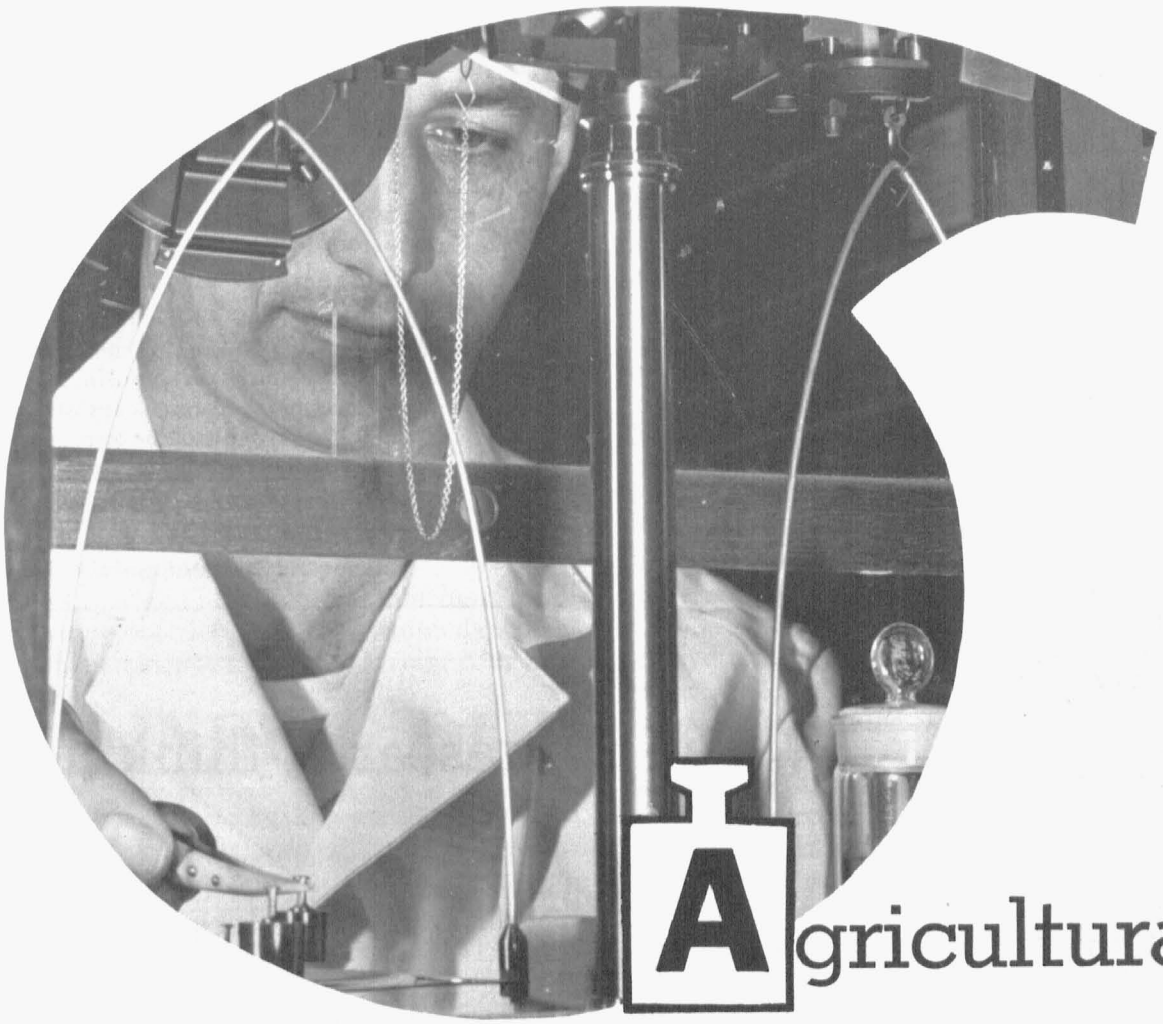
here's **GOOD NEWS!**



Agricultural research for everyone

What Your Missouri Agricultural Experiment Station Did in 1953-54 For You!

UNIVERSITY OF MISSOURI
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
J.H. LONGWELL, *Director*
Bulletin 663 Columbia, Missouri
October, 1955



John H. Longwell, *Director*

Letter of Transmittal

President Elmer Ellis
University of Missouri
Columbia, Mo.

Sir:

I am submitting herewith the report of the Agricultural Experiment Station for the year ending June 30, 1954. This report is submitted in accordance with the Federal law requiring such a report, a copy of which is to be submitted to the Governor of the State and to the Secretary of the Treasury of the United States.

Respectfully Submitted,

J. H. Longwell, *Director*
Missouri Agricultural Experiment Station.

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Samuel B. Shirky,
Assistant Director

research thinking....

Two people out of three of the world's population are today actively engaged in farming. Tonight approximately two people out of three will go to bed hungry.

This startling comparison is at once a condemnation of modern science for its failure to solve the age-old problem of hunger and pestilence, and at the same time a stirring challenge to scientists of vision and good will.

The American farmer has effectively combined science, imagination and ambition to become the most efficient food producer the world has ever known. Under the exigencies of two wars in the last decade and a half he produced "food for war" in record volume. His product was consumed by the insatiable maws of disaster and destruction. Food for ourselves and our friends was a powerful weapon of defense.

We must relentlessly battle to use "food for peace." If we would remain a free nation and promote international peace and brotherhood, we must foster such measures as will enable the tremendously productive American farmer to unleash his initiative and his ingenuity in a full and expanding output, so that a year from now fewer than two people out of three will go to bed hungry.

—*Earl L. Butz.*

This is not just "another report."

Inside this booklet is a concise story of research . . . little stories by folks who have been "finding out" and ferreting out rock-bottom information which some day you can use. Maybe as soon as tomorrow.

This booklet is a report on the sort of research which men work at not because it is just "another project," but rather because they have part of their very lives hitched to it, often quite a lot of their lives when measured in total hours spent in developing it. It is research with an aim and a purpose. That's why this isn't just "another report." Here's what's been found out in studies and quests at your station . . . the Missouri Agricultural Experiment Station. In this booklet, actually, is a fortune to share; because agricultural research is for everybody . . . city and farm folks alike.

