert.	Total				
Wheat silage	\$	\$3.16	\$3.87	\$.96	\$4.72	\$2.85	\$	\$12.00	\$27.50	5.0	\$50.00	\$22.44	
Corn silage		4.05	5.03	1.27	7.00	.38		16.50	34.23	6.95	69.50	35.27	57.71
Corn silage*	\$15.00	4.05	5.03	1.27	7.00	.38		16.50	49.23	9.90	99.00	49.77	72.21
Wheat silage		3.16	3.87	.96	4.72	2.85		12.00	27.50	5.0	50.00	22.44	
Corn grain		2.27	2.87	.87	7.11	.38	1.79	23.26	38.73	34.5	43.13	4.40	26.84
Corn grain*	15.00	2.27	2.87	.87	7.11	.38	2.76	23.26	55.00	55.9	69.88	14.88	37.32
Wheat grain		1.74	5.12	.57	3.36	2.85	.32	12.00	25.96	37.5	71.25	45.29	
Corn silage		4.05	5.03	1.27	7.00	.38		16.50	34.23	4.07	40.70	6.47	51.76
Corn silage*	15.00	4.05	5.03	1.23	7.00	.38		16.50	49.23	6.55	65.55	16.32	61.61
Wheat grain		1.74	5.12	.57	3.36	2.85	.32	12.00	25.96	37.5	71.25	45.29	
Corn grain		2.27	2.87	.87	7.11	.38	1.84	23.26	38.60	32.3	40.38	1.78	47.07
Corn grain*	15.00	2.27	2.87	.87	7.11	.38	3.05	23.26	54.81	53.5	66.88	12.07	57.36

*Denotes same rotation as immediately above except that the corn was irrigated.

NOTE: Production costs are those applying for field size areas.

Crop values are assumed to be: Wheat silage, \$10.00 per ton; Corn silage, \$10.00 per ton; Corn, \$1.25 per bushel; Wheat, \$1.90 per bushel.

Summary of Results on Field Studies of Intensive Two-Crop, One-Year Rotations, 1955

Field	Acres	Crop	Crop use	Yield/Acre	Value/unit	Value/Acre	Total Cost/A	Net Returns/A
B	17	Wheat	Grain	37.5 Bu.	1.90	71.25	\$42.87	\$45.13
		Soybeans	Grain	6.7 Bu.	2.50	16.75		
						88.00		
C	17	Wheat	Grain	37.5 Bu.	1.90	71.25	\$54.77	\$41.68
		Grain Sorghum	Grain	28.0 Bu.	.90	25.20		
						96.45		
D	17	Wheat	Silage	5 T.	10.00	50.00	\$65.07	\$22.43
		Corn	Grain	30 Bu.	1.25	37.50		
						87.50		
E	17	Wheat	Grain	37.5 Bu.	1.90	71.25	\$52.85	\$28.40
		Beans	Grain	4.0 Bu.	2.50	10.00		
						81.25		

Thompson Farm Improvement

M. M. Jones, H. J. Hall, R. P. Beasley, J. W. McKinsey

OBJECTIVE:

To make basic improvements on the farm, principally in water management systems, fences, and buildings, as may be needed, and as may be practical within limitations of budget and personnel.

A topographic map of the west section was made at a cost of \$526, and three drainage ditches were designed and laid out. These ditches are now under construction at a contract price of \$1727.

The farm has been rented to local farmers, mostly on a crop share basis, to derive some income from the place and to control soil erosion until such a

time as long-range plans for the use of the farm may be developed. (*Project 273*)

Utilization of Electricity on Missouri Farms

Kenneth McFate, M. M. Jones

This project was approved in October 1955, and it was some six or eight weeks before financial arrangements were completed to support the project. Kenneth L. McFate was employed as project leader beginning February 1, 1956. Consequently, only preliminary arrangements were made for organizing the project, and no investigations were actually begun in this report year which ended January 31, 1956. (*Project 282*)

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Animal Husbandry

L. A. Weaver, Chairman

Selecting and Breeding for Swine Improvement

C. J. Heidenreich, J. F. Lasley, L. A. Weaver,
L. F. Tribble, C. W. Foley

Among other things completed in this study during the past year data were summarized to determine the value of certain live hog measurements in predicting the carcass value of crossbred pigs. The purpose of this study was to develop methods of predicting carcass value of live hogs so that these could be used for selecting breeding animals.

A total of 81 Landrace x Poland x Duroc and 118 Landrace x Poland crossbred pigs were used in this study. Detailed carcass data were obtained on each of these pigs when they were slaughtered at a weight of approximately 200 pounds. Just prior to slaughter, the following measurements were taken

on each pig: backfat thickness at the shoulder, hip and ham, body length, heart girth and flank circumference. Upon visual observations made during the course of the study, it appeared that different body measurement relationships existed between the two crosses. Therefore, each cross was studied separately.

Three bases of carcass value were used with all measurements expressed as a percentage of the "adjusted live weight." In other words, all animals were corrected to a 3.5 pound fill. These measurements were: percent of adjusted live weight in fat, percentage of adjusted live weight in adjusted loin equivalent. The latter value is a measure of net carcass merit developed and used at the University of Missouri. It is obtained by adjusting the wholesale cuts by factors indicative of their absolute value and by evaluating the primal cuts on a basis of subjec-

tive quality scores.

In the 3-breed cross (LxPx \bar{D}), the 6 body measurements in the live hog accounted for 21, 25 and 51 percent of the variation in the adjusted loin equivalent, percent of 5 primal cuts and the percent of fat cuts respectively. In the 2-breed cross, (LxP), these 6 measurements accounted for 32, 32, and 66 percent of the variation in the adjusted loin equivalent, percent of 5 primal cuts and the percent of fat cuts respectively.

The size of the squared betas for each body measurement indicates the relative importance of these measurements for predicting carcass value. The larger squared betas, of course, indicates a greater predictive importance of these measurements.

Equations to be used in estimating the carcass value of live hogs by the different measurements taken at approximately 200 pounds live weight have been determined. These will be used for the purpose of selecting breeding stock with greater carcass desirability in the different lines and crosses. (*Project 3*)

Acceptability of Meat and Meat Products

Eugene Birmingham, D. E. Brady, L. A. Weaver, Auttis Mullins, Steve Zobrisky

Previous work indicates that the consumer is equally satisfied with cuts from Medium grade, Missouri 0 grade, Choice No. 1 and Choice No. 2 grade pork carcasses. It is of considerable economic importance to determine if there is any significant differences in the speed of processing and shrinkage between the cuts from the above carcass grades. Hams have been selected from Medium, Missouri 0 and U.S. No. 2 grade carcasses. Processing studies are now in progress.

A previous study indicated that consumers do not have a preference for cuts from Choice No. 1 carcasses over the cuts from Medium grade carcasses. Since this study was based on the selection of two cuts, additional testing was undertaken using the trio test for product discrimination. Two adult members (housewife and another adult) from 36 families were selected from the group who had participated in the prior survey. The product tested consisted of sliced bacon, cured ham slices and center cut pork chops.

It is important to note that the cooperators were asked to differentiate between the cuts and to express their preferences on the basis of eating quality of the product. This would not, however, preclude some prior impressions such as might come from the uncooked product. *Part I* of the study was reported in the previous progress report. Subsequent

to this report the Chi Square Test of Significance indicated that the data were not significant and that actually the panel members showed no eating preference for cuts from either grade.

Sliced bacon, cured ham slices and center cut pork chops were obtained from Choice No. 2 and Missouri 0 grade carcasses. The same procedures for sampling were followed in Part II as were followed in Part I. The only discrimination that was found to be significant was made by the housewives between the pork chops. The housewives preferred chops from the Choice No. 2 carcasses on the basis of flavor differences.

While these results may be regarded as tentative due to the limited size of the sample, they do suggest that on the basis of the cooked product consumers can find little which they can use as a basis for discrimination or to indicate preferences.

(*Project 5*)

Production of Young Beeves

J. E. Comfort, L. A. Weaver, C. M. Bradley

Twelve high grade Shorthorn calves that were calved in January-February of 1954 were started on a grain ration of eight parts shelled corn and one part cottonseed meal (by weight) on March 13. They were grazing with their dams on wheat, fescue, Sudan and lespedeza pastures. They were weaned at about 8 months of age, weighing 583 pounds on October 2.

Feeding was continued in dry lot on the same grain ration until December 3 when they averaged 725 pounds. A limited amount of alfalfa hay was fed as the roughage in dry lot.

They made a gain of 418 pounds up to weaning or 2.05 pounds per day. They ate 548 pounds of corn and 69 pounds of cottonseed meal in addition to pasture and their mothers' milk up to weaning time.

During the post weaning period they gained 142 pounds or 2.33 pounds per day on 715 pounds of corn, 94 pounds of cottonseed meal and 226 pounds of hay. Three of the carcasses were in the choice grade and 9 in the good grade and the dressing percentage was 59 percent.

Fourteen March-May calves were started on grain in a creep on June 5 and were weaned December 3, weighing 507 pounds at approximately 8 months of age. They made a gain of 350 pounds or 1.89 pounds daily up to weaning with 498 pounds of corn and 62 pounds of cottonseed meal. During the post-weaning period they gained 240 pounds or 2.12 pounds per day on 1338 pounds of corn, 168

pounds of cottonseed meal and 336 pounds of alfalfa hay. They were slaughtered on March 26 weighing 747 pounds and producing 4 carcasses in the choice grade and 8 in the good grade. They dressed 58 percent.

The early calves were slaughtered at 11 months of age with 10.4 bushels less corn and the later calves were slaughtered at 12 months of age weighing 12 pounds more than the early calves. The sale price in 1954-55 was about the same for both groups of calves.

(Project 78)

Improved Methods of Pork Carcass Evaluation

Auttis Mullins, L. A. Weaver, Steve Zobrisky, D. E. Brady, J. F. Lasley, Leland Tribble

Considerable work has been done at this station and others concerning methods for evaluating live animals as well as the carcass. However, the established methods of evaluating live hogs and pork products produced are not satisfactory. Much of the work has been dependent upon linear measurements, either "external" or "internal" or both. However, chemical methods, physical dissection and specific

gravity techniques are possibly the most accurate methods of determining the composition in terms of fat, lean, and bone.

There has been an increasing realization on the part of the swine industry with regard to acceptability of leanness or absence of excess fat, i. e., both internal and subcutaneous. What is needed is more accurate methods to be developed for evaluating the animal on foot as well as the carcass and its cuts.

Chemical, physical dissection and specific gravity techniques have been developed and a pilot study conducted to evaluate these methods. What is sought is a more accurate criteria of appraising the live animal as well as the carcass and its cuts.

A literature review was made and a revised project outline submitted for these new approaches. The initial procedures involved the obtaining total daily urine collection for 2 consecutive days on 2 hogs, slaughtering the hogs, securing measurements, determining cut-out values on the carcasses, determining specific gravity on the hams and physically dissecting the hams. The data were from one purebred Duroc and one purebred Chester White. The data following suggest that this approach may prove to be quite effective.

Animal Number	Live Wt.	Carcass Length (mm)	Average Back Fat Thickness (mm)	Yield of 4 lean cuts (%)	Creatinine Coefficient	Sp. Gr. of Ham	Weight of Component Parts of Ham		
							Lean Kg.	Fat Kg.	Bone Kg.
402 (CW)	207	750	42.5	49.4	28.90	1.05186	4.4	2.4	.68
175 (Dur)	218	740	49.3	45.2	26.54	1.03575	4.1	3.0	.60

(Project 88)

Stability in Cured Meats

D. E. Brady, R. L. Henrickson, L. A. Weaver, R. B. Sleeth

The work during the past year has been concerned with the dual pumping technique of adding sodium ascorbate along with the sodium nitrite in the curing solution. A simultaneous injection system was constructed. This involved two stainless steel tanks and hose connections. A 65F. salinometer pickle is made up as stock solution. Then equal amounts of the pickle are made in separate containers. Sodium ascorbate is added equivalent to double strength for the quantity of brine, while sodium nitrite is mixed equivalent to double strength in the other container. These are placed in the tanks and the brines are simultaneously injected into the hams. Hams cured in this way did possess an enhanced color; however, refinements will be necessary to make this method adaptable for commercial use.

Subjective and objective color evaluations of the center ham slices indicate differences as reflected by the treatment. Hams cured with sodium ascorbate have a deeper red color than the controls. However, there were certain areas within the ham which did not take a uniform color. This is due, at least in part, to the different myoglobin content of each muscle. The semi-tendinosus is always light after curing. However, the cure containing sodium ascorbate did impart a deeper red color in this muscle, and the shelf life was extended. The color values for five muscles in each ham are now being analyzed.

Intermuscular injections of an ascorbic acid solution into the left ham of 6 hogs before slaughter were made. This method of introducing ascorbic acid into the meat did not prove practical. Bruises in the area of the injections made the product undesirable.

Another group of 10 hams were artery-injected with an ascorbic acid solution immediately after dressing and before the carcasses were chilled. The

pH of the meat ranged from 5.8 to 6.4. This pH range is desirable for the action of ascorbates and may assist in a more rapid penetration of the cure. Additional work with both the hot cure and the curing of hot pork will be necessary to ascertain the merits of this curing technique. Another technique, which has the limitation of double handling, is to chill the carcass 30 hours, artery pump a solution of sodium ascorbate, and place the hams in cure 12 to 18 hours.

Pieces of the longissimus dorsi muscle were cured with combinations of ascorbic acid and polyphosphates to determine the compatibility of these food additives. Where only a single muscle was used, color fixation was uniform.

The results of this work indicate that the polyphosphates are compatible with ascorbic acid and sodium ascorbate. Sodium hexametaphosphate was found to give a deeper red color than sodium triphosphate when used in combination with either ascorbic acid or sodium ascorbate. Monosodium glutamate used alone or in conjunction with ascorbic acid or sodium ascorbate yielded a more desirable color than when it was not used.

(Project 100)

Nutrients Required by Swine

L. F. Tribble, L. A. Weaver, C. M. Bradley

A ration composed of corn, soybean oil meal, minerals and Vitamins A and D was improved by the addition of riboflavin, nicotinic acid and pantothenic acid for weanling pigs in dry lot. The gains of the pigs on the ration supplemented with vitamins gained 7 percent faster than those on the basal ration. The addition of Vitamin B₁₂ to the vitamin supplemented ration increased the rate of gains 10 percent in one trial but failed to improve the rate of gain in two other trials with older and heavier pigs.

The addition of riboflavin, nicotinic acid and pantothenic acid to a corn and tankage ration resulted in 24 percent faster gains and 9 percent less feed per unit of gain for weanling pigs in dry lot. Rye pasture was a good source of the B-Vitamins as pigs on rye pasture made gains equal to those receiving vitamin supplemented rations in dry lot.

A ration composed of corn, soybean oil meal, tankage, fish meal, alfalfa meal, minerals and antibiotic and vitamin supplements proved to be as good as more complicated rations that contained such feeds as oat flour, liver meal, dried skim milk and sugar. Pelleting the ration did not increase the amount consumed or the gains of the pigs.

Pigs weaned at two weeks of age were compared with those weaned at 6 weeks of age. The pigs weaned at 6 weeks were 6 pounds heavier at 8 weeks of age than were those weaned at two weeks. The earlier weaned pigs had rougher hair coats, and were less thrifty and had more variation in size than did those weaned at 6 weeks. The cost of production was about equal for the two methods of weaning.

Several different practical feeding tests were conducted on the value of various protein supplements and management problems connected with feeding these supplements. A basal ration of corn and wheat shorts produced satisfactory gains but the feed efficiency was poor for pigs fed in dry lots from approximately 100 or 200 lbs. This ration was improved by adding soybean oil meal, tankage or fish meal but was not improved by adding cottonseed oil meal. A basal ration of corn and linseed oil meal was inferior to rations composed of corn and soybean oil meal and corn and tankage for pigs from 100 to 200 pounds. However, linseed oil meal was used in combination with soybean oil meal or tankage and satisfactory results were obtained.

When various supplements were fed free choice with corn to pigs from weaning to 200 pounds, the pigs consumed more of the supplements than was needed to balance their ration. Supplements composed largely of soybean oil meal and tankage were satisfactory for growth but when soybean oil meal made up over 50 percent of the supplement, the pigs consumed too much supplement.

(Project 141)

Producing Late Lambs on Roughage and Pasture

*C. M. Bradley, A. J. Dyer, L. A. Weaver
G. B. Thompson*

OBJECTIVES:

To test drought corn and wheat silages as the major roughages for wintering pregnant ewes and to determine the adverse effects, if any, from feeding nitrate containing silage (drought corn silage 1.4 percent nitrate on dry matter basis) to pregnant ewes.

Five pounds of either drought corn silage or wheat silage and two pounds of poor quality oat hay provided an adequate wintering ration (January 11 to April 2) for mature pregnant ewes bred to lamb in April; the criteria were gains during gestation, fleece weights, lambing percentage, birth weight of lambs and lamb gains before weaning.

The daily intakes of digestible protein and total digestible nutrients were lower than the recommend-

ed nutrient allowances of the National Research Council.

There were no adverse effects from feeding drouth corn silage having 1.4% nitrate content to pregnant ewes. Urinalysis revealed the presence of nitrates in one-third of the ewes tested the fourth week of the dry lot feeding period. All other periodic tests for nitrates in the urine were negative.

(Project 142)

Pasture Improvement

J. E. Comfort, L. A. Weaver

Twenty-four yearling Hereford steers that had been wintered on drouth corn silage, wheat silage or Sudan silage making an average daily gain of .88 pounds per day were selected for grazing on the Field Crops Departments experimental pastures at Columbia and Pierce City. Grazing was started on bluegrass and mixed legumes including Korean lespedeza and birdsfoot trefoil at Columbia on April 16 and grazing continued until September 24.

The 9 steers grazing these pastures made an average daily gain of 1.56 pounds per day, a total gain of 251 pounds per steer and 252 pounds gain per acre. Fifteen steers started grazing at Pierce City on April 23. They grazed on fescue and ladino clover, orchard grass and ladino clover, orchard grass and lespedeza, wheat and lespedeza and a supplementary pasture of straight lespedeza.

Because of the dry weather it was necessary to change some of the steers on these pastures during the season. The greater gains were made on each of these pastures during May and June and the light gain in July. The 15 steers on experiment pastures made an average gain of 1.63 pounds per day, a total gain of 249 pounds per steer and the pasture gain per acre was 338 pounds for fescue—ladino, 283 pounds for orchard grass—lespedeza and 330 pounds per acre on straight lespedeza.

The steers were appraised for type and body conformation at the end of the winter feeding period and at the end of the grazing season. The relationship between type, body conformation and gains made on pasture will be studied as the records from more cattle become available.

No incidents of bloat were experienced in 1955 on the experiment pastures. Some ladino clover was in two of the experiment pastures at Pierce City but the ladino made up less than one-half of herbage available for grazing.

(Project 154)

Factors Affecting Rumen Digestion

W. C. Ellis, W. H. Pfander, L. A. Weaver

H. E. Peckham

Some of the conclusions reached in this study include:

1. Different nitrogen sources can vary markedly in their ability to promote efficient nitrogen utilization by lambs.

2. Different nitrogen sources have little effect on the digestibility of the organic matter of the ration.

3. The nitrogen from the different nitrogen sources studied had no effect on the production of volatile fatty acid by the rumen microflora and micro fauna.

4. The expression of metabolic fecal nitrogen in relation to dry matter excretion rather than to dry matter intake led to less variable results in terms of true digestibility and biological value for the lamb.

(Project 158)

Improvement of Beef Cattle Through Breeding

J. F. Lasley, L. A. Weaver, C. M. Bradley, J. E.

Comfort, C. J. Heidenreich

1955 was the best grazing season in three years and the cows, yearling heifers and calves all came through the season in good condition. Twenty-three calves were weaned from thirty cows in the "open" herd. They were sired by two bulls obtained from purebred herds in Missouri and by one bull from a herd in Oklahoma. Sixteen calves were weaned from 38 cows in the "closed" herd. We had the misfortune of losing 4 calves in the "closed" herd shortly after birth and frozen semen from a bull that was "dwarf-free" by pedigree was used on part of the cows in the "closed" herd from May 6 to July 26, 1954 with rather unsatisfactory results. Fourteen of the early calves were sired by 2 bulls that made the best over-all records of all bulls in the 1951-52 and 1952-53 performance tests. Two late season calves were the result of artificial matings. Eight normal calves were sired by one of the two bulls making the best over-all records in the 1953-54 test out of dams that were known dwarf-carrier cows. Thirty grade calves were weaned from 35 grade cows and bred heifers. They were sired by Missouri Larry B1 that made a good record in the 1952-53 test.

Individual growth and feeding records on 6 yearling bulls, performance tested in the winter of 1954-55. These bulls were by four sires. The bulls were self-fed a mixed ration in individual feeding stalls. After the completion of the test, M482, the

bull making the best record, was used with light service in the college herd, and will be mated with 12 known dwarf-carrier cows in 1956. The dwarf-carrier cows in the herd have been used for testing young bulls to be used in the "closed" herd.

The vertebrae in the lumbar region of 9 bull calves were x-rayed by the School of Veterinary Medicine at the University of Missouri. Three of these calves were x-rayed at 1 week of age and six at 4 to 6 weeks of age. Six of these bull calves from the "closed" herd are now on feeding test.

During the winter of 1954-55, the 1954 heifers were fed by sire groups. All of the heifers made satisfactory gains on a ration of drouth corn silage fed free choice plus 1 pound of cottonseed meal per head daily. The two groups of heifers sired by performance tested bulls, however, made larger and more efficient gains than either of the two groups from the "open" herd. This is the first group of heifers produced since the herd was divided into an "open" and "closed" herd.

In 1955 the cows in the "open" herd were bred to two bulls selected from a herd that has been "double checking" their records from the standpoint of dwarf-free production. The cows in the "closed" herd were mated to two bulls from the "closed" herd that have good performance records.

(Project 198)

Retail Distribution of Frozen Meat

H. D. Naumann, D. E. Brady

The implementation of this project is dependent to a large degree on cooperation between the Missouri Agricultural Experiment Station and industry groups. Three meat processors in Missouri have initiated or are planning to initiate a frozen meat development and merchandising program. They have been contacted and have indicated a willingness to cooperate.

The first, a voluntary retail group, has initiated their frozen meat production and merchandising program in the St. Louis area. To date, volume of sales has not developed to the extent where a consumer survey would be practical. Limitations in present volume are attributable, at least in part to: (1) resultant high cost per pound of product, (2) technological problems, i. e., packaging and (3) limited acceptance on the part of retailers and consumers.

The second cooperator, a packer, has delayed development of a frozen meats processing and distribution program ostensibly due to personnel

changes. The third, another packer, has indicated a desire to cooperate and to initiate a distribution program possibly as early as late spring.

Preliminary studies with a modified Saran type of packaging material indicate that the lack of color stability may be a limiting factor in the display life of frozen meats so packaged. Color of frozen beef cuts has deteriorated markedly with exposure to 3600 foot candle hours of light. Studies are now in progress to determine the interrelationship of light intensity, storage temperature and color stability of frozen beef packaged in a modified Saran film.

(Project 217)

Pork Grades in Relation to Consumer Acceptability

D. E. Brady, Eugene Birmingham, H. D. Naumann

A study was conducted using 48 cured hams, loins, and bacon each equally divided into two grades as determined by the grade of the hams. Two grades of ham slices and pork chops were presented to two household consumer panels of thirty-six families each. The housewife in each household was asked to indicate a visual preference upon receipt of the product. Both the housewife and another adult in the household were asked to state their eating preference after cooking.

The "ham" consumer panel made replicate comparisons of grade A (high ratio of lean to fat) and grade B2 (lower ratio of lean to fat) ham slices, and replicate comparisons of ham slices with $\frac{1}{2}$ inch and $\frac{1}{4}$ inch external fat trim. The "pork chop" consumer panel made replicate comparisons of blade pork chops and rib pork chops.

In Table I is summarized the results of the survey. In all comparisons the consumers were more consistent in expressing visual preference than eating preference. The visual preference ratio was 2:1 or higher in favor of the grade A cuts. There was a 1.7:1 preference of the B2 ham slices to the A ham slices. The half inch external fat trim was preferred visually and in the eating test, but the preference was less for the visual.

In a survey of shoppers in three Columbia food stores, three hundred and four shoppers were shown pictures of comparisons used for the household panel and asked to indicate their preferences. Preferences were 4:1 for the leaner blade pork chops and about 2:1 for the leaner ham slices.

Table I -- Distribution of Preferences
- Household Panel -

	Visual			Eating		
	A Grade	B2 Grade	Incon-sistent	A Grade	B2 Grade	Incon-sistent
	%	%	%	%	%	%
Ham slice	47	14	39	18	31	51
Blade P. Chop	47	14	39	32	21	47
Rib P. Chop	50	25	25	25	22	53
	1/2 in. fat	1/4 in. fat	Incon-sistent	1/2 in. fat	1/4 in. fat	Incon-sistent
	%	%	%	%	%	%
Ham slice	36	22	42	31	12	57

(Project 218)

Estrus, Ovulation, Nidation, and Related Functions in the Male

J. F. Lasley, L. A. Weaver

Preliminary data showed that contrary to the beliefs of some people sows do come into estrus while nursing pigs. However, the majority of sows did not come into estrus until the 40th day following farrowing. Approximately 75 percent of the Landrace sows studied came into heat during the latter part of lactation as compared to about 50 percent of the Poland sows. This suggests a possible line difference in this respect.

Milk production curves from sows obtained by weighing pigs before and after nursing indicated that milk production was at a very low level by the 40th day following farrowing. Possibly there is some connection between estrus and milk production in lactating sows. The data obtained indicated that only 50 percent of the sows conceived when bred during lactation as compared to 81 percent bred after their pigs were weaned.

Although more data are needed for final conclusions, the results indicated that litter size at the next farrowing was not greatly affected when the sows were bred during lactation. It was also pointed out that although the majority of sows came into estrus 3 to 5 days after the pigs were weaned at 56 days of age, others did not come into estrus until several days later. Apparently, these sows had been in estrus during the latter part of the lactation period just before the pigs were weaned. (Project 222)

A COMPARISON OF BREEDING EFFICIENCY OF SOWS BRED DURING LACTATION AND AFTER THE PIGS WERE WEANED

	Bred during Lactation	Bred after pigs were weaned*
Avg. days after farrowing when sows were bred	45.9	65.9
No. of sows bred	14.0	21.0
No. of sows settled	7.0	17.0
Percentage of sows settled	50.0	81.0

*Pigs weaned at 56 days of age.

THE INFLUENCE OF BREEDING SOWS DURING LACTATION ON SUBSEQUENT PERFORMANCE

Poland sows		
	Bred during lactation	Bred after lactation
Number of sows	5	7
Days after farrowing when bred	45.8	63.9
Number of pigs farrowed	8.6	8.4
Number of pigs weaned	4.0	6.2
Percent mortality from birth to weaning	57.5	23.7

Landrace sows		
	Bred during lactation	Bred after lactation
Number of sows	19	5
Days after farrowing when bred	48.0	59.8
Number of pigs farrowed	8.9	9.4
Number of pigs weaned	7.0	6.2
Percent mortality from birth to weaning	21.8	34.0

Returns from the Use of Sheep on Small Fertile Irrigated Areas

C. M. Bradley, A. J. Dyer, L. A. Weaver

OBJECTIVES:

- To determine the effects of irrigating pastures grown on highly fertile soil, using the response of ewes and lambs that graze the areas for the determination.
- To study the effects of adding Nitrogen to irrigated pastures grazed by ewes and their lambs.
- To compare the pastures of Orchard grass-Ladino clover, Orchard grass-Korean Lespedeza and Orchard grass under the foregoing conditions.

RESULTS:

- Suckling period before frequent irrigation:*
 - There were no significant differences in total pasture days, ewe and lamb gains and/or losses between the plots of Orchard grass-Ladino clover, Orchard grass-Korean Lespedeza and Orchard grass.
 - Lactating ewes did not maintain body weight although adequate forage was available and lambs gained approximately .3 pounds per day.
- After weaning and during frequent irrigation. (When irrigation was deemed necessary 2 inches of water was applied at the rate of .2 of an inch per hour).*
 - Irrigation increased carrying capacities from one and one-half to three and one-half times.
 - Irrigated plots provided continuous grazing during this period, while it was necessary to reduce stocking rates and for a few short periods remove lambs entirely from non-irrigated plots.
 - Periodic applications of nitrogen in addition to the basal treatment (250# 8-24-8) during this period did not result in increased forage production as measured by total pasture days.
 - Severe parasite infestation developed in all lots. The infestation was severe enough to make eval-

uation of pasture production on the basis of lamb gains inconclusive. Frequent drenching and continuous access to phenothiazine salt did not prevent an 8% death loss due to parasites. (*Project 235*)

Factors Affecting Gains of Stocker Cattle

A. J. Dyer, L. A. Weaver, C. M. Bradley

Silages made from wheat, sudan and drouth corn were compared in wintering rations (1954-55) fed to stocker calves. In addition to silage, each of the rations contained the same amount of cottonseed meal, one pound per head daily and shelled corn in amounts needed to produce an approximate average daily gain of one pound.

OBJECTIVES:

- A. *To compare the nutritive value of wheat, sudan and drouth corn silages fed to stocker calves.*
- B. *To study the effects of adding hexestrol to each of the foregoing.*

Criteria used to measure results were rate of economy of gain.

PROGRESS INCLUDING RESULTS:

During the first 28 days of the test when no shelled corn was added to drouth corn silage, steers made little or no gain; sudan silage produced an average daily gain of .8 pounds without shelled corn; wheat silage was not fed during the first 28 days. For the remainder of the test, 85 days, each lot was divided equally, this making 6 lots of 4 head each. The effects of adding hexestrol (7.5 mg. daily per head) to each ration were studied.

Wheat silage was consumed in smaller daily amounts than the others; i.e. 20.5 pounds, compared with 25.1 and 31 pounds for sudan and corn silage respectively, produced an average daily gain of 1.1 pounds when supplemented with only one bushel shelled corn per head during the 85 day period. Sudan silage was consumed in the second largest daily amounts, produced an average daily gain of .95 pounds and required 3.7 bushels corn per head. Drouth corn silage was consumed in largest amounts, produced an average daily gain of 1.4 pounds with a supplementation of 3 bushels of shelled corn per head. From these data, it would appear that excellent wheat silage of the sort used in this test was superior to drouth corn silage: the latter, however, was slightly superior to sudan silage. The wheat had been ensiled when grain was in the stiff dough state. Grains were plump and the tonnage heavy. Sudan was ensiled toward maturity but with lower leaves stripped from the stalk to a considerable extent by sheep that grazed the area on which it grew. Drouth

corn silage was made from corn that would have yielded approximately 3 bushels per acre.

Adding hexestrol to the ration had little or no effect upon the rate or economy of gain. For example, the difference was .1 pound advantage when added to wheat silage but more feed was consumed. Sudan silage, concurrently was eaten in equal amounts by both lots; when added to corn silage, less corn silage was consumed. Considered from every angle, the addition of hexestrol had no appreciable effects upon the performance of the cattle. However, teat length of non economic importance was increased by the addition of hexestrol to the ration. (*Project 236*)

Rations For Fattening Cattle

A. J. Dyer, L. A. Weaver, C. M. Bradley

OBJECTIVES:

To determine the effects of adding hexestrol (di-hydro stilbestrol) and rumen organisms separately to a standard fattening ration, using the following as criteria:

- A. *Rate of gain*
- B. *Economy of gain*
- C. *Quality of product produced*

Adding 10 milligrams hexestrol to a standard daily ration of ground ear corn, soybean meal and alfalfa hay, increased the rate of gain by 25.98% (3.2 pounds compared with 2.54 pounds) and reduced the amounts of feed required per unit of gain by 11 percent. These results were secured during a 112 day fattening period utilizing long-yearling cattle that weighed approximately 820 pounds at the beginning. Adding 4 grams of rumen organisms per steer to the standard daily ration increased the rate of daily gain by 6% (2.70 pounds compared with 2.54 pounds) but made no change in the amounts of feed required per unit of gain. During the first two weeks, however, there was less scouring—in fact, none, by cattle fed rumen organisms and during that period their gains equalled those made by cattle fed hexestrol.

Compared with both the control lot, and the "rumen organism" lot, hexestrol-fed cattle graded higher on foot, and brought a higher price than the controls by one dollar cwt. and more than the cattle fed rumen organisms by 50 cents cwt., shrank less in transit, and yielded a slightly higher dressing percentage. Cattle fed the rumen organisms had the second highest score on foot and brought fifty cents more per hundred than the control lot. The carcass grade for all lots was disappointing, i.e., cattle graded low choice on foot and average good in the carcass. The U.S.D.A. grader commented that the carcasses were tidy, having only a small amount of kidney

fat and a minimum but adequate amount of exterior fat. The rib eye generally had only traces of marbling, however, and tended to be soft. This was true for all lots of cattle. The grade and the number of each within a lot is listed below:

	Low Good	Avg. Good	High Good	Low Choice	Avg. Choice
Lot 1, Control	one	six		one	
Lot 2, Hexestrol	two	three	one	two	
Lot 3, Rumen org.	one	one	three	two	one

(Project 237)

Carcass Quality of Beef Resulting by Antemortem Handling

L. A. Weaver, D. E. Brady, H. B. Hedrick

From our studies to date, there is sufficient evidence to conclude that dark cutting beef is caused by animals being subjected to abnormal conditions, stress of various forms. The animals homeostatic mechanism in many instances is severely disrupted in its attempt to survive the "stress" and in this particular case the increased and prolonged secretion of adrenalin depletes the muscle of its glycogen stores resulting in carcasses that cut dark.

Our research to date on 35 animals has disclosed in all cases the injection of adrenalin either intramuscularly or subcutaneously will produce subsequent dark cutting carcasses. The darkness of the carcass can be increased proportionately by increasing the dosage of adrenalin. Likewise, excitation of animals with an electric "hot shot" periodically over a 24 hour period has resulted in the subsequent carcasses cutting dark.

Preventive measures namely: injection of pro-tamine zinc insulin following stress and injections of hydrocortisone 12 hours prior to injection of adrenalin and/or 12 hours after injection of adrenalin has resulted in some improvement in the color of the resulting carcasses. (Project 238)

Control of Microbial Development During Meat Processing

D. E. Brady, R. L. Henrickson

One of the major problems confronting the meat industry is the weight loss due to moisture evaporation and trim during chilling and storage above 32 F. Little is known concerning optimum cooler conditions for aging meat in order to provide maximum product protection.

Part of study is concerned with determining the (1) weight losses due to shrinkage, (2) trim losses due to surface discoloration, and (3) extent of mi-

crobial growth during aging as influenced by (1) length of aging, (2) quality of product, (3) temperature, (4), humidity, (5) air velocity, and (6) ultra-violet radiation. Our present work indicates that optimum environmental conditions are not the same for all meat items.

Paired sides, quarters, and wholesale cuts from 50 cattle of various weights and grades were studied. The right side of each carcass or wholesale cut was held under ultraviolet radiation 4 to 7 days at 57°F and 80% R.H. The intensity of germicidal ultraviolet energy varied from 60 to 250 microwatts per square centimeter. The left side of each pair was held 7 to 10 days at 40° F and 80% R.H. In addition 16 ribs were aged two days at 68° F and 90% R.H. and were compared with 16 ribs from the opposite side which were held at 34° F and 90% R.H.

Weight losses were recorded for the first 24 hour period and then subsequently throughout the aging periods. Subjective observations of surface discoloration of fat and lean were made. Effect of intensity and duration of radiation on reducing trimming losses due to microbial growth were determined.

Samples from each treatment were packaged, frozen, and stored. After storage for three weeks the rib, loin, and inside round steaks were broiled at 350° F until they reached an internal temperature of 160° F. Color, drip loss in thawing, and loss in broiling were determined for each steak. Taste panel evaluations were made of aroma, flavor, juiciness, and tenderness. In addition Warner-Bratzler shear values were obtained for each steak.

To summarize, beef of Choice, Good, and Commercial grades has been studied at 68° F, 58° F, 40° F, and 34° F. The relative humidity was varied from 80 to 90% and air velocity over the product from 25 to 30 lineal feet per minute. Beef aged at 68° F, for two days was found to be equal, if not superior, in tenderness and flavor to beef aged at 34 F° for 15 days. Our data thus far indicate that meat aged at the elevated temperature will yield a greater percentage of salable meat. The organoleptic data are presently being analyzed. (Project 257)

The Mineral Nutrition of Ruminants

W. C. Ellis, W. H. Pfander, L. A. Weaver,
G. B. Thompson

Sheep were fed a purified ration formulated as follows:

Solka floc*	20.0
Beet Pulp	20.0
Corn starch	27.5

Cerelose	10.0
Lard	2.0
Casein	15.3
Vitamin A & D	0.2
Minerals	5.0

*Trademark, Brown & Company

The mineral fraction supplied the following elements (by analysis)

Calcium	0.68% of ration
Phosphorus	0.35
Magnesium	0.10
Sodium	0.97
Potassium	0.75
Cobalt	0.49 PPM
Copper	5.76
Iron	57.50
Manganese	41.50
Molybdenum	0.10
Zinc	26.80
Iodine	+

Three sheep received the purified ration and three sheep the same ration supplemented with 3 PPM molybdenum.

	Avg. Daily Gain
Basal	0.11 lb.
Basal + Mo	0.26 lb.

Twelve ewe lambs originating in Colorado were placed on the following ration:

250 gms. timothy hay, low Ca.
200 gms. shelled corn
40 gms. cottonseed meal

They will be continued on this ration.
(Project 248)

Changes in the Physical Structure of Roughages During Growth and Digestion

W. H. Pfander

Wheat and Korean lespedeza were harvested at intervals during their growing stages and separated into leaf and stem. Samples were prepared for examination by X-ray diffraction and electron microscopy. Some of the observations have been made. Certain major differences were observed but no definite relationships can be established until all samples have been examined. (Project 250)

Effect of Nitrate on Cattle and Sheep

Following a severe drouth in central Missouri during the summer of 1954 the forages of this area were in many cases toxic to animals. Abnormal blood bonds were present in the natural outbreaks: among those were nitrosohemoglobin and methemoglobin. These symptoms could be produced by feeding ni-

trate and were also observed in cattle killed by the toxic forages. The forages contained as much as 8 percent potassium nitrate equivalent and usually showed evidence of mold growth.

Seventy head of mature ewes were divided into two lots. Each lot received two lbs. of oat hay, and had free access to salt, bonemeal and water. Lot 1 received five lbs. of drouth corn silage containing initially 1.4% potassium nitrate equivalent. Lot 2 received five lbs. of wheat silage.

	Performance	
Lot number	1	2
No. ewes lambing	29	33
No. live lambs	45	49
Birth wt. lambs, lbs.	10.5	10.7
Fleece wt., lbs.	8.2	8.7

After the ewes had been on the silage for one month, urine samples were collected and tested qualitatively for nitrate by the diphenyl amine test. One third of the urines from Lot 1 gave a positive test. There were no positive tests from Lot 2. After six weeks all urines were negative for nitrate. The nitrate in the corn silage dropped to about one half percent, presumably from bacterial action. Apparently the oat hay contained enough available carbohydrate to protect the ewes by allowing rapid reduction of KNO_3 to NH_3 .

Two mature pregnant beef cows were fed drouth corn silage free choice for one week. They also had access to a small pasture. The cows showed no symptoms of nitrate poisoning but silage consumption decreased at the end of the week.

A herd of mature Shorthorn cows was wintered on drouth corn silage, 2 lbs. of black strap molasses and 1 lb. oil meal. Calving performance was satisfactory. Urine and milk from these cows gave a negative nitrate test. A similar herd receiving no molasses showed distress, 4 cows had dead calves so the silage was removed from the ration. Animals recovered.

Potassium nitrate was mixed with grain and fed to sheep at levels shown below:

% KNO_3 in ration	Methemoglobin gm/100cc	Pack cell vol.
0.5	2.17	41.7%
1.0	0.54	38.5
2.0	4.69	46.1
4.0	1.04	51.6
Control	0.24	41.7

Land in a wheat-lespedeza rotation was fertilized with 250 lbs. of 8-8-8 fertilizer and sown to wheat. On April first the experimental plot was top dressed with 124 lbs. N/acre from ammonium nitrate. On April 16 ewes and lambs were turned to the control and experimental plots. The ewes and lambs did equally well on either plot. The ewes gained 9 lbs. and the lambs 13 lbs. each in the three

weeks. No nitrate was present in either milk or urine of the ewes or the urine of the lambs.

Mature wethers were fed 750 gms. mature timothy hay and given various amounts of potassium nitrate in gelatin capsules. Results obtained:

<u>Dose KNO₃</u>	<u>Wt. Sheep</u>	<u>Effect</u>
24 gms.	31 kgs.	recovered
32	33	recovered
40	33	became very sick, recovered
40	31	died
48	35	died
96	34	died

The toxic dose of KNO₃ when given in capsules, therefore, appears to be about 40 gms. for 32 kg. live weight or 1.25 gm. per kg. body weight.

In one phase of the study mature wethers were used. They were kept in individual cages and given a maintenance ration of 800 gms. mature timothy hay and 212 gms. concentrate mixture containing 1% Ca, 0.84% P, and 6.7% N in two equal feeds. The sterile solutions used were isotonic with sheep blood. The drip was given through a polyethylene tube in the jugular vein at the rate of 180 ml. per hour under pressure of 6 ft. water.

<u>Wt. Sheep</u>	<u>Dose</u>	<u>Effects</u>
56 lb.	25 gms. KNO ₃	No ill effects
56 lb.	2.8 gms. KNO ₂	Died in 2 hours Diagnosis Nitrate Poisoning
80 lb.	90 gms. KNO ₃	Dehydration High con. KNO ₃ in Urine No Methemoglobin
75 lb.	2.5 gms. KNO ₂	Dead in 3 hours

Conclusions: Toxicity is due to presense of KNO₂ in blood stream. KNO₃ is not the cause of death in nitrate poisoning.

Four mature sheep were placed in metabolism cages.

Rations

Alfalfa hay, 800 gms.; corn 400 gms.

Alfalfa hay, 800 gms.

Timothy hay, 800 gms.

Timothy hay, 800 gms.; Cerelose, 50 gms.