Yes, all of us are interested in agricultural research regardless of where we may live, because all of us must be fed, clothed and sheltered. Research, especially agricultural research, because its endeavors are in the fields of food and fiber, is close to the heart of all.

We have come a long way in agricultural research. It isn't hard to remember when the average corn yield

FINDING OUT!

in Missouri was only 28 bushels per acre. Through farmer-applied research, largely, the average yield is now 43 bushels per acre. Today some farmers are producing 150 bushels per acre. One hundred bushels per acre is commonplace. Big corn yields didn't just happen. Many long hours of research which led up to improved hybrid seed corn, soil testing, wise fertilizer application, proper cultivation and practical disease and insect controls filled the Missouri corn cribs with the abundant harvests. Research started the ball rolling, and keeps it rolling, to use a common, every-day expression.

Yields of cotton, small grains, hays and other field crops have been increased in like manner to that of corn. The fruits of orchards and vineyards also have responded to the experiments of the scientists. On pastures and in feed lots the dairy and livestock stories too, are comparable. The results are written in the nation's robust health and reflected again in its world-wide largess, and the buying power of the individual. As agriculture is strong so is the nation.

In the battle against hunger the scientist, and those who apply his "prescriptions," have together found "the Midas touch" in super-abundance. Applied science has used a 20th century "Midas touch" which we, as one nation, have applied to helping lick hunger around the world.

The prophet declared that "the eyes of the master fatteneth his cattle." So also has the foresight and the hindsight of the master greatly added to with yet other eyes . . . the eyes of research which sees all and knows all, and never sleeps.

Jonathan Swift was thinking of practical research when he wrote: "He is a public benefactor who can make two blades of grass grow where but one grew before." The scientist today does more than that, of course. He grows four or five more blades of grass where just one grew before, and he markets them effectively.

Since 1888 your Missouri Agricultural Experiment Station has been studying how to improve the lot of the Missouri farmer through research . . . to make more blades of grass grow where but one grew before . . . how to market those extra blades of grass more efficiently, or how to make them do double-duty in combating world hunger in more pounds of beef, pork, mutton or milk, more economically produced. That's what this report is about. Something which vitally interests all of us . . . you and me!

So, since we are working to combat very practical, everyday things . . . hunger and its compatriot, pestilence . . . the work of the experiment station must be of a very practical kind. The sort which can be used on the farms and in the cities . . . everywhere put to every-day use. It is at the experiment station where an idea passes over from the vapory film of theory into the sordid, hard realm of reality and the province of many questions, chief of which are: "Will it work?" and "Is it of any practical value?"

Because of this very practical side of your scientists, farmers have come to rely upon the findings of the Missouri Agricultural Experiment Station. Between them there has grown up a sort of invisible partnership in this business of farming, and now it is extending to the folks of the cities, because agricultural research is for everybody. As pointed out before we are all users of food, clothing, and shelter, about which men experiment constantly.

The wise men of another day would have appropriately called the research recorded in these pages, which opens the door to new knowledge, "the priceless ingredient." For what is more precious or priceless than to feed the hungry, or clothe the naked or shelter the homeless?

In the pages which follow you'll find the drama of crucible and test tube . . . field and forest . . . land and oxen . . . all aimed at making your own state a better place in which to live by helping reduce, through scientific research, the world's oldest frauds, hunger and want.

The pages which follow tell succinctly of new ideas brought to light at your experiment station.

These are mere "thumb nail" sketches which give you a glimpse—a digest—of what is going on at your station. It is a progress report. Many of the experiments are not completed. Some have just been launched. So judge them accordingly. If you wish more details about specific studies let us know.

"What have they done at 'the station'?" you hear folks ask, denoting confidence in their own Missouri Agricultural Experiment Station. It is a common expression, and has become almost a part of the state's lexicon.

This confidence was not easily earned. It was bought with such "legal tender" as honest, unselfish devotion to a cause . . . the making of two blades of grass grow where but one grew before. So, in the almost three score and ten years of "the station's" existence the people of the state have learned through experience to place confidence in its works and its findings. From their experience has come faith.

The results recorded in these pages represent only one small link in the great chain of scientific events and studies . . . a small contribution to the sum total of the world's wisdom, but a contribution nevertheless. The sage would say: "Here is our contribution. Here is what we've found out. Take it and apply it, and put to practical use in the hewing of stone and the drawing of water. Here is agricultural research for everybody at your own Missouri Agricultural Experiment Station. Here's what we've been finding out!"

Agricultural science serves all!

Many "firsts" have been accorded the Missouri Agricultural Experiment Station. Since its establishment in 1888 it has long been regarded as one of the nation's truly great experiment stations . . . one where the dollar gets a great amount of research done. It is research, too, of the practical sort which can be used on Missouri farms with maximum results.

This same research is of great value to those who live in our towns and cities as well as in the country, because we are all users of food and fiber whether we live on the farm or work in the factory.

Looking at this station's long-time record of service to all the people of Missouri we find that it was the first in America to do many things such as produce and make available to cattle growers preventive vaccine against blackleg in calves.

The station produced and distributed to the medical profession the first smallpox vaccine made west of Boston. It was the first state experiment station to establish a laboratory to put hog cholera serum to extensive scientific and practical tests, and to demonstrate its effectiveness in protecting hogs against the ravages of disease outbreaks.

The Missouri station's feeding trials with beef cattle have demonstrated repeatedly that good to choice animals weighing up to 1100 pounds can be produced chiefly on grass and roughage with less than 15 bushels of corn needed to finish them.

Due largely to the work of the Missouri Agricultural Experiment Station corn yields in the state have been increased to an average of 15 bushels per acre. The station has been largely responsible for the introduction of corn hybrids adapted to the state's conditions, and the breeding of additional ones for higher yields and with disease and insect resistance qualities.

The use of fertilizers in Missouri has increased many fold in recent years, due largely to the practical studies of the station's soil scientists. This work has enabled acreage yields on the entire farm front to be greatly stepped-up. The station's recommendations in the wise and judicious use of fertilizers and soil tests have long been research bright spots of the station in its long years of service to Missouri people.

Going back before the century's turn one finds that this station, even at that early date, pioneered in studies looking to a more abundant life for all Missourians. It has an enviable record in studies such as those in vitamin research in which it has for years been regarded as one of the nation's leaders. Its research studies of Texas fever are well known. The station's work on soil-plant and food-plant relationships have been more than noticeable nationally as has its work in dairy research, and in all instances with men heading them well known far beyond the confines of the state.

The Missouri station stands foremost among the country's great experiment stations as the introducer of new crops, such as lespedeza and soybeans. It has studied out new cropping systems, and one of its

studies alone saved the state's beekeeping industry. Using sulfathiazole to control foulbrood in honey bees a new research epoch was recorded not only for Missouri beekeepers but for honey producers throughout the world. So far reaching is the work of this station.

During the years countless practical experiments have been conducted by the animal husbandry staff of the station which has meant savings of many hundreds of thousands of dollars to Missouri's great livestock industry. The work done in animal nutrition, health, management, and marketing has been legion. Some of its work on manifold fronts have already been recounted.

As the originator of the open-front Missouri poultry, house and in studies aimed at improving the feed using efficiency of poultry, especially broilers, the poultry industry has been benefitted almost beyond computation by the station's work.

It is a pioneer in the use of X-ray and ultra-violet radiation to induce mutation in plants. Some of the first work ever done on soil erosion and water run-off was done at the Missouri station. It was a pioneer in the utilization of "marker" elements in plants and animal nutrition.

In the field of home economics the station has long been the center nationally of vitally important research in home-making for almost a half century. Proper nutrition at various age levels, fabrics best suitable for clothing the family under varying conditions, and home-making problems generally have all been staged at the highest scientific level, but always with the thought in mind of practical application.

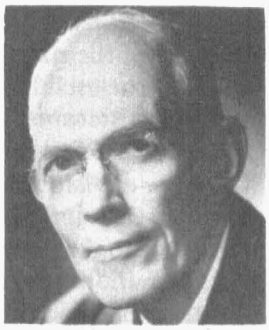
When one even casually examines the work of this station from its beginning, he becomes fully cognizant of the tremendous impact it has had in raising our living standards as a state and a nation. After such a study, brief though it may be, we come to fully realize that the members of the United States Congress, who in 1862 passed the law that made possible the founding of the nation's landgrant colleges, and subsequently the establishment of their handmaidens, the experiment stations, were superb planners and doers. Could they back then in that dark period of the Civil War have envisioned what great good would spring from their actions? If so, they most certainly were men of great vision, as they no doubt were.

The nation's experiment stations have been great bulwarks for good in both peace and war. Their contributions to our way of life would be impossible to estimate by any score or standard. The abundance they have helped create would be impossible to envision in quantity much less compute in value.

Proud of its great record, long before the turn of the century, the Missouri station is equally proud of its more recent research, especially as it sees it put to use on farms and in factories to benefit all people of the whole state. It is proud, too, of the men who have headed the station's research work, because through the many years some of the nation's greatest thinkers have pooled their contributions here in the agricultural sciences.

At your experiment station in its crucibles, test tubes, fields and fallows "tomorrow" is being born "today." Selfishness has no place in science. Likewise, the agricultural research about which you have read is for all. Your Missouri Agricultural Experiment Station, as it has always done since its founding in 1888, serves all the people. Agricultural Science is not selfish.

Agricultural Chemistry



A.G. Hogan, Chairman

Nutritional Requirements of Poultry.

(A. G. HOGAN, R. W. CRAGHEAD.)

The objective of this study is to determine the unrecognized nutrients required by poultry.

Our data show that a mixture of casein and gelatin is partially inadequate as a source of protein, and the conclusions drawn from the data could be erroneous. When the basal diet, which contains casein and no gelatin, is supplemented with arginine and glycine the growth rate is accelerated approximately 20 percent, and the variability in the weights of the chicks is greatly reduced.

Our Ration 3251 is a typical basal diet. Ration 3252 contains casein, arginine and glycine, with no gelatin, and it supports a superior rate of growth. We have repeated these trials, but there was no change in the conclusions drawn.

A ration, No. 3702, was prepared which contained no creatine and no glycine, but did contain 3.0 percent of arginine. In all other respects it was practically identical with Ration 3252.

Lactalbumin has a higher biological value for mammals than does casein and our experience agrees with this report. However, we have observed that when incorporated in a practical ration for the chick lactalbumin has an unusually low biological value.

Since the casein-gelatin-methionine type of diet has been used so extensively it seemed desirable to determine what are its specific deficiencies. Most of the constituents in the ration used in these studies were present in the same quantities as shown in section a. Evidently the first limiting factor in casein-gelatin mixture is arginine. There was no further acceleration of the rate of growth when the amount of arginine was increased from 1 to 1.5%. Likewise there was no increase in the rate of growth when both arginine and glycine were included in the diet, as in Ration 3491.

In the search for unrecognized vitamins limited use has been made of synthetic diets. The rate of growth was not accelerated when the liver extract was included in the diet. If it contains an unrecognized vitamin this same vitamin must be a contaminant in casein or in soybean oil. This possibility will be investigated. Chicks do not grow at the maximum rate on synthetic diets unless they are supplemented with amino acids and if used extensively the cost becomes prohibitive. For that reason practical diets were used almost exclusively in 1952-1953 in our search for unrecognized vitamins or other nutrients. Several workers have stated they could demonstrate a deficiency of unrecognized vitamins in a practical ration. The best average weights of all were obtained when casein was the added protein supplement. It has been asserted that casein contains an unknown vitamin, but as yet its existence has not been convincingly demonstrated. The acceleration in growth rate then, when any of these supplements was included in the diet, could easily be due to a more suitable distribution of amino acids. The data yield little evidence for an unrecognized nutrient.

As a part of the search for unrecognized vitamins hens were divided into three groups, each of which consumed a different ration.

There were no significant differences between the three pens in production rate, or in hatchability of the eggs. In each comparison the chicks consumed the same ration, and the comparisons were between the three pens. There were apparently no significant differences between the pens on any ration type. If it should turn out that there is such a vitamin, it seems improbable that it would be one of much practical importance.

It seemed desirable to make an effort to determine to what extent a practical ration could be simplified with no decrease in rate or efficiency of growth. A group of rations were prepared and used in this study.