When animals were adjusted to above rations, total fecal and urine collections were made. KNO₃ was then given by rumen fistula. Daily collections of feces and urine were made. Analyses have not been completed. (Project 251)

Endocrine Secretions as Related to Growth, Reproduction and Gene Action

J. F. Lasley

Detailed carcass data were obtained on 23 barrows and 23 gilts from the Landrace x Poland cross at approximately 200 pounds or market weight. This was done for the purpose of determining the influence of sex on carcass quality.

The data gathered show differences between barrows and gilts in 13 different carcass characteristics. Gilts exceeded barrows in body length, leg length and in the percentage of bone which indicates that the gilts made more skeletal growth than barrows to market weight. On the other hand, the barrows were fatter than the gilts as shown by a greater amount of back fat in the carcass and in the live hog and by a greater percent of fat cuts in the carcass.

Other carcass traits studied such as the loin and ham area, the percent adjusted loin equivalent and the percent of 5 primal cuts are measures of leanness in the carcass. The gilts exceeded the barrows in each of these traits, indicating that they produce meatier carcasses.

During the fall of 1955, an experiment was designed to further study the influence of sex on the performance and carcass quality of pigs from a purebred Landrace and a purebred Poland line. Four lots of pigs from each of these lines were placed on feed shortly after weaning and will be fed until they reach a weight of approximately 200 pounds. These 4 lots of pigs from each line included the following; normal gilts, spayed gilts, boars and barrows. The experiment is still in progress and will not be completed for a few more weeks. Records are being kept that should show differences in the rate and efficiency of gain, body scores and measurements and in carcass quality. Similar experiments will be conducted in the fall of 1956, but they will be expanded to include lots of pigs of the various sexes which are treated with certain hormones. This study will be made to determine the influence of sex and various hormones on the performance and carcass quality of swine as well as to study the effects of hormones on gene expression.

(Project 276)

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Dairy Husbandry

A. C. Ragsdale, Chairman

Dairy Herd and Farm Improvement Practices

H. S. Peet, A. C. Ragsdale

The dairy cattle breeding program is directed toward developing Jersey cattle with capacity for large milk production, of good size, superior type and long life. The use and development of superior sires, brood cow families and rigid culling have been important factors in working toward this objective. The present herd consists of 33 cows, 29 heifers, 2 herd sires and 4 young bulls. Twenty-eight of these animals, five now in milk, are daughters of Masterman Standard Certify 525009. The daughters of this bull continue to show more type, uniformity and breed character than their dams and the heifers coming into production within the last two months indicate high production. A son of Masterman Standard Certify, Hatch Masterman Buster 560083, has been used on approximately 23 of the older cows with five young daughters now in the herd. Standard Lavender Jest 532680 was mated to the daughters of Masterman Standard Certify. Two young daughters of this bull have thus far been dropped in the herd.

Twenty-three years of Herd Improvement Registry testing and Official Type Classification have provided a background for a constructive breeding program. Herd Improvement Registry records show and average production of 7,115 lbs. of milk and 391 lbs. fat over a 23-year period, with an average of 7,419 lbs. milk and 420 lbs. fat for the last three years. The Hatch Farm herd was classified in April 1955, with seven animals classified "Very Good", 13 "Good Plus" and 5 "Good", making an average classification score of 82.90 for the entire herd.

Also see cooperative Dairy Husbandry projects 35 Dairy Cattle Breeding and 54 Artificial Insemination.

During 1955 studies were continued to determine the value of pasture grasses, sudan, and legumes as soiling crops for dairy cows as compared with normal pasturing of these crops. The crops were harvested with a field chopper and fed to the cows in dry lot. Emphasis was placed on acre yield, consumption, labor and machinery costs, as compared to previous years when the animals grazed the same fields. These studies indicate:

1. The cows consumed from 53 to 70 lbs. chopped grass per day depending upon the moisture content of the grass and weather conditions prior to and at the time of cutting. On a body weight basis the above figure would correspond to 6.0 to 7.7 lbs. chopped grass per 100 lbs. body weight.

2. The yield of alfalfa and alfalfa-brome varied from 4 to 6.5 tons of chopped grass per acre.

3. The average time involved was approximately 40 minutes per day for one man and a tractor to harvest the forage and feed.

4. The cost of the equipment including the field chopper, blower and distributor pipe was just under \$300.00 for the year. This cost is figured on the purchase cost of the equipment and depreciating it on a 10 year basis. The same equipment was used to put up 136 tons of silage, therefore, the entire cost cannot be charged to the practice of feeding chopped grass.

5. Twenty-five acres of alfalfa and alfalfa-brome produced 1301 bales of hay, 136 tons of silage, and sufficient chopped grass to feed 32 Jersey cows from May 24 to October 18, 1955.

6. The increased carrying capacity of a given acreage is evidenced by the 1,301 bales of hay which were harvested on the 25 acres which in 1953 when utilized for normal pasture produced no hay.

7. The normal decline in milk production through advanced lactation was retarded by the feeding of chopped grass rather than pasturing. This was especially true during drouth periods because of a more accurate check on the amount and kind of pasture grasses the animals consumed.

8. There are three conditions which particularly warrant the consideration of using this practice of "bringing the pasture to the cows": (1) on farms with insufficient pasture acreage, (2) on farms where it is desired to increase the number of animals in the herd without increasing the pasture acreage, and (3) on farms which have field choppers available which previously were used only for silo filling.

9. Dairy men and livestock men in this area have shown much interest in this practice and some introduced it into their farming methods, while others plan to use it in the future.

Investigations on preservatives for alfalfa and alfalfa-brome silage have been continued. Two up-

right silos were used for the comparison of silage preserved with cane molasses at the rate of 50 lbs. per ton and silage preserved with sodium bisulfite at the rate of 8 lbs. per ton. Results to date indicate:

1. An excellent quality of silage resulted when either the sodium bisulfite or the cane molasses were used.

2. The spoilage on top of the silos was negligible with each preservative but slightly less when metabisulfite was used.

3. Differences in color were slight but the metabisulfite silage tended to be slightly greener.

4. No difference in palatability was observed.

5. No mold spots were observed in the bisulfite silage and only a few small mold spots in the molasses silage.

A federal tuberculosis-free and a State Accredited brucellosis-free herd has been maintained.

Calfhood vaccination for brucellosis was started in the herd in November of 1955. All females are vaccinated between the ages of 6 and 7 months. They are tested for brucellosis prior to vaccination, 30 to 60 days following vaccination, and again at 15 months of age or before breeding.

Sanitary practices such as washing the udders with a chlorine solution, rinsing teat cups after milking each cow, use of strip cup, diagnostic tests, and controlled milking order have kept mastitis infection at a minimum.

A limited investigation has been made to determine if the frequency of milk fever in dairy cows can be influenced through the feeding of a grain mixture consisting largely of ground oats and wheat bran and feeding a non-legume hay for a period of two to four weeks prior to calving. Insufficient results have been obtained to draw conclusions at this time. The investigation is being continued.

Complete herd, Herd Improvement Registry, Type Classification, health, pasture, crop and feeding records, with costs, have been kept. Detailed results and observations have been recorded.

The Station has cooperated with farm and dairy interests in serving as a source of information on dairy farm management. Emphasis has been placed on the use of local and regional newspapers, radio and television as a means of relaying the activities at the Station and related information to the public.

Special emphasis has been placed on working with Future Farmer, 4-H and Veterans on-the-farm Training, both by tours and discussions at the Station, and by personnel of the Station meeting with these groups.

The Station cooperated with personnel of the

Chicago, Burlington and Quincy Railroad Company in making it possible for groups from the City of St. Louis to visit the Station and points of interest in and around Hannibal. Nine groups, totaling 238 persons, visited the farm through this cooperation.

A total of 571 persons in organized groups and approximately 150 other individuals visited the Station during the year. Among the groups visiting the Station Farm were:

Hannibal FFA Chapter (three trips)	42
New London FFA Chapter	16
Bowling Green FFA	6
4-H Judging Contest	26
County Dairy Tour	32
Hannibal Veterans-in-training	9
Newcomers Picnic	82
Hatch Farm Field Day	120
Ladue Chapel Sunday School	18
Principia School	34
Riverview School Brownies	19
Epiphany School Girl Scouts	26
Glasgow Village School Girl Scouts	15
Bel-Nor School Girl Scouts	26
Cub Scouts (St. Louis)	12
Railroad Enthusiasts	18
St. Louis boys and girls	70
Total	571

(Project 64)

Foremost Guernsey—Breeding for Herd and Breed Improvement

*A. C. Ragsdale, L. L. Rainey, P. R. Cornelison
J. E. Edmondson, C. P. Merilan*

The Guernsey breeding program is directed toward developing cattle of good size, large milk production, superior type and longevity, with particular attention to the development of outstanding sires and brood cow families.

Consideration will be given to good farm practices with emphasis on pasture, silage, hay crops and soil conservation.

The building layout was planned in such a manner as to provide opportunity for study of loose housing vs. conventional type housing for cows in milk, for closed vs. open barns for calves, and for a comparison of aluminum vs. asphalt shingle roofing for heat transmission and for service life.

The influence of a number of outstanding animals of the breed is helping to shape the breeding plans. Langwater Foremost inheritance is now carried by 75% of the herd and Mixer Faithful inheritance by 95%. Mixer Faithful was voted in 1951 the Second Most Influential Cow of the breed. We now have in our herd more than 35 direct female descendants of this great cow, which we are holding and developing, and their number should increase.

The present sires in service are Foremost Footprint with 64 AR daughters, several now on test; Foremost J. C. has 52 AR daughters, many of which are on test and 70 in the herd; McDonald Farms Distinctive has 16 AR daughters, 28 of which are in our herd; Foremost Missourian with 20 daughters; Foremost J. C.'s Recorder with 12 daughters in the herd; Foremost Royal Monarch, 8 daughters; and Foremost Distinctive Supero is now going into service.

A few of the larger records completed during 1955 were:

Foremost Footprint's Quality 15212-729-7yr-2X

Foremost Footprint's Nella 15485-707-Sr3-C

Foremost J. C.'s Nirene 15370-703-Sr2-C

Fairlawn's Superb's Faithful 14473-700-5yr-C
(bred by Foremost)

Foremost Comet's Pattie Marie 13689-713-Jr4-C

A total of 100 records were completed above 400 lbs. fat. Included were five records over 700 lbs. fat; 23 over 600 lbs. fat and under 700 lbs. fat; 20 records over 500 lbs. and under 600 lbs. fat; 26 records over 450 lbs. and under 500 lbs. fat; 26 over 400 and under 450 lbs. fat. Twenty-eight of the above records were completed on 3X a day milking, all other on 2X milking. Most of these were in the 10 months division.

The spring pasture season started April 10, 1955 with the main herd of 100 milk cows on 35 acres of wheat and 12 acres of rye. These crops provided pasture until May 15th. Hay and permanent pasture were available most of that time. Sudan was sowed to replace the wheat, with an additional 12 acres of sudan in another field sown early. The 12 acres was under pasture by May 15th when wheat was gone. Thirty-five acres was back in sudan and being grazed by June 10th. It furnished a large amount of pasture through June and most of July and a limited amount until late October when it was plowed up and resown to wheat. The drouth hit this year and we started feeding silage the middle of August. Alfalfa silage was used until we started filling silos October 1st. We also grazed 35 acres of alfalfa with the milk cows periodically from the first of August until October 1st, with some grazing until November 1st. No small grain was available for fall grazing.

The West Farm unit was on permanent pasture, hay and at times silage from early spring to late fall. No supplementary pasture was supplied.

More than 600 bushels of shelled corn was picked in 1955.

Silage of all kinds for 1955 amounted to nearly 600 tons.

Hay produced and baled during 1955 was almost sufficient to carry the herd through, even though the drouth cut it considerably. We were somewhat in over-supply of mixed and oat hay and short on alfalfa of quality necessary for good milk production. Mixed hays harvested amounted to 4475 60-lb. bales (134 tons). Some of the lower grade hay was chopped for bedding. Some 4620 bales of oat hay of good to fair quality were produced (162 tons). Alfalfa baled totalled 6471 bales, all of reasonable quality (2055 bales first cutting, 2706 bales second cutting and 1710 bales of third cutting total of 210 tons). The fourth cutting was grazed off. Total hay production was 15,566 bales (560 tons). We provided a neighbor, Mr. Moore, with some labor help and baled 750 bales of second and third cutting alfalfa. We exchanged mixed hay and oat hay, bale for bale, for the alfalfa. We cut part of his acreage of fourth cutting on shares and received 175 bales of fine hay. Some of our excess mixed hay was marketed to the Veterinary School and some to the University Station herd.

The only hay purchased during the 1955-56 feeding season was approximately 25 tons of choice alfalfa hay. With reasonable moisture supply, that would not have been necessary.

During 1955, milk produced and sold through the University milk plant totaled 1,115,072 lbs., for \$52,108.62, with 62,971 lbs. whole milk being fed to the calves.

There were 68 living female calves dropped in the herd of which 62 were successfully raised. Sixty-nine males were dropped—20 were kept and raised for breeding purposes and the others sold as bob veal. We sold 28 bulls and 29 females into 15 states in 1955. There should be more choice bulls and more bred females to offer in 1956. We have, up to March 20, 1956, raised ten more bulls for breeding purposes than in the corresponding period in 1955.

Some 2,287 persons signed the Farm register in 1955, representing 36 states and 20 foreign countries. Many visitors do not register, especially when there are larger groups, and on Sundays and holidays. This is also true when some special days are being held at the College. It is estimated that there were more than 4000 visitors to the farm in 1955.
(Project 200)

Enzymes of the Mammary Gland

C. W. Turner, G. W. Pipes, W. F. Williams

H. Yamamoto W. R. Miller, H. C. Damm

T. Elattar

Studies have been carried out to determine the

levels of activity of various purine deaminases in the rat mammary gland throughout pregnancy, lactation and involution. Determination of these enzyme activities throughout the period of mammary gland growth and secretory activity may give some insight into the metabolism of the nucleic acids which are vital to the function of the gland cells, and secondly, may seem to indicate a possible assay technique for determining the stage of mammary gland function during lactation.

Such studies have been made of the activity of four deaminases in homogenates of rat mammary gland, the purine deaminases of adenine and guanine, and purine riboside deaminases of adenosine and guanosine. On the basis of the results obtained to date it appears that only the adenosine deaminase shows a marked change in activity with pregnancy and lactation. This enzyme appears to show an increased activity at the end of pregnancy and in the last quarter of lactation. This may indicate an increased metabolism of adenosine at these times and may be indicative of an increase in nucleic acid destruction.

Assay of Mammogenic Hormone. A hormone of the anterior pituitary, which we have designated the mammogenic hormone, is concerned in the growth of the mammary gland. Since it is present in only small amounts, a more sensitive assay method for its detection has been sought. The determination of DNA of the gland has been used as an index of growth in the rat and rabbit. In applying this method to the small mouse glands, it was found not too satisfactory. During the past year a more sensitive method was reported. This method of DNA determination has been applied to the mouse mammary glands and due to its greater sensitivity, it now appears that it will be possible to measure small increments of duct and lobule-alveolar growth. If further study proves this to be the case, it will make possible the assay of mammogen with small amounts of hormone.

(Project 28)

A Study of Mating Systems as They Influence Characteristics in Dairy Cattle

H. A. Ball, P. R. Cornelison, Kenneth Bower
C. P. Merilan, A. C. Ragsdale, J. M. Buckalew

Preliminary observations from a study of the production and breeding history of each of the 4 herds indicate a rather marked adverse environmental influence on production of the Columbia Jersey herd.

Statistical analyses on the effect of mild inbreeding on production in the Guernsey herd during the period from 1914 to 1918 indicate no significant change in either milk or fat production for 770 cows with inbreeding coefficients averaging four percent and ranging from 0 to 30 percent (only 8 animals had coefficients over 13 percent). However, regression coefficients of production on inbreeding for the 7 major sires, indicated a decrease in production which appears to be more nearly related to the generations of inbreeding rather than to the level of inbreeding of the individual. Regression coefficients for three of the sires (three and four generations removed from foundation sires) indicate an average decrease of 81 lbs. of milk per one percent increase inbreeding (inbreeding coefficients ranging from 0 to 12.5 percent).

Tabulation has been completed on the station Holstein and Jersey herd reproduction records for the period of 1934 to 1954. These data are being analyzed statistically to determine the relationship between conception rate and number of post-calving heat periods prior to breeding.
(Project 35)

Ice Cream Quality as Influenced by Emulsifiers, Sweeteners and Mixes

W. H. E. Reid, J. R. Campbell

A study was made of several factors that influence the marketing quality i. e., flavor, body, texture, meltdown and consumer acceptance of strawberry ice cream which included variable percentages of butterfat, solids-not-fat, sweeteners, overrun, homogenization pressures, stabilizers, and mono and diglyceride types of emulsifiers. Fifty different mixes were studied. Still and motion pictures were made of each of the eleven different series during the meltdown period.

The data show that each factor studied affected within limits the physical properties, marketing qualities and the meltdown of the resulting ice creams. A butterfat content of 10 and 12 percent; serum/solids of 11 and 13 percent produced ice cream more desirable as to meltdown and physical properties; an increase in sugar content decreased resistance to melting; high and low overruns caused increase in resistance to melting and 80 to 90 percent overrun was most desirable as to body and texture; variable homogenization pressures had no appreciable effect on physical properties or meltdown; deviation in amount of stabilizers affected the physical and meltdown properties; mono- and di-glyceride

type (1) emulsifier produced an ice cream generally undesirable in melting qualities but had little effect on the physical properties; type (2) emulsifier produced an undesirable meltdown at most percentages, but improved the texture as percent of emulsifier was increased; variable amounts of gelatin and sodium alginate and mono and di-glyceride types (1) and (2) gave a desirable meltdown when low percentages of both ingredients were used in combination. These data should suggest to commercial ice cream manufacturers desirable methods of improving the quality of their ice creams. The consumer acceptance and marketing qualities of strawberry ice cream should be improved, resulting in increased consumption of ice cream and utilization of larger volumes of milk and milk products.

New types of liquid sweeteners: Six different types of liquid and crystalline sweeteners have been studied to date. A standard mix has been used as a control. Eight different series, consisting of two different mixes per series, have been investigated. Preliminary data show that variable increments of the different sweeteners affect the flavor, body and texture of the resultant ice creams, particularly when comparing sweeteners of the high and low conversion types. The flavor of all ice creams studied has been observed to be acceptable from consumer view point, although two were described as being somewhat excessive in sweetness. The differences in the body of the ice creams varied from very satisfactory to somewhat chewy in three different ice creams. The texture of the ice creams had a rather direct relationship to the percentage of different sweeteners used. There were no appreciable differences in the color or meltdown of the ice creams studied. It would seem that liquid type of sweeteners lend themselves to practical acceptance by the ice cream industry based upon observations in this preliminary study.

A study of spray processed dehydrated ice cream mixes has not been inaugurated since the dehydrated ice cream mixes are not available at this time.
(Project 37)

A Study of Dairy Bull Semen

H. A. Ball, K. W. Bower, P. R. Cornelison
C. P. Merilan, B. W. Pickett, F. M. Orsini

OBJECTIVES:

To study the chemical and physical characteristics of bovine semen and correlate them with spermatozoa

viability and fertility for developing more suitable semen quality tests and storage techniques (diluters, frozen, and dried semen).

Preliminary information from the use of radioactive glycerol in studying the means by which glycerol protects spermatozoa during the freezing process indicates that glycerol is intimately associated with the cell and further that the amount of association varies between ejaculates from different bulls and between different ejaculates of the same bull as well as varying with equilibration time. Detailed investigation of segments of the temperature curve (+4° C to -165° C) for frozen semen suggests that freezing accompanied by crystallization does not occur within the sperm cell but rather that the cell is in a highly viscous, supercooled or vitreous state. These studies are being expanded through the use of *in vitro* metabolic determinations, autoradiographs, X-ray diffraction, electron microscopy and specific heat analysis.

Additional results on cold shock prevention, diluter composition and spermatozoa metabolism are given in the Progress Report for the cooperative project No. 81—"Animal Reproduction". (Project 54)

Influence of Diet on Growth and Development of Calves and older Dairy Animals

P. R. Cornelison, J. M. Buckalew, C. P. Merilan,
H. A. Ball, A. C. Ragsdale

OBJECTIVES:

To determine the influence of diet with special reference to milk replacers and starter rations, the specific mode of action of antibiotics, and to compare the later growth and development of the animals on the experimental rations with similar animals reared under normal feeding and management conditions.

Blood inorganic phosphorus determinations (200) on animals of different ages indicated that the initiation of reproductive function and peak phosphorus value occur at approximately the same age. A limited number of trials using dietary phosphorus supplementation for dairy heifer calves (paired for age, weight and breed) resulted in either higher blood inorganic phosphorus levels or attainment of peak values at an earlier age in the experimental calves compared to the control animals. Additional trials of longer duration are needed to determine if the observed differences are other than transitory imbalances which would be eliminated within a few weeks.

(Project 55)

Endocrine Genetics of Milk Secretion

A. C. Ragsdale, B. N. Premachandra, C. W. Turner, Henry Ruppert, Gayle Pipes, M. D. Borski, Jack Saroff

OBJECTIVES:

With the purchase of a new counter and the development of a head holder for cattle, it has been possible to develop an in vitro method of determining the thyroxine secretion rate of cattle without taking blood samples as in the previous method. The thyroxine secretion rate of individual cattle during growth, pregnancy and lactation is being determined.

The thyroxine secretion rate of fowls has been determined by the blood method. Reports of our observations are included. An *in vitro* method for fowls similar to that described in A above has now been worked out but not yet fully developed.

Studies on the male sex hormone present in cow feces has been completed and reported.

As a continuation of the above study, bovine bile has been extracted and the various preparations are now being assayed for androgenic activity. This will aid us in determining the source of the male hormones in cow feces.

Work on the experimental induction of growth of the udder and the initiation of lactation in sterile heifers is being continued with success. Studies are also continuing on the effect of various hormones upon the maintenance of lactation.

A method has been developed for the extraction and determination of certain adrenal hormones in bovine blood. This study is being conducted as a cooperative project with Dr. Dan Brady of the Meats Section. Only limited data have been obtained so far. (Project 80)

Effects of Temperature on Growth and Related Reactions in Heifers

Samuel Brody, Ruth Perry Stahl, Chu Shan Cheng,
Dennis Hartman, H. H. Kibler, C. Blincoe,
A. C. Ragsdale

Comparisons were made on two groups of Brahman, Santa Gertrudis, and Shorthorn calves grown at constant environmental temperatures of 50° and 80° F from birth to 14 months of age. Preliminary results on the effects of 50° and 80° F environments on rectal temperature, respiration rate, and respiratory ventilation rate in the calves, from birth to 10 months of age have been tabulated.

Analysis of data shows that all three breeds

grew well at 50° F, but only Brahman and Santa Gertrudis did well at 80° F. At age 10 months, the Shorthorns grown at 50° F weighed 578 lbs.; those grown at 80° F weighed only 400 lbs. At 14 months, the average weights at 50° F were: Brahmans, 700 lbs.; Santa Gertrudis, 850 lbs.; and Shorthorns, 740 lbs. At 80° F, the average weights were: Brahmans, 740 lbs.; Santa Gertrudis, 770 lbs.; and Shorthorns, 540 lbs.

Final analysis of the data on the responses of the three breeds of calves to 50°, 80° F, and open shed conditions awaits the termination of the experiment (about April, 1956).

Rabbits were investigated by the same methods and under similar environments as those on cattle. The physiological reactions of rabbits to rising environmental temperatures were similar to those of cattle, just as the nutritional needs of rabbits were similar to those of cattle (except that the *cecum* in rabbits was similar in biosynthetic function to the *rumen* in cattle). Therefore, inexpensive rabbits can be used in pilot experiments in the study of climatic physiology of expensive cattle. (Project 125)

Characterization of Microorganisms to the Dairy Industry

J. E. Edmondson, K. L. Smith, R. G. Jensen

Twelve species or strains variant of lactobacilli were tested by serial dilution for their ability to grow on several defined media. A basic SL broth or agar was modified for many growth trials. Other media used were enriched milk, Briggs, Fabians and V-8 juice agar.

Several modifications of V-8 agar were studied but little variations were noted. All tests were run in duplicate and all results were recorded according to highest dilution showing growth on each medium. Some variation in the highest dilution showing growth was noted but in some instances this could have been due to changing cultures from the basic media to another.

The agar colonies for each species were largest on Briggs. All strains studied grew well on Briggs and V-8 agar. 17 percent of the cultures tested were completely inhibited on Fabians agar. Twenty five percent strains were limited to scanty growth on the same medium. Scant growth was detected on other media studied. It was concluded that Briggs and V-8 agar and Briggs broth support the best growth and would be the most desirable for isolation and culture studies for lactobacilli. (Project 133)

Official Testing of Dairy Cattle and Milk Goats

Paul R. Cornelison

OBJECTIVES:

To provide official testing service to purebred dairy cattle and milk goat breeders in Missouri so that Advanced Registry and Herd Improvement Registry records may be made available for use in planning breeding programs and as a basis for herd improvement. The proving of sires and dams, locating brood cow families and superior transmitting sires are important factors in this program.

This project is basically a cooperative enterprise involving the National Dairy Cattle Breed Association, American Goat Record Society, the Purebred Breeders and the College of Agriculture, Department of Dairy Husbandry.

Each month during the period of this report official testing service was made available to an average ninety-six Missouri herds made up as follows:

26 Jersey Herds	603 cows
43 Holstein Herds	1318 cows
16 Guernsey Herds	536 cows
10 Brown Swiss Herds	205 cows
1 Goat Herd	7 goats

Complete Butterfat and Milk records were tabulated for the above herds. Two forms of official testing, Advanced Registry and Herd Improvement Registry are carried out. Ninety-five percent of the herds enrolled in official testing program are enrolled in the Herd Improvement plan.

During 1955 numerous sires of all breeds were Proven with the proof records published in the Advanced Registry Publication of the several breed associations and in lists published by the U.S.D.A.

Many outstanding brood cows were located through the testing program.

Breeders use records as compiled by testing programs on brood cows and proven sires as a basis for improved breeding practices.

The highest butterfat and milk producing cow for the year in the Herd Improvement Registry program for all breeds was Flo-Ray's Glory, a Guernsey cow owned by R. D. Pennewell, Palmyra, Missouri with 18,798 milk, 1024 fat 365 2x 5-1 (M.E. 365 3x 23,009 milk, 1358 fat).

The high cows for other breeds in the Herd Improvement Registry Program are as follows:

Holstein—Bristol Fifi Man-O-War Dean, owned by O. J. Hartzler, Harrisonville, Missouri, with a record of 21,489 milk, 880 fat 305 2x 9-1 (M.E. 365) 3x 29,226 milk, 1197 fat).

Jersey—Jester Standard Felicity, owned by O. B. Shaw, Chillicothe, Missouri, produced 13,751 milk, 748 fat 205 2x 10-6 (M.E. 365 3x 20,535 milk 1117 fat).

Brown Swiss—Peggy's Nancy of Churchview, owned by Al Markway and Sons, Jefferson City, Missouri, produced 15,142 milk, 708 fat, 305 2x 9-1 (M.E. 365 3x 20,311 milk, 949 fat).

The highest butterfat and milk producing cow for the year in the Advanced Registry Program for all breeds was Fairfield's Newport, a Guernsey cow owned by H. W. Haas, Rolla, Missouri, with 15,153 milk, 804 fat 365 2x 8-5 (M.E. 365 3x 18,511 milk, 982 fat).

The high cows for other breeds enrolled in the Advanced Registry program are North Repelmar Symette, a Brown Swiss cow owned by Repelmar Farms, Versailles, Missouri, with a record of 10,509 milk, 508 fat 305 2x 2-7 (M.E. 365 3x 19,618 milk, 949 fat); Standard Basil Eva Princess, a Jersey cow owned by W. N. Burney, Aurora, Missouri, produced 9,849 milk, 591 fat 305 2x 3-1 (M.E. 365 3x 15,037 milk, 903 fat).

The above mentioned are only a few of the outstanding high producing cows making records during 1955. Along with the official testing programs, encouragement is being given for the breeding of better cattle as well as improving the economic status of the Missouri Dairy Cattle Breeders. (*Project 134*)

Effects of Microorganisms in Dairy Cattle Nutrition

J. E. Edmondson, C. P. Merilan, K. W. Bower,
K. L. Smith, R. G. Jensen

OBJECTIVES:

To determine the specific role and requirements of each microorganism in the rumen flora, including biosynthesis of vitamins, in the utilization of feeds by dairy animals.

In addition to the bacteriological work abstracted under publications, studies are underway on the biosynthesis and excretion of vitamin C, thiamine, riboflavin, niacin, and pantothenic acid in dairy cows and calves. A total of 274 blood samples and 24 milk samples have been analyzed for these vitamins and the results are now being tested statistically for interrelationships between environmental conditions (particularly temperature) and changes in the vitamin content of blood and milk. (*Project 246*)

Quality of Milk and Related Products, Influenced by Handling and Marketing

J. E. Edmondson, R. G. Jensen, G. E. Huskey

OBJECTIVE:

To determine the nature, extent, and causes of deterioration in fluid milk and related products. The investigation will cover the product from the time it leaves the farm until it reaches the consumer. Marketing studies will be made of raw and pasteurized products, with special emphasis on finished product sales in self-service display cases, retail delivery, bulk milk dispensers, package and bulk coin-operated vending machines. Procurement and processing procedures as they influence the flavor.

sanitary, and keeping qualities of the product in market channels will be included in these studies.

Project became active February 1, 1956—progress to date. Temperatures of four-service dairy cabinets in four supermarkets in Columbia are being obtained with a 24 hour recording thermometer at the milk storage level. The average cabinet temperatures in two stores were about 50° F. There was a close relationship between the cabinet and outdoor temperatures. Only one of the four supermarkets maintained a cabinet temperature of 40° F. Milk is commonly held for four days in the cabinets. Most of the milk sold is in one-half gallon paper containers. (Project 284)

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Entomology

P. C. Stone, Chairman

A Study of the European Corn Borer

A. K. Burditt, P. J. Spangler

County agents in Carroll and New Madrid Counties were contacted to obtain names of farmers willing to cooperate in a continuous census of corn borer populations. A number of farmers were contacted by mail and in person in each county. A review of the methods and objectives of this project was presented at the Soil and Crop Conferences held in Carroll and New Madrid Counties in preparation for initiation of this project in the summer of 1956.

Several hundred European corn borer larvae were collected from several counties in Missouri. These larvae were sent to the U.S.D.A. European corn borer laboratory at Ankeny, Iowa for determination of the number of parasitized larvae and identification of the species of parasites found. These studies will not be completed until spring, when the parasites emerge.

A study of the effectiveness of insecticide treatment for control of third brood European corn borer larvae was initiated in New Madrid County. On September 1 an average of 11 egg masses per plant was found in a field of corn planted on June 20 with the variety Pfister 270. Parts of this field were sprayed by airplane on September 2, 1955 with 1½ or 3 pounds of DDT per acre. At that time about 60 percent of the eggs had hatched. The borer popula-

tion was determined on September 15 and again on October 29, 1955. The yield was determined on October 29. (Project 270)

Study of Corn Insects—Corn Earworm, The Southwestern Corn Borer and Others

R. E. Lusk, A. K. Burditt, J. H. Longwell, Jr.,
W. A. Dimmitt, P. J. Spangler, H. E. Brown

The primary objective of one phase of the project was to make ratings of southwestern corn borer infestations on hybrids under yield test at two localities in southwest Missouri. Weather conditions during the season of 1954 and to a lesser degree in 1955 were not favorable to the southwestern corn borer and the species was reduced to a very low level. This low infestation level continued during the season of 1955. Observations made by the Missouri pest survey on the yield test plots for the specific purpose of determining the feasibility of making ratings showed that the populations of borers were too low to warrant further work for this year. The hybrids showing maximum infestation had only 2-3% of the stalks affected. Work at the Oklahoma Station indicated that, to be reliable, maximum infestations must show at least a 25-30% stalk infestation.

Work undertaken in 1953 and 1954, to demonstrate the presence of an antibiotic factor to earworm growth in the silks of certain resistant varie-

ties of field corn, was continued during 1955. An attempt was made to enlarge and refine the tests so as to get definite answers to the questions proposed by our earlier work. Three resistant silks, F6 x F44, Dixie 18 and the inbred C17; and three susceptible silks, WF9 x 38-11 and two inbreds 38-11 and L317 were grown in quantity for silk production for feeding trials. One hundred earworms, in four replications of 25 each, were fed silks of each of these varieties, following the methods used in work of preceding seasons. The earworms were hatched on the silk which was to be fed to them and transferred, when not more than two days old, to individual vials as in past years. Corn silk of the proper kind was kept constantly before the larvae until pupation. Weights were taken with an analytical balance at 24 hour intervals all through the growing period starting at about 5 days old, at which time they became large enough to weigh readily. One replication of each test was fed in large jelly glass containers to determine whether or not the smaller vials were restricting the ultimate size of the larvae. Also, all pupae were sexed to determine the effect of sex on our results.

The quite considerable amount of data obtained from this experiment has not been fully analyzed as yet, but the following tentative statements may be made at this time:

A. No significant differences in the weights of larvae were obtained from the various silks. This result is contrary to our previous finding where average differences of about 40 percent were recorded. These discrepancies may be due to the differences in seasons but they do not seem to be due to technique of feeding.

B. Some differences were obtained in the vial versus jelly glass containers indicating that the vials might be exerting a restraining influence on growth.

C. Sex did not seem to be significant in relation to maximum body weight of larvae.

D. No significant differences were obtained between larval weights when earworms were fed on any of the silks used in the experiment.

Three experiments were carried out during 1955 on insecticidal control of earworm. All of these tests were done in cooperation with the Fruit and Vegetable Insect Control Project #31.

The National Corn Earworm Experiment was participated in by some fifteen states in 1954. Missouri took part in this year's experiment and the tests were made on the South Farm. The experiment was set up to determine if timing of sprays affects lack of uniformity in earworm control in various

parts of the United States. Sprays were composed of 2 pounds of DDT and 1 gallon of mineral oil per acre. Our materials were applied by means of a high wheel compressed air sprayer equipped with a 4 row boom. Two nozzles per row were used. Thirty gallons of spray mixture were applied per acre at 40 pounds pressure.

Plots were 60 feet long by 4 rows wide. Each treatment was replicated 4 times. Aristogold Bantam Evergreen sweet corn was furnished all participants and was used in our tests. Treatment #8 was added to the National Earworm Experiment and consisted of three sprays, applied with a wheelbarrow sprayer at 70 pounds pressure and 150 gallons of spray per acre. The same rates of DDT and oil were used per acre as in the regular test. i.e., 2 pounds of DDT and 1 gallon of oil. (*Project 269*)

Furnishing Missouri Farmers with Timely Information on Insects

H. E. Brown, Lee Jenkins, W. R. Enns, P. C. Stone, Leonard Haseman, C. W. Wingo

Throughout the year the research staff has constantly helped individual farmers and groups of farmers and others seeking information on specific insect problems. Each staff member has participated on the regular bi-weekly College of Agriculture TV programs in order to carry his story of the control of specific insects to the farms. The survey entomologist has provided the research staff with insect information of lasting value by making available at weekly intervals accounts of the abundance or scarcity of all the major species of pest insects in the state. This information is kept on file and provides research workers with the weekly and yearly fluctuations in abundance of pest species of insects. The same information along with observations made by staff members and the extension entomologist was used each week by the agricultural extension service to blanket the state by radio, TV, newspaper articles and letters on the current insect problems and on possible insect outbreaks. The staff attended meetings and worked directly with special groups, i.e. gardeners, fruit growers, cotton growers, livestock men, corn producers, producers of a specialized crop, general farmers, pest control operators, aerial operators and insecticide dealers. Between the staff and these specific groups there has been a constant flow of information for getting the job of insect control done. The staff members have also prepared articles and bulletins to further disseminate insect information. Thus the farmers, insecticide dealers and all individuals and organizations concerned with insect

control had an opportunity to be well informed on their insect control problems. (Project 30)

Control of the Codling Moth and Fruit and other Vegetable Insects

W. R. Enns

OBJECTIVES:

- A. To develop a more efficient spray program for the control of insects and mites attacking tree fruits in Missouri.
- B. To develop an effective program to control insects and mites attacking small fruits in Missouri.
- C. To study the biology of the arthropod pests of vegetable crops in Missouri and develop better methods for their control.
- D. To study the residues of chemicals applied to fruits and vegetables under field and laboratory conditions.

Vegetable Insect Control study personnel on this project participated in the National Cooperative tests for control of corn earworm in cooperation with personnel on the corn earworm project. Experimental design and control data are reported under that project and will not be duplicated here.

Residue analyses of diazinon on sweet corn, applied at four times the normal dosage, were studied. The material was highly effective against corn earworm, blister beetles, and adult southern corn rootworms.

SUBPROJECT 31-B-1

- B. Evaluation of lindane on cucumbers (Supported in part by a grant-in-aid from the Ethyl Corporation).

A repetition of the preceding season's work with lindane on cucumbers was undertaken although certain changes were made in the treatments. A five-acre block of sandy bottom land, as nearly uniform as possible, was selected on State Prison Farm No. 2 at Jefferson City, adjacent to the Missouri River. No pre-planting fertilizer application was made but when the vines started blooming 500 lbs. of 21-0-0 ammonium sulfate fertilizer was applied.

The entire block was planted, by hand, on May 31, June 1, and June 2, the plantings being interrupted by intermittent rains. The variety of seed used was MR-17. Seeding was at the rate of one pound per acre. The rows were 260 feet long, the hills 6 feet apart each way, The planting was then staked off into ¼ acre plots, each seven rows wide, which were then randomized to give four replicates of five treatments, or a total of 1 acre for each treatment. The treatments were as follows:

Block	Treatment	Rate
I	Wettable lindane (25%)	1 lb. per 100 gals.
II	Wettable lindane (25%)	2 lbs. per 100 gals.
III	Wettable lindane (25%) plus Dithane Z-78 (Zineb)	1 lb. per 100 gals. 2 lbs. per 100 gals.
IV	Wettable lindane (25%) plus Captan (50%)	1 lb. per 100 gals. 2 lbs. per 100 gals.
V	Control - No insecticide or fungicide	

All sprays were applied with 3-gallon, compressed air sprayers. Approximately 100 gallons of spray per acre were required after the vines began to set fruit. Sprays were applied every Tuesday and Friday beginning on June 17 and ending August 30. All plots were picked clean every Monday and Thursday beginning July 23 and ending August 29. A total of 22 sprays were applied, and 12 pickings were made, the 10th picking on August 22 setting some sort of record in Missouri for that single picking yielded 21, 124 lbs. of cucumbers or slightly more than 10 tons on the 5 acres.

Total yields by blocks were:

Block	Pounds
I	19,048.25
II	19,122.75
III	19,541.75
IV	19,446.50
V	16,301.25
Total	93,460.50

Analysis of the data revealed that there was no significant difference in yields at the end of the season.

Populations of spotted cucumber beetles were heavy all through the season. Striped cucumber beetles were only moderately numerous, and melon aphids and pickle worms were absent. Somewhat less than 1% of the hills in the control blocks were lost to bacterial wilt. No anthracnose appeared. Undoubtedly the treated plots afforded some protection for the control plots. An untreated plot of cucumbers approximately ¼ mile from the test block and about ½ acre in size was lost completely to wilt and had been severely injured by anthracnose as well.

The following table compares data acquired the past two years:

	1954	1955
Variety	Model	MR-17
Planting date	May 19	May 31
Interval, planting to first picking	55 days	51 days
No. sprays applied	14	22
No. pickings	18	12
Length of picking season	56 days	37 days
Total yield	63,079 lbs.	93,460 lbs.
Yield, highest plot	13,209 lbs.	19,541 lbs.
Yield, control plot	11,798 lbs.	16,290 lbs.
Difference, highest plot and control	1,411 lbs.	3,251 lbs.
Rainfall, calendar year	31.89 in.	37.36 in.
Days over 90°F.	78	51
Days over 100°F.	23	1

A few fairly obvious inferences may be drawn from the preceding table. It appears that little is to be gained by early planting because the entire block, in 1955, planted nearly two weeks later than in 1954 yielded almost half again as many cucumbers in 5 weeks and 12 pickings compared to 8 weeks and 18 pickings. The average yield of cucumbers in Missouri is 100 bushels (5000 lbs.) per acre. In 1954 the experimental block produced over 252 bushels (12,616 lbs.) per acre while in 1955, over 373 bushels (18,692 lbs.) were harvested.

In the preceding table, the last three items listed are probably largely responsible for the increase in yield. However, as in 1954, the difference in yield between the highest plot and the control plot (3,251 lbs.) was insufficient to pay for the pesticides used not to mention the labor. However, the fate of the untreated block a short distance away readily demonstrates the effectiveness of the control program. Had melon aphids and pickle worms appeared in outbreak numbers the results would have been entirely different.

One entire picking was again brought to the Food Processing Laboratories at the University. These cucumbers were brined and pickled, and are now being tested by taste panels, the results of which will appear in the annual report of the Horticulture Department, Project 197.

Residue analyses of the fresh cucumbers made by the Department of Agricultural Chemistry revealed that less than 1 ppm of lindane was present which is well under the legal tolerance of 10 ppm under the Miller Amendment. (Project 31)

Entomology Museum

H. E. Brown, W. R. Enns

OBJECTIVES:

- A. To supply adequate, safe storage for the entomology collections.
- B. To furnish facilities for those qualified to pursue research in the collections.
- C. To increase the representation of specimens in the collections.
- D. To get the specimens authentically determined.
- E. To cooperate with other institutions by reciprocal loans and trades of material for scientific study.
- F. To cooperate with Forest Ecology Investigations.

REPORT OF PROGRESS:

Objective A:

a. Six steel entomological cabinets have been ordered, three have been received and installed in the museum.

b. Thirty storage boxes were presented to the museum by the state entomologist. These will release a number of Comstock drawers for use in the new steel cabinets.

c. The collections have been fumigated as a routine procedure.

Objective B:

a. One graduate student working on his dissertation for the doctoral degree has made excellent use of the museum facilities (see list of publications prepared).

b. The taxonomic work necessary to complete the dissertation on blister beetles was carried on in the museum and is continuing.

c. Dr. B. Elwood Montgomery of Purdue University spent several days in the museum working on Missouri Dragon-flies and Damsel-flies.

d. A thesis on the taxonomy of immature stages of Dragon-flies in Missouri, was completed in the museum during the past summer.

e. Dr. Melville H. Hatch of the University of Washington briefly visited the museum and examined the collections of beetles.