For the first comparison, Rations 3375 and 3376 may be regarded as basal rations. Both contain wheat bran, wheat shorts and alfalfa meal, all of which are commonly included in practical diets. Rations 3378 and 3379 do not contain these constituents and inspection of the results indicates that the chicks on these diets grow as rapidly as those on Rations 3375 and 3376. So far as the rate growth is concerned it is

immaterial whether or not these constituents are in the ration. In order to facilitate the comparison the chicks on Rations 3375 and 3376 are combined in one group, and those on Rations 3378 and 3379 in another.

It seems certain that in this case it was immaterial whether or not the ration contained wheat bran, wheat shorts, and alfalfa meal.

As was mentioned previously, several vitamins are commonly added to experimental diets in order to make sure that they are adequate in all respects except in the factor under consideration. It has been known for some time that all commonly used constituents of chick rations are deficient in riboflavin. Under some circumstances they may also be deficient in vitamin B_{12}. It is almost the universal practice to see that these two vitamins are present in the rations in adequate amounts. The other four vitamins, pantothenic acid, niacin, folic acid and choline are in a more doubtful position. They are commonly included in experimental rations merely to make certain there are no deficiencies in that respect. Diets 3375, 3378 and 3380 on one hand may be compared on the other with diets 3376, 3379, and 3381. A comparison of this type shows that chicks do not grow more rapidly when those three vitamins are included in the diet than when they are omitted. There is no advantage then in adding them to the practical rations we have studied.

Another problem of some importance in poultry nutrition is the number of different sources of protein that should be included in the ration. Some of the more common of these are meat scraps and dried whey.

In examining our data on the supplements mentioned it is suggested that the rations be divided into three groups. The first group, number 3378 and 3382, would be the control. Rations 3383 and 3384 contain meat scraps while rations 3387 and 3388 contain dried whey. If the results on these three groups of rations are compared it will be seen that the chicks grew as rapidly on the basal diet as they did when the supplements were added. It would seem then that soybean oil meal alone has a high biological value, and this value is not increased by the addition of meat scraps or dried whey.

Of all the animal proteins that are included in poultry rations, fish meal probably receives the most emphasis.

In order to compare our data on this point it is desirable to combine the weights on rations 3092, 3378, and 3382 together in one group, and to combine the data and weights on 3093, 3385 and 3386 together in a second group. When the weights of the chicks in these two groups are compared it becomes evident again that there was no rise of any consequence in the weights of the chicks that received the fish meal. This is additional evidence that soybean oil meal contains protein of high quality for the chick.

Many of the protein supplements used in poultry rations are low in the sulphur containing amino acids and much emphasis has been placed upon the importance of adding methionine to practical rations. In order to get a better idea as to the importance of including methionine in a poultry ration it would simplify the comparison to combine rations 3378 and 3379 in one group, rations 3382 and 3417 in a second group, and rations 3380 and 3381 in a third group. As would be expected there are slight differences in the weights of the chicks. However when rations 3378 and 3379 are compared with numbers 3382 and 3417 it becomes evident that when methionine is added to these diets there is either no increase in their rate of growth or else the increase in rate is so slight as to escape notice. Ration 3380 and 3381 do not contain added methionine, but they do contain corn gluten which has been substituted for a portion of the soybean oil meal. Inspection of the data makes it clear that the biological value of the ration is not improved by substituting corn gluten for a portion of the soybean oil meal.

The studies on methionine were continued. It will be noted that small amounts of animal protein have been added to the diet, including meat scraps, fish meal and dried whey. The rations have been arranged so as to show what advantage is to be gained by adding methionine to these diets. The simplest way to make this comparison is to combine the three rations 3383, 3385, and 3387, in one group, and rations 3384, 3386, and 3388 in another group. Inspection shows that the growth rate was accelerated when methionine was added to the rations that contained either meat scraps or dried whey. There was no acceleration when the ration contained fish meal as a source of animal protein.

There is no doubt that vitamin B_{12} is required by the chick. However, the vitamin is readily transferred from the hen to the egg and thus to the chick, and the supply obtained in this way may be sufficient to last for a period of some weeks. It is a common practice to make sure that vitamin B_{12} is included in the rations given to baby chicks but under most practical conditions this precaution is probably unnecessary *(Project 10).*

Vitamin Requirements of Herbivora.

(A. G. HOGAN, M. MILLS).

The composition of this diet consisted of ground wheat, wheat shorts, wheat germ, Brewer's yeast, dehydrated alfalfa meal, steamed bone meal, NACL, vitamin A-D mixture, $MnSo_4 4H_2o$, and ascorbic acid. The average gain in weight of animals, for the first 12 weeks after weaning, was approximately 5 grams per

day. In this example the rate of growth of the males and females was approximately the same. As a rule the average daily gain of the males is about one gram higher than that of the females. For our purpose it is exceedingly unfortunate that the growth rate, and the response of the animals in other respects, is highly variable. The age, weight and vigor of the animals at weaning have an important effect on the subsequent response. This variability usually necessitates large numbers of experimental animals, also time consuming repetition.

It was shown some time ago that guinea pigs grow and reproduce on synthetic diets. Originally, dried yeast was used as a source of water soluble vitamins but this has been replaced by synthetic or purified vitamins. The animals do as well when the vitamins are supplied in this manner as when they are supplied in yeast. It has been demonstrated that guinea pigs require a bulky diet and some years ago it was the custom to include about 15 percent of some form of cellulose in experimental rations. Superior rates of growth were obtained when certain natural feedstuffs were included in the diet, such as linseed oil meal or spinach. It was our opinion at the time, that these natural feedstuffs contained an unrecognized vitamin, of critical importance to the guinea pig. It seemed, however, that before putting in any considerable effort or time looking for such an unrecognized nutrient we should make an effort to improve our synthetic diets, and to obtain increased growth rates, by using nutrients now available. The vitamin mixture included in the synthetic diets was practically the same throughout, and the one most commonly used, included vitamins A, D, E, and K with thiamine, riboflavin, and pyridoxine. Abscorbic acid was supplied separately at the rate of 15 mg. per animal daily.

From some standpoints these trials have been highly successful. The young are normal in appearance, they grow at a normal rate, and the percentage of mortalities has not been excessive *(Project 11).*

Rat and Hamster Nutrient Requirements During Reproduction Cycle.