Objective C:

a. A small collection of Scale Insects (Homoptera, Coccidae) together with some literature pertaining to that subject was presented to the museum by Dr. E. D. Bueker, formerly with the Medical School.

b. A collection of immature insects has been started. Somewhat more than 1000 vials of specimens constitute the collection at present. In addition, a collection of about 300 specimens of dragon-fly naiads, in alcohol, has been acquired.

c. A collection of slides on which are mounted stained pollen grains of various flowers has been received as the result of another thesis for a Master's degree. This was made in connection with a study of honey-bee activity in the pollination of flowers.

d. Numerous specimens have been added to the collections as a result of routine work on other projects by staff members. In addition, some usable specimens have been added from those sent in by various agencies for determination. No organized collecting trips have been undertaken.

Objective D:

Some of the following groups of insects were sent to specialists for authentic determination:

Darkling Beetles (Tenebrionidae) — Cornell University

Skin-Beetles (Trogidae) — American Museum of Natural History

Thrips (Thysanoptera) — Illinois Natural History Survey

Termites (Isoptera) — U. S. National Museum

Roaches (Orthoptera) —Kansas State College
Cutworms (Phalaenidae)—U. S. National Museum
Wasps (*Polistes*)—R. R. Snelling, Turlock, California
Syrphidae (Diptera)—U. S. National Museum
Cicindelidae (Coleoptera)—American Museum of Natural History

Objective E:

a. The following groups of insects are on loan for study to various institutions and individuals as indicated:

Melanotus (Elateridae)—University of Nebraska
Pyrausta (Lampyridae)—California Academy of Sciences
Ephemeroptera —University of Nebraska
Tenebrionidae (Coleoptera)—Cornell University
Donaciini (Coleoptera)—E. J. F. Marx
Tetralonia (Hymenoptera)—Michigan State College
Orthocentrinae (Hymenoptera)—University of Wisconsin
Fanniinae (Diptera)—University of Kansas
Nemotelus (Diptera) —University of Kansas

b. The following groups are on loan to us:
Aquatic beetles (several families)—P. J. Spangler
Blister beetles —W. R. Enns
Dryinidae (Hymenoptera)—H. E. Brown

c. The following, which were on loan to us, have been returned:

Odonata nymphs—M. C. Grabau

d. The following groups, loaned by us, have been returned:

Lampyridae (Coleoptera) —California Academy of Sciences
Lycidae (Coleoptera) —California Academy of Sciences
Cantharidae (Coleoptera)—California Academy of Sciences
Erotylidae (Coleoptera)—Cornell University
Languriidae (Coleoptera)—Cornell University
Lytini (Coleoptera)—Illinois Natural History Survey
Epicutini (Coleoptera)—University of Arizona
Geotrupini (Coleoptera)—University of Tennessee
Omophronidae (Coleoptera) —University of Minnesota
Poecilona (Coleoptera)—University of Idaho
Scolytidae (Coleoptera)—Canada National Museum
Tychius (Coleoptera)—Cornell University
Calendra (Coleoptera)—American Museum of Natural History

Tenebrionidae, in part (Coleoptera)—Cornell University

Zygoptera and Anisoptera (Odonata) —Purdue University

Bombidae (Hymenoptera)—Purdue University

Melissodes (Hymenoptera) —University of Kansas

Ephemeroptera, in part—University of Nebraska

Psychodidae (Diptera)—University of Nebraska

Corixidae (Hemiptera) —University of Kansas

Notonectidae (Hemiptera) —University of Kansas

Objective F:

Limited time being available for work on acorn insects, little effort was made to study the subject. However, in cooperation with the Forestry Department, wire rearing cages were constructed, set in the ground at the Ashland Wildlife Area, and partially filled with soil and a number of infested acorns. Observations to date are inconclusive concerning the success of this method for rearing acorn weevils. This particular objective is far too complicated and time consuming to be pursued further on this project (*Project 36*)

Study of Sulfa Drugs and Antibiotics on Disease Organisms in the Bee Hive

Leonard Haseman

One colony of bees was selected and fed sulfathiazole twice. One-half gram of the drug was given in each feeding of one gallon of sugar syrup. These feedings were made in May 1955 and June 1955. The samples of honey, pollen and other hive products were to have been taken during the summer, fall and winter for laboratory bioassay tests but the colony apparently had an old queen and it went all to pieces before fall and required additional treatments which completely upset the experiment as planned. No sampling was done, therefore, and we were obliged to await the spring of 1956 to repeat the feeding and sampling tests. However, we did secure pure cultures of *Bacillus larvae* from the Entomology Research Branch of the U.S.D.A. and instructions on preparing proper culture media for growing pure cultures of *Bacillus larvae*. Dr. Robert N. Goodman of the Horticulture Department made preliminary tests in treating *Bacillus larvae* on culture plates with known concentrations of sulfathiazole and terramycin so that when we repeat the apiary tests and take the samples in 1956 we should be ready to carry through the laboratory tests properly. Also, Dr. Goodman plans to utilize other species of bacteria on culture plates which are known to be susceptible to much lower concentrations of sulfathiazole than *Bacillus larvae*.

Since the colony of bees went to pieces and no samples were taken from the hive and bioassayed in the laboratory, no progress was made on determining possible effect of sulfathiazole found in the hive on the fire blight organism (*Erwinia amylovora*). Again, however, some tests were made in the laboratory by Dr. Goodman on the effects of known dosages of sulfathiazole on cultures of the fire blight organism. It is hoped that some worthwhile progress may be made in the coming year.

(Project 45)

Biological Investigations and Control of Flies, Etc. as Animal Pests

C. W. Wingo

Previous work in the field and laboratory experiments had indicated that of the organic phosphate insecticides considered for house fly control as residual applications, only two, Diazinon and American Cyanamid 4124 were worthy of further testing. Accordingly, large barns at the University were sprayed with either Diazinon or American Cyanamid 4124 at 1%. Sprays were applied so as to insure complete coverage of all interior surfaces. A weekly count of predetermined resting stations was made to evaluate the effect on house fly populations.

At the end of the season flies from the native population present in the Diazinon-treated barn were tested for development of possible resistance to Diazinon. Flies of this native strain exposed for three seasons to fresh deposits of 1% Diazinon and breeding in Diazinon-treated manure were knocked down (with no subsequent recovery) within an average time of 7 minutes. This is not significantly different from the knockdown and kill afforded by fresh deposits of 1% Diazinon on this fly population at the end of the 1953 and 1954 control seasons. No check of possible resistance to Experi-

mental Insecticide 4124 was made as only a single spray had been applied.

The effect of Aroclor 5460, a chlorinated polyphenyl, in combination with organic phosphates used in house fly control, was further explored in 1955. The 1954 experiments had indicated some additional residual activity of the insecticides might be expected when 1% of the chlorinated polyphenyl was added. In 1955 unpainted plywood panels were treated with 1% Diazinon, 1% Bayer L 13/59 and Experimental Insecticide 4124 alone and with 1% Aroclor 5460 added. These panels were periodically exposed to house flies of the beef barn strain for records of knockdown and/or kill as the residues aged. Records were kept for over a 170 day period. However, data accumulated after the 70 day point were found to be highly variable due to the very knockdown effect afforded by the treated surfaces. In the case of Diazinon and Bayer L 13/59 the addition of the resin had an adverse effect, apparently sealing the active insecticide closely in or to the wooden surface so that it was not available to the flies. There was no appreciable change in the action of the experimental insecticide 4124 when 1% Aroclor was added. It is of interest to note that house flies exposed continuously to surfaces treated with 1% Diazinon or 1% 4124 alone experienced 100% mortality in a 24 hour period when these treated surfaces were 170 days old.

A test area located approximately 6½ airline miles north of Eminence, Mo. was located, surveyed and marked into 40 acre treatment blocks and 20 acre buffer areas in 1954. Maps showing the location and physical features of this study area have been prepared and are on file. Preliminary studies of the tick populations were made in July, August and September of 1954.

The two 40 acre plats were dusted for area control of *A. americana* as follows:

Plot	Location	Date	Insecticide	Rate		Wind	Weather
				Act./Acre	Temp.		
I	40 N	4/2/55	10% DDT	4#	62°	S. E. 5 mph	lt. drizzle
II	40 S	4/1/55	5% DDT	2 #	53°	N. 5-8 mph	O'cast

Both plats were dusted by air using a Stearman biplane. Flight paths were East to West on Plat II and North to South on Plat I. Wind was light on both days and drift (by inspection) seemed negligible. Glass plates coated with vaseline were placed in each plat for later determination of actual DDT deposits on the areas. These plates were laid on the ground around and under representative cover and contour features so as to obtain a reasonable sample of the area dusted. Plates, so exposed, were checked by chemical analysis by Dr. E. E. Pickett for DDT.

The variation in tabulated results of percentage reduction of adults and nymphs is indicative of two conditions, (1) the relatively low population of the Lone Star Tick and (2) the difficulty with which tick populations are measured in the field. The results of this preliminary study are encouraging in that they show clearly that residue resulting from aerial application of both 4# and 2# of DDT/acre applied very early in the season, at approximately the time first tick activity starts, shows a definite depressive effect on the tick population 110 days

later. These data also indicate that practical area control may be achieved with early season applications of a more effective material than DDT.
(Project 46)

The Influence of Different Elements and Plant Nutrients on the House Cricket and Other Insects

Harry E. Brown, P. C. Stone

OBJECTIVES:

To determine the effect varying amounts of different minerals, minor elements and other nutrients, as laid down in plants, may have on the rate of growth, longevity and reproductive potential of the house cricket and other insects when fed upon growing plants or parts of plants.

This year emphasis was placed on the laboratory rearing of day old crickets for 30 days or longer on many different diets to determine the factors in special diets responsible for causing rapid or retarded growth. A great variety of foods were supplied by the advisory departments of Animal Husbandry, Soils, Horticulture and Biochemistry. They consisted of sheep rations, a pig ration, red clover hay from five Sanborn Field soil plots, additives to drinking water and various combinations of Cerophyl and Universal food which included the four known growth factors of Cerophyl combined with Universal food, and Cerophyl mixed separately with many of the components of Universal food.

The house cricket, *Acheta domestica*, was used as a bio-assay animal in sixteen major experiments and many other short tests during the year. The most extensive experiments were carried out in cooperation with Dr. Thomas D. Luckey of the Biochemistry Department in a search for the factor or factors responsible for rapid growth of day-old crickets when fed a diet consisting of Cerophyl and Universal food (Science, Sept. 3, 1954, Vol. 120, No. 3114, Pages 396-398). During 1954 a rapid growth response was detected when crickets were provided with a diet of equal parts of Cerophyl and Universal food and with double distilled drinking water (Project 74)

Investigation of the Biology and Control of Field Crop Insects

H. E. Brown, Lee Jenkins, P. C. Stone, C. W. Wingo
R. E. Lusk

Soybean variety plantings at the Sikeston fields were examined on August 23rd to determine the percent of leaf surface destroyed on the terminals of the soybean plants. The results were estimated as follows:

S2-716	60% of terminal leaf surface gone
S-100	25% of terminal leaf surface gone
S2 7158	40% of terminal leaf surface gone
Dorman El	50% of terminal leaf surface gone
Dorman	40% of terminal leaf surface gone
L-4	10% of terminal leaf surface gone
Durtchsoy 67	15% of terminal leaf surface gone
Ralsoy	60% of terminal leaf surface gone
Ogden	15% of terminal leaf surface gone
Lee	15% of terminal leaf surface gone
Perry	50% of terminal leaf surface gone

Variety	No. pods	
	Checked	Damaged
Brown Soy	100	0
Lee	100	0
Ogden	100	0
Ralsoy	100	0
Durtchsoy 67	100	4
L-4	100	10
Dorman	100	0
Dorman El	100	0
S2 7153	100	1
S-100	100	3
S2-7160	100	4
Perry	100	4

An experiment was set up to determine the value of soil insecticides as a control for bean leaf beetles on soybeans. These experiments were set up in cooperation with R. Q. Brown, County Extension Agent of Mississippi County, Willard James, County Extension Agent of Pemiscot County, and Mr. Wagner of New Madrid County.

Two fields in each county were selected, one on sandy soil and one on heavier soil.

In order to have treated areas large enough to get away from the influence of the migration of adult beetles, each treated area contained 5 acres in a strip not less than 150 feet wide. The insecticides were applied with a row crop sprayer at the rate of about seven gallons of dilute spray per acre. The soil was treated just ahead of discing or working the soil previous to planting the soybeans.

The two fields in Pemiscot County were treated by the use of a spray from an airplane.

The rates of application were as follows:

Dieldrin ½ pound per acre

Dieldrin 1 pound per acre

Heptachlor ½ pound per acre

Heptachlor 1 pound per acre

The treated fields were inspected at weekly intervals starting May 25th and continuing through August. No difference was observed between the treated and untreated areas.

In one field a 14 foot strip was treated with 2 pounds of Dieldrin per acre. No difference could be observed between the treated and the untreated check.

Bean leaf beetles were less numerous in most soybean fields than during 1954. There was only slight evidence of leaf damage in the Sikeston,

Charleston and Caruthersville areas during the summer until the last breed appeared, which reached a peak about August 12th and caused noticeable damage to the leaves in several fields. (*Project 102*)

Study of Mites and Ticks in Missouri

W. R. Enns, P. C. Stone, C. W. Wingo

During July, a survey was made of apple orchards in various sections of the state. Collections of leaves infested with Spider Mites (Tetranychidae) were made and brought in to the laboratory. The mites thus collected are now being processed and embedded on slides. Collections were made in 22 orchards in the state.

On several occasions mites were received for identification from various agencies in the state. Several times the tropical rat mite was sent in from St. Louis. An interesting shipment of mites was received from St. Louis where they were infesting vinegar vats. These mites were determined as members of the family Acaridae.

Mites were received from the Veterinary Clinic which were taken from two cats so badly infested with mange that they had to be euthanized. The mites proved to be *Notoedres cati*, the mange mite of cats.

Ticks infesting an invalid's home in Russelville, Missouri were reported. Investigation showed them to be American Dog ticks but no immediate source of the infestation could be found. Prophylactic treatment with DDT was applied to the house.

Among the interesting additions of ticks to the Acarina collection are some deer ticks that were taken from the stomach of a white-tailed deer killed in season by a hunter.

A few additional families of hydracarina were added to the collection. These have been sent away to a specialist for determination.

This project is being terminated as a distinct project, but the main objective of building up an Acarina reference collection will be continued under Project #36, Entomology Museum, and the biology and control of mites and ticks will be studied under other appropriate projects. (*Project 131*)

Cotton Insects in Missouri

Lee Jenkins, A. J. Williams

The cotton crop in southeast Missouri got off to a slow start due to cool, rainy weather in April. The cotton plants came through the ground and made a little growth. Then the weather retarded growth and the leaves showed cool weather damage.

There was no noticeable insect damage to cotton, except an occasional field with some damage from seed corn maggot or occasional marginal damage from grasshoppers, until in early July when the cotton fleahopper caused some damage. On July 13th field surveys on cotton fields in the Sikeston area indicated that one field in six had sufficient populations to justify spraying. A report in the Sikeston paper had indicated that 90 percent of the fields of cotton in the "boot heel" area were in need of control measures for fleahoppers. On July 14th a report was given to the Sikeston paper based on the survey in the area. It was pointed out that the fleahopper problem had been greatly exaggerated, and that growers should carefully check their fields for fleahopper populations before spraying. It was further pointed out that spraying now could reduce insect parasites and predators, thus allowing cotton boll worms and mites to become a problem. Fleahopper infestations varied greatly in different areas of the cotton fields in many cases. By August 18th a few cotton fields had enough boll worms to justify spraying.

European corn borer larvae were first observed infesting cotton plants in Missouri on August 9th at Sikeston, Missouri. Attention was first attracted by the wilted cotton plant above the point of entry. In some cases the plant would break over.

On August 19th European corn borer larvae were found in cotton bolls at Gideon. At about the same date Mr. George W. Thomas found corn borer eggs on a cotton leaf. The larvae found at this time were small. Later observations by the author and by George W. Thomas indicated that the early instar larvae fed for a time on the surface between the bracts and the boll. The larvae then bored into the bolls causing damage similar in appearance to that of the cotton boll worm. In early September mature corn borer larvae were found in the cotton bolls. No mature larvae were found in the stems at this time.

Mr. George W. Thomas found European corn borers infesting cotton in Dunklin, Stoddard, Butler, Pemiscot, Scott and Mississippi Counties.

On December 17th a further check on European corn borer in cotton stalks was made by the writer and Mr. George W. Thomas. Borer damaged stalks were split to determine the presence of larvae. Only three out of the twelve fields examined were found to have over-wintering fifth instar larvae. The percent of borer damaged stalks in these fields ranged from one to two percent.

A further survey made by Mr. A. J. Williams, from December 26th to January 14th, indicated the

following rate of infestation by European corn borer larvae.

Cotton boll weevils were not a problem in southeast Missouri during most of the growing season. Adult migration accounted for a high percentage of the adult population during September and October. Mr. A. J. Williams reported that in a few fields near Kennett the yield was reduced considerably. However, he did not consider that spraying would have been profitable for boll weevil control.

Mr. Bert Robbins, County Agent, New Madrid County, called attention to a field of cotton heavily injured by wilt which was later identified as Fusarium wilt by Dr. M. D. Whitehead, Pathologist, Field Crops Department, University of Missouri.

The cotton plants were badly injured or entirely killed in areas of a field adjoining piles of gin trash piled in rows along areas of the field. Apparently the gin trash influenced the concentration of nematodes which are considered to be important in causing Fusarium wilt in cotton. Tomato plants in the areas had club roots indicating heavy nematode damage.

Dr. Vernon G. Perry, Associate Nematologist, Department of Plant Pathology, University of Wisconsin, found Root knot nematodes, Stubby root nematodes and Dagger nematodes.

Infestations of mites on cotton were confined, for the most part, to margins of cotton fields and spots along the edges or scattered through the field.

Among the cotton fields observed was one that had been sprayed for fleahoppers in mid-July. By the first week in August red mites had caused considerable damage to the leaves and by August 9th some of the bolls were drying up and falling off. Many of the plants had shed 50 percent of their leaves.

The red spider problem in Missouri seemed to drop off after mid-August. The control was probably due to the presence of large numbers of parasites and predators, especially in unsprayed fields.

In one case a field had been sprayed three times previous to the boll worm attack. On August 22nd a total of five sprays had been applied, three for insects other than boll worm and two for boll worm control. In this field 12½ percent of the bolls were damaged. An adjoining field of cotton belonging to a neighbor that had not been sprayed at all, had 3 percent damaged bolls, and it was difficult to find any boll worms.

An airplane application of Aramite at 1½ pints per acre gave fair results on red mites. A spray using a high boy sprayer with drop nozzles gave excellent results when 1½ pints of liquid Aramite was used per acre. (*Project 214*)

Effect of Temperature, Humidity, and Wind Velocity Upon Magnitude and Persistence of Pesticide Residues

P. C. Stone, H. E. Brown, C. W. Wingo, P. J. Spangler

Work on this project was not initiated because the NC-19 technical committee decided that insufficient funds were available to begin work on NC-19B and therefore discontinued NC-19B and allocated all NC-19 funds to NC-19A. A new Missouri Agricultural Experiment Station Project 283, which conforms to NC-19A, is being submitted to replace the discontinued Project 249. (*Project 249*)

Investigation of Plant and Animal Tolerance to Soil Insecticides

P. C. Stone, H. E. Brown, C. W. Wingo, P. J. Spangler

Project #283 was written during the month of January, 1956 and thus there is no progress to report for the period February 1, 1955 to January 31, 1956. This project is partly the outcome of work initiated, carried out and reported under Corn Insects Project #269 for 1955-56. (*Project 283*)

Weed Control

*W. C. Etheridge, O. H. Fletchall, Carl Hayward,
D. L. Klingman, H. D. Kerr*

Effectiveness of pre-emergence herbicide treatments was not improved by smoothing the land with a drag or roller in corn or soybean experiments.

2, 4-D was not exceeded by any of the new chemicals tested for pre-emergence weed control in corn from the standpoint of corn yields. The new chemicals included acetamides, carbamates, and benzoic acids.

Repeated treatments of 3 lb/acre of 2, 2-dichloropropionic acid (dalapon) eliminated stands of weedy grasses in birdsfoot trefoil seedlings, but supplemental mowing was necessary for the control of broad-leaved weeds. Stands of birdsfoot trefoil treated with dalapon were from 2 to 7 times those obtained with mowing only.

Dalapon at 4, 8, and 12 lb./acre, applied in March, effectively reduced stands of bluegrass to allow the establishment of birdsfoot trefoil seedlings.

Almost three times as much forage was eaten by cattle in brush areas basal treated with 2,4,5-T in diesel oil, or where the trees were cut and the stumps treated with the same herbicide mixture, as was eaten on the untreated areas.

An aerial spray of 2 lb./acre of an ester of 2,4,5-T was more effective than an ester of 2,4,5-trichlorophenoxy propionic acid in defoliating hickory in the year of treatment, but the propionic acid formula-

tion was slightly more effective on 3 of 4 species of oak. Both chemicals gave a higher percent defoliation on oaks than on hickory.
(Project 156)

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Field Crops

M. S. Offutt, Chairman

A Study of Field Crop Diseases

M. D. Whitehead

OBJECTIVES:

To determine the diseases of economic importance to field crops of Missouri and to describe those found to be new.

To make crop yield loss estimates due to diseases of field crops in Missouri.

To determine the resistance ratings of present breeding lines, hybrids and varieties in the common diseases of the crops concerned, to search for high types of resistance and to cooperate with the plant breeders in the development of new, more resistant varieties.

To determine the optimum and limiting environmental factors for disease development and to search for cultural methods of control of the diseases.

To test the established and newly developed chemicals and antibiotics for possible effective economical control of seedling and mature plant diseases.

To study available methods of inoculation for inciting epiphytotics and develop new techniques for the study of diseases of field crops. (Project 127)

Breeding Hybrid Corn for Missouri

Carl Hayward, Phil Smith, J. H. Longwell, Jr.,
M. D. Whitehead, Arnold Matson

OBJECTIVES:

- A. Develop Agronomically Superior Hybrids
- B. Develop Hybrids for Special Purposes
- C. Conduct Investigations in Pathological, Entomological, and Cultural Problems, and in Breeding Techniques.

REPORT OF PROGRESS:

Obj. A. A new yellow double cross Missouri 845, (WF9 X Oh7A) (BIO X CI03), has been released to commercial channels for utilization in the

northern region of Missouri. The results from a five-year average show this hybrid to yield approximately 7 bushels per acre better than U.S. 13. It is more resistant to lodging and drops fewer ears than U.S. 13. Enough seed to plant about 60,000 acres in 1956 was produced last year. Pilot productions of Mo. 810W, No.4047W, and Mo. 800A were grown in 1955 to determine their commercial suitability as well as to produce large quantities for farmer trials.

The blight resistant CI64 was substituted for susceptible K64 in two commercial white hybrids. It was found that the yielding factors of K64 have been retained in CI64 as well as the blight resistance. CI64 should prove quite beneficial during years of epiphytotics of *Helminthosporium turcicum*.

Obj. B. Research work on the breeding of a high amylose starch strain was started in 1950. Numerous crosses, exotics, and open pollinated varieties were analyzed for amylose content. One strain from the Cassel open pollinated variety was isolated and the amylose content is 37 to 40%. Normal is about 25%. This strain was crossed during the past year with a strain from Purdue whose amylose content is 47%. The seed of this cross gave an amylose content of 27%. Apparently the determiners of the two strains are not allelic, and it is therefore possible to isolate a strain with an amylose content above 47%.

Three new double cross pipecorn hybrids are now ready for release. These are Mo. Pipe 4, 6, and 8. They have been tested rather extensively for standing ability, grain yield, and commercial pipe cob suitability. These hybrids will replace the hybrid pipe composite currently in use.

Obj. C. One hundred and twenty inbred lines were rated for resistance to *Helminthosporium turcicum* and *Helminthosporium maydis*. These lines included a number of recoveries of existing lines. The inoculation of the plants with *H. turcicum* was not as successful as in previous years, but the inoculation with

H. maydis was highly successful. Many of the new lines were much more resistant to these diseases than the parental material, while some were not any better than the parents.

The *Diplodia zeae* isolate study was continued in 1955. The isolate from Minnesota was still the least virulent, but the Missouri isolate instead of the Oklahoma as in 1954 was the most virulent. The three isolates generally reacted independently when used on specific single cross combinations but occasionally reacted only in degree of virulence.

Fifty-six inbred lines grown at Sikeston were rated for earworm damage. A number of these lines showed a high degree of resistance. In an earworm study using resistant and susceptible lines in crosses, it was found that the results conformed closely to those obtained with the same material in 1954. The crosses of one or more resistant lines to susceptible lines produced hybrids which were more resistant than the crosses of known susceptible lines but not as resistant as crosses between resistant materials. The effect appeared to be intermediate. All readings were made by members of the Department of Entomology.

In a rate-of-planting study representing hybrids of different maturities and prolific tendencies and planted at 8,000, 12,000, and 16,000 plants per acre, it was found this year that the prolifics, disregarding maturity, gave a higher yield than the non-prolifics and that at the higher plant populations the number of ears per plant of the prolifics approached 1.0 and the differences in yield between prolifics and non-prolifics was small.

The results this year of a date-of-planting test showed that as the dates were delayed, the yield and the number of days from planting to tasseling decreased, while lodging, number of dropped ears, ear height, earworm penetration, damaged kernels, and European corn borer larvae and tunnels per plant increased.

The results of the rate-of-planting and date-of-planting studies are for this year only and do not necessarily reflect the results of future years.

The cross sterility factor, Ga, is being transferred to approximately twenty white lines. The second backcross is being made this winter. The cross sterility factor in white hybrids will eliminate the fertilization of the ovules of a particular hybrid by pollen other than its own. This factor will be especially useful in eliminating yellow contamination and will benefit both the seed producer and the farmer.

The cytoplasmic male sterility factor and pollen restorers are being transferred to a number of white and yellow inbred lines. When the work is completed, the seed producer will not have to detassel

his double cross production fields, and it will not be necessary for him to blend male sterile double cross seed with male fertile seed since the pollen restoring factors of the male parents will completely restore pollen production in the double cross. (Project 85)

Improvement of Missouri Farm Seeds

*Cari Hayward, W. E. Astin, L. E. Cavanah,
Viola Stanway*

Fields of seed were thoroughly examined for the qualities best seen in actual crop growth on 26,829 acres. During these field inspections, the standing crops were also examined for general purity, healthiness, and freedom from objectionable weeds. This acreage, under certification, was located in 65 counties within the state on 300 seed growers farms. This included fifty varieties, in total, of corn, cotton, soybeans, sorghums (including Sudan grass), rice, winter wheat, rye, winter barley, oats, grasses and legumes.

Certification is restricted to those crops and crop varieties recommended for use in Missouri, by the Missouri Agriculture Experiment Station.

Of the 26,829 acres field inspected, 25,447 acres were approved and accepted for certification, subject to the approval of seed inspection and detailed tests by the Seed Testing Laboratory. These tests are a large part of the annual work of the Seed Testing Laboratory.

Certification completed on the 1955 crops is as follows:

Crop	Growers	Acres Inspected	Acres Accepted	Bushels Inspected	Bushels Certified
Wheat	51	2,548	2,363	46,198	42,955
Barley	22	1,217	1,089	21,475	20,477
Rye	1	24	24	402	190
Grasses	13	1,127	1,127	235,890*	173,540*

*Pounds.

The above amount of certified seed does not include seed retained by the growers for their own production for the 1956 crop.

Crop acres inspected and accepted for certification with the estimated production is as follows:

Crop	Growers	Acres Inspected	Acres Accepted	Est. Bushels Certified
Corn	57	3,159	3,130	78,225
Cotton	27	2,405	2,405	722 T.
Oats	27	1,516	1,510	31,000
Soybeans	207	13,878	12,912	226,385
Rice	3	486	486	29,160
Sorghum	4	82	69	93,150
Legumes	9	258	233	81,500 lbs.
Sudan grass	5	72	72	450

In addition to the certified seed produced, breeders and foundation seed of new and old varie-

ties was produced and distributed to Association members for further increase as follows:

A. 899 bushels of Foundation seed of B-475 winter barley.

B. 471 bushels of Foundation seed of Mo. O-205 oats.

C. 276 bushels of Foundation seed of Pawnee winter wheat.

D. 125 bushels of Foundation seed of Dorman soybeans.

E. 759 pounds of Foundation seed of Climax lespedeza.

F. 32 bushels of Lee soybeans and 100 bushels of Vermillion Wheat to be further increased before being distributed to Association members.

G. And 47,743 M.V.K.'s of eleven single-cross corn lines and 4800 M.V.K.'s of four inbred corn lines.

The Seed Testing Laboratory tested seed samples in a more orderly manner than in prior years. Operating on a seasonal schedule permitted the reporting of the results of the analysis before the best time for sowing the seed had passed. Though the number of samples to be tested decreased, the laboratory operated more in an educational capacity for which it is designed. A large part of the work is directed in the detailed tests of certification program. (Project 19)

Heredity In Corn

M. G. Nuffer, E. H. Coe, Jr., Margaret H. Emmerling

OBJECTIVES:

- A. Determine the effect of x-rays and ultraviolet radiation on gene mutation.
- B. Find means of controlling mutation by the use of genetic modifiers and mutations.
- C. To study the mechanisms by which genes control biochemical processes.
- D. To gain a better understanding of the gene by studying the structure of selected loci such as C, A, and R.
- E. To discover and analyze any genetic markers and phenomena that might facilitate the accomplishment of the above 4 objectives.

There has been a long-standing controversy concerning the ability of x-rays to induce gene mutation. Highly significant results bearing on this problem have been obtained in this year's data. Using special genetic stocks which are more efficient in revealing the kind of events that are caused by x-rays and ultraviolet radiation, because they contain genes which are known to mutate under certain conditions and which are accurately marked by other closely linked genes, it has been possible to determine that in corn, x-rays do not cause changes of

the gene itself but only deficiencies and rearrangements of the genetic material. Ultraviolet radiation on the other hand produces in these same stocks mutants which resemble in all but one respect the type of mutants occurring spontaneously or induced by hereditary agents. This one exception is the failure of the mutant to be able to revert again to the parent type. A manuscript containing a detailed account of this work is now being prepared for publication.

Control of the rate and type of mutations that can occur at selected loci, though considered out of reach in the past, would be an important advantage in any breeding or genetic research program. Advances made during the last few years at this laboratory and others have brought such control within the realm of expectation. During the last year four independent hereditary factors that regulate the mutability of a single gene (A_1) in corn have been found to increase or suppress (depending on which was used) mutation frequency at this locus within a range of several thousand fold.

Other cases of one or more genes causing another gene to mutate have been found and studied during the last year. The purpose has been to find ways of applying this type of approach to any desired gene. At the present time only those genes found in the above described mutation systems can be manipulated at will.

An intensive investigation is now under way to determine the mechanism by which one gene can influence the mutability of another.

A mutable gene (bz_2) involved in one of the above systems has been located on chromosome #1 between *An* and *Gs*.

In studies of genetic control of anthocyanin synthesis, clear understanding of the steps in pigment production has been hampered by a restriction to static technics in the identification of end products of gene action. Experiments of a more dynamic sort, upon the active synthesis of pigment, could be conducted with aseptic cultures of aleurone tissue. Some progress in the development of suitable technics for such cultures has been made. Also, attempts to demonstrate enzymatic activity in anthocyanin synthesis show promise as a method for study of synthesis *in vitro*.

Improvement of the Missouri Soybean Crop

L. F. Williams, A. L. Matson, W. C. Etheridge
Carl Hayward

OBJECTIVES:

- A. To develop new varieties of soybeans for the various

production areas of Missouri with improved yielding ability and chemical composition and improved resistance to shattering, lodging, and diseases.

- B. *To secure information needed to make recommendations to farmers on the adaptation and performance of new and standard varieties of soybeans.*
- C. *To secure information on the effects of varying the dates and rates of planting on yield and other characters for the varieties commonly grown in Missouri.*
- D. *To secure basic information which will improve the efficiency of the breeding program. This includes such studies as the effects of specific diseases, the inheritance of characteristics, and the relative efficiency of various methods of breeding.*

SUMMARY:

A. Breeding material is now on hand to supply a range of varieties of suitable maturity for any part of Missouri, resistant to bacterial pustule and wild-fire and equal to or better than present commercial types. Two of these will be increased for possible release.

B. Variety test plots at fourteen locations indicate that the new variety Clark has wide adaptation and can be recommended all over the state. It will be medium late in northern Missouri and early in the southeast.

C. Date of planting studies indicate that Clark can be planted earlier than other common varieties. Perry shows this trait to a lesser extent. May 16 planting is better than later plantings for Clark, Perry and equal to later planting for Chief and Wash. Early varieties are best planted June 16.

D. The inheritance of Seed coat color, wavy leaf, plant habit, and maturity has been studied and revisions of terminology suggested. Progenies from radiated seeds are being studied and a new radiation experiment irradiated aimed at securing resistance to disease.

(Project 49)

Cotton Production Efficiencies

*Norman Brown, W. C. Etheridge, A. L. Matson
O. H. Fletchall, Marvin Whitehead*

OBJECTIVES:

A. To compare and evaluate different varieties as to their inherent ability for yield and quality under various environmental conditions.

B. To develop a cotton variety that is better adapted to Missouri conditions than existing varieties in regard to earlier maturity plus high quality.

C. To test rates and sources of nitrogen as compared to winter legumes on yield and earliness of

cotton that is grown in a two-year rotation with corn. To test the effects of starter fertilizer on cotton.

D. To find ways to reduce weed control costs in cotton production by the use of chemicals combined with various mechanical methods.

E. To test different chemicals for effectiveness in removing leaves from mature cotton plants in order to promote rapid opening of bolls, reduce damage from diseases, and increase grades of lint.

(Project 160)

Testing and Breeding of Winter Barley

*Carl Hayward, J. M. Poehlman, D. T. Sechler
C. F. Hayward*

OBJECTIVES:

To breed winter barley for yield, winterhardiness, and disease resistance, with special emphasis on resistance to the smut diseases.

Acreage of winter barley continued to increase with a planted acreage of 499,000 acres in 1955. This compared with 299,000 acres for the preceding year. The increase in acreage results from the recognition of winter barley as a valuable feed crop, particularly in seasons of drouth, restriction on wheat acreages, and the increased safety in growing the crop which comes from greater use of fertilizers and new, more productive varieties. The Missouri B-400 variety distributed in 1950 is now planted on an estimated 90 percent of the Missouri acreage.

*A new variety, Mo. B-475, from the cross Admire x Early Beardless was distributed to growers in the fall of 1955. Mo. B-475 is superior to Mo. B-400 in yield and winterhardiness, threshes more cleanly than Mo. B-400, is resistant to common races of loose smut (*Ustilago nuda*) and semi-loose smut (*Ustilago nigra*), moderately resistant to mildew, and similar to Mo. B-400 in straw strength and height.*

(Project 90)

Missouri Rice Production

*Daie Sechler, Charles Hayward, J. M. Poehlman
Norman Risner*

OBJECTIVES:

To breed early varieties of rice for Missouri and to study methods of producing rice on our soils.

New Mo. R-500 variety.—A new, early medium grain variety of rice was released by the Missouri Agricultural Experiment Station.

Yield Tests.—Yield tests were grown at Palmyra and Puxico as follows:

Palmyra—

- a. USDA Uniform Group I, short and medium

grain varieties (12 entries)

b. USDA Uniform Group II, long grain varieties (2 entries)

c. Experimental strains from Mo. (32 strains)

Puxico—

a. USDA Uniform Group I, short and medium grain varieties (8 entries)

b. USDA Uniform Group II, long and slender grain varieties (13 entries)

c. Experimental strain from Mo. and other nurseries (19 entries)

Increase and observation plots.—Several hundred increase and observation rows were grown at each Palmyra and Puxico. Selections from R27 and R140 were harvested to purify these strains.

Crosses made.—Nine crosses were made to incorporate better straw into some early adapted varieties.

Fertilizer test.—A fertilizer test was conducted at Palmyra in cooperation with the Department of Soils. No increase in yield was obtained with the use of various nitrogen carrying fertilizers.

(Project 173)

Breeding New Strains of Soft Wheat

Carl Hayward, J. M. Poehlman, Dale Sechler
Charles Hayward

OBJECTIVES:

Breeding and Evaluating new strains of soft wheat with Resistance to Leaf Rust, Loose Smut, and Hessian Fly.

REPORT OF PROGRESS. —(1955 Crop Season)

A. *Yield tests.*—Nine yield tests were grown at Columbia and one each at Bethany, Marshall, Pierce City, and Sikeston.

The highest yielding strains in 1955 were three selections from the cross Vigo—Clarkan x Norin 66. This is of unusual interest because they are also short and early, characteristics derived from the parentage of the Japanese parent Norin 66. Of the advanced strain, W6113, Kawvale-Thorne, and W6020, Thorne-Clarkan, gave the best yields. Dual, Royal, and Clarkan were the best varieties in that order.

B. *New Breeding Materials.*—In the new strain observation nursery, 591 strains were grown in increase rows of which 50 were harvested and advanced to yield tests. Of 4056 head rows grown, 597 were harvested. These represented selections from 27 crosses.

C. *Bulk hybrids and new crosses.*—52 bulk hybrids were advanced one generation and 7 new crosses were made in 1955.

D. *Cooperative U.S.D.A. Uniform Nurseries.*—

The following U.S.D.A. Uniform Nurseries were grown in 1954 at Columbia:

U.S.D.A. Uniform Eastern Soft Wheat Nursery.

U.S.D.A. Winter Wheat Rust Nursery.

U.S.D.A. Spring Wheat Rust Nursery.

U.S.D.A. Uniform Hessian Fly Nursery.

E. *Disease Nurseries.*—Artificial inoculation were made by Dr. Whitehead to establish a leaf rust epiphytotic throughout the nursery. Seasonal conditions were unfavorable and only a light infection was obtained. Heavy mildew was observed throughout the nursery from natural infection.

F. *Hessian Fly Nursery.*—A Hessian fly nursery was grown at Columbia under the supervision of Mr. Elmer T. Jones, Entomology Research Branch, Manhattan, Kansas. All strains with fly resistant parentage were included in this test along with entries from Kansas and the Nebraska Agricultural Experiment Stations. Many of the Missouri strains were also tested by Mr. Jones in the greenhouse at Manhattan.

G. *Wheat Quality Studies.*—Wheat quality studies of leading varieties and experimental strains were continued in cooperation with the Scott County Milling Company and the Department of Home Economics. Seven samples from the variety test plots were milled on an experimental mill by the Scott County Mill, and the flour turned over to the Department of Home Economics for baking and other quality tests. Also 53 samples of experimental strains were sent to the U.S.D.A. Federal Laboratory at Wooster for preliminary testing.

(Project 202)

New Strains of Oats For Missouri

Carl Hayward, J. M. Poehlman, D. T. Sechler
Charles Hayward

OBJECTIVES:

To breed an improved, early variety of oats, with stiff straw, good seed quality, and resistance to the prevailing races of crown rust, stem rust, and smut.

Mo. O-205.—The Mo. O-205 variety distributed in 1952 continues to lead other named varieties in our tests in both yield and test weight. Present breeding work is being directed toward the improvement of the variety by breeding for stiffer straw, greater rust resistance, and improved market quality.

Yield tests.—Thirty varieties and experimental strains were grown in a uniform test at each Columbia, Bethany, Pierce City, and Sikeston. Due to the nature of the season, the late maturing strains were among the highest strains and the varieties Clint-

land and Newton, along with O-205 were the three top strains in yield. This is the first year that Clinton and Newton have been among the top yielding strains in our tests. In addition, 95 strains and varieties were tested for yield at Columbia. These included the varieties in the uniform Red oats nursery, the uniform North Central States Nursery, and a group of new selections from crosses between Mo. O-205 and various rust resistant varieties. Yields at all stations were exceptionally good. Top yield was produced by a late strain from the uniform North Central States Nursery, C.I.5962, with a yield of 118.8 bushels, followed by Mo. O-205 with a yield of 110.1 bushels. Lodging was heavy in these tests due to the weight of the grain and to windstorm damage.

Experimental Strains.—Approximately 5,000 experimental strains were grown at Columbia for observation and selection.

Improving the Lodging Resistance of Mo. O-205.—Mo. O-205 has been crossed with a Scottish variety, Craig Afterlea, and C.I.5345, Clinton-Overland, to improve its lodging resistance. About 2500 selections from the cross to Craig Afterlea were grown in 1955 and an equal number from the cross to Clinton-Overland. Most of these selections were late in maturity and lacking in disease resistance. One early stiff-strawed selection from the cross O-205 x Craig-Afterlea was advanced to drill plots. It has exceptionally good straw and moderately good yield but lacks rust resistance. Backcrosses of stiff-strawed lines to O-205 are being made.

Addition of Stem Rust Resistance to O-205.—Addition of the B.C. genes for stem rust resistance to O-205 is being made by the backcross method. Selections from the original cross were included in yield tests in 1955. Progenies from the first backcross were tested in plant rows. The third backcross was made in the greenhouse and the F₁ generation from the third backcross was grown in the field. The B.C. genes for resistance are identified by growing strains in a rust nursery inoculated with race 8 of stem rust. It is hoped to retain the A gene for resistance by using O-205 as the recurrent parent.

Breeding for Crown Rust Resistance.—F₃ generation plants from a Columbia x Marion cross were grown in the field and strains with superior crown rust resistance selected. It is hoped to combine genes from O-205 and Marion by this procedure.

Breeding for Quality.—Crosses have been made between O-205 and several strains of excellent quality in order to improve the quality of O-205 oats.

Uniform Nurseries.—The following uniform oats nurseries were grown at Columbia:

Uniform Red oat yield nursery.

Uniform North Central States yield nursery.

Uniform Winter hardiness nursery.

Uniform oats rust nursery.

Uniform oats smut nursery.

Winter Oats.—The uniform winter oats yield nursery was grown at Pierce City and Sikeston, and a winter hardiness nursery grown at Columbia. Twelve winter oats bulk hybrids were advanced and selection made from them. (*Project 203*)

Water in Agricultural Production

Phil Smith, W. C. Etheridge, M. S. Offutt

OBJECTIVES:

To learn the effect of irrigation on yield and quality of corn grown under different levels of fertilization.