(A. G. HOGAN, B. L. O'DELL, E. J. PENROD, J. S. GORDON, J. H. BRUEMMER).

The major objectives of the study have been the effect on the incidence of congenital abnormalities of:

1. Deficiencies of the major vitamins other than vitamin B_{12} and riboflavin.
2. Amino acid deficiency and imbalance.
3. Miscellaneous stress factors, including phenylhydrazine anemia, alloxan diabetes, hyperinsulinism, cortisone, thyroid active compounds and hypnotics.

A Summary of the Study

1. Female rats made deficient in vitamin B_6 by use of an antagonist, desoxypyridoxine, produced offspring of which about 5 percent were hydrocephalic.
2. Deficiencies of thiamin, niacin and biotin induced by their respective antagonists did not produce hydrocephalus but they increased the incidence of skeletal defects.
3. Deficiencies of lysine and of tryptophan did not cause hydrocephalus but caused a somewhat higher incidence of other abnormalities.
4. The hypnotic drugs, urethane and phenobarbital, produced more skeletal defects than is normal.
5. Treatment with insulin, alloxan and dinitrophenol resulted in a slight increase in malformations.
6. A deficiency of vitamin B_{12} resulted in an increased concentration of desoxyribonucleic acid in the brain tissue of newborn rats but not in liver tissue.
7. The pentose nucleic acid content and rate of P^{32} uptake in the PNA of both liver and brain is decreased by a deficiency of vitamin B_{12}.
8. The cytochrome oxidase activity in the liver, kidney, and muscle tissue of vitamin B_{12} deficient newborn was decreased.
9. A semipurified ration that contains soybean meal as the source of protein and is supplemented with vitamin B_{12} maintained normal reproduction through three successive generations *(Project 32).*

Conserving the Nutritive Value of Foods.

(LAURA M. FLYNN, W. GEHRKE, U. N. LAMBETH, A. E. MURNEEK, E. E. PICKETT, M. S. ZUBER, A. G. HOGAN).

Microbiological assays were made of 13 samples of low-protein corn and 15 samples of high-protein corn for certain nutritionally essential amino acids and nicotinic acid. The range of protein in the low-protein corn was 8.8 to 10.3% (av. 9.9%), and protein in the samples of high-protein corn ranged from 12.8 to 15.4% (av. 14.3%). Microbiological assays gave these average results for low-protein corn and high-protein corn, respectively: 1) tryptophan, 87 and 99 mg.%; 2) lysine, 314 and 380 mg.%; 3) methionine, 199 and 239 mg.%; and 4) nicotinic acid, 2.53 and 2.40 mg.%. The average results of chemical determination of cystine in the low-protein corn and the high-protein corn were, respectively, 144 and 182 mg.%. When the protein content of corn increased, the amount of each nutrient per g. protein decreased. Average amounts of the nutrient, per g. of protein in low-protein corn and in

high-protein corn, were, respectively: 1) tryptophan, 8.9 and 6.9 mg.; 2) lysine, 31.1 and 26.6 mg.; 3) methionine, 20.3 and 18.1 mg.; 4) cystine, 14.6 and 12.8 mg.; and 5) nicotinic acid, 0.258 and 0.169 mg. *(Project 33).*

Nutritional and Dietary Population Studies.

(A. G. HOGAN, E. J. PENROD, J. M. VANDEPOPULIERE)

It was shown some time ago that an arthritic-like syndrome can be produced in guinea pigs by giving them a diet that contains a disproportionately large amount of phosphorus, with a low calcium: phosphorus ratio. Later on the Wisconsin group reported that the rate of growth of guinea pigs is accelerated when cellulose as a source of bulk is removed from the diet, and it is replaced with gum arabic. There was another increase in the rate of growth when magnesium oxide and potassium acetate were included in the diet along with gum arabic. It seemed at the time that we should take advantage of this new information. Diets of this type were used extensively. However, after this new technique was adopted the effects on the animals, when there was a large increase in the amount of dietary phosphorus, was greatly reduced. We had supposed previously that an unrecognized vitamin was required to prevent the arthritic-like syndrome. This theory became more doubtful when it was shown that gum arabic, magnesium oxide and potassium acetate had some of the nutritional properties previously ascribed to an unrecognized vitamin. One of our most important problems during the last year, was to study the relation between the degree of injury when the diet contains an excessive amount of phosphorus and the other variables in the diet, celluflour, gum arabic, magnesium oxide and potassium acetate. The vitamin mixture included in the synthetic diets was practically the same throughout. This mixture was included in all rations. When all data are considered together they show that:

Gum arabic is superior to celluflour.

The addition of magnesium and potassium improves the rations.

Rations are made unsuitable for guinea pigs by a relatively small excess of phosphorus in the diet *(Project 53).*

Spectographic Analyses.

(E. E. PICKETT, MYLES GRABAU, Y. C. LEE, CECIL GOBERDHAN).

A record of 2587 analyses performed for the Missouri Agricultural Experiment Station, and 1801 for the various departments of the University of Missouri, making a total of 4388 analyses performed.

The amounts of potassium, calcium, magnesium, iron, manganese, copper, cobalt, and zinc in various types of soil extracts of ten representative Missouri soils were correlated with their economic value *(Project 76).*

Fertilizer and Analytical Report.

(C. W. GEHRKE, A. G. HOGAN).

Comprising the various departments of the College of Agriculture in a detailed list, indicated those cooperating in the fertilizer control program. Also there was developed a rapid, accurate, analytical method for the analysis of calcium in agricultural materials. This method will be of great aid in the analysis of agricultural products for calcium.

An improved procedure was developed for the analysis of magnesium in limestones. The magnesium was determined directly in the sample by titrating with versenate using F-241 indicator. This was accomplished by dissolving the sample in dilute HCl, precipitating the R_2O_3 by means of a buffer at a pH of 5.5, then adding a solution of Na_2SO_3 to precipitate the calcium. The filtrate is analyzed for magnesium. This method for magnesium is rapid and accurate.