To learn the effect of irrigation on yield and quality of soybeans.

To learn the effect of irrigation on yield and quality of pasture for beef cattle.

To learn the effect of irrigations on yield and quality of forage crops.

Moisture conditions were generally favorable at the McCredie Station during the 1955 growing season. Precipitation was near average with 10.5 inches of rainfall compared to the 60 year average of 11.05 inches for the June through August growing period. However, a typical 23 day drouth period from July 14 to August 7 reduced crop yield well below maximum on the claypan soils. Subsoil moisture was replenished during the winter and spring and high temperatures were not a problem as in 1954.

Experimental Results: The effect of irrigation on corn yields at two nitrogen fertilization levels and two plant populations is shown in Table 1. The higher level of nitrogen did not increase yield over the 150 pound per acre rate. There is some indication that the extra nitrogen on the dry plots decreased yield. This may be attributed to nitrogen stimulated vegetative growth so as to use the available moisture supply early before the grain was matured. As one should expect the thinner spacing resulted in the largest number of ears per stalk, but again the increase in nitrogen appears to be detrimental. Ears per stalk generally increased with moisture level. The largest ears were obtained at the highest nitrogen level and low-or plant population on the irrigated plots. Thus the sacrifice in ears per plant obtained by the use of the higher nitrogen rate was offset by larger ears. Hence, there was little difference in yield on the irrigated plots due to increasing the nitrogen rate from 150 to 240 pounds

per acre. Since only two nitrogen levels were used one cannot tell how near the 150 pound rate came to the optimum.

(Project 204)

Pasture Improvement With Legumes

E. M. Brown, Carl Hayward

OBJECTIVE:

To determine which legumes to use with adapted grasses for profitable pasture production under different conditions of weather, soil, and use.

Birdsfoot trefoil drilled March 11 in untreated bluegrass sod, in disced sod, in sod treated with Dalapon at 8 and 15 pounds an acre, and in sod treated with TCA at 15 and 25 pounds an acre established stands of 7, 45, 37, 33, 13, and 43 percent respectively by June 16, but by September 30, the stands of birdsfoot trefoil had declined to 5, 4, 6, 1, 5, and 10 percent respectively. Stands of ladino established in sod with like treatments were 17, 76, 81, 70, 50, and 42 percent respectively on June 16, and were 28, 68, 72, 58, 68, and 35 percent respectively on September 30.

A 9-acre rotation-grazed bluegrass pasture at Columbia from which both Korean lespedeza and *L. striata* had been eliminated and in which the bluegrass had been reduced to a 28 percent stand by two successive years of drouth, carried April 16 to September 24, nine steers which gained 252 pounds an acre and at the daily rate of 1.56 pounds per steer. Nothing was required to restore this drouth damaged pasture except to reseed the lespedeza.

(Project 213)

Testing Grasses and Legumes for Pastures

J. D. Baldrige, E. M. Brown, M. S. Offutt

OBJECTIVE:

To compare new species and varieties of forage grasses and legumes made available by plant introduction and by plant breeding with species and varieties now in use to determine their value for pasture, for hay, and for grass silage in different climatic regions and on different soils in Missouri.

None of the 14 varieties of bromegrass established in September, 1950, at Sikeston and top-seeded with ladino in March, 1954, made sufficiently rapid growth recovery after simulated-grazing mowing treatments to provide a grass-clover ratio which could have been pastured by cattle or sheep without serious danger of bloat.

New variety tests of orchardgrass and of red clover seeded at Lathrop and at Sikeston failed to establish useful stands.

(Project 220)

Breeding and Developing Birdsfoot Trefoil and Lespedeza

J. D. Baldrige, M. S. Offutt

Trefoil appears to be more and more difficult to grow as it is moved southward through Iowa and Missouri. Varieties with improved southerly adaptation are needed. The extent to which climate and day length, soil, diseases, and other factors are involved in this matter is not known.

Seed production in trefoil is uncertain and is greatly influenced by weather factors. The seed crop of Empire must taken from the first cutting (brief early grazing may facilitate harvesting). The seed crop of European is best on the second crop following an early first cutting. Stands of trefoil should not be too thick (especially true of Empire), and should be mixed with grass. Pure stands in Missouri tend to become weedy, and rank weeds interfere with blooming and seed setting and encourage disease. Bluegrass and possibly orchard grass are suitable companions. Tall fescue is too aggressive and redtop or timothy, if rank, shade and reduce seed setting, especially in Empire. Empire tends to die out badly when cut in the seed stage, while European tends to maintain good stands.

At least four things limit farm use of trefoil: uncertain establishment, uncertain persistence, poor seed habits, and medium productivity.

Outstanding results of the Year: (a) Old and new strains of annual lespedeza were grown in the nursery and a small number of advanced hybrids were selected for further testing in 1956. (b) Very early strains of *L. striata* were found in an introduction from Korea. (c) Artificial epiphytotics of wilt were produced for studying the reaction of new strains to the disease. The secondary spread of wilt by natural means was so great that the controls were heavily inoculated and the experimental results were inconclusive. (d) Regional variety broadcast tests were smothered by weed grasses and abandoned at Pierce City and at Sikeston. Weedy grasses seriously interfered with the Columbia test. Weedy grass infestations are a serious problem in variety testing; selective control by dalapon herbicide offers some promise in the solution of this problem. (e) Mild infestations of Korean with wilt and tar spot were observed in experimental pastures and meadows at Co-

lumbia and locations outstate. (f) Date of maturity and forage production was determined for 8 strains of lespedeza at 5 dates of planting. (g) Over 40 pounds of breeders seed of Climax were produced. (Project 221)

Testing Alfalfa Strains

M. S. Offut

OBJECTIVE:

The improvement of alfalfa in yield, quality, and resistance to disease through the selective testing of varietal strains.

Hardy Alfalfa variety yield tests were seeded at five locations in the spring of 1955. Satisfactory stands were obtained at the Columbia, Lathrop, Weldon Springs, and Pierce City locations. At Sikeston, a severe cold spell in late March, after the seedlings had emerged, almost completely destroyed the stand. It will be necessary to make a new seeding at Sikeston in the spring of 1956. Yields were obtained at Sikeston, however, from an old stand established in the fall of 1950. Buffalo was used as the check variety in all tests.

Columbia—The Columbia test, which was established in the spring of 1955, was harvested once for forage in 1955. None of the varieties were significantly higher in yield than Buffalo. Ranger, Atlantic, Nomad, DuPuits, and Rhizoma were significantly lower in yield than Buffalo. Socheville and Du Puits appeared to have more spring vigor and to recover faster after cutting than any of the other varieties included in the test. Rhizoma and Vernal were less severely damaged by downy mildew than were the other varieties.

Lathrop—The hardy alfalfa test seeded in the

spring of 1955 at Lathrop was not harvested for forage yields in 1955 because of the dry weather and competition from weedy grasses.

Weldon Springs—The test seeded at Weldon Springs in the spring of 1955 was harvested twice for forage during 1955. In this test, Atlantic, Williamsburg, Vernal, Oklahoma Common, and Ladek were significantly higher in yield than Buffalo. None of the varieties were significantly lower in yield than Buffalo.

Pierce City—The test at Pierce City was seeded originally on March 11, 1955, but a severe freeze on March 26 killed a major portion of the young alfalfa seedlings. A second seeding was made in mid April. The test was not harvested for forage during 1955 due to competition from weedy grasses. The plots were chipped twice during the summer, and at the time of the first killing frost in the fall the stands were vigorous and relatively free of weeds.

Sikeston—The 1955 results of the test at Sikeston further indicate that the non-hardy varieties of alfalfa cannot be counted upon to survive the winters in Missouri, even in the extreme southern part. The varieties were classified into three groups in relation to their winter hardiness. Ranger, Atlantic, and Kansas Common were the most hardy. Indian, Chilean, African, and California Common were the least hardy, while Caliverde, Italian, and French (probably the variety designated as Socheville) were intermediate in winter hardiness. The forage yields from the Sikeston test for the two-year period 1954-55 do not indicate that the non-hardy varieties have enough superiority in yield, even in the seedling year, to warrant their use.

(Project 241)

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Forestry

R. H. Westveld, Chairman

Christmas Tree Culture

R. B. Polk, R. H. Westveld, J. M. Nichols

Results continue to show a direct relationship between seedling size and the survival, growth, and quality of trees. Plantations established during the drouth years of 1953 and 1954 with plots planted at random to seedlings of small, medium, and large

sizes were replanted in spring, 1955. The percentage of replanted spots ranged from 60 percent to less than 5% per experimental planting—depending on such factors as site, preparation of site, care subsequent to planting, and source of seed. Records of the replant spots are being kept for the various plots in these plantings. Stocking at the close of the 1955 growing season approached 100 percent at Ashland

and was approximately 80 percent at Weldon Spring where the drouth had continued to be severe through most of the summer. Some fall and winter mortality has followed in both areas, due to the record dry period that extended from early October 1955, until January 31, 1956.

In years prior to 1955, the superiority of a 1-percent DDT emulsion as the most effective known means of chemically controlling the pine tip moth had been demonstrated over the same insecticide at percents of 0.25 and 0.50 and over various rates of other such insecticides as wettable DDT chlor-dane, and lead arsenate.

In 1955 tests, a DDT emulsion continued to show a superiority when compared with several new insecticides (dieldrin, heptachlor, and malathion). All of these insecticides are more expensive than DDT, and rates were determined in terms of cost relative to that of an effective DDT emulsion formulation. (*Project 9*)

Investigations on Oak Wilt

T. W. Bretz, R. H. Westveld, T. W. Jones,
W. D. Buchanan

Two foreign oak species and one native species of *Castanea*, not previously tested for susceptibility to oak wilt, have been found susceptible when artificially inoculated. New accessions of 4 introduced species of *Quercus* and one species of *Castanea* previously reported susceptible were also found to be susceptible when artificially inoculated.

Delayed symptom expression was observed in oaks of the red-black group after artificial inoculation. A number of trees growing in the nursery and in the field, inoculated in early summer of 1954, showed no oak wilt symptoms until early summer of 1955. Development of the fungus may have been arrested by the extremely high temperatures immediately following the inoculations in 1954.

Prevalence of more normal, moderate temperatures during the summer of 1955 is believed to account for the marked increase in success in laboratory confirmations of field diagnosis of oak wilt, as compared with confirmations in 1953 and 1954.

Results of preliminary work indicate that the oak wilt fungus can be introduced into oak bolts and will persist and spread for at least a limited period of time.

V-8 juice agar has been found to be a good medium for growth and both asexual and sexual sporulation of the fungus.

Fungus spore mat formation during the spring, summer and fall of 1955 on wilt-killed trees was

exceedingly rare.

It has been established that local spread of oak wilt may occur through natural root grafting between diseased and adjacent healthy trees. Sanitation (removal and destruction of infected trees) has not reduced the amount of local spread. Isolation of infected trees (by poisoning all oaks in a 50 ft. band around them), and isolation combined with sanitation, have reduced the amount of spread within root-graft distance.

The reduction in local spread, as indicated in the preceding paragraph, is nullified in terms of overall oak wilt control, by the concentration of new infections in a 50 ft. zone adjacent to the poisoned (50 to 100 ft. from previously infected trees and beyond root-graft distance). As used under Missouri conditions, therefore, these measures have not given control of oak wilt.

It is thought that long distance, above ground spread of the oak wilt fungus may be accomplished by insect vectors. The bark beetle (*Pseudopityophthorinus minutissimus*) is suspect because it is known to attack and breed in actively wilting trees and to feed on healthy trees. Six trees, of 81 inoculated in 1954 with inoculum consisting of macerated (in water) bark beetles that emerged from oak wilt infected wood, developed typical oak wilt symptoms in 1955, suggesting that these insects could serve as vectors of the fungus.

Transmission has not been accomplished by means of Nitidulids and other mat-feeding insects removed from fungus spore mats and placed in fresh wounds on healthy trees.

Of a total of 1200 trees wounded at weekly intervals from March 29 to June 14, 1955, only 7 trees developed oak wilt during the season. One of these trees was wounded April 19, 6 were wounded April 26. A total of 100 trees were wounded on each of these dates, so there appears to have been little correlation between the wounding and the incidence of wilt. (*Project 52*)

Improvement of Low Quality Understocked Hardwood Stands

L. K. Paulsell, R. H. Westveld, A. J. Nash, J. M. Nichols

The two sets of fire plots were burned and re-examined as specified. Analysis of previously collected data was continued and a manuscript partially completed. Water infiltration tests were made which indicated a very significant difference between the infiltration rate on annually burned and unburned forest land. A study of the changes in herbaceous and bryophytic flora resulting from fire was made.

Time was spent chiefly on observation and follow-up on trees previously pruned. A very limited amount of time was spent on analysis of data. Some consideration was given the problem of water sprouting.

Data pertaining to visible signs of defect were recorded on approximately 100 trees. The logs were cut and additional log data were collected. The logs were hauled to the University Forest sawmill for processing and a lumber recovery study.

Some release work was done on plots previously planted. This was mainly removal of the overstory through deadening. Ten plots were planted in accordance with the work plan. Complete survival and height data have been taken. (*Project 75*)

Guide to Native and Introduced Range Plants of the Missouri Ozarks

C. L. Kucera, J. S. Arnold, S. C. Martin

REPORT OF PROGRESS:

- A. The completion of a grass key.
- B. Completion of range collections.
- C. Three years of phenological observations.
- D. Composition of 1 manuscript.
- E. Keys to other forage groups are being prepared for the Handbook. (*Project 79*)

Marketing the Timber Crop

*Lawrence Leney, W. J. O'Neil, R. C. Smith,
R. H. Westveld*

In March of 1955 the posts in the Columbia plot were again tested by having a loop of $\frac{1}{2}$ inch manila rope placed around the post three feet from the ground and a pull of 40 lbs. exerted to the east with a spring balance. If the post did not fail it was considered still serviceable. Twenty three posts failed. Sixty-six posts are still left in the plot serviceable.

In 1950 at Weldon Springs, Missouri 345 posts have been treated with penta. These posts were piled in a building and were not placed in the ground until 1955. These posts consisted of 75 ash and 60 each of hickory, cottonwood, black oak, elm, and 30 black locust.

In October of 1953 at the Logging Show at St. James, Missouri, 75 posts were given the "double diffusion" treatment. These posts consisted of 20 sycamore, 21 oak, 22 shortleaf pine and 12 hickory.

Three hundred and fifty posts were treated in 1954 at Weldon Springs by the "double diffusion" method. These posts consisted of 75 cottonwood, 50 each of ash, elm, hickory and black oak. Seventy-five additional posts were treated at Weldon

Springs with a proprietary treatment (Osmosalts). There were 15 posts each of ash, elm, hickory, black oak and cottonwood.

All of these posts were set out in a plot at Weldon Springs. The posts were randomized by placing numbers for all posts in a bowl. The bowl was thoroughly shaken so the numbers were mixed. Then the numbers were drawn out one by one and the number recorded. The first number withdrawn became the number of the first post to be set out. The last number withdrawn became the number of the last post to be set out.

Posts were spaced 3 ft. apart and a diagram of plot was made and the numbers recorded. They will be tested with a spring balance and a pull of 40 lbs. Control posts (posts not treated) are included with the treated posts so a comparison of durability can be obtained.

Posts will be checked annually to see how they are resisting deterioration and decay.

It is planned to drive metal staples into the posts in 1956 to test the durability of metal fasteners.

Samples of the solutions used in the double diffusion process were analyzed by the Agricultural Chemistry Department to determine the actual concentration of chemicals in the solutions at time of treatment. A sample was taken at the beginning of the soak period for each group of posts so any differences which occurred in adjusting the solution between groups would be known. A sample post was picked at random from each of the species treated by double diffusion and is now being analyzed for chemical concentration in the wood. The wood samples being analyzed are as follows: (1) The outer $\frac{3}{4}$ inch layer at the ground line (2) The outer $\frac{3}{4}$ layer near the top of the post (3) The wood to the inside of the $\frac{3}{4}$ inch layer at the groundline (4) The wood to the inside of the $\frac{3}{4}$ inch layer near the top of the post. These data will give an indication of the concentration of chemical at both the ground and top of the post and also for the $\frac{3}{4}$ inch shell as compared to the interior of the post. (*Project 120*)

Reproduction and Forest Stand Improvement Cuttings

*J. M. Nichols, P. W. Fletcher, L. K. Paulsell,
R. C. Smith, R. H. Westveld*

The effects of thinning young planted and natural stands of eastern cottonwood were summarized in two chapters and the appendix of a graduate student thesis. These data cover three consecutive

drouth years and the 1955 growing season which was more nearly normal. Many of the eleven-year-old planted trees are 9 inches in diameter and 70 feet tall. No reduction in volume growth occurred as a result of thinning, with slight increases occurring on some plots. Both basal area and crown densities approached the original values within the four-year period.

Work was continued on the summary and analysis of data on the Stand Improvement Cuttings. Necessary maintenance including plot marking, painting and fire line construction was accomplished. Noticeable on the plots is the high mortality due to past years of drouth. Water sprouting is apparent on many of the pruned crop trees. Several years will be required for any significant results of this work.

The set of six one-acre plots established the previous year at University Forest were cut according to the work plan. Time records were made of the various phases of the operation. The logs were hauled to the mill for further processing on this study and as a part of 75-F Decay and defect study. Plots were permanently marked on the ground. Plot data and time records have been partially summarized. No actual concrete results will be available for a number of years since a cutting methods study must be on a long term basis.

The block of six one-acre plots established the previous year at Weldon Spring Forest were cut according to the work plan. Logs were scaled and defect data were taken for project 75-F. Logs were sold to a local sawmill.

Treatment	Board-Foot	Volume
	Live Trees	Dead Trees
Selection cutting	1836	459
15 inch diameter limit	2992	564
High-grading	3525	----
Salvage cutting	----	520
19 inch diameter limit	620	1790
Check (no cutting)		

A second replication of 6 one-acre plots was established in another mature oak stand and data collected preparatory to cutting.

A white oak sale, totalling 367 trees, was made on bid for \$4986, equivalent to 90¢ per chord foot of stave bolts. Seven bids were received, on this sale. When these trees were offered in 1954, no bids were received due to a sudden depression in the market. A saw timber sale, totaling an estimated 940 M. bd. ft., of northern red oak, black oak, white oak, post oak, hickory, ash, elm, sycamore, and black walnut was marked and sold on bid for \$21,080, or \$22 per M. This is more than double the price per M possible on small-volume timber sales. Complete records of volumes marked are being kept by blocks and species. (*Project 122*)

Ecological Studies in Forestry

*P. W. Fletcher, R. E. McDermott, L. K. Paulsell,
R. H. Westveld, J. M. Nichols*

As was the case in 1953 and 1954, the mast crop in both upland and bottomland oaks was light. There are indications, however, that 1956 may be a good year. If so, crown diameter relationships to mast production may be established. Weevil infested acorns of shumard, black, white, and swamp white oaks placed in copper screen traps under forest conditions did not provide a means of obtaining adult beetles in the first season. However, examination of these traps in the spring and fall of 1956 may indicate that these insects can remain in the dormant state through two seasons. Examination of 800 tagged northern red oak acorns that were placed in lots of 50 adjacent to 16 permanent quadrats on the Ashland Wildlife Area indicated that no successful germination and establishment occurred. Indeed, by late spring of 1955, none of these acorns could be found which is indicative of the extreme wildlife pressure on the area.

A forest inventory of the Mingo Refuge near Puxico, Missouri indicates a gross volume of 30 million board feet and a net volume (after cull) of 22 million feet. In general, stand density is not desirable as evidenced by average basal areas (sq. feet) that are 20 percent below those commonly recommended for similar stands in the Delta of Mississippi.

A K-20 aerial camera with a minus blue filter and XX film is adequate for a precise method of sampling redcedar populations. Clear weather or days that have high, thin clouds are best. Depending upon sample size and ground control intensity, altitudes of 500 ft. and 1500 ft. are recommended. Where 60% overlap is desirable, altitudes of 2500-5000 ft. are necessary.

As in 1954, an optical examination of fenced and unfenced plots in the timbered area adjacent to an improved pasture of the Weldon Spring Experimental Farm indicates no cattle grazing pressure in the forest reproduction. Previous sampling methods were not expanded due to the transfer of cooperating personnel. (*Project 123*)

Economics of Timber Production

R. C. Smith, R. H. Westveld, A. J. Nash

During the year, this project was practically dormant. One forest owner was visited in 1954. Missouri Agricultural Experiment Station Circular 349, issued in July 1950, summarized the work done

on this project and no progress has been made since.

A check was made on a number of plots for mortality during the three year drouth period; the results were summarized in Missouri Farm News Service, Dec. 1, 1954. Two new growth plots were established during the year, one in McDonald County and one in Barry County.

Some time has been spent in the office in preparation for the 1956 field season checking on plot locations and plans for field examination.

During the summer of 1955 data were collected from county records in 12 counties in the Southwestern Ozark Region. From aerial photographs areas were outlined which were either forested or cleared farm land. Ownerships listed separately on the county tax books were found within such areas for which assessed valuation and total taxes could be obtained for an 11-year period, 1944-1954. Records were obtained for a total of 374 ownerships entirely forested representing 55,778 acres. For comparative purposes similar tax records were obtained for 141 ownerships consisting of cleared and improved farm land representing 10,033 acres. Data were totaled for each county by years. (*Project 124*)

Techniques for Improving the Results of Forestation

*P. W. Fletcher, L. K. Paulsell, R. B. Polk,
R. H. Westveld, J. M. Nichols*

Two experiments were established during the year, as follows: (1) Twenty-two plots, involving a total of 4896 hardwood seedlings, were planted on the Weldon Spring Experimental Farm. These are located on an old field occupying a ridge between timber blocks 23 and 29. The most northerly extension of these plots is approximately 3 chains southward of the high-voltage transmission line that crosses the ridge. Most of the seedlings were machine planted, and results are being compared with hand planting through the planting by grub hoe of random rows in the various plots. Details with regards to species, seedlings per plot, replications, and total seedlings planted can best be presented through tabulations, as follows:

Species	Seedlings per plot	Number of plots	Total seedlings planted
<u>Maclura pomifera</u> (Raf.)			
Schneid.	144	2	288
<u>Liriodendron tulipifera</u> L.	144	2	288
<u>Juglans nigra</u> L.	144	2	288
<u>Quercus alba</u> L., Missouri source	144	2	288
<u>Quercus alba</u> L., Ohio source	144	2	288
<u>Robinia pseudoacacia</u> L.	144	2	288
<u>Catalpa speciosa</u> Ward.	144	2	288

<u>Liquidambar styraciflua</u> L.	144	2	288
<u>Fraxinus pennsylvanica</u>			
Marsh.	144	2	288
Random mixture of above	576	4	2304
Total seedlings, all species: 4896			

Spacing of seedlings in this installation was 6 feet apart in rows 8 feet apart. In general, rows follow the contours; and the irregularity of old-field width along with varying curvature in ridge direction made necessary irregular plot dimensions, and a plot of the plot layout is on file.

The planting site was deeply and fully plowed during the fall preceding in early April, 1955. A large disc plow was used, and this type of equipment has been found less satisfactory for site preparation than a moldboard plow. The latter turns the soil over, weed and grass seed are deeply buried, and the consequence is a sparser herbaceous cover during the growing season that follows. Contrarily, the disc plow mixes the soil, and the reduction of herbaceous cover is much less. Either type of plow leaves the ground very rough, and harrowing is generally required to smooth the planting surface.

Early season survival was good for all species, but drouth conditions prevailed on the area through most of the growing season, bringing increased suffering to the seedlings. Foliage curled, became either partially or wholly dry, and the leaves of many seedlings were destroyed by insects. Grasshoppers, in particular, have plagued vegetation on these old-field sites since the advent of the current drouth in 1952. This curling, dying back, and insect destruction of foliage made a survival count of the seedlings too difficult by late summer. Hardwood seedlings that die back under these conditions frequently sprout again next spring. For this reason, survival records will not be attempted until early in the 1956 growing season. (*Project 157*)

Effect of Forest Cover on Soil and Water Resources

P. W. Fletcher, L. K. Paulsell, R. H. Westveld

Observations suggest that the superficial root systems of dense scarlet oak stands growing above a subsoil pan are less able to extract soil moisture than the deeper root systems of less-well-stocked stands growing on slopes without a subsoil pan. In other words, stand density for scarlet and black oak stands on flatwoods sites should be reduced well below the stocking developed during the forties, in keeping with the root depth and water storage limitations imposed by the fragipan.

Soil moisture records revealed that dense stands of pole-size oaks quickly extracted the available moisture

above the pan. Wilting percentage was reached progressively at deeper depths, until by late July of 1953 and 1954, there was no moisture available for the trees down to the three foot depth. Survival of the trees during the late summer of both years was dependent almost entirely upon the small amount of rainfall which came at infrequent intervals, and penetrated only the surface soil layers.

It is also quite possible that the presence of a seasonal perched water table definitely slows down the growth rate of these trees. Aside from creating anaerobic conditions (poor aeration) which certain tree species may better tolerate than others, this condition may also retard early spring growth. It is well known that a poorly drained and poorly aerated soil is too wet and too cold for early spring growth of farm crops.

Another possible consequence of a perched water table is worth mentioning. Where shortleaf pine has been planted on these Lebanon post oak flats, it seems highly possible that the trees could begin to show symptoms of little leaf disease any time after they are 20 years old. Research on this disease indicates that the chief causal agency, *Phytophthora cinnamomi*, thrives in damp, warm subsoil, attacking the pine roots, and impairing their ability to absorb essential nutrients, including nitrogen. Such conditions prevail on a Lebanon silt loam in the early part of the growing season, persisting into the early summer.

That the flatwoods and post oak flats are seasonally too wet and too dry for good growth and development of many species of trees is further demonstrated by the limited capacity of these soils to store water. Out of 40 inches of soil above the pan, 17.63 inches is the total water storage capacity. Of this 7.40 inches are almost never available for storage, as this space is occupied by water held so tightly (wilting percentage) that even plant roots can't extract it. The remainder, 10.23 inches, is the total opportunity for storing water. However, depending upon the time of year, 7.69 inches of this may not be available for storage, as in late winter, and early spring, because it may already be occupied by water. This is the water available for plant growth (below field capacity, above wilting percentage). This space is emptied by plant roots and the evaporative power of the atmosphere.

Only 2.54 inches are available for water storage except during and immediately after a long rain-storm. This space includes the large pores in the soil (above field capacity) which can be emptied by the force of gravity. Water which is temporarily detained

in this storage space is slowly released laterally to wet-weather seeps and intermittent streams.

Daily soil temperature readings at eight depths beneath the soil surface show that the removal of trees and litter increased the mean monthly temperature of the upper three feet of soil by 10 degrees F. in June, July, and August, and decreased it 2 degrees in December. The annual net effect was a soil temperature increase of 3.3 degrees. Thus, the areas without trees and litter were both wetter and warmer in the spring and summer than the areas with trees and litter. This means that clear-cutting and burning, in effect, moved this experimental plot from southern Missouri to northern Louisiana for the summer, and to southern Iowa for the winter.

Four years of record show that the canopy of a dense pole-size mixed oak forest intercepts 15 percent of the rainfall in the winter and 30 percent of the rainfall in the summer.

Several more years of record are needed before dependable values are available for storms of all sizes throughout all seasons of the year, particularly since the present record covers three drouth years, said to be an event of once in 300 years.
(Project 158)

Utilization of Native Timber and Residues

Lawrence Leney, R. H. Westveld

Ten wood using industries have been visited during the year with no new problems being observed. The predominant problems are the drying and utilization of low grade lumber and a general need for more specific knowledge about the properties of woods growing in Missouri.

Specimen boards of post oak and red oak under air drying conditions were weighed periodically from June 1954 until June 1955. It was possible to calculate the variation in moisture content of the boards throughout the year. The data show the post oak to be consistently one to two percent higher in moisture content than the red oak. The reason for this difference has not been determined so further work is planned. The moisture content of all boards changed from an average of about 12 percent moisture content in June 1954 to 9 percent in July 1954 and back to 12 percent in January 1955. This shows that it is possible to dry lumber to 12 percent or less under air drying conditions in the vicinity of Columbia.

Two thousand feet of Sycamore lumber was sawn from 19 logs ranging from 13 inches to 25 inches in diameter. Notation was made of shake and checking before the logs were sawn. The lumber

was separated into three piles such that each log was evenly represented in each pile. The log number was marked on each board. When stacked for drying three different methods were used: (1) end-racking (2) flat piled with roof (3) flat piled without roof. As labeled boards from each log are represented in each method of drying warpage should be traceable to either the characteristics of the log or the method of drying.

Other studies planned in this phase of work have been held inactive until the personnel is available to accomplish the work. (Project 159)

Inferior Tree Species Control

L. K. Paulsell, R. H. Westveld, J. M. Nichols

The 18 plots of persimmon treated with 6 chem-

ical applications in February 1955 were checked for results in August 1955. Some treatments had caused defoliation, some discoloration of foliage, and some plots appeared normal. It was apparent that accurate results could not be gotten before another growing season. Eighteen plots of sassafras were treated with 6 chemical applications in March, 1956.

The following table summarizes results from study on removal of undesirable trees in timber stand improvement initiated at University Forest in 1953. Undesirable trees including post oak, black oak, blackjack oak and hickory were treated in May, 1953, October, 1953 and February 1954. (Project 166)

Percent of Treated Trees in Each Condition Class* in September, 1955.

Treatment (Seasons Combined)	4-8 in D.B.H.				10 in D.B.H. and Larger			
	A	B	C	D	A	B	C	D
Axe Girdle (No chemical)	0	7	41	52	0	9	11	80
2,4,5-T, 8 lbs AHG Kerosene, high frill	1	2	22	75	0	6	0	94
2,4,5-T i lbs AHG, Kerosene, low frill	1	1	32	66	0	34	0	66
2,4,5-T, 8 lbs AHG water, low frill	29	8	11	52	45	9	1	45
Sodium Arsenite (low frill)	0	0	20	80	0	3	3	94
Sodium Arsenite (half-strength) low frill	0	3	40	57	0	0	3	97
Sodium Arsenite (half-strength) high frill	0	3	62	35	0	0	13	87
Ammate, 4 lbs/gal. water, low frill	3	8	28	61	24	12	3	61
CMU, 1 tablespoon per inch of DBH, applied to soil around base of tree.	35	7	0	58	17	29	0	54
Seasons (treatments combined)								
Summer	1	0	14	85	3	9	3	85
Fall	13	6	31	50	13	13	4	70
Winter	2	7	35	56	30	16	2	52

*Condition Classes: A- No apparent effect, B- partial top-kill, C- Complete top-kill with new sprouts, and D- complete top-kill without sprouts.

Marketing Christmas Trees

R. B. Polk, R. H. Westveld, J. M. Nichols

To test consumer acceptability of Missouri grown trees, several hundred each of Scotch pine and jack pine were harvested from experimental plantations. These were divided among five sale lots —two in Columbia, one in St. Charles, one in Kirkwood, and one at Weldon Spring. In some cases, trees were in direct competition with out-of-state evergreens. In the St. Charles sales, for example, the Missouri-grown trees, especially Scotch pine, moved strongly in competition with balsam fir of good quality on the same lot. Trees were priced by species and grade (Table 1.) By way of brief presentation: (1) the Missouri-grown trees had a very favorable reception under strong out-of-state competition (large surpluses of trees were available in Columbia and the greater St. Louis area); (2) Scotch pine moved more readily at higher prices than did Jack pine; and (3) trees were graded as *premium*, *standard*, and *utility* (listed in descending order of quality),

and trees of better grade sold more readily at higher prices than did trees of lower grade. Thus, the facility with which trees are marketed is very directly and strongly influenced by good plantation practices.

Table I.--Prices per foot of height of Missouri-grown Christmas Trees marketed in 1955 by grade, species, and sale area.

GRADE	Scotch pine		Jack pine	
	St. Louis	Columbia	St. Louis	Columbia
Premium	\$1.001/	\$.50	\$.50	\$.40
Standard	.75	.40	.40	.30
Utility	-.2/	--	.30	.20

1/ Trees 8 feet tall and over sold for \$1.50 per foot.

2/ No Scotch pine of utility grade harvested.

On all of the five lots, a strong demand existed for a range of sizes from 3 to 10 feet tall. Also, requests for trees as tall as 12 feet were surprisingly high, apparently due to a growing use of trees by churches, stores, and many different kinds of organizations.

The winter yellowing of evergreens, especially jack pine, has been discussed in other reports as a problem. Moreover, this phenomenon has been related to light as a causative factor. Early cutting and

storage of trees following the onset of dormancy seems to offer one means of adjusting to this problem. Jack pine cut November 7, 1955, before pronounced yellowing and stored in a damp basement retained a good color and freshness of appearance in excess of 90 days.

The painting of trees offers another means of overcoming the color problem. There is a very enthusiastic but limited market for painted trees of various colors —white, silver, and gold being more popular in recent years. Since the demand for painted Christmas trees is difficult to predict, and since the painting process adds considerably to the investment in a tree, some experienced retailers equip themselves with a portable sprayer and paint trees only on order.

The costs of painting an average 5-foot jack pine of medium crown density was at Weldon Spring in 1955 found to vary by materials, as follows:

Kind of material	Labor	Material	Total
White paint (oil base)	\$.15	\$.45	\$.60
White paint (water base)	.10	.40	.50
Silver (aluminum lacquer)	.06	.20	.26
Gold lacquer	.06	.60	.66

Painted trees brought approximately twice the price per foot of unpainted trees.

White and silver finishes were more popular in 1955. Several kinds of gold lacquer tarnished within several days after application, leading to the realization that sources of supply for this color must be considered very carefully. Gold trees had been popular in 1954, probably because a better quality of material had been used.

A small, portable, diaphragm-type DeVilbiss sprayer is being used to paint the trees. (*Project 245*)

Marketing and Processing of Hardwood Paneling

*Lawrence Leney, L. K. Paulsell, R. C. Smith,
R. H. Westveld*

During the first half of the year a pilot study of consumer preference was conducted on panels produced during the previous year. Several actual sales of paneling material were made to establish the fact that a market exists at prices which will enable producers to operate profitably. A correlation of standard lumber grades required to produce given paneling grades was completed. During the last half of the year advice was obtained from a marketing specialist and an architect to help prepare an interview for testing consumer preference. More than 20 finishing systems were prepared on sample boards and the more promising ones were applied to wall mock-

ups. Preliminary work on installing paneling with nails was begun including design and construction of a laboratory nailing device. The assistance of a mechanical engineer in the College of Engineering was obtained to design a metal clip for fastening panels.

Concerning the manufacture of paneling, a major change became necessary because the cooperation of commercial firms contracting for kiln-drying of lumber and machining to pattern proved unreliable. Consequently the Forestry Dept. has undertaken to do the entire processing of paneling with its own facilities. A shed-type of building 30 by 80 feet in size was erected, and a dry-kiln of 2000 board-foot capacity was purchased, along with a used wood molder and other auxiliary equipment. More than 12,000 board feet of timber was logged and sawn into rough one-inch lumber. This paneling stock, chiefly red oaks and post oak, was stacked for air seasoning. Systems of pricing manufactured goods, including lumber, were reviewed in the library.

Our preliminary work plan was sent to the forestry staff of the Agricultural Experiment Stations in Illinois, Indiana, and Michigan. Later, two of our staff visited these agencies to obtain their advice. The persons contacted offered very constructive criticism and recommendations based on their research. This was perhaps our most valuable activity. (*Project 259*)

Effect of Soil and Parent Material on Distribution of Native Ozark Timber Species

P. W. Fletcher, R. E. McDermott, R. H. Westveld

It can be definitely demonstrated that sandstone as it occurs as a major geologic formation or as a lense in other formations is the major parent material factor associated with natural occurrence of shortleaf pine in Missouri. The sandstone (s), however, must be located in well dissected terrain. Pine is not found on broad, flat ridges and only sparsely in gently rolling country. The major pine bearing stratum of the Missouri Ozarks is the Roubidoux Sandstone. The LaMotte Sandstone is also an excellent pine-bearing stratum, but of relatively limited acreage. The granite and porphory formations have natural pine, some of which is of major economic importance. In general however, the pine that occurs on granite and porphory is not as abundant nor as thrifty as pine growing on deeply dissected sandstones.

If Reynolds county is considered as the center of the distribution of shortleaf pine in the Missouri

Ozarks, several geologic and physiographic limitations for pine become evident as one proceeds away from this county on the cardinal points. To the East, the topography gentles and broad, flat ridges covered by loess of river origin become limiting. South of Reynolds county, one proceeds upsection geologically into the Jefferson City limestone which is limiting to pine. To the West, a combination of gentle relief plus the upsection occurrence of limestones limits pine. In southwest Missouri, small patches of native pine are found (Saunders' Tower, Lanagan, etc.), but here the pine is associated with lenses of sandstone within the dolomite formations. As one proceeds North from Reynolds county, pine be-

comes restricted by gentle relief of the Roubidoux Sandstone and a soil mantle of transcontinental loess on the ridges. Also, to the North, the upsection distribution of dolomites limits the occurrence of pine.

One major exception to sandstone or the granites and porphories as pinebearing parent material occurs in the Derby-Doerun. Derby-Doerun is a dolomite of the upper Cambrian. Pine may be found on a unique facet of this formation where the dolomite occurs in a coarse, granular layer from 10-15 thick in close proximity to the surface. Presumably, this coarse dolomite produces soil moisture relationships that are similar to those of soils derived from sandstones. (*Project 260*)

Home Economics

M. W. Mangel, Chairman

Rate of Change in Hemoglobin to Methemoglobin in Ground Beef

Margaret Mangel, Mina Glidden

Data have been evaluated. The presence of a relatively stable pigment form, presumably Keilin's Sulf-metmyoglobin, has been demonstrated in pigment solutions treated with hydrogen sulfide water and cysteine. It is possible that this pigment occurs to some extent in untreated cut meat and pigment solutions to produce the effect on the spectrophotometric readings noted in the early study of the method. (*Project 87*)

Consumer Acceptance and Preference for Meat and Meat Products

Virginia K. Halt

Two major groups of experiments have been conducted. Both were concerned with the effectiveness of a grading system in classifying a heterogeneous beef supply into more homogeneous classes. This problem is one of the most basic to consumer preference work since meaningful descriptions of consumer preferences among products (grades) necessarily presumes adequate definition of those products (grades).

The first groups of experiments involved the use of laboratory taste discrimination panels to compare eating differences among carcasses of various

grades. Preliminary comparisons were made between grades, between carcass weights, and between both grades and weights. Short loin and top round steaks ranging from Average Prime to Average Commercial were in the tests. The results showed a very surprising lack of association between number of judge discriminations and the grade and/or weight "distances" between the samples.

Large-scale field tests of consumer preferences were postponed in order to explore these results further. Twenty short loins from 20 cattle were purchased in the lower third of each of the four top federal grades. Also 20 short loins were obtained in the weight range 480 to 510 and 20 in the range 650 to 710 in the low Choice grade. One-half of the steaks from the 20 Prime short loins were used in trios with one-half of the steaks from the 20 Good loins. Likewise, the Small Choice and Large Choice loins, and the Choice and Commercial loins were compared. The other steaks were used to compare 10 Prime short loins with the other 10 Prime short loins, etc. In general, discriminations *within* grades were almost as frequent as for trios *between* grades. The proportion of discriminations within the Large and Small Choice groups actually exceeded the proportion of discriminations between those groups. In an ideally effective grading system all 20 pairs of Choice and Commercial or Prime and Good loins should be discriminated between. Actually, significant discrimination was found for 7 of the 20 pairs

of Choice and Commercial, and 11 of the 20 pairs of Prime and Good loins. As a corollary to segregating different products, there ideally should be no discriminations between pairs of loins of the same grade. Actually, significant discriminations between pairs of loins within a grade ranged from only 2 of 10 pairs in the Good grade to 7 of 10 pairs for the Commercial grade.

Analysis of variance of Warner-Bratzler shear measurements of every loin tasted indicated that the mean shear values of Choice and Good significantly exceeded that of Prime. The greatest variance of shear values within a grade was for Commercial.

The experimental results support the hypothesis that consumers cannot discriminate better between loin steaks from different present federal beef grades than between steaks within those grades. This hypothesis challenges ideas long held about grading. It is possible that the results do not apply to the population because of the test methods used or the smallness of the sampling of carcasses. Tests were conducted January-June, 1955.

A pilot study for future large-scale consumer field testing was conducted simultaneously. A sample of 41 Columbia households received pairs of loin steaks for seven weeks. Two replicates were given of each of the following comparisons: Prime and Good, Choice and Commercial, Large Choice and Small Choice, Commercial and Small Choice, Commercial and Large Choice, Prime and Commercial, Prime and Small Good. Certain socio-economic characteristics of households were obtained. Several matters of methodological interest were explored including the use of schedules printed on mark-sense punch cards.

The second group of experiments involved testing the same hypothesis with a sample of 226 households in Metropolitan St. Louis (Missouri side). Every household received two pairs of frozen steaks per week for three weeks. Ratings of each steak on a scale developed by the Quartermaster Corp were obtained. Two replicates were made of each of three comparisons: Prime and Good, Choice and Commercial, Choice and Choice. Two adults tasted and gave preferences in each household. Respondents were not informed as to the grade of steaks or the possibility of replicates.

Careful product control was maintained. Both short loins were purchased from 126 carcasses grading in the lower third of the grade and weighing 550 to 600 pounds. Identity of every steak as to grade, carcass, and loin position number was maintained from the cutting laboratory to the household.

Tests were conducted September-October, 1955. Analysis of the results is just beginning.

Six steaks from each of 14 cattle in each of the six grade groups were reserved for laboratory panel testing. Thus there is an excellent opportunity for comparing the results of consumer and laboratory panels. This tasting will begin in February, 1956. (*Project 109*)

Studies on Utilization of Processed Food and on Food Improvers

Leta Mabarg, Marilyn Holman, Helen Gordon, Georgia Amick

Family sized recipes for 15 types of sweet rolls and yeast breads using high proportions of non-fat dry milk solids have been developed and standardized. More work needs to be done to compare instant non-fat dry milk solids with that previously on the market and to make adjustments if necessary.

Testing enzymatic action of different concentrations of enzyme solution will be completed. Several methods of applying these tenderizers to piece meats have been tried to find the best method of applying these tenderizers to meat to prevent disintegration of the meat on the outside before the enzyme penetrates the interior of the meat.