Work has been continued on the development of paper partition and column chromatographic methods for the determination of amino acids, amines, carbonyls, sugars and organic acids. These methods were applied to extracts from biological materials such as forages, milk, corn silk, steroids, nucleic acid preparations, and extracts or distillates of meat, etc. The work was done in cooperation with various departments such as, Soils, Entomology, Agricultural Chemistry, Animal Husbandry, Biochemistry, and Dairy Husbandry *(Project 132).*

Mineral Content of Missouri Bluegrass and Lespedeza.

(E. E. PICKETT, CECIL GOBERDHAN, Y. C. LEE, MYLES GRABAU).

The following determinations were completed during 1953 in connection with this project:

Plants: 134 samples; copper, cobalt, zinc, boron, phosphorus, potassium, sodium, calcium, magnesium; a total of 1206 determinations.

Soils: 134 samples; boron, calcium, magnesium, and potassium; a total of 536 determinations.

Plants: 20 Composite samples; iodine.

A study of these results was begun in order to determine if the data may reveal any interesting or significant correlations or evidence of deficiencies. This study is not yet completed *(Project 147).*

Ionic Concentration of Evaporated Milk.

(C. W. GEHRKE, JUNIUS MCINTYRE, J. M. BAKER, H. E. AFFSPRUNG, ROBERT DINIUS).

Solutions of the calcium salts of chloride, citrate and dihydrogen phosphate have been made in casein solutions and the activities measured. The potential measurements obtained in casein sols are compared to those obtained in true solutions of the same salts at the same molal concentrations, and to theoretical curves calculated from the Debye-Huckel theory. The various solutions, in casein sols, were heated at 120 degrees C. for 15 minutes, cooled, and the activities remeasured. The pH was checked in nearly all solutions, heated and unheated. No interaction of the casein with the calcium, in either the unheated or the heated solutions could be found, with the possible exception of $Ca(H_2PO_4)_2$. It was noted that when the calcium ion activity reached a value of about 0.03 the casein sol coagulated although no significant change occurred in the measured activity of the calcium ion, or in the pH. The behavior of the casein in all the solutions resembled that of a hydrophobic colloid.

In the study of the effect of heat upon ionic availability in milk an ion-exchange batch equilibration procedure is reviewed. It was used to compare the availability of calcium and phosphorus in raw and heat treated skim milk.

The data for the availability of calcium and phosphorus for exchange after various heat treatments indicates that the ionic state is effected by more intense heats.

The availability of calcium was observed to decrease in the range of 0-25% as the length and intensity of heating were increased. The effect upon phosphorus availability was not as pronounced.

The rate of removal of the calcium was found to remain constant to the 70% level, after which the rate of removal decreased with prolonged contact time.

With a 10 second contact time 44% of the total phosphorus was exchanged. A nearly constant rate of removal occurred as a function of contact time to the 65 - 68% removal point. The removal leveled off at this time. These studies indicate that about one-third of the phosphate in milk is organically bound and not available as ions.

Two finite slopes were obtained by the resin-contact time method in studies on the exchangeability of both calcium and phosphorus from skim milk *(Project 148 A)*.

Ionic Concentration of Evaporated Milk.

(C. W. GEHRKE, J. M. BAKER, H. E. AFFSPRUNG).

This contract research project in connection with the office of the Quartermaster Food and Container Institute for the Armed Forces, Chicago, Research and Development Division, Office of the Quartermaster General.

The evidence indicates that changes in the stability of milk, which are brought about by processing conditions, are a result of changes in the protein structure as well and that the ionic materials in milk, depending on their availability, determine the colloidal charge on the protein and thus act as physical stabilizing or destabilizing agents. The processing conditions to which milk is subjected quite possibly increase or decrease the concentration of a particular ion, such as calcium by insolubilization or phosphate by ester hydrolysis and thus affect the protein stability.

These experiments will give some insight into the tie up of inorganic ions with the proteins, or the insolubilization of the ions into colloidal or other phase systems. This data will be correlated with the data on activity of ions as determined by ion exchange membrane measurements in "A" and colloidal charge as determined by zeta potential measurements.

Some of the factors to be considered in the study are forewarming temperature, processing temperature, sterilization conditions, seasonal period, type of container, and electrolytic or hot dipped *(Project 148 B)*.

Agricultural Economics

O.R. Johnson, Chairman



Pricing of Farm Poultry.

(JESSE C. GRADY).

Data on 1469 head of heavy hens has been collected from four processing plants. No analysis has been made at this time, but the data reveals that 84.7% of the hens were graded as A grade, 13.23% as B grade and 2.07% were of C grade.

The method used in pricing heavy hens, when a flat price is paid for all grades, has not yet been determined. It is hoped that the method of pricing can be determined that will give a guide to farmers as to whether they should sort hens by grades before selling. The processor has to price on a flat price if all grades are sold together. The processor's price is based on the percent of A, B, and C grades expected from a coop of mixed grades and also in relation to the price spread between grades of dressed fowl *(Project 12 C).*

Seed Prices and Economic Characteristics.

(J. C. GRADY, JR., L. WYSE).

Farmers and the seed industry in general can benefit from a study of the movement of seed into and out of the state plus the cost of handling seed from the farmer producer back to other farmers. A schedule was designed to get the following information. (1) Where firms in the seed business obtained their seed. (2) Prices paid to farmers for seed and the retail sales price. (3) What processes the seeds went through. (4) Cost of performing individual processes and other overhead cost. (5) Methods of buying, selling and transporting. These are only major items which the schedule was designed to get when completed. Twenty-two counties were sampled. There were 155 firms handling more than 5000 lbs. of seed in the sampled counties. Each county was sampled individually and a total of 43 schedules were completed from those selected randomly. The completed schedules have been coded and the data put on I. B. M. cards but no analysis has been made *(Project 12D).*

Development of Wildlife Goals.

(FRANK MILLER).

The total number of hunting and fishing licenses sold in Missouri increased from 219,431 in 1935 to 719,103 in 1949. The sale of non-resident licenses from 15,511 to 48,200 during this period. Expenditures of people who seek recreation through fishing and hunting exceed six million dollars a year. A conscious effort to provide fish and game for these people is necessary to a continuation of this income.

The investigation shows that the various wildlife species of Missouri are found in definite areas where soil conditions, cover, and feed supply favor their development. The breeding stock needed to provide game for animal harvest is directly related to the feed supply and the cover that is available in the natural range area of the animals.

In the case of fish there is a definite relationship between available feed, intensity of stocking in ponds, lakes, and streams and rate of growth. These facts should be kept in mind in setting up management practices and creel limits *(Project 14 C).*

How Land Is Being Used.

(FRANK MILLER).

Data have been prepared for each county in the state showing trends in land use, in acreage and yields of crops, numbers of livestock, and in number and size of farms since 1920. In Saline County, for example, the number of farms reached a peak of 2,971 in 1934. Since that year the number has declined and stood at 2,402 in 1950. The acreage of cropland stood at 247,031 in 1934, dropped to 241, 473 in 1940, and rose again to 250,136 in 1950. The decline in cropland has been continuous in some counties. The area in pasture and woodland has gone up as the cropland has declined *(Project 14 D).*

Some Technological Changes in Land Use.

(FRANK MILLER, WILLIAM C. GEORGE).

This study embraces a survey of 465 operators who recently started farming in the cotton and rice growing section of northeastern Arkansas and showed that 46.0 percent used tractor power exclusively and 29.5 percent used both tractor and team power. Only 24.5 percent depended entirely on horses and mules. About 93.3 percent of these farms were smaller than 160 acres. They were too small for efficient use of tractor equipment. This fact resulted in high unit costs for power and machinery and inefficient use of labor. Family incomes were low. Not all of the farms were fully mechanized. Tractors were used to pull improvised machinery, but the purchase of standard equipment and the replacement of the power unit itself out of income will be difficult. As a consequence many of these farms may never be fully mechanized. In time they will be joined together or absorbed by larger units *(Project 14E).*

Rent Shares on Different land.

(FRANK MILLER).

The proportion of farms rented in Missouri declined from 35.6 in 1940 to 20.2 in 1950. The decrease was general in all sections except the Delta Cotton, Corn, and Soybean area. However, the reduction was not as great in some of the northwestern counties as for the state as a whole. In Atchison County, for example, the reduction was from 46.3 percent to 40.7 percent. In Pemiscot County the proportion of farms rented increased from 70.0 percent in 1940 to 72.5 percent in 1950 *(Project 14G).*

Missouri Agriculture Atlas.

(JAMES E. COLLIER).

Sixty maps have been completed and approximately twenty others are in various stages of preparation. Data have been prepared for writing explanatory text material regarding each map. Entire project is to be completed during the current fiscal year *(Project 14I).*

Standards for Cattle Carcass Grade.

(ELMER R. KIEHL, WILLIAM L. WASSON).

Data from 529 beef steers and heifer carcasses were used in the analysis. Measures of important physical characteristics believed to be related to grade have been completed. Fourteen single regressions were computed for steers and heifers separately and for steers and heifers combined. The analysis showed that the best physical indicators of grade were carcass width, lateral fat measure, plumpness of the round and carcass weight. Multiple regression analysis indicated that carcass weight length and the lateral fat measurement at the rib eye combined were significantly related to grade.

Simple correlation analysis were applied to subjective data, that is the official graders' descriptive evaluation of the carcass as related to federal carcass grade. These gave a considerably higher relationship. This may be due to the tendency of the grader to select descriptive terms which would justify the grade placed on the carcass. Much of the analysis this year has been with this qualitative data and relating it back to the physical data *(Project 59 C).*

How Egg Quality is Effected.

(JOHN D. MILLER. ROBERT HURST).

This is a study of consumer buying practices among 100 negro families in St. Louis:

Some of the results:

1. Egg prices vary by type of store and by the amount and type of service rendered. Stores giving credit, cashing checks, and furnishing delivery service charged more for poultry and eggs than stores furnishing any other combination of service. Egg prices were 12¢ higher in this type of store than in stores that furnished check cashing service and free parking only.
2. The quantity of poultry and eggs consumed varied with various home tenure groups. Those who were home owners spent 18% of their food dollar for poultry and eggs, renters of unfurnished quarters spent 15%, while those who rented furnished quarters spent only 8.5%.
3. Those who were owners of furniture and/or a home spent less of their total food dollar for high protein foods but more of it for poultry and eggs.
4. Customers who used credit for their grocery buying had higher grocery costs than those who did not use credit *(Project 60 A).*

Financing Plans in the Broiler Industry.

(JOHN D. MILLER).

Broiler growers in the three major regions of the state were contacted and interviewed regarding the methods of financing their broiler operations. Here are some conclusions:

1. Those who finance broiler growers initiate a system and do not vary from their program once it has been established.
2. The growers financial condition has little to do with the credit agreement.
3. Some instances of interest cost appear to be as high as 20%.
4. In many cases the carrying charge is a hidden cost, and may range from 5 to 20¢ per cwt. of feed or from ½ to 5¢ per chick.
5. Many growers do not know of different financing plans or how much the one they are using is costing them *(Project 60 B).*

Assessing Property for Tax Purposes.

(FRANK MILLER).

Land price trends compared with the assessed valuations and with market values in nine counties will be studied. A publication similar to Research Bulletin 490, Assessment of Property for Tax Purposes in Missouri, will be prepared *(Project 61 A).*

Cotton Marketing in Missouri.

(J. W. MCKINSEY).

During the past year arrangements were made for the cooperation of buyers in three additional markets (Kennett, Denton and McCarty). Data, including price paid the farmer, weight of cotton, bale number, grade and staple of each bale, date of ginning, and date of sale were collected on cotton sold in one of these markets for three years, (McCarty) and collection was begun on similar data in the other 4 markets *(Project 65 A).*

The Kind of Meat the Public Demands.

(E. R. KIEHL, U. J. RHODES, T. C. KINTER).

The objectives agreed upon were the following:

a) To ascertain consumer choices with respect to grades.
b) To determine consumer knowledge of grades.
c) To determine which physical characteristics of meat influence grade preference.
d) To determine the extent to which preferences may exist for particular sizes of cuts.
e) The nature of the relationships between the methods of meat preparation and eating satisfaction and grade preferences.
f) To study the efficiency and practicability of several alternative methodological techniques both in interviewing procedures and in the analysis of data.

The sample will consist of household consumers in Metropolitan St. Louis to be interviewed in fifteen grocery stores handling fresh meats. The field work is to be done during the week of February 1 through February 6, 1954. It was estimated that a sample of 1400 interviews would give a sufficient degree of reliability.