A satisfactory formula has been devised using hydrogenated fat and dry milk solids. Recipes using this mix have been formulated and standardized for biscuits, muffins, coffee cake, sweet rolls, fruit cobblers, fruit puddings, cookies and fritters and preliminary testing of products has been done. These recipes need some further testing. Dried eggs will be incorporated in the mix next. (*Project 130*)

Consumption, Characteristics, and Serviceability of Textiles in Children's Clothing

Adella Ginter, Betty Harper, Donna Swall

Two qualities of boy's cotton flannel shirts were worn and laundered thirty times. Similar control groups were laundered only. Measurements of weight, breaking strength and elongation, shrinkage, yarn counts and color changes have been made on the garments discarded at the predetermined periods. Visual changes in the garments have been noted. The analysis of data is not complete.

Another quality of cotton flannel shirt and a gingham variety have been added to the study. They are being worn by twelve year olds. The periods of wear to be represented are 10, 20, 30 and 40 days. This study provides for evaluations similar to those made on the first two qualities of shirts.

Laboratory measures are being made of the fabrics used in the new garments and in those after they have been discarded from service. Construction details of the garments as affected by service are also being noted. (*Project 162*)

Studies to Improve Food Utilization, Selection, Preparation and Storage Practices

The bulletin "Cookies for Children" has been published. Fourteen tested cookie recipes are given. These cookies are made using natural foods as brown sugar, molasses, honey, whole grain cereals, whole wheat flour and milk. They contribute to the daily food needs with minerals, vitamins, and protein. These cookies are appetizing, satisfy hunger and keep well. No staff has been available for working on the study of Current Food Preparation Practices in U. S. (*Project 163*)

Testing Various Flours

Leta Maharg, Marilyn Holman, Helen Gordon

Tests for 1954 flours have been completed. Seven flours from the 1955 wheat selections are being tested for use in cakes and cookies. Three of these flours are from the control wheats and the other four are from the promising selections of wheat tested last year. Tests are not completed, therefore results are not available.

A pilot study has been in progress on developing uses for soft wheat. The experimental work has been chiefly with whole wheat and various granulations. Cooked whole wheat used in some products as cookies seems to dehydrate upon standing and becomes hard. Coarse granulations have not proved too satisfactory in some recipes as cookies and bread. Whole wheat flour has given good results in both cookies and bread.

A study was made on the incorporation of egg white solids into white cakes. Some of the methods used gave promising results but more work needs to be done. *Project 219*

Economic Significance of Pork Grades in Relation to Consumer Acceptability

Virginia K. Holt

All interviewers involved in this study observed an almost universal awareness of excess fat in the comments of the consumers and their intent to select for leanness.

The difference in outside fat in the pictures used in the store survey of ham slices trimmed to one-fourth and one-half inch external fat seemed to be compensated by a difference in marbling. It was observed that many consumers chose the one-half inch trim as the leaner slice because of this difference in marbling. This kind of confusion may have resulted in the household panels; there is no good evidence on this.

The grade A picture standard was too lean to obtain sufficient A's without exercising a "liberal" interpretation of the standards. This suggests that the existing ham standards need to be subjected to review.

Most consumers visually preferred leaner pork. The A and B2 ham slices and blade chops were usually enough different in internal fatness that consumers detected the difference and chose the leaner. This indicates that the difference in ham grades is large enough to be detected and that such grades could be developed for ham and blade chops. A preference at equal prices for leaner pork will doubtlessly be reversed with sufficiently high price premiums on the leaner. There is no good way to estimate those premiums except by sales tests.

There was an inconclusive division of opinion about eating preferences. The aversion to fat is probably so great in relation to eating differences that the latter *probably* has a negligible influence on repeat-sales.

Differences in internal fatness of loin and rib chops were too small to be consistently detected. (*Project 219*)

■ ■ ■

Horticulture

R. A. Schroeder, Chairman

Horticulture Farm

Staff of the Department of Horticulture

REPORT OF PROGRESS—

Constructed 6 acre lake.

Constructed settling basin for water entering University Farm from adjoining property.

Raised dam on 30-acre reservoir two feet there-

by increasing water holding capacity by approximately 60-acre feet of water.

Completed installation of "tubes" below the 11-acre and 6-acre lakes in order to control the overflow.

Purchased and laid underground 4500 feet of 8" steel irrigation pipe.

Constructed one residence for Farm Manager.

Completed clearing of farm. This amounting to approximately 40 acres.

Spread approximately 250 yards of road rock.

Purchased fencing and completed fencing around approximately two-thirds of the farm.

(Project 116)

Use of Water in the Production of Horticultural Crops

*A. D. Hibbard, V. N. Lambeth, Mohsen Nour
R. A. Schroeder, Joe Corgan*

Soil moisture block stations previously installed in 7 irrigated apple orchards were read at approximately weekly intervals throughout the growing season. Four of these orchardists had stations in orchard blocks which received no irrigation. The season of 1955 had normal rainfall, but most growers with irrigation systems applied additional water.

Apparent Moisture Utilization by Mature Apple Trees.
Season 1955

Non-irrigated blocks					
Orchard	Precip. in.	Consump- tive Use in.	Use Per day in.	Moisture below 50% days	Moisture under 10% any level days
E	23.8	32	.17	83.	11
P	27.5	26	.22	100.	7
S	20.2	22.5	.21	38.	0
Y	20.2	29	.24	20.	0
Average	22.9		.21	60.	4

Irrigated blocks						
Orchard	Precip. in.	Irrig. in.	Con- sump- tive Use in.	Use Per Day in.	Moisture below 50% days	Moisture under 10% any level days
P	22.4	12	33	28	0	0
H	20.9	20	47	31	41	0
Be	33.8	8	48	27	71	7
S	20.2	8	36	38	0	0
Br	20.3	15	37	33	0	12
Average	23.5	12.6		31	22	5

The growing season precipitation varied at these 7 locations from 20.2 inches to 33.8 inches. The average was 23.1, about 1 inch under normal. Mature apple trees without irrigation utilized on the average .21 inches of soil moisture daily during the

growing season. There were periods of from 20 to 100 days when the root zone contained less than 50% of its total capacity for available moisture and periods of 4 to 11 days when some part of the root zone was at the wilting point.

The seasonal precipitation in the irrigated orchards was almost identical to those not irrigated. From 3 to 20 inches of irrigation water was applied with the average being about 10.6 inches. These orchards showed an apparent daily consumption of .28 inches of water. This is an increase of .07 inches per day or equivalent to 13 inches of moisture. In season of normal rainfall there was still an apparent need for one foot of additional moisture. This figure is probably too low because there were periods when some part of the root zone was at the wilting point in the irrigated orchards. More information is needed on the effect of tree size and vigor in respect to moisture utilization. Mature trees in orchards which had not been irrigated in previous years utilized moisture at slower rates than those which had been irrigated.

Soil moisture characteristics were evaluated for several orchard soils. Available water holding capacities varied from 1½ inches to 2 inches of water per foot depth of soil.

Pot cultures of fruit tree seedlings and strawberries all gave lower growth rates at minimum moisture levels below 70% of field capacity, but above the wilting point.

Irrigated and non-irrigated treatments were established for tomatoes and sweet-potatoes on a Menfro silt loam at the Horticulture Experimental Farm. With 10.6 inches of rainfall, well-distributed in the period June 20—Sept. 1, the effects of irrigation on yields of these crops were markedly less than for the very dry years 1952-54.

The application of 3.5 inches of irrigation water increased canning tomato yields 2 tons per acre and 4.5 inches increased sweet-potato yields approximately 90 bushels per acre. Attempts to maintain the available soil moisture above 40 percent of field capacity to a depth of 2 feet on the Menfro soil sometimes resulted in temporary water-logging of the top foot of soil. This suggested that better responses to irrigation may have been limited by low oxygen supply to the roots.

(Project 1)

Nutrition of Fruit Crops

*D. D. Hemphill, A. D. Hibbard, Mohsen Nour
H. G. Swartwout*

Soil and leaves from mature apple orchards were

analyzed for total phosphorus and available phosphorus in the soil and total leaf phosphorus. The leaf phosphorus was more closely correlated with total soil phosphorus than available phosphorus. Lowest leaf phosphorus levels were found in trees from non-irrigated orchards. The irrigated leaves contained about 27% more phosphorus.

Pot culture experiments with young plants of apple, peach and strawberry were made with potassium levels of .84%, 3% and 6% of total exchange capacity, 15 m.e. The design was factorial with phosphorus levels of 120 pounds and 240 pounds per acre and minimum moisture levels of 10%, 40% and 70% of field capacity. With increased moisture levels the concentration of both K and P increased the plants. Higher soil levels of K and P increased concentration at higher moisture levels, but had little effect at the lower moisture levels. Increased adsorption of either K or P was associated with an increase in leaf concentration of the other element. The percentage of Ca and Mg in the leaves was not affected to any extent by the soil moisture level. Strawberry plants growing at 3 and 6 percent levels of K showed severe marginal burning at the lower moisture levels. The specific conductance at which injury occurred was between 30 and 75 MHOS.

New Fields—Cooperative experiments established with growers at three locations in the state in spring of 1954. Variable levels of N, P, K, Ca and Mg used. Due to drouth conditions during summer of 1954 none of the plantings made a satisfactory row of plants. Low levels of fertility gave as satisfactory results if not better than high levels. No further records taken due to condition of fields.

Old Fields—Complete fertilizer increased yields when applied in February before the 2nd, 3rd or 4th harvests and was superior to N or P alone.
(Project 4)

Use of Antibiotics and Antibacterial Substances in Disease Control

R. N. Goodman

RESULTS—Fireblight and its control—

Data from field trials strongly suggest that fireblight in a given season actually occurs as two independent waves of primary infection. The interval between waves varies from 2-5 weeks.

As rooted in previous years the initial wave blossom blight and twig infection emanating therefrom is controlled by 2-3 sprays of streptomycin applied during bloom at 50 ppm concentration.

Three years data firmly establish the effective time interval between sprays at 5-7 days.

In the field, the fungicides, captan, sulfur and the dithiocarbamates did not appear to reduce antibiotic activity nor did such insecticides as lead arsenate, DDT and Dieldrin.

Greenhouse experiments on compatibility of insecticides and fungicides with streptomycin, in all cases, suggested some reduction in antibiotic potency.

Antibiotic translocation studies indicated the following:

A. From bioassays detecting micro-quantities of streptomycin in tomato and apple leaf tissue it was determined that penetrants actually induce greater uptake of antibiotic sprays than do growth regulators (hormones). Thus it is tentatively assumed that their mechanisms for providing increased effectiveness from antibiotic sprays are entirely different.

B. Streptomycin bioassays of apple leaf and fruit tissue from trees that had been plugged in the trunk with streptomycin capsules indicated that;

- 1.) Streptomycin is extensively translocated upward.
- 2.) Its movement is preferentially to apical tissue.
- 3.) It is stable in apple fruit and leaf tissue for more than 115 at concentrations of 10 & 40 ppm respectively.

C. Bioassays of potatoes that had been dipped for 1 minute in 250 ppm of streptomycin permitted detection of this drug at 10 ppm after 120 days.

Antibiotics in control of horticultural crop diseases.

Carnation wilt (*Pseudomonas caryophylli*)

- A. Of 7 antibiotics tested Streptomycin and Polymixin were capable of providing a high degree of control of carnation wilt. Cuttings were artificially inoculated after 18 hour dips in antibiotic solutions of 100 ppm.
- B. Streptomycin thus far provides the best disease control, however it has a slight inhibitory effect upon rooting.
- C. Bioassays demonstrate antibiotics to be poorly translocated in unrooted carnation cuttings. However, improved translocation (6X) results when 0.01M K_2HPO_4 is added to the antibiotic solution.

Bacterial spot of peach (*Xanthomonas priuni*)

- A. After 3 years of testing antibiotics for "bacterial spot" control, the first positive results ever recorded were obtained in experiments at the Mt. Grove Fruit Station.
- B. Seven and five antibiotic sprays at 50 or 100 ppm initiated 30 days after full bloom provided the following information:
 1. Number of spots/leaf and extent of leaf area infected was markedly reduced by all treatments.

2. Ratio of leaf abscission (drop), induced by the disease, between treated trees and controls was 1:8.
3. Two of four varieties in the test were Elberta and July Elberta, both extremely susceptible to the disease and both responded well to antibiotic therapy.

Dactylum mold of mushrooms (*Dactylum dendroides*)

- A. Actidione effectively eradicated the fungus pathogen at 2.6 ppm applied as a low pressure spray.
- B. No discoloration or deleterious effect was observed at 2.6 ppm on mature uninfected mushrooms in the treated beds.
- C. Bioassay for residue of actidione on treated mushrooms was negative.

(Project 27)

Marketing Fruits and Vegetables

R. A. Schroeder, A. E. Gaus, J. W. McKinsey

A. E. Gaus contemplated completing calculations and writing the data. Data are to be the basis of Ph.D. thesis.

Regional Fruit and Vegetable Marketing reports on NCM-13 were made by the active states, Purdue, Minnesota and Ohio State.

(Project 63)

Virus Diseases of Stone Fruits

D. F. Millikan

More than 3000 scion and seed source cherry trees are being maintained in isolated blocks and indexed periodically for virus infection. All diseased trees are promptly removed. In addition to cherry stocks, one plum and one peach scion block have been established and more will be added to the program in the future. Plum seed sources from certified trees are to be established once suitable varieties can be found that are free from infection. This phase of the program has proceeded most satisfactorily and all cherry stocks offered for sale in 1955-56 are eligible for certification.

The possibility of virus infection in our apple and pear stocks is receiving increasing attention. What appears to be a fruit symptom was found and described during the 1955 harvesting season. This disorder resembles spray burn except that the entire fruit is blemished and no fruit on the affected tree is free from this malady. Obviously, this is a serious condition if any degree of spread should occur and the infectious nature of the condition is under investigation. The cracking of Virginia Crab is being

investigated and all varieties on Virginia Crab not showing this pitting are being propagated for future propagation purposes.

The physiological factors associated with virus infection are being exploited. Nucleic acid synthesis is of particular interest and evidence is accumulated indicating that drastic effects on the RNA fraction accompany virus infection. Such information is especially useful for the biochemical blocking studies being planned. These studies already indicate that chemical therapy using certain nucleic acid derivative analogs will inhibit virus multiplication. (Project 68)

Control of Diseases in Ornamentals, Etc.

D. F. Millikan, R. A. Schroeder, J. E. Smith
Wm. Broce, Jr.

Systemic chemicals HD 160 (Rohm and Haas) and 1182 (Carbide and Carbon Chemical) at dilution of 500, 400, 300 and 200 ppm; and 522 (Monsanto) and 6462 (Monsanto) at dilutions of 200, 100, 50, 25 and 20 ppm were used for dipping roots of rooted carnation cuttings 24 hours before planting in sand cultures. Safe ranges for each were determined to be as follows: HD 160, 200 ppm; 1182, 200 ppm; 6462, 100 ppm; 522, 20 ppm.

Rooted cuttings were treated in safe concentrations as indicated in A and inoculated with *Fusarium dianthi* at transplanting time. Temperature or inoculation techniques have failed to produce the disease to date.

Close to 1000 soil tests have been made for commercial florists and recommendations sent. Repeated followup tests have been encouraged and practiced by most growers. Over-fertilization and excess soluble salts continue to be major problems, especially with those who do not submit samples regularly.

Carnation flowers were severed just below calyx and placed dry-pack in a 40° refrigerator. At the end of 2 weeks stem was placed in 100° F water and left one week at 40° F. Flowers made into a corsage were wearable for one evening.

Better Times roses were placed in tap water adjusted to pH 4.0. "Morelife", 5% glycerin, 25 ppm Phytomycin and 300 ppm Maleic hydrazide alone and in all possible combinations were added to the acidified water as preservative treatments. Room temperature varied from 57° to 85° during the 7 days of the treatment. Opening of the flowers was retarded 1 to 3 or more days in every treatment containing maleic hydrazide. Best color was retained in the treatments of morelife plus glycerin and maleic

hydrazide plus phytomycin. Morelife alone and in combination had a dehydration effect on foliage.
(Project 114)

Production of Small Fruits

*D. D. Hemphill, Robert Nevins, T. J. Talbert
Thomas Hogard*

Fifteen named varieties and seven numbered selections were set in 1954 and fruited in 1955. Virus-free strains as well as regular strains of eight of these varieties were compared in this test. Virus free strains of Sparkle, Premier, Dunlap, Robinson and Bellmar were decidedly superior in yields to regular strains. Armore, Bellmar, Blakemore, Dunlap and Premier were the highest yielding varieties and best adapted varieties.

B. Determination of Causes of Sterility of Blackberries and Development of Methods of Control.

1. Insecticides applied before and at time of bloom were ineffective.

2. The antibiotic Actidione applied at monthly intervals during the growth of the new canes had no effect on the sterility of the plants.

3. Plants grown from hot water treated root cuttings exhibited a sterility as mother plants.

4. Seeds from partially developed fruit were not viable.

5. Approach grafts were made between new canes of Early Harvest variety which does not exhibit sterility condition and wild strain that is sterile for most part to determine if condition can be transmitted by grafting.

C. Improvement of Strawberries by Breeding.

Approximately 1000 seedlings were fruited in 1955 from crosses made in 1953 and 1954. Thirteen selections were made for further evaluation. Sixteen of the twenty-six selections made in 1954 were considered worthy of further testing. Approximately 2000 seedlings were grown for evaluation in spring of 1956. Daughter plants of selections have been placed in an insect-proof house to maintain virus-free plants of the selections while they are being evaluated.

(Project 119)

Commercial Culture of Truck Crops and Greenhouse Vegetables

V. N. Lambeth

The testing of breeding lines and commercial stock was conducted according to the recommendations of the Field Test Committee of the South-eastern Sweetpotato Cooperators Group. Nine varie-

ties and advanced breeding lines were included in the replicated plots and four lines in the observation plots.

Fifty-four sweetpotato root samples collected at random from commercial growers in the state were submitted for the regional internal cork survey being conducted by the U.S.D.A. and the Mississippi Agricultural Experiment Station. The findings of this survey will show the extent to which this virus has invaded the state. Samples of two Porto Rico strains were also sent to Dr. E. M. Hildebrand of the U.S.D.A. Agricultural Research Service for a separate internal cork study.

A cooperative effort with growers in Southeast Missouri was successful in securing a sizable acreage agreement with the Gerber Products Company of Fremont, Michigan.

The Missouri Station participated in the Southern Tomato Evaluation Program (STEP) Trials and followed closely the testing procedures suggested for both the Replicated Plots (9 lines) and Observational Trials (40 lines). Of these lines and commercial varieties, several were found to be superior to Rutgers, the leading processing variety. Many of the lines were superior in productivity but fell short in fruit characteristics and general appearance.

Cooperative test plantings approximately one acre in size were established in Stone, Barry, Newton, Saline, Pettis and Howard counties. Yields of good canning quality tomatoes ranged from 4.35 to 11.07 tons per acre. This variation in yield was closely associated with rainfall in July and August, which varied widely at the test locations. Rainfall and air temperatures were very favorable in most cases during May and June, but moisture and high temperatures became limiting later in the season. For this reason, marked responses to additional nitrogen applied as sidedressings were not apparent in unirrigated plantings.

The Missouri Station participated in the North Central Regional Irish Potato Trials which included promising breeding stock and commercial varieties best adapted to the area. With cool temperatures and good rainfall distribution, yields were exceedingly good and differences among varieties very significant. Two breeding lines from the North Dakota Station looked especially promising (ND 2910-IR and ND 457-1-16) but require further testing under more "normal" conditions to determine their adaptability to this state.

Anhydrous ammonia treatments furnishing 66 lbs./A. nitrogen in addition to a standard application of 250 lbs./A. 5-20-20 fertilizer increased irish potato yields from 205 bu./A. to 326 bu./A. in repli-

cated test plots near Richmond, Missouri. (*Project 121*)

Culture of Stone Fruits

A. D. Hibbard, T. J. Talbert, Joe Corgan

A. No result data are available on this part since the peach tree planting upon which this work is to be done was planted this year at the New Horticulture Farm at New Franklin, Missouri. A block of 150 trees were set in the spring of 1955. They made excellent growth and will be ready for the pruning experiments outlined as objective in the original project plan.

B. No data were collected on this part of the project because of the killing by frost of the entire peach crop throughout the commercial district where the work had been planned. (*Project 126*)

The Breeding of Vegetable Crops

A. D. Hibbard, V. N. Lambeth

The watermelon crop of 1955 was grown at the New Horticulture Farm, near New Franklin, Missouri. This land proved to be fairly well suited to the normal growth of watermelons for a season similar to 1955. Cooperative replicate yield and new variety observation trials were conducted according to the plan followed by the experiment station in the commercial watermelon producing states.

In the breeding work, some 100 lines were grown under observation. Seed were saved from 250 hand-pollinated melons. These melons were also scored for desirable external and internal characteristics when cut. Selected lines developed from crosses of Missouri Queen and Black Diamond have been selected to the point where a mass increase of seed is desirable. These melons have the commercial qualities of the Black Diamond combined with the wilt resistance of the Missouri Queen. The flesh is of somewhat fine texture and better flavor than most commercial lines of the Black Diamond. Some progress was made in combining anthracnose resistance into these breeding lines. Work was continued on the development of a commercially desirably ice-box type with fusarium wilt resistance. A few lines were crossed with the Royal Golden to introduce the golden rind color into the small-home garden type. (*Project 128*)

Reproduction in Horticultural Plants

D. D. Hemphill, A. E. Murneek, Robert Nevins

Groups of photoperiodically sensitive ("short-day") soybean plants, var. Biloxi and photoperiodi-

cally neutral tomato plants, var. Master Marglobe were exposed to short (8-hour) and long (16-hour) photoperiods beginning on the day they were treated with the antiauxin TIBA, the object being to see whether it would interact and possibly modify the effects of the photoperiod on flower bud initiation. The results showed that the day-neutral tomatoes, though somewhat inhibited in growth by short days, reacted more strongly to TIBA treatments as regards flowering. Biloxi soybeans on the contrary were more affected by the photoperiod (short days) in production of flowers.

NPA (N-metaphthalamic acid) was applied to several series of very young (cotyledonary stage) and to older tomato plants, as a spray at concs. of 100, 200, 300, 400 and 600 ppm. with and without subsequent spraying with TIBA at 200 ppm.

TIBA was found predominantly more effective than NPA in modifying growth and reproduction. The effects of TIBA alone on meristems of the tomato were studied microscopically and it was found that its earliest influence was a retardation of the vegetative meristems as a result of which floral primordia are developed at vegetatively inhibited nodes after resulting in a marked increase in number of flowers produced.

The relatively new antiauxin NPA, when used alone as spray at concs. of 200, 300, 400 and 600 ppm was found to be a much "milder" inhibitor of growth resulting in a markedly increased formation of flowers (Table 1). This antiauxin is being studied further in regard to its inhibition of terminal vegetative meristems.

Table 1. Effects of NPA (N-meta tolylphthalamic acid on number of flowers formed on first cluster of tomatoes, variety Master Marglobe.

No. of Plants	Conc. of spray	Avg. no. of flowers per cluster
8	Not sprayed (controls)	5.1
8	100 ppm	6.4
8	200 ppm	15.6
8	300 ppm	16.1
8	400 ppm	15.0
8	600 ppm	14.0

p-Chlorophenoxyacetic acid, 2,4-dichlorophenoxyacetyl D,L-Methionine, N-meta tolylphthalamic acid and 10 analogues of this chemical were applied as foliage or flower cluster sprays to increase fruit set in greenhouse tomatoes. p-Chlorophenoxyacetic acid applied as a cluster spray was the most effective spray.

N-meta tolylphthalamic acid applied as a foliage spray was not effective in increasing set of field tomatoes or lima beans.

Relationship of auxin to dormancy studied in peach bud. Auxin extracted by ether, separated by paper chromatography and assayed by color reactions and avena and pea growth tests. Indication of more than one active substance on possible indole-3-acetic acid and another with an Rf value of about .4 to .5. (Project 129)

Control of Weeds in Horticultural Crops

D. D. Hemphill, Thomas Hogard

CIPC (isopropyl-N-(3-p-chlorophenyl) carbamate) tested for 4 years and 3 years respectively are superior to presently recommended herbicides and will be recommended for use in vineyards.

Fourteen chemicals evaluated as herbicides in vegetable crops. New promising results: TCA (sodium trichloroacetate) in broccoli and cabbage, CDEC very promising in green and lima beans, sweet corn, okra. Dalapon in potatoes.

Control of chickweed, henbit, crabgrass and bermuda grass studied. TCB (2,3,6-trichlorobenzoic acid) gave excellent kill of henbit; ammonium sulfate most satisfactory kill of chickweed, Alanap 1F for pre-emergence control of crabgrass and disodium methyl arsonate for post-emergence control and methyl bromide for eradication of bermuda grass.

CPCPC (chloropropyl chlorophenyl carbamate) promising for weed control around young apple trees. (Project 146)

Promotion of Horticulture

T. J. Talbert, R. A. Schroeder

Report of research findings and recommendations were given to the horticultural crop producers in the state through the following department publications:

1. Horticultural News
2. Floricultural News
3. Vegetable News
4. Weekly Spray Letter

The apple merchandising work of bringing producer and buyer in touch with each other in the form of an up-to-date availability of apples letters.

The attending of horticultural meetings by all staff members to present information of interest to producers and other research workers.

Assisted in the conduction of Short Courses in the fields of Floriculture, Landscape Gardening, Vegetable Growing and Fruit Production.

(Project 169)

Downy Mildew and Black Rot Control on Grapes

R. A. Schroeder, H. G. Swartwout

DOWNY MILDEW—In tests on the Concord variety for the control of downy mildew after the disease had become established on the foliage, the effectiveness of the different treatments was as follows: 1st and excellent, captan 1-100 plus Actidione 1 ppm plus 4 ozs. Triton B1956 spreader; and excellent, bordeaux 3-4-100 both with and without Triton spreader; 3rd and excellent, bordeaux 2-2-100 both with and without Triton spreader; 4th and good, captan 2-100 plus 4 ozs. Triton; 5th and fair, captan 2-100 without spreader. There was light marginal leaf burn and foliage dwarfing with the bordeaux but no observable injury with the other treatments.

BLACK ROT—Due to the loss of the grape crop from late spring freeze no information was obtained on black rot control. (Project 194)

Hormone Sprays for Fruit Thinning and Control of Preharvest Drops

A. E. Murneek, R. A. Schroeder

An NA-amide spray, at 100 ppm concentration applied at petal fall on heavily blooming old Wealthy trees, had but slight thinning effect (Controls 68.2% of flower clusters set fruit, sprayed 60.1%). Similarly young Golden Delicious trees sprayed with NA-amide at 100 ppm had a very heavy set of 55.7%. This was reduced but slightly to 52.2%, when 5 days later the same trees received an additional spray of NA (Naphthaleneacetic acid) at a concentration of 10 ppm.

In another orchard NA-amide at 75 and 100 p.p.m. was applied at petal fall to 12 year old Golden Delicious trees. Thinning, though better, was still insufficient: Checks 79.7% flower clusters with fruit, sprayed trees 56.4% and 59.4% respectively.

A study of seed content in the apples, which is a good index of efficiency of a thinning spray, showed practically no difference:

Wealthy: Checks, average of 5.6 seeds per fruit, sprayed 5.7. *Golden Delicious*: Checks 8.1, sprayed 8.7 and 8.8 respectively. The fairly popular NA-amide spray is not an efficient material for thinning of biennially bearing varieties of apples.

IPC at 750 and 1000 ppm, applied to heavily blooming Jonathan trees ca. 3 weeks after petal fall, did not thin the excessive fruit set on these trees.

(Project 195)

Response of Vegetables to Established Cationic Saturation Levels

V. N. Lambeth

Fertility plots were established on Menfro silt loam at the Horticulture Experimental Farm at Franklin, Missouri. The soil has a cation exchange capacity (C.E.C.) of 12.54 m.e./100 gms. and tested as follows before fertilizer treatment:

	P ₂ O ₅	Exc. K	Exc. Ca	Exc. Mg	Buffer Hydrogen
Lbs./A	30	260	3100	350	3000
M.E./100 gms	--	0.33	7.75	1.46	
% of C.E.C.	--	2.63	61.80	11.64	23.92

The stable organic matter content was 0.9% and the pH 6.1. The following fertility treatments were established by thoroughly incorporating the fertilizers in the upper foot of soil:

1. No Ca, P or K added.
2. P₂O₅ increased to 300#/A.
3. P₂O₅ increased to 300#/A.; K to 4% of the C.E.C.
4. P₂O₅ increased to 300#/A.; K to 4%; Ca to 75% of C.E.C.
5. P₂O₅ increased to 300#/A.; K to 4%; Ca to 75% + Boron (20#/A)

Ammonium nitrate at a rate of 100#/A was applied to all plots at the start of the season.

Each treatment plot (30 ft. x 40 feet in size) was replicated four times in randomized arrangement. A favorable moisture level was maintained through the season by supplemental irrigation — above 40% of field capacity to depth of 12 inches.

Rutgers tomatoes were transplanted May 12 and grown to maturity.

The only striking response to fertilization was to phosphorus fertilization where an increase in phosphorus (P₂O₅) from 30#/A. to 300#/A. increased the yield of marketable fruit from 5.69 tons per acre to 10.74 tons per acre. There were no significant responses to cationic saturations above the initial levels—2.63% for potash, 61.8% for calcium and 11.64% for magnesium.

It is suggested that yields may have been limited by tight soil structure. Response to higher cation levels would not normally be expected except in higher yield ranges—where the nutrient removal is much greater. (Project 196)

Elimination of Chemical Residues

Melvin Johnston, Neil Finley

Three replications (21 gal.) each of sprayed and control lots have been fermented. The sprayed lots

were taken from field plots of four insect control schedules and control plots (unsprayed). Bacteriological examination of the fermenting brine for yeasts, coliform bacteria and proteolytic bacteria indicate that these organisms are not affected by the lindane residue from the insect control schedules. Examination for Lactobacilli in the brine indicates that these acid-formers are affected by the spray schedules.

Salt stock from last year's work (Field Control schedules) was processed into sour, sweet and dill pickles. Organoleptic analyses for flavor of the pickles did not indicate a significant effect of the spray residues; however, when lindane was added to the cucumber brine at the rate of 10 ppm, this flavor was adversely affected. Chemical analyses of the field plots samples showed that the raw sprayed cucumbers contained 1 ppm or less of lindane and the pickles contained a smaller amount. Where lindane was added to the brine, the pickles contained 4.68, 8.10 and 7.00 ppm for sour, sweet and dill, respectively. (Project 197)

Pesticides for Disease Control and Effect on Fruit Finish

H. G. Swartwout

SOOTY BLOTCH CONTROL—*Test No. 1*—As compared with unsprayed controls and controls not receiving lead arsenate the application of lead arsenate at 3-100 in the calyx, 1st and 2nd cover sprays delayed the summer appearance of sooty blotch for a little over 70 days. In a low area with poor air drainage sooty blotch became evident on unsprayed trees the first week in July whereas the disease did not appear until the last week of September where early season applications of lead arsenate had been made.

Test No. 2—Two lead arsenate sprays (3-100) with 2 ozs. Triton B 1956 spreader applied in June shortly before the usual time for the appearance of sooty blotch gave nearly 80 percent clean or practically clean fruit to harvest time (Sept. 10) as compared with only 6 percent clean fruit on unsprayed controls. The duration for complete protection was about 70 days.

Captan at 2-100 in two June sprays did not adequately protect the fruit against sooty blotch under a like disease potential.

Test No. 3—Two applications of lead arsenate at 2-100 plus 1 lb. of captan as arsenical safener plus 2 ozs. Triton B 1956 spreader when applied in July (12th and 22nd), effectively erased sooty blotch lesions that had appeared but which were not well

established.

Residue analysis on fruit samples replicated several times showed only one lot with a combined lead and arsenic residue in excess of the federal tolerance and this sample was only slightly above the 7 ppm allowed.

The insecticide Diazinon was applied at 2-100 in three separate periods to determine any effect it might have upon fruit finish. These periods were as follows: (1) 1st, 2nd, 3rd covers; (2) 3rd, 4th, 5th cover; (3) 6th and 7th covers. No adverse effect upon fruit finish was observed on Jonathan, Delicious and Golden Delicious; the three varieties used in the test.

(Project 232)

Technology of Apple Products

Melvin Johnston, Neil Finley

The study is concerned with the development of a technique for the making of a good quality frozen concentrated apple cider. The problem is being approached from the standpoint of the quality of the more popular varieties for cider and the enhancing of these qualities by partial fermentation of the juice. The Jonathan, Winesap, Golden Delicious, Red Delicious, York Imperial, Rome Beauty and Ben Davis were characterized for acidity, sugar, flavor and aroma. A blend of one part Jonathan, Golden Delicious and Red Delicious produced a good quality juice.

Selected strains of *Saccharomyces*, *Candida*, *Debaryomyces*, *Hansenula*, *Endomycopsis*, *Torulasporea*, *Schizosaccharomyces* and *Zygosaccharomyces* were used to partially ferment the apple juice. Of the yeast strains examined, *Candida krusei*, a distillers yeast, a bakers yeast, *Endomycopsis monosporus*, *Hansenula fabianii* and *Saccharomyces fragilis* imparted a desirable flavor and aroma (fruity) to the cider. With the exception of the distillers and bakers yeast strains, these yeasts are low alcohol producers which is a desirable characteristic. The amount of alcohol, volatile acid, esters was determined for each of the 18 yeast strains studied. Loss of sugar during the fermentation period was determined. Flavor and odor were determined organoleptically. (Project 233)

Technology of Irish Potato Products

Melvin Johnston, Neil Finley

A. Irish potatoes, variety Waseca of size 1½ to 1⅞", were stored at 45°F. and 65% R.H. in 5 pound sample replicates. Package types used were polyethylene 15 mil, perforated; polyethylene, 15 mil, sealed; polyethylene, 25 mil, sealed and fiber mesh

bag. Treatments used were sorbic acid, tetrachloroethylene, Dowcide A, agri-mycin, S.T.S. (streptomycin), actidione, chlorine, control with I.P.C. sprout inhibitor and control (no sprout inhibitor). All the potatoes were treated with I.P.C. (sprout inhibitor) except the ones indicated. The 15 mil perforated polyethylene bag retained a significantly (.01 p value) greater amount of usable quality potatoes after 3½ months storage; 25 mil sealed polyethylene was lowest and 15 mil sealed polyethylene and mesh bag were intermediate. Sorbic acid was significantly (.01 p value) more effective in retaining the quality of potatoes after 3½ months storage; actidione and Dowcide A were least effective; and the other treatments were intermediate. I.P.C. (sprout inhibitor) appears to improve keeping quality of potatoes. In addition to the 3½ month examination, the samples were examined after 1½ and 3 month storage

B. Seventeen varieties of Irish potatoes were examined for their adaptability to Frozen Mashed Potato production. Six of the varieties (Michigan 1363, North Dakota 2910-IR, North Dakota 457-1-16, Keswick, Waseca and Early Gem) warrant further study of their qualities. A Blue Value Index determination of free starch was correlated with the consistency of the thawed prepared product. A reasonably good agreement was found between the index and organoleptic rating of consistency of the samples. (Project 234)

Identification, Pathogenicity, and Physiology of Horticultural Plant Pathogens

D. F. Millikan

Approximately 75 letters were answered concerning diseases affecting horticultural crops. In addition several trips were made to examine conditions that could not be covered by mail. Three diseases new to the state were found and one of these had not been reported on the affected crop within the country. Facilities are set up for improved service during the coming year. (Project 258)

Bacterial Spot, Brown Rot, and Peach Scab Control and the Effect of Some of the Newer Pesticides Upon Fruit Finish of Peaches

H. G. Swartwout

Single tree replicates of Elberta were sprayed with an organic silver complex and captan at 2, 4, and 6 lbs.—100 gals. for the control of bacterial spot. Sulfur sprayed trees and unsprayed trees were used

as controls. Due to weather conditions no bacterial spot developed this past season (1955); although heavy infections had occurred in this area the two preceding years.

Spray programs of sulfur and captan were ini-

tiated to determine their comparative merit in the control of brown rot and peach scab and their effect upon fruit finish, but due to a late spring freeze which killed most of the fruit buds these tests were discontinued. (*Project 243*)

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Poultry Husbandry

E. M. Funk, Chairman

Minimizing Quality Losses in Shell Eggs and Dressed Poultry

E. M. Funk, R. F. Grotts, Glenn Froning

Storage experiments confirm previous results that egg losses in commercial storage can be reduced significantly by heat treatment. With eggs held at room temperature, we have experienced losses from organisms that survive the heat treatments.

From the measurements made to date, there appears to be no significant difference in the quality of eggs laid by hens in cages and their sisters on the floor, except that the hens in cages produced a slightly larger egg (not for release as yet).

The amount of thick white declined as the birds aged and as they entered the summer months. However, these birds are still (November 1955) producing good quality eggs (all A quality).

The quality of eggs held at 80°F. declined rapidly in contrast to eggs held at 30°F. However, there appeared to be no difference in the decline in quality of eggs laid by hens in cages and on the floor.

Tests made with A-C Polyethylene emulsion 629 showed that it was more effective in preventing evaporation and in reducing mold growth than oil processing.

The Oswald-Fenske pipettes were satisfactory for measuring viscosity of egg albumen. The relative viscosity of the thin albumen ranged from 3 to 8 times that of water. The viscosity of thick albumen of hen eggs (12 months in production) averaged 80 times that of thin albumen from the same eggs whereas in eggs laid by pullets coming into production the corresponding figure was 127 times.

The refractive index of the albumen of eggs laid by birds coming into production declined as laying progressed.

Results obtained indicate that soiled eggs may be cleaned so as to keep well in storage. Other results indicated that hens in cages may produce slightly larger eggs than their sisters on the floor (not for release). Otherwise there appears to be no difference in the quality of eggs laid by hens in cages and others on the floor.

A polyethylene emulsion was more effective in preventing evaporation and mold development than oil processing. The interior quality of such eggs was also superior to the controls or oil processed eggs. (*Project 17*)

Rations for Growing Chicks

Jimmie Savage

Studies during the past year have been concerned with the effect of addition of DL-Methionine and animal fat to the ration given in Table I.

The procedures used were as follows:

DATE STARTED—August 4, 1955.

EXPERIMENTAL PERIOD—Ten weeks.

LOCATION—South Poultry Farm, University of Missouri.

BREED—Lancaster x New Hampshire.

HATCHERY—W. B. Smith, Columbia, Missouri.

NUMBER STARTED—103 per pen, duplicate pens used for each ration.

MANAGEMENT—Started on clean shavings and litter was not changed during experimental period. Vaccinated with combined Newcastle and bronchitis dust vaccine at one week of age.

RATIONS—Basal—Table I.

Basal + .05 percent DL-Methionine

Basal + 5% fat (replaced 5% of yellow corn)

Basal + .05 percent DL-Methionine + 5% fat stabilized tallow)

DATA OBTAINED—Individual weights at ten weeks of age and feed efficiencies for the ten week period were obtained for all birds.

249-C contains per pound: Riboflavin 2.0 gm.; Ca Pantothenate 4.0 gm., Niacin 9.0 gm., Choline Chloride 10.0 gm.

Choline Chloride Mix contains 25% choline chloride dried citrus meal.

COMPOSITION OF BROILER RATION

Ingredient	Percent
Ground Yellow Corn	60.5
Soybean Oil Meal, Solvent	31.0
Fish Meal (60% Protein)	3.0
Dehydrated Alfalfa Meal (17% Protein)	1.5
Dicalcium Phosphate (20% P)	2.0
Ground Limestone	1.0
Salt	.5
A and D Oil (1500 A, 600 D)	.25
MnSO ₄ (Technical, 70% MnSO ₄)	.02
2-49-C	.1
Choline Chloride Mix	.1
Pro-Pen 2:3	.075
NiCarbazin	.05
CALCULATED ANALYSIS:	
Crude Protein, %	21.8
Crude Fat, %	3.0
Crude Fiber, %	3.4
Calcium, %	1.2
Phosphorus, %	.9
Riboflavin, mg./lb.	2.9
Pantothenic Acid mg./lb.	7.0
Niacin, mg./lb.	21.0
Choline, mg./lb.	720.0
Vitamin A, I.U./lb.	3640.0
Vitamin D, I.C.U./lb.	680.0
Productive Energy, Cal./lb.	905.0
Methionine, %	.34
Cystine, %	.32

Pro-Pen 2:3 contains 2.0 gm. per pound of procaine penicillin and 3.0 mg. per pound of Vitamin B₁₂.

In those groups that received either methionine alone or fat plus methionine the average weight exceeded that of the basal. The groups that received fat weighed slightly less than those that received the basal diet. Although the indications were that methionine improved growth slightly the differences between duplicate pens indicates such differences in growth rate are of doubtful significance. Additional trials are required for more data on this phase.

The addition of fat improved feed efficiency slightly, added methionine also produced a slight increase in feed efficiency and the combination of fat and methionine was more effective than either alone.

It would appear that the basal ration may be on the borderline with respect to content of sulfur amino acids required by the chick, and additional methionine must be supplied in order to efficiently utilize the additional energy provided in the form of added fat. (Project 24)

Testing the Performance of Different Strains and Crosses of Poultry

Q. B. Kinder, A. B. Stephenson

Investigations in this study included the performance of six parental pure lines introduced in

1954 for the full year of 1954-55 and the part year performance (to December 1, 1955) of their offspring in purebred, crossbred, and strain cross combinations along with performance of commercial crosses and hybrids. Eighteen hundred and fifty chicks were hatched and 1438 pullets housed. This included 5 purebred, 3 strain crosses, 26 crossbred combinations, and 7 commercial crosses and hybrids.

Part year performance records on the test crosses indicate:

1. Earlier sexual maturity in test crosses as compared to purebreds. No difference in test crosses as compared to commercial crosses and hybrids.

2. Test crosses using a Leghorn on the male side were earlier in sexual maturity than the reciprocal mating.

3. Mortality was higher in test crosses using Leghorn males on heavy breed hens than reciprocal matings.

4. Selected strain crosses and selected crosses appear to perform equal to commercial hybrids and superior to untested commercial crosses.

5. Selected purebreds appear to compete closely with the better test crosses and hybrids. (Project 26)

Care of Hatching Eggs

E. M. Funk, Bobby R. Jones

Results obtained this year indicate that eggs held at 50°F. hatch better eggs than eggs held at 60°F. or 70°F.

Results with turning eggs during incubation verified previous experiments which showed that turning eggs through 90°, 120° and 150° increased the percentage of hatch above that obtained when eggs were turned through 60°. There is also more evidence that eggs turned in more than one plane and at greater angles improved hatching results.

The study indicates there may be some advantage in incubating eggs in a natural or near horizontal position instead of incubating them on end and at an angle of 42 degrees.

Evidence indicates that a higher (88°F. wet bulb reading) humidity in the hatching compartment at the beginning of the hatching period gives better hatching results than a lower humidity (80°F. wet bulb reading).

(Project 40)

Thyroxine Secretion Rate of Growing Turkeys

H. V. Biellier, E. M. Funk

Experimental work during the past year has been directed at determining the effects of gonadal hor-

mones on growth and finish on market turkey poults. One brood of 250 Thompson Large Broad Whites were hatched May 5, 1955 and placed on experiment immediately.

The poults were brooded in chick batteries until five weeks of age. After removal from batteries at five weeks the poults were randomized into five experimental lots of mixed sexes. From five weeks of age until twenty weeks of age the poults were reared in a pole-frame rearing shelter with wire enclosed sides. All birds were weighed at each two-week interval.

Crystalline testosterone (male hormone) was included in regular ration at levels of 10, 20, 40, and 80 grams per ton and fed from six to 16 weeks of age. The higher levels were effective in stimulating rate of gain in both males and females. Treated birds of both sexes developed extensive head furnishings, head coloring, and beards. Females developed male-like characteristics but fighting and mating did not occur. The male poults that received 80 grams of testosterone per ton of feed gained 8.4 percent more than the controls and females 9.5 percent.

(Project 72)

Effect of Protein Level on Egg Production, Egg and Body Weights

Q. B. Kinder, Mike Kelly, Jimmie Savage

CONCLUSIONS:

1. Raising the average protein intake level from 15.25% to 17.3% in total ration by increasing the protein in the mash portion resulted in slightly but significantly lower egg production. (Significant at a 5% level).

2. Variation of protein level in this experiment had no effect on egg weight, body weight, or adult mortality.

3. Feed efficiency was slightly better on the 20% protein mash and hand fed grain. Part of this could be due to difference in production and energy level of ration.

4. Data suggest that energy level of ration needs to be considered along with protein level. The energy level of the 24% laying mash was 6% lower than the 20% mash.

(Project 118)

Factors Affecting the Quality of Shell Eggs

E. M. Funk, James Forward

Results show the steps necessary to produce and market quality eggs are: produce infertile eggs, keep

nests clean, use shavings or absorbent nesting material, use plenty of nests, gather frequently, keep eggs cool, cool in wire basket before casing, hold where humidity is high, case small end down, market often, and sell on graded market.

The objectives are to determine the value of refrigeration (natural and mechanical) and thermostabilization in maintaining the quality of shell eggs from the farm to the wholesale dealer in the Central market. The value of short-time thermostabilization 1½ to 2 minutes at 150°F. in maintaining the quality of washed soiled eggs will be tested.

The broken out score of the eggs showed the eggs held in the cooler were of higher quality than those held in the basement, and those held in the basement were much higher than those held at room temperature. Soiled washed eggs were as high quality as clean eggs held in the basement. Soiled washed thermostabilized eggs were of higher quality than clean eggs held in the cooler. (Project 161)

Systems of Breeding for Poultry Performance

E. M. Funk, O. B. Kinder, A. B. Stephenson

OBJECTIVES:

A. To test specific combining ability in the recurrent selection method of breeding poultry.

B. To compare the recurrent selection method with the more conventional intra-flock method.

Plans for the Future. No major changes in the general plan of conducting the experiment are anticipated. The reduced number of strains will permit more emphasis to be placed on individual differences within a strain. More of the test crosses will be with the segregating strain as the female parent than the reciprocal cross because of the economic advantage of higher production in the female side of a cross. (Project 164)

Systems of Flock Replacement

O. B. Kinder

After brooding to 8 weeks of age in brooder houses, chicks were randomized to confinement shelter and to range. Five hundred and fifty chicks of three ages were grown in three divisions of the confinement shelter and 781 of the same breeding and age groups were grown on range. Records on mortality, missing birds, and weight at housing are reported. Yearly egg production and mortality will be reported at end of laying year.

It will be noted that death loss from other than accidents and pickouts was 1.7% higher in the con-

Treatment	No. Birds	Dead		Accident		Pickout		Missing		Housing	Avg. 22
		No.	%	No.	%	No.	%	No.	%		Wk. Body Weight
Confinement	550	32	5.8	16	2.9	5	1.0	1	0.2	90.0%	4.06#
Range Reared	781	32	4.1	3	0.4	12	1.5	17	2.2	91.8%	3.89#
Deviation from Range Reared			+1.7		+2.5		-0.5		-2.0	-1.8%	+0.17#

finer birds. Accidental deaths due to smothering were higher, but this was due to 12 birds smothering by piling up after being scared the first night in the shelter. Pickouts were more common in the range reared birds which was not expected. Apparently failure to turn birds out early enough from small range shelters results in more pickouts than continuous confinement where more area is available. Two percent more birds were missing from range or unaccounted for than in confinement. This figure was on the front range. The overall range figure on missing birds was about 3.5 percent; indicating a location effect. Disregarding the accidental deaths, the number housed from confinement and range was about the same. Average body weight at housing favored the confinement reared birds by 0.17 pounds or about 4 percent.

Feed per pullet housed under a self feeding program resulted in identical feed consumption of 17.6 pounds for both range and confinement. The confined birds ate 59% mash, 33% corn, and 8% oats as compared to 50.6% mash, 36.3% corn, and 13.1% oats for the range reared birds indicating a slightly lower protein requirement for the range reared birds. Feed efficiency slightly favored the confined birds due to a slightly heavier housing weight.
(Project 244)

Rations for Laying Hens

Jimmie Savage, Mike Kelly

Four pens of 200 birds each were placed on two levels of energy in the mash portion of a self fed mash and hand fed grain system of feeding. Productive energy values of the higher level mash calculated 817 calories and the low energy 729 calories per pound. Birds were hand fed oats in the morning and corn in the afternoon on the basis of what they would clean up in 15-20 minutes. One pen of 200 White Leghorns and one pen of 200 crossbreeds were placed on each ration and feed, production, mortality and body weight records recorded for a period of 10 months after housing.

Table I. Feed Record Summary 10 months 1954-1955

Treatment	% Consumed			Calories per lb.	Feed per doz. Eggs
	Mash	Corn	Oats		
Low energy	60.55	24.15	15.30	834	4.75
High energy	60.85	23.85	15.30	886	4.69

Although there was a slight improvement in egg production 0.5% and feed efficiency 1.3% on the

Table II. Body Weight, Egg Weight, Mortality and Egg Production

Treatment	No. Birds	Body weight 300 days	Average Egg Weight	% Mortality	% Egg Production
Low Energy	400	4.98	25.46	6.0	66.6%
High Energy	400	4.89	25.43	7.0	67.1%

higher energy level these were not significant. Body weight in January was slightly higher for the low energy group. Part of this may have been due to slightly higher egg production from the high energy group. Egg weight and mortality were essentially the same with the two groups. In general the increase in energy level of 88 calories per pound of laying mash or 52 calories per pound in the total ration were of insufficient magnitude to give any significant difference in productive performance. Further trials with a greater difference in energy level of mash portion should be made.

(Project 255)

Nutritional Requirement of the Chick

J. E. Savage

A basal purified diet was used to study the effect of supplements of liver protein and amino acids on growth rate of chicks. Values given are the averages for two trials with duplicate lots in the first trial. It is apparent that the supplement of liver protein as in Ration 4048 improved growth rates. In Ration 3491, a supplement 1.5 percent of glycine and 1.0 percent of arginine hydrochloride was almost as effective as the supplement of liver protein. Growth rates observed with the diet that contained both liver protein, arginine, and glycine as in Ration 4049 were not significantly higher than where the ration contained either the liver protein or the arginine and glycine. This would indicate that almost all of the growth promoting effect of liver residue could be duplicated with supplements of synthetic amino acids.

Considerable variation was observed in those birds that received the casein-gelatin basal ration, and the lower average weight of the basal group is generally due to the presence of several chicks that weigh much less than average. These low-weight

chicks also exhibit rather characteristic symptoms of muscular leg weakness and poor feathering. Other chicks on the basal diet, Ration 3251, appear essentially normal except for a slight deficiency in feather growth. The reason for this growth variation is not known at this time.

Exceptionally good growth for Single Comb White Leghorn chicks was obtained on the basal ration with male chicks averaging almost 400 grams at four weeks of age. Neither liver protein nor ar-

ginine supplements produced a marked acceleration in growth rate although the groups that received liver protein did weigh slightly more than the basal group. Omission of the gelatin and adding 1.0 percent arginine hydrochloride and 1.5 percent glycine supported growth rates comparable to the liver protein supplemented group. The results with graded levels of arginine were inconclusive. Glycine alone was ineffective.

(Project 277)

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Rural Sociology

C. E. Lively, Chairman

Cultural Factors Affecting Illness in Rural Missouri Areas

Mary Bonwell, Edward Hassinger, C. E. Liveley
R. L. McNamara

A schedule was devised for an inquiry into cultural factors affecting rural health. The schedule was pre-tested carefully and was then used in home interviews of 152 farm and other open country families in Laclede County. It should be pointed out that the experience gained in the pilot study of Carter County in 1954 was very helpful to the research staff in planning and executing the "full-scale" work this year. In addition to the family interviews, a study of hospital discharges has been undertaken in Laclede County to furnish evidence on extent to which a centrally located hospital serves the people of the county; the reliance on hospital insurance; and the cost and duration of hospital care. Finally, in the field phase of this study, interviews have been held with key county people especially those familiar with health conditions such as physicians, nurses, and agricultural welfare leaders.

A coding plan for the data collected has been devised and put into operation, and tabulation of the material is under way. Plans for publication include a first bulletin on the extent of illness and the use of medical services to be followed by separate bulletins on: paying for health care including the use of insurance; attitudes and opinions of rural people toward physicians and toward scientific care of illness; and health practices and preventive measures.

Detailed results are not yet available but the first bulletin as mentioned above is scheduled for completion this year. (Project 201)

The Rural Church in Missouri

C. M. Coughenour, L. M. Hepple, J. S. Holik
C. E. Lively

In the State sample of 345 rural clergymen, 75 percent were church-type and 25 percent were sect-type. Approximately 42 percent had received less than a college education, 33 percent had received some college training, and 25 percent had completed college and received some seminary training. A majority of them, 201, devoted only part-time to the work of the ministry, while 144, or approximately 42 percent, devoted fulltime to the ministry. Significant differences were found between church-type and sect-type, as well as between full-time and part-time, clergymen. The clergymen in the sample had on an average 1.9 churches, and served 190 members. They received \$1591 in salary, \$47 in fees, and \$1057 in other income which made an average total income of \$2705 for the year 1951-52. Only 47 percent of them were furnished a parsonage. The average amount of time per week devoted to seven categories of work is as follows: preparation of sermons and speeches 7.4 hours, Bible reading 6.4 hours, general reading 5.8 hours, conferences and/or confessionals 1.9 hours, visitation 10.7 hours, Sunday schedule 3.3 hours, and weekday religious services 1.2 hours. The total time spent per week for these activities was 36.7 hours.

An index of religious group action was constructed to make possible the comparison of churches

with one another and to determine the relationships between churches and certain environmental factors. A three item index consisting of the size of the group, Sunday worship services, and religious education score was used. There were some significant differences between the mean index of religious group action for the rural social areas, but these differences were affected greatly by the distribution of certain religious bodies. The correlation between the index and the level of living was low for the entire State. However, in some sections there was a significant relationship in that the low level of living was related to low index of religious groups action, and a high level of living was related to a high index of religious group action. The relationship for the State was low because in one area there was a negative correlation between these two items. The correlation between the index and soil types was .38. The correlation between the index and the rate of tenancy was .04. The index was correlated significantly with the population base per church and the population-membership ratio for townships.

The preferences of the respondents in the attitude and opinion poll were analyzed in terms of certain characteristics. It was found that there were no great differences in terms of such variables as residence in open country or village, race, and occupation. There were a few questions where the variables of age, sex, and education made some difference. There were consistent differences between respondents in terms of church-type and sect-type, and in some cases in terms of specific religious bodies. Differences were also found in terms of the six selected areas. Since the six areas cannot be combined and thought of as a state sample, any statement of detailed results would have to be given for each of the six areas. (*Project 143*)

Social and Cultural Factors Affecting the Dissemination and use of Scientific Farm Information by Missouri Farmers

*C. M. Coughenour, H. F. Lionberger, C. E. Lively,
J. S. Holik*

Material for this study was drawn from interviews with 279 farm operators and wives living in a single rural community in the good farming area of Northeast Missouri. Interviews were taken in 1950. The general purpose of the study was to define elements in the social structure of the community that might have a bearing on the diffusion and use of farm information and to determine how they operate.

The structural elements considered were the community, neighborhoods, social cliques, kinship

and work exchange groups, special interest organizations, and personal attributes of individuals (status factors) which tend to structure communication on a person-to-person basis.

The most obvious influence of the community and the five neighborhoods delineated was the containing influence exerted on patterns of interpersonal communication. Over three-fourths of the persons sought as sources of farm information by farm operators living at the periphery of the community were persons on the inside. The same tendency was in evidence in somewhat lesser degree with neighborhood residents who also showed a greater inclination to confine information seeking relationships to fellow members than residents in control areas of comparable size and location. Prevailing community standards permitted wide latitude in the choice of individuals as sources of farm information and in decisions regarding farm practice permitted. Perhaps even more important was the fact that alertness to new developments in farming was a status factor. Community sanctions thus operated to encourage change rather than to slow it down.

Because of norms of conduct relating to the exchange of farm information and because circumstances of local residents is commonly known, a type of source needed to convince doubters and skeptics is provided. In a sense the community also served an integrative function by establishing channels of communication between organizations and people of influence in the local area. Social differentiation in terms of prestige which is largely a product of social interaction within the community, is necessary both for proper organizational functioning and for the diffusion of farm information.

Whether or not there is any difference in norms pertinent to the diffusion of farm information between neighborhood and non-neighborhood residents was not definitely established. However, neighborhood residents placed a greater emphasis on other persons as sources of farm information than non-neighborhood residents. The latter placed more emphasis on the mass media than the former. The places of most frequent contact and discussion of matters related to farming with other farmers were neighborhood centers. For non-neighborhood residents the village center and organizational meetings took precedence.

Although neighborhood residents did not vary much from non-neighborhood residents in the number of improved practices used there was some evidence to indicate they adopted new practices for different reasons. That is non-neighborhood residents may have been somewhat more motivated by ration-

alistic norms of efficient production than neighborhood residents while the latter may have been more inclined to accept changes in order to keep up with their neighbors.

Failure of selected farm residents to agree on the number of rating categories used in rating other farmers on a prestige basis was taken as evidence of the non-existence of clear cut social classes. However prestige differences were found and agreement as to the placement of individuals in the prestige hierarchy was high.

In the quest for information on a person-to-person basis the general tendency was to look up the prestige scale for persons sought as sources. This was true with all three types of information seeking relationships used. Although there was a slight but significant tendency for prestige to operate as a barrier to communication it operated within an overriding pattern in which farm operators at all prestige levels, except the very highest, made most use of farmers as sources who had a higher prestige rating than themselves. Of significance in negating the slight tendency for prestige to serve as a barrier was the fact that this barrier was least in evidence in the most important information seeking relationships namely those with "local influentials."

Although farmers were inclined to deny the existence of same, social cliques and other informal groups of a related nature were in evidence. By defining all situations involving the transfer of farm information within, without, and across clique lines in an assumed order of resistance to communication and by computing and comparing the proportion of possible opportunities for contact used it was possible to detect relative amounts of influence exercised.

While there was definite evidence that common clique or related informal group membership facilitated the diffusion of farm information among fellow members evidence concerning their restrictive influence was questionable. Where significant differences did occur they usually were at the point on the assumed resistance continuum where the information seeker was confronted with mechanisms of groups exclusion. Also it is highly significant that evidence of a clear cut continuum of resistance was most in evidence in the use of contacts with "local influentials" who elsewhere have been shown to be eminently qualified to give advice.

In some respects social cliques and neighborhoods seemed to serve much the same function in the diffusion of farm information. Both tended to increase contacts with fellow members and thus also in a sense to restrict contacts with non-members. In line with a thesis that farmers residing in non-neighborhood areas may be more rationalistically oriented

to farm technology than those living in neighborhood areas, clique membership which is usually associated with rationalistic standards was greater outside than inside neighborhoods. Also in accord with this reasoning was the finding that contacts were most restricted in the most selective information seeking relationships namely those with local influentials.

Some formal organizations are specifically organized for the function of disseminating farm information and the improvement of farm technology. For them the question of function requires little investigation. Also a latent function of providing opportunity for contacts and thus the communication of ideas is provided. Perhaps indicative of this function was the tendency for active participants in formal organizations to use more persons as sources of farm information than those less active or those who did not participate at all.

When treated as a status factor and when analyzed in terms of the proportion of possible contacts used by seekers and persons sought with differing amounts of participation a preference for high participants was in evidence. However, analysis here, as with other status factors, was complicated by an association of both technological competence and prestige with social participation and therefore by the influence which both of the former exerted in the choices made. However, all evidence pointed to technological competence and perhaps prestige as being more important than social participation. (*Project 29*)

Human Factors Affecting Food Selection and Consumption Patterns

*C. L. Gregory, C. E. Lively, L. S. Malone,
M. L. Bowman*

In this initial stage of the project, the personnel have been engaged in reviewing published reports of similar pieces of research and in assembling a bibliography around the general topic of food selection patterns. Over three hundred titles have been indexed and examined and a fair proportion of these have been abstracted to provide a ready reference to significant and related pieces of work.

Out of this examination of other pieces of work, a plan is being developed for the interviewing of persons and the collection of data directly related to the research problem outlined by this project.

No interviews have been made as yet but it is anticipated that some preliminary schedules will be collected within the next 2 or 3 months. (*Project 266*)

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Soils

W. A. Albrecht, Chairman

Soil Testing Routine Methods

M. H. Brown, E. R. Graham, Vernon Renner
Robert Gast

Ten laboratories indicated their willingness to test magnesium solutions with the thiazol yellow method. However, results were obtained from only three laboratories. These labs were Missouri, Wisconsin, and Cornell, all of which reported successful results to the 10 percent level for magnesium as determined with this method. The reason for its failure was due to the high concentration of ammonium acetate in the soil extract.

The results of the study on the possibility of combining reagents B, C, and D for the routine magnesium analysis showed improvement when the mixture was freshly prepared. However, the keeping qualities were poor and when the improvement was considered against the poor keeping quality factor it was decided to keep the reagents separated.

Results of our study on a power driven soil preparation equipment showed that the time gained from mechanical soil preparation did not balance the mess and dust caused by the equipment.

Properly compounded chemicals, standard solutions, check soil samples, and special equipment were made available and on request were shipped to county agents.

(Project 170)

Soil Treatments for Maximum Crop Yields

Carl Hayward, J. A. Roth, George Smith

Crop production costs, such as interest and taxes or rent, tillage, seed and harvesting, vary little regardless of yields. Soil treatments that will produce maximum yields offer the possibility for lower unit cost and increased farm income. These liberal nutrient additions have increased problems of management because of residual effects. There is much interest in the maximum nutrient addition that can be used on various crops.

The season of 1955 was very favorable for small grains. The yields were some of the highest on record. However, the residual effect or the increase of release of nutrients from the soil following the dry season of 1954 prevented additions of phosphorus and potassium from showing the same magnitude of increase secured in previous years. In some cases levels of nitrogen that have produced highest yields in former seasons caused lodging and reduced yields. The shortage of summer moisture prevented most of the major elements from limiting growth and yields of soybeans, forages and corn were not materially affected by these heavier treatments.

The following table gives results of application of nitrogen at 132 pounds per acre to wheat and barley on eight soil types in Southeast Missouri in 1955, and also gives averages for the past three years.

Rate of Nitrogen Application in Spring Yield - 1955 - Bu. per acre

Plot	Soil Treatment	Causey -							
		Yount	Matthews	Freshour	Renner	LeGrand	F. Wallace	J. Wallace	Roth*
1	None	10.4	24.4	22.8	25.9	21.4	27.4	23.7	37.7
3	Starter	14.5	31.2	31.0	35.7	27.2	30.9	22.5	47.8
12	33 N spring + starter	20.2	36.7	38.2	35.6	34.9	36.8	25.8	48.0
14	66 N spring + starter	21.5	47.2	36.5	38.7	36.6	39.2	32.4	56.8
15	100 N spring + starter	22.5	47.8	31.1	40.9	33.0	38.1	35.0	64.5
16	132 N spring + starter	23.5	41.6	27.2	38.0	36.1	39.5	37.6	61.3
			3 year average						
1	None	12.7	23.8	20.3	27.5	22.9	27.4	22.3	18.4
3	Starter	19.5	30.9	29.5	36.0	34.3	34.6	26.4	31.5
12	33 N spring + starter	29.4	36.9	39.5	39.4	41.9	37.6	30.8	41.3
14	66 N spring + starter	30.2	42.9	41.3	41.0	43.1	40.0	37.6	41.1
15	100 N spring + starter	35.0	43.3	39.1	42.5	42.7	38.4	37.5	35.2
16	132 N spring + starter	30.9	39.7	37.7	43.7	45.1	40.2	40.0	38.0

*Barley - remainder wheat

**Stanley - Davis farms (2 yr. av.)

(Project 230)

The Characteristics and Development of Heavy Clays in Missouri Soils

W. T. Higdon, C. E. Marshall, C. M. Woodruff
Victor Nash

Theoretical work arising from a comprehensive

review of our findings on the dissociation of clay minerals led to a reexamination of data previously published (Marshall & Krinbill, *J. Physical Chem.*) together with nonpublished material. This was brought together in a paper prepared for the 4th Clay Congress. The conclusion drawn was that po-

tentiometric and conductometric methods give the same quantitative picture of cation dissociation from clays provided the mean cation activity does not exceed 0.01 molar. Since most of our measurements were at lower activities than this, strong substantiation of conclusions stated previously was afforded.

A Hagerstown profile from Southeast Missouri was selected for detailed study. This is of limestone origin and every care was taken to select a site where loess contamination would be at a minimum. The sand, silt and clay fractions were determined and separated and the clay fraction was further subdivided for detailed study. Quantitative x-ray determinations were attempted on the silt and clay fractions in order to get as complete a picture as possible of the minerals present. The parent limestone contained glauconite. The soil profile samples were found to contain kaolinite, hydrous mica montmorillonite group material and a little vermiculite, the proportions varying with depth. The investigation is being continued.

The manner in which cations are released from feldspars to soil colloids or to the soil solution is little understood. The present investigation included three main parts: (1) the action of acidic solutions on feldspars and the effects of conversion to the surface acidic form by the action of cation exchange resins; (2) the study of cationic activities at feldspar surfaces as determined by clay membrane electrodes or dilute suspensions; (3) the study of the entry and release of particular cations by exchange with salt solutions. The results indicate that feldspar surfaces have a number of very distinctive properties in cation exchange. The cation exchange capacity is not constant. It varies widely with the nature of the ions entering and leaving. Fixation effects are very strong with particular cations, e.g. NH_4 . All cations seem to be held with at least two bonding energies. In neutral salt solutions it is concluded that any unorganized layer of surface silicate cannot be more than one or two unit cells in thickness. (Project 6)

Effect of Deep Fertilization on Runoff and on Yields of Corn and Alfalfa

George Smith, Phil Smith, D. D. Smith, V. C. Jamison

A 30 inch deep subsoiling and fertilizing treatment increased corn yield from 41 to 52 bushels per acre during the first crop season after treatment. Alfalfa yield was not increased during the seeding year by deep treatments the first year after treatment but on another experiment it was significantly increased

during the seeding year by deep treatment made 8 years before.

Subsoiling did not result in increased water penetrations after a series of rain following a severe drouth.

Evapo-transpiration for the full year on a 9 acre terraced and contour farmed field in corn totaled 29.2 inches or 1.2 inches more than rainfall minus runoff. It totaled 17.9 inches for the 120 day period following corn planting or about 1 inch less than from small isolated plots in corn with similar fertility treatments.

(Project 70)

Effect of High Fertility on Runoff Erosion From A Claypan Soil

George Smith, Phil Smith, D. D. Smith, V. C. Jamison

Continuous corn allowed 4 times the erosion under corn following a two year grass and legume meadow, both with full treatments, but less than half that under corn in an unfertilized rotation. A mulch of last years corn stalks which was light and quickly decomposed, was ineffective in control of soil erosion under corn during 1955.

Erosion from contour farmed plots with a full slope length (420 ft.) was 1.68 times that from 90 foot plots farmed up and down slope. Runoff from the larger plot was 1.26 times that from the smaller. Full soil treatments were no more effective in producing corn than starter treatments alone during 1955 when the shortage of soil moisture was about 6 inches. But for meadow, full soil treatments increased hay yield by 1.5 tons per acre or 57 percent. Crude protein was increased 0.157 tons per acre or 39 percent. (Project 77)

The Permanence of Grass-Legume Sod

W. A. Albrecht, T. M. Dean, George Smith

A series of plots were seeded to blue grass, orchard grass and brome grass, with different soil treatments. These were seeded on Sharpsburg silt loam at Lathrop in 1950. The stands were slow in becoming established and the growth in 1955 was the first that showed the effects of the treatments. All of the area was seeded to ladino clover, but only an occasional plant can be found. Where rock phosphate was the source of phosphorus, the growth is equal or better than where superphosphate was added. There appears to be little difference between fall and spring applications of nitrogen. The results indicate applying all of the nitrogen at one time increased the forage yields as much or more than adding the same quantity at intervals within the same season.

Pasture Fertilizer Treatments
Lathrop, Mo. - lbs/Acre - Sharpsburg Silt Loam

Plot	Treatment	Blue Grass	Orchard Grass	Brome Grass
1	None	1167	3337	4134
2	Rock Phos.	1195	4625	4582
3	Rock Phos. + 66# N Spring	2874	6503	7343
4	Super + 66# N	2960	6276	6930
5	Super + K Cl + 66# N Spring	2789	5294	6603
6	Super + 66# N Fall	----	6688	7400
7	Super + 33# N Spring + 33# N Summer + 33# N Fall	2206	6219	6603
8	Super + 33# N Spring + 33# N Fall	2875	5849	5948
9	Super + Traces + 66# N Spring	2966	6759	7400

The pastures on the Kotchedoff Farm near Salem were reseeded in the spring of 1955. Drouth in 1954 killed the stand.

Grazing records were obtained on the Hofer Farm. On strips where no treatments had been applied there was little growth. No records were collected from these areas for yields of forage. Where orchard grass and ladino were grazed, an average of 63 days of pasture provided 205 pounds of beef per acre. The fescue ladino pasture provided 55 cattle days per acre, producing a total of 135 pounds of beef per acre. The dry summer prevented any grazing after June 7. (Project 99)

Crop Sequences and Continuous Cropping as Affected by Legumes and Soil Fertility

W. A. Albrecht, George Smith

The results obtained in 1955 continue to show that availability of essential nutrients to the growing crop is more important in both yield and efficiency of production than in crop sequence or rotation. The data indicate that the total addition of organic materials of carbonaceous nature from liberally fertilized grain crops will be greater than is usually secured from the return of legumes and farm manure. The nitrogen added by legumes (particularly when cut for hay) is not sufficient for optimum yields of non-legumes.

The season was ideal for small grains with some of the highest yields ever obtained. However, summer rainfall was short in mid-summer and limited corn yields. Data were obtained that indicated an advantage of following a shallow rooted crop with a deep rooted one. In some locations where subsoil moisture was not replenished following a deep rooted crop in 1954, yields were reduced.

The yields of grains in cropping systems with different legumes gave yields in 1955 that were not

in agreement with results obtained in past years. With the exception of the yield of wheat in a cropping system with timothy, chemical nitrogen did not increase yields. In a number of areas the added nitrogen depressed yields. There was no consistent effect of the nitrogen on corn. Where nitrogen was added, an excess in the soil was indicated by lodging of the small grains on some plots. This would suggest that following the dry seasons of 1953 and 1954 that sufficient amounts of this element had become available natural breakdown in the soil to be sufficient to balance the available moisture supply.

The stand of both red and sweet clover have been poor during most of the past few seasons which could account for the lower yields than were obtained following some of the other legumes and the timothy.

Yield of Wheat and Corn in 1955 in Cropping Systems With Different Legumes* (Putnam Silt Loam)

	Wheat		Corn	
	No N	66 N**	No N	66 N
Red Clover	31.0 Bu.	38.0 Bu.	36.6 Bu.	33.4 Bu.
Sweet Clover	43.0	39.0	54.4	59.7
Lespedeza	47.0	38.0	55.9	55.7
Soybeans	50.0	40.0	70.2	66.5
Ladino	42.0	42.0	71.9	65.3
Alfalfa	----	44.0	----	68.9
Timothy	39.0	52.0	67.1	69.6

*The cropping system was legume, corn, wheat. Calcium, magnesium, phosphorus and potassium were added to bring the soil to proper saturation. 4-24-12 @ 200 lbs/A was applied as starter fertilizer for both wheat and corn.

**Nitrogen applied to corn only.

(Project 117)

Minor Soil Elements

*W. A. Albrecht, C. E. Marshall, V. L. Sheldon,
George Smith, David D. Parberry*

The composition and quality of timothy, alfalfa, and red clover crops, given trace element treatments on the soil growing them, was put under chemical and biochemical study and under bioassay be weanling rabbits and young crickets.

The timothy hays grown on an outlying field were given nitrogen as salt, and that coupled with 30# and 60# of nitrogen as solutions. The trace elements were coupled with the treatments representing 40# of nitrogen as salts and 60# of nitrogen as solution. The five trace elements, boron, zinc, manganese, cobalt, and copper were used singly and then all five in combination. The chemical analyses for boron, zinc, and cobalt were made by the spectrograph, those for phosphorus, calcium, potassium, magnesium, sodium, manganese, iron and sulfur by customary analytical procedures.

The microbiological assay for ten essential amino acids in these timothy hays were carried out.

It is of interest to note that for the total amino acids, the hay given cobalt was highest. It was, therefore, also significantly high in its concentration of the individual amino acids. Also when amino acids are considered, the timothy hay fertilized with all five amino acids was relatively high, since that also includes the cobalt treatment.

In the case of three fields of cooperating farmers, who are growing alfalfa given fertilizer, with and without boron, careful microbiological assays were made of the methionine contents of the hay. The soils had no treatments and then combinations of 0-9-27 with boron or this fertilizer with magnesium. In two of these cases, the fertilization plus boron lowered the methionine concentration, while in the third it put it to a significantly high level. More significant was the increase of methionine due to the use of magnesium along with the fertilizer on the soil.

Since tryptophane, like methionine, is a commonly deficient amino acid in vegetation, and since alfalfa is such a common "protein supplement" for corn, the alfalfa given fertilizer with boron on thirteen farms in nine different counties, (four in South, five in North), in Missouri was given careful study using a revised method for microbiological assay for this amino acid. The data are assembled giving the concentrations of boron and of total nitrogen as well as the tryptophane in both the dry matter and in its relation to the nitrogen. The addition of fertilizer with boron increased the concentration of this element in the crop in twelve of the thirteen cases. It reduced the nitrogen concentration in like numbers of cases. In all but three cases it increased the tryptophane in relation to the total nitrogen, or served to favor conversion of more of the total nitrogen into the amino acid tryptophane. In these three exceptions, two were in South Missouri and one in North Missouri.

Since trace elements have been used on some of the plots on Sanborn Field as final supplements to all else that would normally be added as soil treatments before trace elements are applied, four of the plots given trace elements and supplying clover in 1954 were selected and the clover put under bioassay by rabbits after nine of the essential amino acids had been determined. The clover was put up into a ration with constant crude protein, ample vitamins and inorganic elements and these fed to weanling rabbits. The data are assembled to show the differences in the gains by weight by the rabbits per unit of the combination of the nine essential amino acids as given by the different treatments of the soil in-

cluding in each case the trace elements in the starter fertilizers. (Project 92)

Fertilizer Applications on Farm Crops

*W. A. Albrecht, M. H. Brown, Carl Hayward,
James A. Roth, George Smith*

Residual effects carried over from the previous season, particularly where corn was a failure in 1954, were far greater than has been generally believed. In many cases heavy applications of nitrogen to the preceding crop produced excessive vegetative growth and caused serious lodging. It is apparent that following dry seasons quantities of nutrients probably above normal are released, and where the subsoil has a high clay content that removal by leaching is of minor importance.

In the studies at Columbia and Lathrop, these carry-over effects were apparently sufficient for optimum yields. Experiments that had formerly given wide differences due to treatments failed to give much response.

Small grain experiments in Southwest Missouri showed a more vigorous vegetative growth from fertilizers carrying sulfur. However, the grain yields were not significantly different where mixed fertilizers contained sulfur. Ammonium nitrate and urea gave the same increases in yield of wheat, barley and oats as did ammonium sulfate.

Small grain yields from experiments in the Southeast Missouri area show the greatest variations of any obtained in 1955.

In the previous two years, fall applications of nitrogen on the heavier soils have been equally or better utilized by wheat than spring applications. However, the severe freeze on March 26 injured the grain receiving fall applied nitrogen since the plants were farther advanced.

Application of all nitrogen at time of seeding has given inferior yields on sandy soils. On the heavier soils, the time of application of nitrogen has had little effect on yields except in the 1955 season when the more vigorous growth produced by the earlier applications resulted in greater damage from the late March freeze. The application of all nitrogen at time of seeding gave more fall and winter vegetative growth than would be desirable unless it is desired to pasture the crop. The good response from December applications suggests the desirability of nitrogen applications before growth starts in the spring. Too frequently wet ground prevents a spring application from being made until it is so late that full benefits are not received.

Studies on the soil reactions of anhydrous ammonia have been continued. The results indicate that percentage retention is increased with closer spacing of knives, or with a lower quantity applied in a given amount of soil. When liberal applications are made soils of low exchange capacity or those with a high percentage saturation of calcium cannot absorb these quantities of the ammonium ion. Under these conditions the ammonia is only trapped as ammonium hydroxide and may move to the surface and be lost when water evaporates from the surface of the soil. The results would indicate that anhydrous ammonia should be applied after land has been plowed. Under some conditions, plowing after ammonia application could result in some of the weaker held ions being lost by volatilization or from the evaporation of soil water that contains dissolved ammonium hydroxide.

Studies have been made of the influence of calcium saturation on ammonia adsorption. Although soils containing free calcium carbonate showed a slightly greater loss than acid soils, the difference was not of sufficient magnitude to warrant any change in method of application. There appears to be little need for making applications deeper than six inches. However, it is probable that ammonia loss may occur on some soils if it is placed only 3 or 4 inches below the surface. Significant losses can occur even though no vapor can be observed.

(Project 178)

Missouri Soil Survey and Land Classification

H. H. Krusekopf, Clarence Scrivner, M. E. Springer

All the Soil Survey activities described in the Annual Progress Report, 1955, were continued during the past year. These include the soil survey of Howard county as the major project.

Study of the Forest Soils in The Ozark Region

H. H. Krusekopf, M. E. Springer and C. L. Scrivner

OBJECTIVES:

Study the relation of soils to the Pleistocene deposits in northwestern Missouri.

Participation in the preparation of a soil map and soil key of the North-Central states.

The soil survey cooperated with the Soil Conservation Service in the conversion of conservation surveys formerly made by the S.C.S. to standard surveys in 4 county soil districts. The purpose of this is to make all surveys in the state of the same detail and type, and to adopt a uniform system of soil classification. A similar conversion in the soil classifica-

tion of 4 additional counties is to be made this year.

Observations made in Howard county and elsewhere in the state have confirmed previous observations, that some soils are affected much more adversely by drouth than other. Deep, permeable and well-granulated soils are least affected. Crop damage was most severe on sandy, shallow, dense, and light colored soils of poor granular structure. Soil classification thus is an aid in defining and locating the lands most frequently affected by unfavorable moisture conditions—either a deficiency or excess of moisture.

When the soil survey of Howard county is completed, work will be resumed in Henry county. There are more than 70 counties in Missouri yet to be surveyed.

Desert pavement and vesicular layer are described as distinct horizons of some Gray Desert soils. Distribution of 2 mm. particles in the profile along with laboratory tests suggest that accumulation of gravel and stones at the surface to form a desert pavement is not due solely to removal of finer material by wind or water. There has also been some upward movement of coarse fragments from the nearly stone free layers below.

Some properties of vesicular layers are pointed out by field and laboratory study. Natural vesicular structure was destroyed by sieving and a new, but similar, structure formed by merely wetting and drying the soil. This led to a hypothesis for origin of the vesicular layer as a pedogenic horizon.

(Project 206)

The Fertility Level of Missouri Soils

*W. A. Albrecht, M. H. Brown, E. R. Graham,
W. T. Higdon*

The results of the root exchange studies on plants grown in false bottom cylinders filled with cherty gravel and nutrient solution showed that the exchange phenomena of the cherty gravel was low as compared to soils or clay, but it was high when compared to roots. It was concluded that substrata to be of value in root studies would need to be more inert than cherty gravel. The plants grow well in the nutrient chert mixture, therefore the roots could be separated from the chert and used for exchange studies. Actually the roots grown on the cherty gravel nutrient solution mixtures were healthier than the roots of plants previously grown on sand nutrient mixtures.

Exchange studies of the roots were made by rinsing Ca saturated roots, and hydrogen saturated roots in dilute solutions of heavy metals. The re-

sults revealed that when ions were exposed to the root systems individually they were adsorbed more strongly by the Ca roots. However, in combinations of the ions, this relation did not hold, except for iron. Exchange studies, conducted after each trace element treatment, with acid and alkaline washes, indicated that the metallic cations were more active in exchange than was calcium but less so than was hydrogen.

The results of the boron studies on Missouri soils revealed the following items of importance.

Soil Type	Boron Content of Alfalfa p.p.m.	Physiological Conditions of Plants	Available Boron Content of Soil p.p.m.	% O.M.
Boron Treated Soils				
Knox	56.0	Normal	1.80	---
Marshall	50.0	Normal	2.20	2.5
Bremer	47.0	Normal	2.15	3.3
Marshall	45.0	Normal	1.95	2.5
Marshall	43.0	Normal	2.15	2.4
Putnam	41.0	Normal	1.30	----
Grundy	33.0	Normal	.80	3.5
Weldon	32.5	Normal	.88	---
Shelby	31.5	Normal	1.30	1.5
Weldon	30.0	Normal	.75	---
Soils with No Boron Treatment:				
Bremer	27.0	Normal	.60	3.2
Putnam	25.0	Normal	.60	---
Sharpsburg	22.5	B deficient	.40	1.5
Grundy	22.0	Normal	----	3.5
Seymour	21.5	B deficient	.35	2.7
Shelby	17.3	B deficient	.60	1.5
Weldon	16.5	B deficient	.30	---
Putnam	16.0	B deficient	.55	---
Putnam	15.6	B deficient	.53	---
Menfro	10.0	B deficient	.25	1.2

A study of an additional 22 different soil types of Missouri revealed that only 50 percent of these soils contained hot water soluble boron in amounts sufficient for the normal growth and reproduction of alfalfa.

The weathering studies made on Hawlite, Colemanite, and Bakerite showed that all three of these minerals were weathered rapidly by H-Clay, H-IRIZO amberlite, and by chelating compounds such as EDTA. The boron mineral Tourmaline was not weathered by any of the chemical weathering agents, but was weathered by hot fresh distilled water.

Preparations have been made for a greenhouse experiment on the growth of soybeans in various media, to be conducted in the spring of 1956. These preparations comprise (1) characterization of colloidal media through activity measurements of K+ and Ca++. (2) Preparation of large quantities of the media for the actual experiment. A cation exchange column has been built for use with colloidal suspensions so that one cation can easily be replaced by another. Calcium and potassium systems will be mixed in the requisite proportions so as to define

both the K+ and Ca++ activities and also to grow soybeans under various K and Ca ratios. The colloidal media include two clays and a cation exchange resin. True solutions of chlorides and bicarbonates are also included. (*Project 207*)

The Protein Role of Nitrogen in Organic Matter

W. A. Albrecht, V. L. Sheldon, John de Jonge

In order to determine the protein role of nitrogen in organic matter grown of variable composition as this is determined by the fertility of the soil, bioassays as well as chemical and biochemical analyses were made of grains and forages harvested on well characterized soils given specific fertility treatments.

Weanling rabbits, usually litter mates, were the bioassay means, and were grown for a limited time in ample numbers, so far as possible.

Corn and wheat grain fertilized with nitrogen; timothy hay fertilized with nitrogen and "trace" elements; and red clover from Sanborn Field were all put under the bioassay. Inorganic analyses, and microbiological assays for their amino acid contents were made of the timothy and red clover hays while microbiological assays for the methionine content were made of wheat grain as sulfur treatments of the soil might modify it, and similar microbiological assays were made for the relation of nitrogen to methionine and tryptophane in alfalfa grown on fertilized soils given also Borax.

In all of the results, the major feature emphasizing itself is the complexity of the interactions of varied inorganic fertility elements in modifying the composition of the grain or forage when measured by the concentration of the total nitrogen and this element in the diversified organic compounds like the nine or ten amino acids, commonly considered essential for the laboratory white rat. While chemical and biochemical analyses measure many differences in the organic compounds synthesized by the plants according to treatment of the soil with inorganic fertilizers, the bioassays do not necessarily correlate closely with what the different analyses, so far made, readily suggest. The theoretical integration of the data of chemical and bio-chemical analyses into animal values did not seem possible. Nevertheless, the four cases of maximum efficiencies in nutrition by red clover in a balanced feed for rabbits resulted where the complex soil treatments included as separate treatments, the return of organic residues in three cases, trace elements in two cases, lime (both

calcium and magnesium) in two cases and, strange as it may seem, one case of no treatment.

Naturally the ultimate test of nitrogen in organic compounds synthesized by plants must come through bioassay of the protein values as they represent growth of animal bodies. This final result in the series of interactions which are started by the soil is still chemically and biochemically far removed from the fertilizers and other treatments given the soil at the outset. Yet after balancing the nitrogen, the vitamins and the essential inorganic elements in the red clover grown with different crop-rotations and soil treatments, the highest biological value of the red clover appeared where the analyses showed the higher values for the sum of the essential amino acids by microbiological assay, and where the soil treatments indicated either no chemical modification or such on a rather extensive scale in accordance with the chemical soil tests.

By these studies there is additional evidence to suggest that if high protein values as animal feed are to be grown into the organic products of crops, attention to the role of nitrogen alone is of not much help. Improvement in the soil fertility in many aspects other than this one element by which crude protein is measured must be brought about. Thus the return of crop residues and the use of trace elements was associated with the soil treatments growing the clover hays in which the protein role of nitrogen was most efficient suggest that research emphasis for more complete protein production in agricultural crops should be given to these two soil treatments. (*Project 208*)

Investigation of the Effects of Meteorological and Climatological Variations on Agricultural Production in Missouri

W. L. Decker

Soil temperatures have an important effect on agriculture. They exert a control on the rate of germination and growth, on the activity of the soil's microbiological population, and on the weathering processes of the soil. Since soil temperatures are difficult to measure, there is a deficiency of soil temperature records. This work was instigated to provide a method for estimating soil temperatures from meteorological and soil factors.

Soil temperature observations were taken at three, six, twelve, and twenty-four inches below the surface with thermocouples. The measurements consisted of two daily temperatures observations which were taken at each depth in each of three fallow and three grass plots. The dependent variables for the

prediction analysis were the averages of the six daily observations.

Two models were used to obtain regression equations for prediction of the three inch soil temperature. In the first model, the air temperatures used as predictors were the temperature of the invading air T_u , defined as the upstream air temperature, and the temperature of the air twenty-four hours previous to the soil temperature observation T_1 . The second model utilized the temperature of the air at the time of the soil temperature observation. In both regression analyses the daily solar energy S , the average night cloudiness C , the average wind velocity W , and the average soil moisture resistance M_3 were used. The latter measurements were obtained from Bouyoucos soil moisture blocks.

For deeper soil levels the antecedent air temperatures were used as predictors. These antecedent temperatures were: for the six inch depth, T_3 the air temperature three hours earlier than the observation time; for the twelve inch depth, T_4 the air temperature ten hours earlier; and for the twenty-four inch depth, T_5 the air temperature thirty-two hours earlier. The observed soil temperature at the next shallower depth and the average soil moisture resistance were also used as independent variables.

The air temperatures expressed as T_u , T_1 , and T_2 were positively correlated with the three inch soil temperatures. From the three inch soil temperature analysis, which employed T_u and T_1 as predictors, it was noted that T_1 exhibited a greater effect on the soil temperature than T_u . When other factors were held constant a change of 1° F in T_1 changed the three inch soil temperature by 0.3° to 0.7° F, while a change of 1° F in T_u only yielded a 0.1° to 0.2° F soil temperature change. From the analysis based on the second model, each 1° increase in T_2 resulted in a $.3^\circ$ to $.7^\circ$ increase in the three inch soil temperature. The model which used T_u and T_1 along with the other variables as predictors explained a larger percent of variability than the second model; but the increase in precision was so small that it does not appear worthwhile to employ the two variable models.

The daily total of calories of solar energy received was found to be positively correlated with the three inch soil temperature. When S was combined with the other independent variables, its effect did not vary a great deal. Each 100 calorie change in the daily solar energy was associated with a 1° to 2.5° F. change in the three inch soil temperature.

Clouds occurring at night reduced the amount

of energy lost by nocturnal radiation and increased the observed soil temperature. This effect was most pronounced during the warmer part of the year. An overcast night sky increased the three inch soil temperature the following afternoon by 2°F. over the temperature which would have followed a clear night.

The average wind speed was negatively correlated with the three inch soil temperature during the warm portion of the year. Wind provides a mechanism for the mixing of the lower atmosphere and for heat removal from the surface. Average wind velocities of ten miles per hour reduced the three inch temperature by as much as 4° or 5°F. over a near calm condition.

According to these results the three inch soil moisture was not correlated with the three inch soil temperature during the winter and spring seasons. The failure in obtaining a significant relationship was due to the small variation in soil moisture during the cool seasons of the year. In summer and fall, when variability was greater, lower soil moisture values were associated with higher soil temperatures. This negative relationship was due to the decrease in specific heat as the soil became drier.

For deeper soil levels the temperature of the next shallower depth was employed as a variable. The three inch soil temperature was used to predict the six inch soil temperature, the six inch soil temperature was used to predict that at twelve inches, while the twelve inch temperature was used as a predictor for the twenty-four inch depth. The temperatures at these shallower depths provided the best predictors for the soil temperatures at levels below three inches.

The simple correlation coefficients between the antecedent air temperatures and soil temperatures for depths below three inches were positive; but when expressed in terms of the partial regression coefficients, these relationships became negative. These negative values seem to indicate that decreasing air temperature is associated with an increasing soil temperature. This paradox is the result of the closer relationship between antecedent air temperature and the soil temperature at the shallower depth than on the temperature at the depth under investigation.

For the levels below the three inch depth, soil moisture exhibited an erratic effect. It was usually positively correlated with the soil temperature of the same depth, but sometimes the correlation was negative. No physical explanation for this variation was found. (*Project 210*)

Infiltration Rates and Available Water Capacity for Major Soils of Missouri

J. A. Roth, Phil Smith, Vernon C. Jamison

Preliminary tests at McCredie, Columbia, and Elsberry on Mexico silt loam, Seymour silt loam, and Sharon silt loam where the soil surface is loose and dry, the rate found with single ring infiltrometers was three to seven times faster than with sprinkler irrigation. On soils with a sealed surface or on sod the rates were about 1:1. The irrigation rates were between 0.7 and 0.1 inches per hour, depending on the condition of the soil surface, including moisture in the layers at and near the surface.

A laboratory has been constructed and equipment assembled for studies on available moisture storage capacity of soils. The first samples have been taken from pasture plots at McCredie, and are being processed for moisture release relationships. (*Project 211*)

Soil Tests and Fertilizer Response

E. R. Grabam, J. A. Roth, George Smith

Past cropping practices and soil variations have focused attention on soil tests as the most practical means of arriving at the percent saturation and probable nutrient need for efficient crop production. Acceptance of soil testing as a practice has been more rapid than field correlation. This work is being conducted to measure the effects of different levels of nitrogen, phosphorus and potassium addition on the yields of different crops.

In most of the work, the yields were influenced by the above normal carry over from the dry season of 1954 and shortage of soil moisture during the summer of 1955.

Small grain experiments were conducted at eight locations in Southeast Missouri in 1955 (complete data are attached to Progress Report of H 178—this work with soil testing was a portion of other field experiments). These results point to the need for the development of new testing procedures (Probably different extracting solutions.) On soils with a high clay and organic matter content there was an excellent response to added nitrogen when minerals were in ample supply. Apparently under the wet conditions that prevailed in the spring, the soil organic matter did not break down and the soluble chemical nitrogen was beneficial. On two soils with over 3% organic matter, applications of 33 and 66 pounds of nitrogen per acre increased yields up to 12 bushels per acre. In some past seasons more favorable for nitrogen release the response on these

same soils has not been great. Where soil tests for phosphate were less than 100 pounds per acre there was a substantial benefit from phosphate. Only one of the eight soils showed much response to potassium. This soil had an exchangeable potassium test in the surface soil of slightly over 100 pounds.

Soil tests were made of all fields where cotton experiments (Project H 267) were conducted in 1955. Response varied on various soils. In some cases response was obtained from additions of phosphorus and potassium although the tests indicated an adequate level of these nutrients. This would suggest the need for different extracting solution or a recalibration of laboratory results to properly correlate with field response.

Soil test correlation studies were started at Weldon Springs and Leonard in 1955. Records were obtained of corn yields at both locations and with oats at Weldon Springs. One series of plots at Leonard was irrigated, but the other yields were limited by weather conditions and the results suggest the soil supplied adequate nutrients for the limited yields without nutrient addition. In all of these experiments all elements except the one being studied are added in sufficient quantity to remove them as factors of production. (Project 229)

The Improvement of Soil Fertility Through Heavy Applications of Nitrogen, Etc.

J. A. Roth, George Smith

Data were collected from experimental work on this project at Columbia and Weldon Springs. The studies in Southeast Missouri with cotton hulls was conducted in cooperation with a farmer. The results in 1954 failed to show either positive or negative effect. Because of the farmer's fear of introducing Johnson grass or other noxious weeds, the work was discontinued in 1955.

The work at Columbia where the twenty ton applications of carbonaceous residues were made in 1950 continue to show that these applications may be balanced with chemical nitrogen without a depression of crop yields. The yields of corn in 1955 (organic matter added) ranged from a low of 72.2 bu. to a high of 76.5 bu. The yield from no organic matter—no nitrogen was 65.6 bu. For a five year average (1954 yield is not considered because of the drouth) the low yield is 88.4 bu. and the high 92.4 bu. This data would suggest it is possible to add large amounts of carbonaceous residues with proper nutrient addition without depression of crop yields.

It is of interest that oat yields have been the highest where no organic residues or nitrogen was

added in 1950. This treatment has not caused as much lodging, which probably accounts for the higher yield of this small grain. The effects of the manure and sewage sludge are disappearing. In 1955 these treatments produced the lowest small grain yield.

Yields of Corn and Oats as Affected by Heavy Applications of Organic Material in 1950.

Organic Matter Added in 1950	Corn Yield		Oat Yield	
	1955	5 yr. av.	1955	6 yr. av.
20 tons sawdust*	73.9	90.7	94.9	80.4
20 tons sewage sludge*	75.4	90.8	85.2	69.3
20 tons straw*	75.4	92.4	112.4	85.5
None	72.2	91.8	94.9	97.7
20 tons corn cobs*	73.1	88.4	94.9	82.7
20 tons corn stalks*	76.5	93.1	100.8	74.8
20 tons manure	72.2	91.2	77.5	74.9
No chemical nitrogen**	65.6	78.4	85.2	74.7

* 1000# N per acre plowed down with sawdust; 800# with remainder of organic materials.

** All other plots received 120 pounds of chemical N before each corn crop. Starter fertilizer applied to all plots.

(Project 231)

Soil Treatments for Alfalfa

T. M. Dean, George Smith

The drouth of 1954 killed new seedings of alfalfa in experiments in most sections of the state. These were reseeded in 1955. The shortage of moisture in midsummer in 1955 and some infestations of grasshoppers limited growth to one or two cuttings that contained considerable grass and weeds.

The following results were obtained at Lathrop on Sharpsburg silt loam. Only one cutting was made. No visible differences could be noted in growth and the various treatments show little difference in their effect on yields. The entire area was limed.

Alfalfa, Lathrop, 1955

Soil Treatment	2nd Yr.	3rd Yr.	4th Yr.
	Alfalfa	Alfalfa	Alfalfa
No fertilizer	3241 lbs.	2792 lbs.	2760 lbs.
0-20-0 @ 500	3304	3530	2952
Rock Phos. @ 100	3433	3209	2952
0-20-10 @ 500	3145	2984	3080
0-0-10 @ 500	3080	3016	3080
10-20-10 @ 500	3080	2984	3016
0-20-0 @ 500	3145	3113	2984
10-20-10 @ 500 + Mg CO ₃	2888	2984	2888
10-20-10 @ 500 + Boron	2952	3237	2824
10-20-10 @ 500 + Traces	3048	3304	3237

Alfalfa experiments at Sikeston were reseeded in the spring of 1955. A stand was secured, but growth was small and because of the amount of wild grasses and weeds, the plots were only clipped and no yield records were obtained.

A new series of treatments were made at Weldon Springs and seedings made in the spring of 1955. Two cuttings were made. However, the yield differ-

ences were small and did not correlate with treatments. The weed content and soil variability apparently accounted for the small difference in yield and the figures were not included.

A similar condition existed at Pierce City as was found at Weldon Springs. A good stand was obtained despite the dry summer and it appears that satisfactory records may be secured. In a new stand reseeded at Columbia on March 12, 1955, one cutting was made, on July 18. (*Project 242*)

Energetics of Cationic Relationships in Soils and Plants

C. M. Woodruff

The original investigation of this subject suggested that soils were adequately supplied with potassium when the energy of exchange amounted to 2500 calories per equivalent; 3000 calories was satisfactory; 3500 calories was border line and 4000 calories represented a series deficiency. These values applied to crops of corn, small grains and legumes. During the year of 1955, correlations were obtained for cotton. The results indicated that cotton responded to fertilization with potassium at energy levels in the soil of 3000 calories per equivalent. These results are in agreement with the generally known fact that cotton requires higher levels of potassium in the soil than do the other common crops. No evidence was found that cotton would respond to potassium when the energy relationship between potassium and calcium was of the order of 2500 calories per equivalent.

Alfalfa was grown in soil brought to different energy balances with respect to magnesium and calcium. The energies of exchange for the replacement of calcium by magnesium varied from -690 calories in the most magnesium deficient soil to +6.1 calories in the soil that was 32% saturated with magnesium. There were no significant differences in the growth or appearance of the alfalfa over this range of values. However, the molar ratios of magnesium to calcium in the alfalfa plants were found to range from 0.06 at the -690 calory level to 0.57 at the +6.1 calory level. Apparently alfalfa will grow at very low levels of magnesium in the soil. The molar ratio of the activity of magnesium to the activity of calcium in the soil was found to be twice that of their molar ratios in the exchange complex of the soil. Hence magnesium is a very active ion as compared with calcium in the exchange complex of the soil and like potassium is effective in plant nutrition at much lower levels than are necessary for calcium.

The energy balance between hydrogen and calcium in soils saturated with bases was found to be

about 8000 calories; and in soils half saturated with bases the energy balance was about 4500 calories. Soils that are 80 to 100% saturated with bases exhibit energy balances of 6500 to 8000 calories. Such degrees of base saturation are considered desirable for plant growth. However, some soils from California that were producing over 60 bushels of wheat per acre and 100 bushels of corn per acre were observed to be doing this at energy balances of 4500 calories per chemical equivalent. These results suggest that the energy balance between hydrogen and calcium is not necessarily a criterion of the nutrition of plants with respect to calcium. Instead, the effects of hydrogen on the activities of such ions as iron, manganese and aluminum when these ions are present in large amounts, may account for the relationships commonly observed between hydrogen and calcium. (*Project 263*)

Soil Fertility and Cotton Production

J. A. Roth, George E. Smith

The results obtained in 1955 point to the necessity of conducting work of this kind for a period of years before making definite suggestions. The wet soil conditions in early spring apparently retarded nitrification and reduced availability of phosphate. Some of the soils of higher clay content that failed to give an increased yield in the dry seasons of 1953 and 1954 produced the largest increase in yield from added nutrients in 1955. Although increased quantities of nitrogen did, on some soils, slightly delay maturity the addition of a balanced supply of nutrients resulted in the greatest efficiency and the lowest cost per unit of production.

The results indicate the necessity of proper calibration and correlation of laboratory soil tests for most efficient use of added nutrients. Laboratory soil tests appear to be the best indication at present in determining deficiencies in a given field. However, some soils that appeared to contain ample nutrients gave a significant increase in yields from added soil treatments. It would appear that cotton may be a "weaker" feeder than some of the grain and forage crops where most of the calibration work with these tests has been conducted.

To speed planting operations much of the soil treatment applied to cotton has been plowed under or placed in beds prior to seeding. In one experiment conducted in both 1954 and 1955, on the same farm, the importance of placing available nutrients close to the seed for nourishing the young plant was indicated. The results indicate that at this northern location for cotton production the application of start-

er fertilizers at time of planting was very beneficial. (Project 267)

Soil Fertility and Corn Production

*Phil Smith, Leslie McDowell, Lewis Barnes,
Carl Hayward*

The nutrient carry-over from the dry season of 1954 was quite evident in the corn crop (and other crops) in 1955. Yields on untreated soil, or where nutrient additions were made in 1955, were above those obtained in previous years. Under the limitations of short summer moisture supply, this carry-over or release from the soil produced as high yields as where liberal additions were made. Particularly on soils with considerable clay in the subsoil, it appears that where liberal nutrient additions are made the time of fertilizer application for corn is of much less importance than formerly believed.

Residual Effect of Nitrogen on Corn
South Farm - Columbia, 1955

Nitrogen Applied	Applied* 1954	Applied** 1955
0	76.5	71.8 Bu.
100	69.6	70.5
200	68.8	79.6
300	79.9	75.6

* Applied to corn in 1954
** Soybeans in 1954

In an experiment in Southwest Missouri near Jasper, the residual effect of nitrogen applied in 1954 failed to show any significant effect on yields of corn in 1955. The yields ranged from 27 to 31 bushels per acre regardless of treatment, indicating that a shortage of summer moisture prevented any of the treatments from having a significant effect on crop growth.

Despite shortages of moisture, ample populations of corn were required to give most efficient utilization of fertilizer nutrients. In experiments on Putnam silt loam where the soil was well supplied with minerals and where 100 pounds per acre of nitrogen was added, a population of 9,000 plants per acre produced a yield of 51 bushels per acre. Where the stand was increased to 12,000 plants, the yield was increased to 63.4 bushels, and where the stand was 18,000 the yield was 70 bushels.

In similar experiments in Northwest Missouri on a deeper soil (Sharpsburg) the population had less influence. Where ample nutrients were provided a 10,000 population produced a yield of about 75 bushels per acre. Populations of 15,000 and 19,000 gave approximately the same yield of 81 bushels.

Evidence obtained the past few seasons indicates that when moisture is in short supply excessive rates

of plants may reduce yield of corn. However, a proper nutrient balance can result in more effective use of available moisture. An adequate stand of corn is required to utilize these added nutrients.

Rates and Sources of Nitrogen

Response of corn to nitrogen was satisfactory in areas where summer moisture was not limiting. The following results were obtained from three locations.

Response of Corn to Different Rates of Nitrogen
Application

# Nitrogen	Putnam Silt Loam	Marshall Silt Loam	Menfro Silt Loam
No Nitrogen	71.8 Bu.	29.8 Bu.	34.6 Bu.
50# N	----	59.5*	73.1
100# N	70.5	71.8	81.4
200# N	79.6	78.8	70.0
300# N	75.6	82.8	66.4
*66# N			

(Project 268)

Reclamation of Eroded Soils

C. M. Woodruff

OBJECTIVES:

To determine the effects of legumes without nitrogen compared with grasses fertilized with nitrogen on the productivity of eroded land.

To determine the effects of rate of planting corn on the yield of corn from eroded land.

To determine the efficiency of different rates of phosphate fertilization by both rock phosphate and super phosphate for the growth of red clover over an extended period of time on the eroded phase of the Shelby loam.

The season was exceedingly dry. The hay on the plots of this study was not harvested in 1955.

Because of the dry season the corn yields from the subsoil plots were very low. No significant difference in yields were obtained for the different rates of planting.

After six years of cropping the subsoil of the Shelby loam to red clover with different rates of rock phosphate fertilizer the total yields of hay in grams per pot were as follows:

Rock Phosphate Applied In lbs. per acre:	0	63	125	250	500	1000	2000	4000
Yield: Gms. per pot:	50	42	43	45	53	55	84	113

No appreciable increases in yield were obtained until a total of 2000 pounds per acre of rock phosphate had been applied. Double this amount of fertilizer or 4000 pounds per acre resulted in a total increase in yield of only 63 grams of hay per pot. A similar amount of P₂O₅ supplied as super phosphate resulted in an increased yield of 458 gms. of hay over that of the untreated soil. Super phosphate

was very effective in increasing the yields of red clover. (Project 209)

Effects of Climatological Variations on Missouri Agricultural Production

W. L. Decker

In the Progress Report for last year estimates of the likelihood of dry periods of varying lengths for six locations were presented. During the current year expectancies for 13 additional locations were computed.

There is a pronounced seasonal distribution in these dry period expectancies. The chance of a dry period originating during the first half of June is considerably less than for any other period. The first

fifteen days of August is another period of low dry period expectancies. Greatest hazards are associated with the last half of July and the second half of August.

There is considerable variability in the computed expectancies between locations but no attempt has been made to study these differences. Some of these differences are due to random variation while the remaining are attributed to the geographic distribution of the climatic variable.

No progress has been made toward the determination of the probability of precipitation amounts. This lack of progress is due to difficulty in the coordination of the program by the Technical Committee of NC-26. (Project 281)

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Veterinary Medicine

A. H. Groth, Dean

Blood Titre Studies in Brucellosis

Cecil Elder, A. H. Groth, D. E. Rodabaugh

Further work was carried out in trying to perfect a method of differentiating between blood agglutination titres of strain 19 vaccinated cattle and naturally infected cattle by the injection of killed strain 19 *Brucella* organisms. Since previously reported work at this station showed the injection of killed *Brucella* organisms would not distinguish between some individuals with low titres, work this year was designed to attempt to clarify the status of such animals.

In an effort to obtain infected cattle carrying a low agglutination titre, all infected animals of the University beef herd were tested. Only four individuals with a suitable titre of 1/100 were found. Repeated tests were made to establish the stability of this titre. They were then each injected with 5 ml. killed strain 19 organisms intramuscularly and retested at regular intervals. One animal showed a titre increase of one full dilution the second week after injection, and two more were up one dilution the fourth week after injection. The titre of the other animal did not change throughout the test period. Since we had previously found that blood titres of vaccinated animals will show increases within the first week after injection of killed strain 19 organisms, the above

animals were considered, on the basis of our tests, to have been carrying an infection titre.

Later during the year seven additional cows with a blood agglutination titre of 1/100 were purchased from known infected herds and their blood titres were checked periodically to determine if they were remaining at a constant level. Four of the cows developed an increase in titre of one or more dilutions within five months after purchase and two showed decrease. Only one cow remained positive at the 1/100 dilution. All seven of these animals were injected with 5 ml. killed strain 19 organisms intramuscularly. Daily blood tests were made for ten days, followed by two tests at weekly intervals. The four cows which had shown an increase in blood titre prior to injection maintained a stationary titre for two weeks after injection then showed a slight increase. The three cows reacting at 1/100 or less prior to injection showed a rapid increase in titre from 4 to 6 days after injection. This is contrary to expected results in infected animals. Laceral tissue and colostrum were available from two of these cows and this was cultured and also injected into guinea pigs. The results of these tests were negative for *brucella* organisms.

Nine adult vaccinated cows were available for comparison tests. Blood samples were collected for seven days after injection of killed organisms and

maximum titres recorded. All cows in this group developed a titre increase of at least one dilution within 4 to 6 days after injection. Those animals which reacted in titre dilutions of $1/200$ or higher at the time of injection increased in titre only one dilution after injection, whereas the animals with lower titres increased several dilutions.

On the basis of our studies with the infected cattle of the University beef herd, the time of titre rise might be regarded as significant in our attempts to differentiate between infection and vaccination titres. The three cows which had been purchased as infected cows but had receded to very low titres may have eliminated the infection and were carrying only a residual blood reaction from the previous infection. In such cases, one might expect a rapid increase in titre following injection of killed organisms. (*Project 8*)

Internal Parasites of Ruminants

Cecil Elder, A. H. Groth, D. E. Rodabaugh,
G. C. Shelton

Work on this project was divided into three parts as follows:

Part I.

This involved the study of the value of low-level phenothiazine in the feed of dairy calves for the prevention of internal parasites. Twelve young dairy calves (7 Holstein, 2 Brown Swiss, 2 Jerseys, and one Guernsey) were obtained early in the year and started on the experiment. Six of the calves were placed in stalls with concrete floors and the bedding changed regularly in an attempt to keep the calves as near free of parasites as possible. The other six calves were raised in portable pens according to the method of Davis and Bowman.

May 30, 1955, the twelve calves were divided as nearly as was possible into three equal groups, and each of the groups was placed on approximately one acre of newly established pasture of orchard grass and lespedeza. Each group received a grain mixture and was fed at the rate of 1- $\frac{1}{2}$ pounds daily for each calf.

Small numbers of animals were used and because of this fact the results were very difficult to interpret. The calves in Group 2 that received phenothiazine treatment gained an average of 19 pounds per calf more than calves in Group 3 which were also parasitized but which received no phenothiazine. Group 2 calves gained only 7 pounds per calf more than the Control Group 1. From this data no conclusive results could be demonstrated because of the small numbers of animals.

Part 2.

Two pastures of approximately 4 acres each were used on the experiment. Pasture No. 1 had been grazed by sheep for several years and was considered contaminated with larvae of internal parasites. Eighteen ewes and their lambs (a total of 34 sheep) were kept on this pasture all season and given no treatment for parasites. Pasture No. 2 had not been pastured by sheep for several years and was considered relatively free of parasites. There were 14 ewes and their lambs (a total of 27 sheep) in this pasture. They were given access to a phenothiazine and salt mixture (1-10) all season. Fecal egg counts were made on all sheep every two weeks. Both pastures were grazed very closely during the season and were considered as being heavily stocked.

Early during the season, about June 1, the lambs of Pasture No. 1 developed a heavy infestation of parasites and five lambs died with parasitism within a few weeks. Three other lambs in the pasture showing extremely high egg counts were selected for treatment. They were each given a two ounce dose of liquid phenothiazine per orum. Within two days the egg counts had fallen to negligible numbers. Two of the lambs thus treated were autopsied to determine efficiency of the treatment. Both lambs still retained a considerable number of *Nematodirus* and *Trichostrongylus* with a few *Ostertagia*. The lamb with the highest egg count at the start of the treatment had over 1000 *Hemonchus* in the abomasum. These results would indicate a failure on the part of liquid phenothiazine to remove a satisfactory number of parasites from heavily infested lambs.

The sheep and lambs in the No. 2 pasture, receiving phenothiazine-salt mixture, showed some increase in egg counts during the season but the infestation was not sufficient to produce clinical symptoms.

Part 3

This part of the experiment involved the pasturing of three calves, approximately 6 months of age, in sheep pasture No. 1 which was described as being heavily infected with sheep parasites. The calves had been raised as parasite-free and had been kept on clean pastures prior to being placed in the sheep pasture. The calves were placed in the pasture Sept. 16 and kept there until November 15. Fecal samples were collected and examined every two weeks for parasite ova.

During the pasture period there was no evidence of the calves becoming infested with ovine parasites. It would thus appear that calves are fairly resistant to ovine parasites under pasture conditions.

However, during the month of August preceding this pasturing period, the pasture became extremely drouth-stricken and it is possible that much of the previous infection was destroyed. Further work should be carried out with calves being pastured with sheep at the expected time of heaviest parasitic infestation among the sheep. (*Project 108*)

Hog Cholera Immunization

Cecil Elder, A. H. Groth, D. E. Rodabaugh

This year's work was a continuation of studies of stress factors which may interfere with the development of strong immunity in pigs vaccinated against hog cholera. The stress factors selected this year was the administration of a heavy dose of porcine Mixed bacterin administered simultaneously with a single injection hog cholera vaccine of rabbit origin into pigs that were receiving a protein deficient ration.

A total of 18 sows were bred and put on experiment, about December 1. Nine of the sows were placed in dry lots and fed a ration consisting of 95 parts ground yellow corn and 5 parts linseed oil meal. They were given access to a mineral mixture of equal parts ground limestone, steamed bone meal and salt. The remaining nine sows were placed on a blue grass pasture and fed a ration as nearly complete as could be devised. When the sows farrowed, the pigs were kept on the same ration and in the same lots as their mothers until after weaning. All pigs were vaccinated against hog cholera two weeks after weaning with a single injection vaccine (SW-IVAX). Half of the pigs of each lot were also given a 10 ml dose of porcine mixed bacterin at the time of vaccination against hog cholera. Thirty days after vaccination half of the pigs in each lot were given a challenge dose of hog cholera virus and temperatures were recorded for at least 14 days after date of challenge. The remaining pigs were placed on a balanced fattening ration and challenged with virus 90 days after vaccination. Cholera susceptible control pigs were also challenged with virus at the same time to determine the virulence of the virus used.

Among the pigs that were challenged 30 days after vaccination, only one pig died of hog cholera. This pig was in the dry lot group which had received the bacterin as a stress factor. Several more pigs of the dry lot groups developed high temperatures approximately seven days after the first pig became ill, indicating a possible build-up of virulence in the virus. This reaction was not confined to the group that had received bacterin.

The pasture pigs that had been receiving a balanced ration showed a temporary temperature increase within two or three days after injection of virus but had no further complications. Two control pigs became ill the third day after challenge but did not follow a typical course of acute hog cholera. One control pig finally died after prolonged illness but the other recovered completely.

The remaining pigs that were challenged at 90 days after vaccination showed very little reaction to the virus. There was a temporary increase in temperature among the dry lot pigs at about the 7th day after injection, but this receded almost immediately. Temperature readings in the pasture pigs were complicated by an outbreak of erysipelas, but apparently there were no manifestations of virus reaction. (*Project 140*)

Pregnancy Diseases in Sheep

H. H. Berrier, Cecil Elder, A. H. Groth

Sodium propionate was fed flocks of sheep after a diagnosis of pregnancy disease had been made by clinical examination or by autopsy. In 5 flocks totaling 209 pregnant ewes which were fed sodium propionate no more losses from pregnancy disease were encountered. There was one loss from endometritis two weeks following lambing.

The dosage used was one-half ounce twice daily sprinkled upon or mixed into the grain ration. Flocks were treated from one to two weeks.

It is difficult to evaluate a report such as this except to say we did observe that in addition to the correction of some feeding and management practices there were no losses from pregnancy disease following the use of sodium propionate in the grain rations fed even though losses had occurred in these flocks prior to the use of this drug. (*Project 144*)

Pullorum Testing and the Production of Pullorum Antigen

*A. J. Durant, H. C. McDougal, A. H. Groth,
P. M. Newberne*

OBJECTIVES:

- A. Produce necessary antigen for the tube agglutination test to detect pullorum carriers.
- B. A report on the number of samples tested.
- C. The varieties of *Salmonellas* isolated from poultry.
- D. An examination of sera to determine the incidence of intermediate strains of *S. pullorum*.

PROGRESS REPORT:

- a. Tube antigen remaining from 1954-55, and

antigen produced was sufficient for testing 316,556 samples. Tube antigen remaining on hand is sufficient for testing 15,000 samples.

b. Total number of chicken samples tested 10,431. Number of 4+ chickens = 5 percent reactors 0.047.

Total number of turkey samples tested 60,875. Number of 4+ turkeys 242. Percent reactors 0.38.

Total number of samples tested 71,306.

Number of 4+ birds 247.

Percent reactors 0.34.

c. Salmonella cultures isolated from poultry.	20
S. typhimurium	20
S. colorado	1
S. chester	1
S. anatum	1
S. meleagridis	1
S. manhattan	3
S. sandiego	1
S. Group E	1
S. pullorum, Standard	48
S. pullorum, Intermediate	12
S. pullorum, Variant	7
Total	96

d. The first examination of sera, 1-25 dilution, from six (6) flocks showing complete reaction is indicated below. The two columns on the right indicate the reaction of the 85 four-plus reactors one day later when subjected to standard and intermediate antigen.

Total Birds	4+ Reactors	Retest on Same Samples With	
		Standard Antigen	Intermediate Antigen
Flock 1 1215	13	4+ Samples = 0	4+ Samples = 3
Flock 2 696	53	4+ Samples = 0	4+ Samples = 1
Flock 3 133	5	4+ Samples = 0	4+ Samples = 4
Flock 4 154	5	4+ Samples = 1	4+ Samples = 0
Flock 5 431	6	4+ Samples = 0	4+ Samples = 4
Flock 6 515	3	4+ Samples = 1	4+ Samples = 2
Total 3144	85	4+ Samples = 2	4+ Samples = 14

The above sample concerning 3,144 turkeys indicates a high percent of intermediate infection in Missouri turkey flocks. (Project 145)

Studies on the Prevention of Disease Transmission from Carrier Sows to Baby Pigs

A. H. Groth, A. A. Case

The use of a modified live hog cholera virus of porcine origin and hog cholera anti-serum were continued in use for the control of hog cholera. Each pig was vaccinated by giving 2 cc of virus in one flank and 10 cc serum in the opposite flank, administered subcutaneously.

A total of 320 pigs in Campus lots and 427 pigs in South Farm lots were vaccinated against hog

cholera in 1955, a total of 747 for the entire year.

There has been no hog cholera diagnosed in University swine since the Fall of 1951. Only modified live virus of swine origin is in use on the University swine.

The pigs were vaccinated as nursing pigs 5 to 7 weeks of age while still nursing the sow in most instances but several lots of older pigs were vaccinated after weaning as several lots were weaned early in other research projects. No pigs were vaccinated under 5 weeks of age.

The use of the modified live virus and serum plus the control of other infections (parts B and C) has greatly reduced the post vaccination reactions and other complications which were so troublesome prior to start of this program in 1952. The complications have been less each farrowing season since the Fall of 1951.

A total of 25 farm calls were made during the Spring of 1955 and 12 farm calls were made during the Fall of 1955. As many or more trips were made to the Campus hog barns during 1955 for the purpose of carrying out this program.

Campus lots, a total of 224 pigs vaccinated with Duovax at 1 week of age before being placed on pasture at between 1 and two weeks of age. Except for the unusually severe tissue reactions, results were as good as can be expected in such young pigs from the use of such a bacterin. There was less trouble from erysipelas than has been usual in past seasons. The dose used was 2 cc administered subcutaneously in the right flank.

As the cross bred pigs and Landrace pigs were set aside as controls, no swine erysipelas bacterin was used on them until several pigs in lots I and II contracted swine erysipelas while on pasture. These lots were then given the bacterin. None of the South Farm (Animal Breeding herd) that received the usual course of Duovax contracted swine erysipelas during the later pasture period in the Spring of 1955. Vaccination of the other lots, mentioned above, controlled any farther erysipelas. At first, the pure bred Poland China and Duroc received 1 1/2 cc of duovax bacterin when about a week of age. This was given subcutaneously in the right flank. The usual severe tissue reactions to the bacterin occurred but the pigs were protected against swine erysipelas, for the Spring pasture season.

In all, about 300 South Farm pigs and 224 Campus pigs were vaccinated with bacterin against swine erysipelas. This is a total of 524 for the Spring season. As less trouble has been experienced in the University swine herds from swine erysipelas during the Fall farrowing and pasture seasons, the swine ery-

sipelas control program on pigs has been aimed at the Spring crop of pigs.

In limited use, but planned for more use is the immunization of brood sows and gilts with booster doses of bacterin at least a month before the farrowing date. This method has showed enough promise to warrant additional trials with the view of protecting the pigs through their dams until near weaning age. 15 sows on the Campus herds have been on this trial which is continuing.

Four cases of confirmed erysipelas occurred last Spring, all in unprotected control lots and one suspect case in the Fall pig crop. This is much less than was usual several years ago before the swine erysipelas program was started, using a bacterin.

On the Campus, each piglet received ½ cc mixed infection bacterin soon after farrowing and a repeat dose of $\frac{8}{10}$ cc in one week just before going to pasture. This was given subcutaneously in the left flank and a total of 250 piglets were given the anti-salmonella vaccination on the Campus during the Spring of 1955.

At the South Farm, during the Spring, the purebred Poland China and Duroc litters were also vaccinated with Salmonella cholerasuis bacterin and, when trouble started in the Landrace litters, those were vaccinated with the salmonella bacterin. A total of 250 Spring pigs at the South Farm received the vaccination.

Results were uniformly good although the weather was unusually severe and pasture conditions were very unfavorable.

The salmonella bacterin has been quite effective although there are other conditions such as staphylococcosis and streptococcosis present which the salmonella bacterin cannot be expected to protect against.

During the Fall, no salmonella bacterin was used until this condition broke out in several litters at the South Farm which were the housed control lots for some pasture lots on another experiment. Salmonellosis was confirmed by bacteriological isolation from the sick pigs in one lot, so the rest of the lots exposed to these pigs were given bacterin. The outbreak was halted in this manner. (Project 175)

Salmonella Infections in Fowls

A. J. Durant, H. C. McDougal, A. H. Groth,
P. M. Newberne

After allowing thirty adult turkeys to become accustomed to their new surroundings, they were bled. Serum from the samples when exposed to Standard S. pullorum antigen, using the tube agglu-

tionation test, did not respond as sera from them while on the farm. The first test on the farm indicated that twenty of the thirty birds were 4+ or complete reactors at a dilution of 1-25. However, 48 days later at the Veterinary Research Farm only 6 of the twenty gave 4+ reactions at 1-25. Of the remaining 10 birds, originally giving 2+ and 3+ reactions, only one was 4+, the remainder 2+ or lower to negative.

Final results on the 30 adult turkeys are best shown in table form.

Bird Number	Dilution			Type	Area
	1-25	1-50	1-100		
*6930	0	-	-	Standard	Oviduct
*6926	1	-	-	Intermediate	Oviduct
T7203	1	1	0	Standard	Testicle, C. Tonsil
6911	0	0	0	Intermediate	Oviduct
9758	6	8	4	Standard	Ovary
9437	5	1	0	Standard	Kidney
9806	3	2	0	Standard	Heart

*Tested 3 different dates. The remaining 5 were tested 13 different dates. Initial farm tests not included.

(Project 176)

Drug Studies

Arthur D. Allen, John F. Lasley, Andrew W. Uren

In the fall of 1955 six sows were treated with pregnant mare serum (Gonadogen, Upjohn) in an effort to induce estrus. Injections were made behind the ear at a depth of $\frac{3}{4}$ to 1 inch. Daily observations for estrus were made. Three lactating sows were treated at 25 to 39 days postpartum with 200 i.u. of Gonadogen (10 Cartland-Nelson units). No estrus was exhibited in the sows prior to weaning the pigs at 56 days of age. Two lactating sows were treated at 42 to 43 days with 400 i.u. of Gonadogen (20 Cartland-Nelson units). No estrus was exhibited in the sows prior to weaning the litters at 56 days. One sow which had lost her litter was treated 51 days postpartum with 400 i.u. of Gonadogen (20 Cartland-Nelson units.) No estrus was exhibited by 56 days postpartum.

The levels of treatment used were arbitrarily arrived at. However, these levels of treatment appear too low to give the desired response. The addition of chronic gonadotropines with the pregnant mare serum will be used to raise the endogenous level of both the luteinizing hormone and follicular stimulating hormone. Intramuscular injections in the ham region will be used in future work.

(Project 177)

Measures of Speed and Extent of Absorption of Various Antibiotics and Sulfonamids

C. J. Bierschwal, A. W. Uren, H. E. Dale

The Absorption of Sulfamethazine by the Bovine Uterus

Four Jersey cows were used in this study. Each had completed one gestation period and were non-pregnant, nonlactating and in the diestrous phase of their cycle. A sterile 25% solution of 250 ml. of sodium sulfamethazine was administered to each animal by means of a Chamber's uterine catheter directly into the lumen of the uterus. Jugular blood samples were taken before injection and ½, 1, 1-½, 2, 4, 6, 12, and 24 hours after injection. All samples were analyzed for total sulfonamid by the method of Bratton and Marshall.

It was found that therapeutic amounts of sulfamethazine were rapidly absorbed from the diestrous bovine uterus. Peak blood serum concentration of the sulfonamid was reached in 2 hours. Therapeutic concentrations were maintained for 12 hours, and the drug was present in measurable quantities twenty-four hours after administration.

The Absorption of Aureomycin by the Bovine Uterus:

Ten dairy-type cows were used in this study. Each had completed at least one or more gestation period and was, at the time, non-pregnant, non-lactating and in the diestrous phase of their cycle. Each cow received 40 cc of an aqueous solution containing 1 gram of crystalline aureomycin. In eight cows the solution was deposited in the lumen of the uterus with a Chamber's uterine catheter; in two cows the solution was injected intravenously. Jugular blood samples were taken before injections and at ½, 1, 2, 4, 8, 12, and 24 hour intervals. The samples were assayed for antibiotic activity using the Food and Drug Administration agar diffusion method.

Uterine absorption occurred in all eight of the cows injected, with the peak concentrations usually being reached in 2 hours. The blood serum levels varied considerably in individual animals, with relatively low blood serum levels of aureomycin activity occurring in all cases studied.

A much higher level of aureomycin activity was found in the blood serum following intravenous administration in the two cows tested, which was to be expected.

Two phases of the study:

Measure of speed and extent of absorption of various antibiotics and sulfonamids from the non-gravid, post-parturient bovine uterus, have been completed.

The absorption of sulfamethazine and the absorption of aureomycin from the non-gravid bovine uterus. A search of the literature revealed no study of the absorption capabilities of the bovine uterus, even though treatment of that organ with antibiotics and sulfonamids has become routine.

Our studies have shown that the bovine uterus is capable of absorption and in the case of the sulfonamid sulfamethazine, the drug is absorbed in therapeutic amounts. (*Project 177*)

Studies on Drug Toxicity in Chicks

P. M. Newberne, H. C. McDougal

Megasul at levels above 0.0125% caused postural and locomotor disturbances with increased excitability. The birds exhibited symptoms that might be mistaken for epidemic tremors or the nervous form of Newcastle disease. Weight gains were progressively less as the drug level increased. Some degree of tolerance to the drug developed after two weeks. There was an initial elevation in hemoglobin followed by a progressive decrease after the first week in birds on higher levels of Megasul. This was accompanied by a decrease in platelets with muscular and subcutaneous hemorrhage. A Neutrophilia was present which was in contrast to agranulocytosis reported in birds using other coccidiostats. The apparent depression in bone marrow was reflected in the red cell series and hemoglobin determinations.

Liver degeneration and necrosis was more advanced around the Central Veins. Areas of focal necrosis and regeneration were present. Vacuolization of the liver cells was general. (*Project 177*)

Experimental Surgery on the Ruminant Stomach

J. T. McGinty, H. E. Dale, E. F. Ebert, A. W. Uren

Feeding a fasting cow increased first her rumen temperature (measured by thermocouple), followed by increase in rectal (body) temperature. Injecting antipyretics (which increase heat loss and, therefore, lower body temperature), on the other hand, lowered first the rectal (body) temperature, followed by increase in rumen temperature. These differences in time sequence of temperature change following feeding and antipyretic injection suggest that, by appropriate methods, this rumen heat production could be measured by difference between indirect calorimetry which does not include the rumen (99% of the rumen bacteria are obligate anaerobes) and direct calorimetry which includes the rumen heat. Following a 24 hour fast the mean temperatures of the rectum, lower, middle, and upper rumen of two dry

Jersey cows were 100.3°, 101.0°, 101.6°, and 101.7° F respectively; when normally fed the temperatures were 100.6°, 101.7°, 103.6° and 104.0° F respectively. Feeding thus greatly increased the rumen temperature but slightly the rectal temperature; watering sharply reduced the rumen temperature but slightly the rectal temperature. When the rectal temperature was 100.3° F. and the rumen temperature was 101.7°-104° F, the blood temperature, as here measured

(thermocouple in tip of a 72-inch polyethylene catheter inserted into the right jugular vein), was 99.1° F 6 to 18 inches deep, and 100.3° F 24 to 36 inches deep. Environmental temperature rhythms contributed substantially to rectal and rumen diurnal temperature rhythms which were 1° F higher during hot (70-100° F) than cold (10-40° F) weather. Details will be published in a Missouri Bulletin. (*Project 252*)

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Publications

E. B. Winner, Editor

REPORT OF PROGRESS:

Administration:

Staff members and their responsibilities are as follows:

- 2 staff members—bulletins
- 1 staff member—radio
- 1 staff member—television
- 1 staff member—news
- 1 staff member—special writings and motion pictures
- 1 staff member—administration and organization, development of new phases of program, and assisting with present ones.

Radio:

Thirty-six stations used the tape recorded programs. Two-page daily farm news service provided all stations in the state. Through spring and summer, special recordings on the insect situation were made for several key stations. A total of 144 Extension agents participated regularly in radio programs one or more times per week during the year. In addition, nearly 100 agents made occasional broadcasts.

Publications:

All manuscripts submitted by the Experiment Station staff and approved for Station Publications were edited and processed.

News Releases, Periodicals, Special Publications:

Research data were processed and furnished to weeklies, dailies, farm magazines, and trade papers. Stories were provided to these papers and magazines through weekly issue of the Farm News Service, specials, and tips to staff writers of various publications. In addition, periodicals such as the monthly Announcer and others, and special publications were edited and published.

Television:

Two 30-minute television shows were presented weekly over KOMU-TV. In addition, a weekly 15-minute kinescope was sent to seven stations. And an even larger number were furnished pictures and slides on news events as available. County agent programs were organized with several stations and training sessions held with agents. Programs on KOMU-TV were determined by the Division of Agricultural Sciences Television Committee which includes a representative from each of the Departments of the College of Agriculture and the School of Veterinary Medicine.

Motion Picture:

Limited work was continued on this program during the year. Stories and scripts were prepared on three films—apples, Christmas trees, and hybrid corn.

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CONTRIBUTIONS TO SCIENTIFIC JOURNALS

- 1562 On Consumer Grades for Foods, by V. James Rhodes and Elmer R. Kiehl*, University of Missouri, Agricultural Economics Department. Submitted September, 1955, for publication in the *Journal of Farm Economics*.
- *The authors gratefully acknowledge helpful reviews by Dr. Gerald Engelman, Livestock Section, AMS, USDA, and Professor D. E. Brady, Animal Husbandry, University of Missouri.
- 1563 (Abstract) The Effect of Thyroxine on Thyroid Function As Shown by I^{131} , by G. W. Pipes and C. W. Turner, Univ. of Mo., Department of Dairy Husbandry. Submitted October, 1955. Dr. G. W. Pipes will present this abstract at the Atomic Energy Symposium in Michigan in January, 1956.
- 1564 Late Season Twig-Infection, A Serious Limitation to the Effectiveness of Antibiotic Sprays for Fireblight Control, by R. N. Goodman, Univ. of Mo., Horticulture Department. Submitted October, 1955, for publication in the U.S.D.A. *Plant Disease Reporter*.
- 1565 The Association of I^{131} -Labeled Lactogenic Hormone With the Cytoplasmic Nucleoprotein of the Mammary Gland Cell, by W. F. Williams and C. W. Turner, Dairy Husbandry Department, Univ. of Mo. Submitted October, 1955, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1566 The Effect of Heat on Calcium in Milk, by J. M. Baker and Charles W. Gehrke, Dept. of Agricultural Chemistry, Univ. of Mo. Submitted October, 1955, for publication in the *Journal of Dairy Science*.
- 1567 (Abstract) The Performance of Some Chemicals As Pre-emergence Herbicides for Weed Control in Corn, by Dr. O. Hale Fletchall and Dayton L. Klingman, Dept. of Field Crops, Univ. of Mo. Submitted October, 1955. Research Report of the North Central Weed Control Conference.
- 1568 Seasonal Changes in the Nucleic Acid Content of Necrotic Ring Spot Infected Cherry Leaves, by D. F. Millikan, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in *Phytopathology*.
- 1569 (Abstract) Chemical Weed Control in Cucurbits—1955, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1570 (Abstract) Chemical Weed Control in Green Beans, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1571 (Abstract) Pre-emergence Weed Control in Sweet Corn, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1572 (Abstract) Weed Control in Peppers and Tomatoes, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955 for publication in Research Report—North Central Weed Control Conference—1955.
- 1573 (Abstract) Herbicides for Cole Crop Transplants, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1574 (Abstract) Pre-emergence Control of Crabgrass in Lawns, by T. W. Hogard and D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1575 (Abstract) Post-emergence Control of Crabgrass in Lawns, by T. W. Hogard and D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1576 (Abstract) Spring Control of Henbit in Lawns, by T. W. Hogard and D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1577 (Abstract) Spring Control of Chickweed in Lawns, by T. W. Hogard and D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October, 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1578 (Abstract) Bermuda Grass Eradication in Lawns, by T. W. Hogard and D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted October 1955, for publication in Research Report—North Central Weed Control Conference—1955.
- 1579 An Abnormality of the Proventriculus of Chicks on Synthetic Diets, by P. M. Newberne, D.V.M., and Robert W. Craghead, B.S., Dept. of Veterinary Bacteriology and Parasitology, School of Veterinary Medicine, and Dept. of Agricultural Chemistry, Univ. of Mo. Submitted October, 1955, for publication in the *Journal of American Veterinarian Association*.
- 1580 Time Study of Parallel Terraces, by Dwight D. Smith, Dept. of Agricultural Engineering, Univ. of Mo., Eastern Soil and Water Management Section, SWC, ARS, U.S.D.A. Submitted November, 1955, for presentation at winter meeting of ASAE, Chicago, Illinois in December, 1955.
- 1581 Energy Exchange and Thermoregulation in Cattle and Man 50° to 105° F Ambient Temperature, Samuel Brody, Dept. of Dairy Husbandry, Univ. of Mo. Submitted November, 1955, for publication in *Refrigerating Engineering Including Air Condition*.
- 1582 (Abstract) Weed Control Around Newly Transplanted Apple Trees, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted November, 1955, for publication in "Research Report"—North Central Weed Control Conference.
- 1583 (Abstract) Chemical Weed Control in Grape Vineyards, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted November, 1955, for publication in "Research Report"—North Central Weed Control Conference.
- 1584 Weed Control in Small Fruits, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted November, 1955 for publication in Proceedings of Iowa State Horticultural Society.
- 1585 Lateral Pressures in Silage and Design of Horizontal Silos, by Merle L. Esmay and Donald B. Brooker, Dept.

- of Agricultural Engineering, Univ. of Mo. Esmay, former Professor of Agricultural Engineering at the Univ. of Mo., is now at Michigan State University. Submitted November, 1955, for presentation at the meeting of the American Society of Agricultural Engineers at Chicago, December, 1955.
- 1586 Habitat Notes and Description of the Larva of *Cicindela Circumpicta* Johnsoni Fitch, by Paul J. Spangler, Dept. of Entomology, Univ. of Mo. Submitted November, 1955, for publication in the *Journal of the Kansas Entomological Society* (Central States Entomological Society).
- 1587 European Corn Borer as a Pest on Cotton in Missouri, by Lee Jenkins and George W. Thomas. Dept. of Entomology, Univ. of Mo. Submitted November, 1955, for publication in the *Journal of Economic Entomology*.
- 1588 Soils, Nutrition, and Animal Health, by Wm. A. Albrecht, Dept. of Soils, Univ. of Mo. Submitted November, 1955, for publication in the *Journal of the American Society of Farm Managers and Rural Appraisers*, Chicago.
- 1589 Salt Concentration a Factor in the Availability of Phosphorus From Rock Phosphate As Revealed by the Growth and Composition of Alfalfa, by D. O. Howe and E. R. Graham, Dept. of Soils, Univ. of Mo. Submitted November, 1955, for publication in the Proceedings of the Soil Science Society of America.
- 1590 Fertility of the Soil Outlines Biotic Geography, by Wm. A. Albrecht, Dept. of Soils, Univ. of Mo. Submitted November, 1955, for publication in *Geographical Review*.
- 1591 Thermodynamic, Quasithermodynamic and Non-Thermodynamic Methods As Applied to the Electrochemistry of Clays, by C. Edmund Marshall, Dept. of Soils, Univ. of Mo. Submitted November, 1955, for publication in the Proceedings of the Third National Conference of Clays.
- 1592 Weed Control Around Newly Transplanted Apple Trees, by D. D. Hemphill, Dept. of Horticulture, Univ. of Mo. Submitted December, 1955, for publication in Proceedings of the North Central Conference—1955.
- 1593 Improved Techniques in Terrace System Layout and Construction, by R. P. Beasley and L. Donald Meyer, Dept. of Agricultural Engineering, Univ. of Mo. Submitted December, 1955, for publication in the *Journal of the American Society of Agricultural Engineers* and is to be presented at the Winter meeting of ASAE in Chicago on Dec. 12, 1955.
- 1594 Effect of a High Phosphorus Diet on the Acid-Base Balance in Guinea Pigs, by B. L. O'Dell, J. M. Vandepopuliere, E. R. Morris, and A. G. Hogan, Dept. of Agricultural Chemistry, Univ. of Mo. Submitted December, 1955, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1595 Detasseling Responses in Corn, by Clarence O. Grogan, Dept. of Field Crops, Univ. of Mo. Submitted December, 1955, for publication in the *Agronomy Journal*.
- 1596 Indications of *Xanthomonas Pruni* Control With Antibiotic Sprays, by R. N. Goodman and P. Shepard, Dept. of Horticulture, Univ. of Mo. Submitted December, 1955, for publication in the *U.S.D.A. Plant Disease Reporter*.
- 1597 Regulation of Lactation, by Charles W. Turner, Dept. of Dairy Husbandry, Univ. of Mo. Submitted December, 1955, for presentation at the Atomic Energy Symposium at Michigan State College, January 12-14, 1956.
- 1598 How Long May American Foulbrood Spores Remain Viable?, by Leonard Haseman, Dept. of Entomology, Univ. of Mo. Submitted December, 1955, for publication in the *Journal of Economic Entomology*.
- 1599 A Method for Urine-Feces Separation in Young Chickens, by Paul M. Newberne, D. V. M., Dept. of Veterinary Bacteriology and Parasitology, School of Veterinary Medicine, Univ. of Mo. Submitted December, 1955, for publication in the *American Journal of Veterinary Research*.
- 1600 Effect of Environmental Temperature Rhythms on Blood and Serum Volumes and Body Water in Dairy Cattle, by Homer E. Dale, Samuel Brody, and Gloria J. Burge, Depts. of Dairy Husbandry and Veterinary Physiology Division of Agricultural Science, Univ. of Mo. Submitted January, 1956, for publication in the Federation Proceedings. This paper will be presented before the Annual Meeting of the Federation in Atlantic City, April 16 to 20, 1956.
- 1601 Reactions of New Zealand Giant Rabbits to Ambient Temperatures 9°-40°C, by Harold D. Johnson, C. S. Cheng, and Samuel Brody, Dept. of Dairy Husbandry, College of Agriculture, Univ. of Mo. Submitted January, 1956. This paper is to be published in the Federation Proceedings and will be presented before the Annual Meeting of the Federation in Atlantic City, April 16-20, 1956.
- 1602 The Characteristics of Some Rumen Lactobacilli, by R. G. Jensen, K. L. Smith, J. E. Edmondson and C. P. Merilan, Dept. of Dairy Husbandry, Univ. of Mo. Submitted January, 1956, for publication in the *Journal of Bacteriology*.
- 1603 The Absorption of Aureomycin by the Bovine Uterus, by C. J. Bierschwal, D.V.M., A. W. Uren, D.V.M., M.S., Dept. of Veterinary Medicine and Surgery and the Dept. of Veterinary Physiology and Pharmacology, Univ. of Mo. Submitted January, 1956, for publication in the *Journal of the American Veterinary Medical Association*.
- 1604 An Unusual Fruit Symptom in Apple, by Dr. D. F. Millikan and W. R. Martin, Jr., Dept. of Horticulture, Univ. of Mo. Submitted January, 1956, for publication in the *Plant Disease Reporter*.
- 1605 The Effect of Exogenous Estrogen on Parturition in Sows, by A. M. Gawienowski, D. T. Mayer, M. M. Muhrer and J. F. Lasley, Depts. of Agricultural Chemistry and Animal Husbandry, Univ. of Mo. Submitted January, 1956, for publication in the *Journal of Animal Science*.
- 1606 A New Name for the Dark Race of *Tropisternus Mexicanus* (Castelnau) from the Southeastern United States, by Frank N. Young and Paul J. Spangler, Dept. of Zoology, Indiana, and Dept. of Entomology, Univ. of Mo. Submitted January, 1956, for publication in the *Florida Entomologist*.
- 1607 Bioenergetics of Milk Production with Special Reference to the Effects of Environmental Factors, by Dr. Samuel Brody, Dept. of Dairy Husbandry, Univ. of Mo. Submitted January, 1956, for publication in the *Journal of Dairy Science*—the 50th anniversary number.
- 1608 Severe Root-Knot Nematode Infection of the Soybean Variety Lee, by Marvin D. Whitehead, Arnold Matson and Leonard Williams, Dept. of Field Crops, Univ. of Mo. Submitted January, 1956, for publication in the *Plant Disease Reporter*.
- 1609 Cationic Reactions of Feldspar Surfaces, by V. E. Nash

- and C. E. Marshall. Dept of Soils. Univ. of Mo. Submitted February, 1956. for publication in *The Journal of Physical Chemistry*. To be given at the Colloid Symposium.
- 1610 Estrogen Content of Milk of Open and Pregnant Cattle and Effect of Synthetic Estrogen Feeding, by C. W. Turner, Dept. of Dairy Husbandry, Univ. of Mo. Submitted February, 1956, for presentation at meeting of American Dairy Science Association and for publication in the *Journal of Dairy Science*.
- 1611 Stimulation of Udder Growth and Lactation in Infertile Dairy Heifers, by H. L. Ruppert, Jr., H. Yamamoto, and C. W. Turner, Dept. of Dairy Husbandry, Univ. of Mo. Submitted February, 1956, for presentation at meeting of American Dairy Science Association and for publication in the *Journal of Dairy Science*.
- 1612 Abstract—Evaporative Cooling in Indian- and European-evolved Cattle, by R. G. Yeck and S. Brody, Dept. of Dairy Husbandry and Agricultural Engineering, Univ. of Mo. Submitted February, 1956, for publication in the *Journal of Dairy Science*.
- 1613 Evaluation of the Thyroid Activity of Dairy Animals, by G. W. Pipes and C. W. Turner, Dept. of Dairy Husbandry, Univ. of Mo. Submitted February, 1956, for presentation at the 1956 meeting of the American Dairy Science Association.
- 1614 Experimental Mammary Gland Growth in Rabbits by Estrogen and Progesterone, By Hiroo Yamamoto and Charles W. Turner, Dept. of Dairy Husbandry, Univ. of Mo. Submitted March, 1956, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1615 Mechanics of Sheet Erosion, by D. D. Smith and Walter H. Wischmeier, Depts. of Agricultural Engineering and Soils, Univ. of Mo. Mr. Wischmeier is Analytical Statistician, SWC, A.S., U.S.D.A., Agricultural Engineering Department, Purdue University, Lafayette, Indiana. Submitted March, 1956, for presentation at the spring meeting of the American Geophysical Union in Washington, D. C. on April 30.
- 1616 Studies on Drug Toxicity in Chicks, by P. M. Newberne, and H. C. McDougale, Dept. of Veterinary Bacteriology and Parasitology, School of Veterinary Medicine, Univ. of Mo. Submitted April, 1956, for publication in the *Journal of Poultry Science*.
- 1617 Microbiological Determination of Nitrate, by G. B. Garner, J. S. Baumstark, M. E. Muhrer and W. H. Pfander, Depts. of Agricultural Chemistry and Animal Husbandry, Univ. of Mo. Submitted April, 1956, for publication in *Analytical Chemistry*.
- 1618 Ammonium Chloride As An Agent To Acidify the Urine of the Bovine, by Paul Nicoletti, A. W. Uren, D.V.M., M.S., and Homer E. Dale, D.V.M., M.S., Ph.D., Dept. of Physiology and Pharmacology, School of Veterinary Medicine, Univ. of Mo. Submitted April, 1956, for publication in the *American Journal of Veterinary Research*.
- 1619 The Experimental Induction of Growth of the Cow's Udder and the Initiation of Milk Secretion, by C. W. Turner, H. Yamamoto, and H. L. Ruppert, Jr., Dept. of Dairy Husbandry, Univ. of Mo. Submitted April, 1956, for publication in the *Journal of Dairy Science*.
- 1620 Critical Points in the Schechter-Hornstein Colorimetric Method for Lindane, by Charles W. Gehrke and Joseph L. Bevirt, Dept. of Agricultural Chemistry, Univ. of Mo. Submitted April, 1956, for publication in the *Journal of Agriculture and Food Chemistry*.
- 1621 The Transfer of Leaf-Rust Resistance From *Aegilops Umbellulata* to Wheat, by E. R. Sears, U. S. Dept. of Agr. and Field Crops Dept., University of Missouri. Submitted April, 1956, for publication in the Brookhaven Symposia in Biology, "*Genetics in Plant Breeding*."
- 1622 The Effect of Phenothiazine Upon Thyroid Function in Dairy Animals as Shown by Radioiodine, by G. W. Pipes and C. W. Turner, Dept. of Dairy Husbandry, Univ. of Mo. Submitted April, 1956, for publication in the *Journal of Dairy Science*.
- 1623 Correlation of Field Stalk Lodging, Two Stalk Rotting Fungi and Chemical Content of Stalks in Corn, M. S. Zuber, C. O. Grogan, M. E. Michaelson and C. W. Gehrke, Univ. of Mo. and U.S.D.A. Submitted April, 1956, for presentation at the American Society of Agronomy meetings in November.
- 1624 The Physician's Relations with the Public: Past and Present, by Edward Hassinger, Dept. of Rural Sociology, Univ. of Mo. Submitted April, 1956, for publication in the *Rural Sociology Journal*.
- 1625 Some Indications and Implications of Age Misstatement in Census Reports, by Robert L. McNamara, Dept. of Rural Sociology, Univ. of Mo. Submitted May, 1956, for publication in *Rural Sociology Journal*.
- 1626 A Cooperative Study of Top Cross Tester Parents of Maize, by C. O. Grogan and M. S. Zuber, Dept. of Field Crops, Univ. of Mo. Submitted May, 1956, for publication in the *Agronomy Journal*.
- 1627 Preliminary Tests Indicate That the Small Oak Bark-beetle May be a Vector of the Oak Wilt Fungus, by William D. Buchanan, Dept. of Forestry, Univ. of Mo., and Central States Forest Experiment Station, Forest Service, U.S.D.A. Submitted May, 1956, for publication in the *Plant Disease Reporter*.
- 1628 A Device for Rapid Field Measurement of a Soil's Hydraulic Permeability, by Peter W. Fletcher, Dept. of Forestry, Univ. of Mo. Submitted May, 1956, for publication in the Soil Science Society of America Proceedings.
- 1629 Studies on Drug Toxicity in Chicks, by Paul M. Newberne, D.V.M., M.S., and William B. Buck, Dept. of Veterinary Bacteriology and Parasitology, Univ. of Mo. Submitted May, 1956, for publication in the *Journal of Poultry Science*.
- 1630 The Effect of Environmental Temperature on Blood Volume and the Antipyrine Space in Dairy Cattle, by Homer E. Dale, Gloria J. Burge, and Samuel Brody, Depts. of Veterinary Physiology and Pharmacology and Dairy Husbandry, Univ. of Mo. Submitted May, 1956, for publication in the *American Journal of Veterinary Research*.
- 1631 Endocrine Factors Influencing the Intensity of Milk Secretion A. Estrogen, Thyroxine, and Growth Hormone, by C. W. Turner, H. Yamamoto, and H. L. Ruppert, Jr., Dept. of Dairy Husbandry, Univ. of Mo. Submitted May, 1956, for publication in the *Journal of Dairy Science*.
- 1632 The Communication of Farm Information in a Missouri Farm Community: A Study of Structural Factors and Personal Influence, by Herbert F. Lionberger and C. Milton Coughenour, Dept. of Rural Sociology, Univ. of Mo. Submitted May, 1956, to be read at the Annual

- Meeting of the Society for Social Research, Chicago, June 1-2, 1956.
- 1633 The Hospital in Your Community, by Robert L. McNamara, Dept. of Rural Sociology, Univ. of Mo. Submitted May, 1956, to be read before medical staff of Louise G. Wallace Hospital, Lebanon, Missouri, June 5, 1956.
- 1634 Beta-Gauge for Hair Measurements, by Clifton Blincoe, Dept. of Dairy Husbandry, Univ. of Mo. Submitted June, 1956, for publication in *Science*.
- 1635 Lindane Residue in Cucumber Fermentation, by Melvin R. Johnston, Food Processing Laboratories, Mo. Agr. Exp. Sta., Univ. of Mo. Submitted June, 1956 for pre-Technologist, St. Louis, June 10-14, 1956.
- 1636 Nitrogen Utilization by Lambs Fed Purified Rations Containing Urea, Gelatine, Casein, Blood Fibrin, and Soybean Protein, by William C. Ellis, Dept. of Animal Husbandry, Univ. of Mo. Submitted June, 1956, for publication in *Journal of Nutrition*.
- 1637 Influence of Plastic Vat Cover on the Fermentation of Cucumbers, by Neil Finley and Melvin R. Johnston, Food Processing Laboratories, Univ. of Mo. Submitted June, 1956, for presentation at the 16th Annual Meeting of the Institute of Food Technologists, June 10-14, 1956, St. Louis.
- 1638 Effect of Controlling Environmental Conditions During Aging on the Quality of Beef, R. B. Sleeth, R. L. Henrickson, and D. E. Brady, Food Processing Laboratories, Univ. of Mo. Submitted June, 1956, for presentation before the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.
- 1639 Sodium Ascorbate in Stabilizing Cured Meat Color, by R. L. Henrickson, R. B. Sleeth and D. E. Brady, Food Processing Laboratories, Mo. Agr. Exp. Sta., Univ. of Mo. Submitted June, 1956, for presentation before the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.
- 1640 Results of Consumer Studies of Meat Purchases, by V. James Rhodes, Agricultural Economics Dept., Univ. of Mo. Submitted June, 1956, for presentation before the Interregional Livestock Production and Marketing Conference, Cornell University, June 14, 1956.
- 1641 Effects of Organic Fungicides and Antifungal Antibiotics on Mushroom Mildew, and Lipstick Mold, by Robert N. Goodman, Dept. of Horticulture, Univ. of Mo. Submitted June, 1956, for publication in *Plant Disease Reporter*, August 15, 1956.
- 1642 Vegetation and Soil Relationships in the Glade Region of the Southwestern Missouri Ozarks, by C. L. Kucera and S. Clark Martin, Professor of Botany, Univ. of Mo., and Range Conservationist, Central States Forest Experiment Station, Forest Service, U. S. Dept. of Agr. and Mo. Agr. Exp. Sta. Submitted June, 1956, for publication in *Ecology*.

STATION PUBLICATIONS

July 1955—June 1956

Research Bulletins

- 584 Experimental Trials of Wildlife Food and Cover Plants by Thomas S. Baskett, July 1955, 24 pages, 2000 copies.
- 585 Value of B-Vitamins in Rations for Growing-Fattening Swine by L. F. Tribble, J. F. Lasley and A. G. Hogan, July 1955, 20 pages, 1500 copies.
- 586 Dehydrated Pork Studies by R. L. Henrickson, D. E. Brady, C. W. Gehrke and R. F. Brooks, July 1955, 12 pages, 1500 copies.
- 587 Influence of Light and Nutrition on Color and Growth of Redcedar Seedlings by R. F. McDermott and P. W. Fletcher, July 1955, 16 pages, 1700 copies.
- 588 Gene Structure and Gene Function by G. W. Beadle, J. R. Laughnan and H. E. Bent, July 1955, 68 pages, 2000 copies.
- 589 Treatment of Surface Water Supplies for the Farm Home by M. L. Esmay, B. E. Guyer, M. D. Shanklin and L. H. Tempel, July 1955, 36 pages, 1500 copies.
- 590 Embryo Abortion as Mechanism of "Hormone" Thinning of Fruit by F. G. Teubner and A. E. Murneek, August 1955, 88 pages, 1500 copies.
- 591 Uterine Phosphatase Concentrations and Their Relationship to Number and Weight of Embryos in the Rat by H. E. Bredeck and Dennis T. Mayer, September 1955, 24 pages, 1500 copies.
- 592 Effect of Supplementary Amino Acids and Adenosine Phosphates on Motility and Metabolism of Bovine Spermatozoa.
- 593 Environmental Physiology and Shelter Engineering With Special Reference to Domestic Animals. XXXVI. Interrelations Between Temperatures of Rumen (at Various Depths), Rectum, Blood and Environmental Air; and the Effects of an Antipyretic, Feed and Water Consumption by Samuel Brody, H. E. Dale and R. E. Stewart, October 1955, 20 pages, 2000 copies.
- 594 Mineral Composition of Missouri Feeds and Forage by E. E. Pickett, October 1955, 24 pages, 1500 copies.
- 595 Environmental Physiology and Shelter Engineering With Special Reference to Domestic Animals. XXXV. Heat and Moisture Removed by a Dairy Stable Ventilation System During Diurnal Temperature Rhythms by R. G. Yeck, December 1955, 28 pages, 1500 copies.
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Station Bulletins

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547 Good Pastures Pay by E. Marion Brown, April 1956, 24 pages, 2000 copies.

635 Using LP Gas as a Tractor Fuel by C. L. Day, M. D. Cannon, M. M. Jones, June 1956, 8 pages, 2000 copies.

RESEARCH GRANTS

Herman Frasch Foundation

For research dealing with the composition of food and the accumulation of calcium phosphate in animal tissue.

Rockefeller Foundation

For support of a study in Missouri of the rural church as a social institution.

Missouri Poultry Improvement Association

For support of research in poultry management.

American Poultry and Hatchery Federation

For research in connection with the effect of various methods of turning eggs during incubation.

Merck and Company, Incorporated

For support of research on the nutritional requirements of swine.

Missouri Conservation Commission

For farm forestry research.

National Oak Wilt Research Committee

To help support investigation of oak wilt disease in Missouri.

American Potash Institute

For research dealing with the relationship of potash to soil fertility.

Swift and Company

For research on the influence of soil composition and treatment on the composition of forages and the resulting development of animals.

International Minerals and Chemical Corporation

For support of research on the hypothesis that the nutrition of plants is based upon the roots exuding hydrogen or acidity in exchange for, or solvent action on, the inorganic contents of the soil.

Tennessee Corporation

For research on the function of the so-called trace elements, copper, manganese, and zinc.

Nitrogen Division Allied Chemical and Dye Corporation

For research in connection with soil fertility and plant nutrition.

American Plant Food Council

For support of research in connection with the possible effects of sulfur, in its various forms within the soil, as this relates itself to plant production and the resulting organic materials.

United States Public Health Service

For study of the relation of nutrition to hydrocephalus in infant rats.

United States Public Health Service

For support of research on the intermediary metabolism and the mediating enzymes related to growth, cellular secretion, and tissue involution of the mammary gland and to the endocrine modification of these processes.

National Soybean Processors Association

For research on weed control.

National Livestock and Meat Board

For research in the assaying of tissues from cattle fed diethylstilbestrol and other estrogens.

Swift and Company

For research on mineral nutrition of ruminants.

Hoffman-La Roche, Inc.

For research in connection with food preservation and utilization-stability in cured meats using ascorbic acid and other stabilizers.

Dannen Mills, Inc.

For the support of research in connection with improvement of the soybean crop, quantitatively and qualitatively.

Grace Chemical Company

For support of research on roughage and concentrate digestion and utilization by ruminants.

Phillips Petroleum Company

To support research in soil fertility.

General Foods Corporation

To determine the potency of some natural products in the prevention of an arthritic-like condition in the guinea pig.

Hales and Hunter Company

To promote graduate study in the field of livestock and poultry nutrition.

American Cancer Society, Inc.

For a study of growth and function of the mammary gland with special reference to the enzymes of the gland.

Missouri Farmers Assn.—Seed Division

For research relating to improvement of hybrid corn varieties for Missouri.

National Soybean Processors Assn.

For research to improve the soybean crop.

Walnut Grove Products Company

To study the role of hormones in livestock feeding.

United States Atomic Energy Commission

To study the inheritance of productive processes in domestic animals by endocrine methods using radioactive isotopes as tracers.

Hales and Hunter Company

For research in connection with rumen culture.

Carbide and Carbon Chemical Company

For research in connection with herbicidal evaluation of sodium 2, 4, 5, trichlorophenoxyethyl sulfate and dichloral urea on certain vegetable crops.

Charles Denny and Company

For research on horticultural crops.

National Livestock and Meat Board

To investigate the effect that various kinds and degrees of stress to which cattle are subjected during marketing are upon the resultant carcass; to determine the role of the endocrine system in producing and preventing the depletion of muscle glycogen.

National Science Foundation

For research to secure fundamental information of the effects of various cutting tool edges on wood cells and surfaces under different conditions.

Mathieson Chemical Corp.

For research in the field of horticultural crops.

The Upjohn Company

For studies of acti-dione as a material for the control of various horticultural crop diseases.

Foundation for Research on Human Behavior

To study television as a factor in motivating changes in farm practices and the purchase of farm supplies.

Potash Rock Company of America

To study the release of cations from feldspar and from other primary minerals occurring in granites.

National Grape Cooperative Assn., Inc.

To study the nutritional requirements and the development of fertilizer practices for the Concord grape and to study the control of grape diseases.

Missouri Farm Electric Utilization Council

For research on utilization of electricity on typical Missouri farms.

Pasteuray Corporation

For research relating to shrinkage, bloom, and aging characteristics of beef as influenced by ultra violet radiation.

Velsicol Corporation

To investigate the effect of soil insecticides on the germination and seedling growth of farm seeds and to study the minimum dosage rates of commonly used insecticides for grasshopper control.

United States Forest Service

For research to determine proper methods of managing bottomland hardwoods for timber and wildlife management.

Missouri Seed Improvement Association

To construct a house on the University South Farms.

United States Weather Bureau

To study the occurrence and persistence of drought.

Monsanto Chemical Company

For research to determine the efficiency of special chemical formulations for destroying certain stages of *Ascaridia galli* in the soil or litter.

Charles Pfizer and Company

To evaluate the effect of terramycin on reproduction of the bovine.

United States Atomic Energy Commission

To study the influence of climatic factors on growth and productivity of animals and involved physiological reactions with the aid of radioisotopes.

Missouri Farmers Association

For research related to use of gypsum on Missouri soils.

CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1956

Appointments

Perry Lee Adkisson, Assistant Professor of Entomology
John W. Allen, Assistant in Agricultural Engineering
Horace E. Armstrong, Assistant in the Department of Agricultural Economics
Joseph F. Arnold, Research Associate in Forestry
Lewis Earl Barnes, Assistant in Soils
Lloyd D. Bender, Instructor in Agricultural Economics
Robert E. Berry, Assistant in the Department of Agricultural Economics
Betty Lee Blase, Assistant in Home Economics
Kenneth E. Blase, Assistant in the Department of Agricultural Economics
Melvin G. Blase, Assistant in the Department of Agricultural Economics
Mary B. Bowman, Assistant in Rural Sociology
Curtis H. Braschler, Assistant in the Department of Agricultural Economics
Durward Brewer, Instructor in Agricultural Economics
William Broce, Jr., Assistant in Horticulture
John S. Bullock, Assistant in Soils

Arthur K. Burditt, Assistant Professor of Entomology
Johnny R. Campbell, Assistant in Dairy Husbandry
Edward J. Carroll, Instructor in Agricultural Chemistry
Patricia Walsh Cleaver, Assistant in Home Economics
James R. Cook, Assistant in Animal Husbandry
Ruth I. Cooper, Assistant Professor of Home Economics
Joe Corgan, Assistant in Horticulture
R. Bruce Curry, Instructor in Agricultural Engineering
John de Jonge, Assistant in Soils
William A. Dimmitt, Assistant in Entomology
Harlan E. Fiehler, Assistant in the Department of Agricultural Chemistry
Neil Finley, Assistant in Horticulture
Charles W. Foley, Assistant in Animal Husbandry
Frederick W. Forsythe, Assistant in Field Crops
Howard D. Friese, Assistant in the Department of Agricultural Economics
Glen W. Froning, Assistant in Poultry Husbandry
Robert Gast, Assistant in Soils
John F. Gerber, Assistant in Soils
Nina L. Glidden, Instructor in Home Economics

Gary E. Hanman, Assistant in Agricultural Economics
David N. Harrington, Assistant Professor of Agricultural Economics
Dennis Hartman, Assistant in Dairy Husbandry
Charles F. Hayward, Assistant in Field Crops
Charles N. Hinkle, Assistant in Agricultural Engineering
Teddy Omar Hodges, Associate Professor of Agricultural Engineering
Glenn E. Huskey, Assistant in Dairy Husbandry
Edwin A. Jaeneke, Assistant in the Department of Agricultural Economics
Bobby Roy Jones, Assistant in Poultry Husbandry
Laverne J. Kebert, Assistant in Home Economics
Mike Kelly, Assistant in Poultry Husbandry
Harold D. Kerr, Research Associate in Field Crops
Arnold W. Klemme, Assistant Director, Agricultural Experiment Station
Helen Louise Koehler, Assistant Professor of Home Economics
Samuel R. Koirtzohann, Assistant in Agricultural Chemistry
Ron Lauter, Assistant in the Department of Agricultural Chemistry
Kieffer Ross Lehman, Assistant in the Department of Agricultural Economics
Lawrence S. Malone, Assistant in the Department of Rural Sociology
Arnold L. Matson, Instructor in Field Crops
Marion L. Martinson, Assistant Professor of Home Economics
Richard C. Maxon, Assistant in Agricultural Economics
Otis E. Miller, Assistant in Agricultural Economics
Albert H. Miller, Assistant in Agricultural Engineering
Roberta A. Mitchell, Instructor in Home Economics
Clay R. Moore, Instructor in Agricultural Economics
Francis L. Moritz, Administrative Assistant in the Office of the Dean and Director
Leslie L. McDowell, Assistant in Soils
Kenneth L. McFate, Assistant Professor of Agricultural Engineering
Andrew J. Nash, Assistant Professor of Forestry
Victor Nash, Instructor in Soils
Hugh D. Naumann, Assistant Professor of Animal Husbandry
Frank M. Orsini, Assistant in Agricultural Chemistry and Dairy Husbandry
David B. Parberry, Assistant in Soils
Hugh E. Peckham, Assistant in Animal Husbandry
Thomas W. Pope, Assistant in Dairy Husbandry
Ruth L. Ragsdale, Assistant in Home Economics
Violette Regan, Assistant in Home Economics
Robert J. Reid, Assistant in the Department of Agricultural Economics
Jack Saroff, Instructor in Dairy Husbandry
William P. Sappenfield, Associate Professor of Field Crops
Dale T. Sechler, Assistant in Field Crops
Milton D. Shanklin, Assistant in Agricultural Engineering
Robert L. Shotwell, Research Associate in Entomology
Rhule B. Sleeth, Assistant in Animal Husbandry
Ernest T. Smerdon, Assistant in Agricultural Engineering
Billy Ray Smith, Assistant in Agricultural Chemistry
Kenneth Leroy Smith, Assistant in Dairy Husbandry
Paul J. Spangler, Instructor in Entomology
Eldon L. Spicer, Assistant in Horticulture
Dennis Glen Spelman, Assistant in Agricultural Engineering
Donna S. Swall, Assistant in Home Economics
William R. Thomas, Assistant in Agricultural Chemistry
Earnest L. Tipton, Assistant in Agricultural Economics
A. J. Williams, Assistant Professor of Entomology
Norman J. Wilson, Assistant in the Department of Agricultural Economics
Steve Zobrisky, Instructor in Animal Husbandry

Resignations and Withdrawals

Arthur D. Allen, Assistant in Animal Husbandry
John W. Allen, Assistant in Agricultural Engineering
Joseph F. Arnold, Research Associate in Forestry
J. M. Baker, Analyst in the Department of Agricultural Chemistry
Roy O. Baker, Assistant in Animal Husbandry
Mary Katherine Timms Bishir, Assistant Professor of Home Economics
Betty Lee Blase, Assistant in Home Economics
Kenneth E. Blase, Assistant in Agricultural Economics
Melvin G. Blase, Assistant in Agricultural Economics
Clifton R. Blincoe, Instructor in Dairy Husbandry
George T. Blume, Instructor in Rural Sociology
Henry E. Bredeck, Assistant in Agricultural Chemistry
Joseph Henry Breummer, Instructor in Agricultural Chemistry
John M. Buckalew, Instructor in Dairy Husbandry
Thomas A. Burns, Assistant in Agricultural Chemistry
Johnny R. Campbell, Assistant in Dairy Husbandry
Patricia W. Cleaver, Assistant in Home Economics
Charles M. Coughenour, Assistant Professor of Rural Sociology
James T. Custod, Assistant in Agricultural Chemistry
Ethel R. Cutler, Assistant Professor of Home Economics
John de Jonge, Assistant in Soils
W. A. Dimmitt, Assistant in Entomology
Joe Wheeler Duck, Associate Professor of Agricultural Education (deceased)
Margaret H. Emmerling, Assistant Professor of Field Crops
William C. Etheridge, Professor of Field Crops. (deceased)
Neil Finley, Assistant in Horticulture
Ernestine Frazier, Professor of Home Economics
Wayne C. Freeark, Assistant in Agricultural Chemistry
James H. Gholson, Assistant Professor of Dairy Husbandry
Sammy L. Gowing, Assistant in Soils
Louise Nelson Tucker Grabau, Instructor in Animal Husbandry
Myles Grabau, Assistant in Entomology
Robert F. Grotts, Assistant in Poultry Husbandry
John Guillion, Assistant in Agricultural Chemistry
Gary E. Hanman, Assistant in Agricultural Economics
Betty Harper, Assistant in Home Economics
Charles J. Heidenreich, Instructor in Animal Husbandry
Charles A. Helm, Professor of Field Crops (deceased)
William T. Higdon, Assistant in Soils
Albert G. Hogan, Professor of Animal Nutrition
Marilyn Holman, Assistant in Home Economics
Robert G. Jensen, Assistant Professor of Dairy Husbandry
John M. Kays, Assistant Professor of Animal Husbandry
Mike Kelly, Assistant in Poultry Husbandry
S. Clark Martin, Research Associate in Forestry
Albert H. Miller, Assistant in Agricultural Engineering
Victor Nash, Instructor in Soils
David Parberry, Assistant in Soils
Hugh E. Peckham, Assistant in Animal Husbandry
Jack J. Preiss, Research Associate in Rural Sociology
R. C. Prewitt, Supervisor Fertilizer Inspection
Verna A. Rhodes, Instructor in Home Economics
Lola W. Schmitz, Assistant in Home Economics

FINANCIAL STATEMENT
University of Missouri
Agricultural Experiment Station
July 1, 1955 to June 30, 1956

	Hatch Fund	Bankhead- Jones 9b3 Fund	AMA Fund	State Appro- priations	Fertilizer Fees	Station Sales	Station Grants	TOTAL
Balance from 1954-55	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	\$ 83,026.51	\$ 98,821.79	\$ 80,716.99	\$ 249,384.60
Receipts from the United States Treasury, Appropriation for the Fiscal Year ended June 30, 1956	\$508,765.09	\$70,575.00	\$36,475.00	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	\$ 615,815.09
Receipts from State Appro- priations for the Fiscal Year ended June 30, 1956	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	\$544,007.42	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	544,007.42
Cash Receipts for the Fiscal Year ended June 30, 1956	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	\$230,697.66	\$306,626.62	\$160,497.19	697,821.47
Total Receipts	\$508,765.09	\$70,575.00	\$36,475.00	\$544,007.42	\$230,697.66	\$306,626.62	\$160,497.19	\$1,857,643.98
Salaries and Wages	\$364,166.47	\$50,875.92	\$22,004.80	\$367,089.86	\$ 69,947.40	\$ 75,670.69	\$ 98,222.00	\$1,047,977.14
Traveling Expense	12,522.64	4,431.79	2,047.82	22,041.14	13,990.96	7,347.93	3,120.15	65,502.43
Transportation of Things	802.96	54.74	-----	804.03	448.38	593.49	335.35	3,038.95
Communication Service	2,062.54	172.97	101.25	4,471.09	2,261.99	1,589.74	426.87	11,086.45
Rents and Utility Service	5,590.65	360.83	23.00	11,070.18	2,403.18	10,249.43	158.57	29,855.84
Publication and Printing	142.43	46.37	105.67	32,334.93	5,130.85	1,072.35	210.87	39,043.47
Repairs and Replacements	20,978.81	3,132.92	911.80	31,533.74	20,147.16	40,591.35	8,682.09	125,977.87
Supplies and Materials	86,015.53	8,578.69	3,355.37	64,844.43	28,726.71	64,473.81	31,040.66	287,035.20
Land, Buildings and Equipment	16,474.31	2,920.77	2,141.58	9,743.57	28,666.21	21,228.59	5,082.82	86,257.85
Other	8.75	-----	-----	74.45	118.60	392.77	37.12	631.69
Total Expenditures	\$508,765.09	\$70,575.00	\$30,691.29	\$544,007.42	\$171,841.44	\$223,210.15	\$147,316.50	\$1,696,406.89
Unexpended Balances June 30, 1956	-----	-----	\$ 5,783.71	-----	\$141,882.73	\$182,238.26	\$ 80,716.99	\$ 410,621.69



The Missouri Agricultural Experiment Station leads in the study of dwarfism. Above snapshot shows station scientists busy making injections in this extremely important study.