The nature of the study will require rigid controls of beef cuts used in the displays in the stores. Approximately 4500 lbs. of beef would be required to be rigidly selected on the basis of federal grade standards within specified carcass weights. Beef short loins and chucks are to be purchased from a cooperating meat packer. These will be cut into steaks and roasts according to rigid cutting specifications by the University Meats Laboratory. Fresh meat will be displayed each day. Fifteen display boxes were constructed for the purpose of displaying meat in the stores.

Selection and training of interviewers under actual store conditions was accomplished during the week of January 19, 1954. Further revisions of procedures and schedules were made in preparation for field work beginning February 1, 1954 *(Project 86 A).*

Changes in Fluid Milk Distribution.

(S. F. WHITTED, J. N. SMITH).

This study covered forty of the fifty bottling plants in Missouri with paper packaging machines which distribute milk outside the town in which they are located, up to a maximum distance of 185 miles. Each of these plants distributed an average of 3,416 quarts of paper packaged milk a day outside of the town in which it was located. This was 31 percent of the total volume packaged in paper and 45 percent of the volume packaged by these plants. Sixty percent of the milk distributed out-of-town was handled on wholesale routes of the bottling plant. Most of the remaining out-of-town milk was handled by local dealers. Very little out-of-town milk was distributed on retail routes. The major portion of the outside sales were made by plants located in medium to small cities.

This seems to indicate that most of these outside sales are an attempt to spread the high fixed cost of the installation of a paper bottling machine over as large a volume as possible in an attempt to lower unit costs. As a result of this trend, many small towns and villages previously dependent on a meager local supply of ungraded milk now have an adequate supply of pasteurized inspected milk available *(Project 93 F).*

Marketing of Grain Storage in Missouri.

(J. WENDELL MCKINSEY, NORMAN TEMPEL).

Data outlined on the schedule used in previous years in the St. Louis market area, Southeast Missouri, and the Southwest Missouri grain producing area were collected from 50 country elevator operators in 12 counties in Northwest Missouri, representing primarily the Kansas City marketing area. The counties were chosen in a random manner and data were secured from all of the country elevators in the counties chosen. These data are being analyzed separately and also in connection with the data previously collected from 100 country elevators in the other three areas. Data collection was accomplished in September and October of 1953. Analysis is not sufficient to ascertain the principal results *(Project 104 B).*

What it Costs to Produce Corn.

(CLIFTON W. LOOMIS).

Corn production costs, cultural methods, and level of fertilization records are being obtained on 90 farms located on Putnam and Mexico soils. Data which will provide information in the general field of the economics of corn production will be obtained both for the 1953 and 1954 crop years. Records are being taken on 30 "high" fertilization farms, 30 "medium" fertilization farms, and 30 "low" fertilization farms.

Research carried out under this project during the past year included a farm enterprise study of 56 Central Missouri dairy farms.

This research in corn production will provide information which will assist Missouri farmers in deciding the optimum input of corn fertilization under changing cost-price situations.

Research in corn production will continue into next year to include fertilization and yield records on at least one other soil type in the state *(Project 110 A).*

Farm Products Study Near Joplin, Mo.

(FRANK MILLER, R. S. MONESS, OLIN AYRES).

The study shows that two-fifths of the farms in the Joplin area are smaller than 40 acres. Many of these

places are rural residences. The land is rented to a neighbor. Some of the people carry an enterprise to supplement their off-farm income. The average income from these sidelines varies from $100 to $2100 *(Project 111 A).*

Farm Business Analysis.

(C. W. LOOMIS, F. L. NEWMANN).

Farm business records for 1950 are being obtained from a sample of thirty large businesses and thirty small businesses in North Central Missouri. An analysis of yields, income, labor efficiency, and other farm business factors of all farm records obtained under this major project is in the process of being completed.

Investigations in progress will provide information pertaining to necessary size of farm business to provide adequate incomes under present Missouri conditions. During the summer of 1954 records will be obtained on livestock farms in an area of concentrated cattle feeding and hog production. A random sample of farms will be studied, and tentative plans call for selecting additional large farms in an effort to reduce size as a variable affecting farmers' incomes *(Project 112 A).*

Refrigeration Techniques on Eggs Quality.

(J. D. MILLER).

Sample design for the different types of retail display techniques have been developed. Arrangements have been made for the equipment necessary to measure and record temperature change *(Project 113 A).*

Prices of Farm Products and Production Changes.

(O. R. JOHNSON, J. D. MILLER).

Monthly prices covering corn, hogs and beef cattle, for the two periods 1930-39 and 1946-52, were recorded and analysis made. Monthly turkey prices from 1933-39 and 1946-52 were used. With soybean meal and broilers the time the examination was made covered only the period 1946-52. These prices were corrected for deflationary influences by applying the wholesale price index with 1935-39 as the base period. The war period 1940-45 was purposely omitted.

Price trend lines were computed for the over all period for hogs, cattle and corn. For the short period 1946-52, trend lines were computed for all the products studied except corn which is not yet completed. The indexes of seasonal variation for corn, hogs, and beef cattle were computed using the link relative method.

1. The short period following World War II does not seem adequate for study of price trends.

2. The longer period including pre-and post-World II years is too heterogeneous to be serviceable for prediction purposes. Cycles and deviation from trend may prove most valuable for procedure purposes *(Project 115 A).*

Where do Missouri Consumers get their Meat Supplies?

(E. R. KIEHL, D. I. PADBERG).

A geographical sample area has been selected with Kansas City as the wholesaling and processing center. Concentric rings were drawn on a map of the state at 25 mile intervals from Kansas City to extend 150 miles out. A sample number of towns and villages were selected within each sample area (ring). A probability sample of stores were selected within each sample town.

A schedule is being developed on which the sample stores will record location of sources of supply, invoice prices of wholesale cuts, and retail prices of selected retail cuts. It is hoped that the sample stores will report over a period of nine months to enable an analysis of the extent and causes of changes in source of supply.

It is believed that sources of supplies to the various towns in the outlying areas from the wholesale center change seasonally. Other wholesale sources enter into supply of meat when relative surpluses or shortages develop among the different retail meat cuts *(Project 150 A).*

Costs and Methods of Meat Retailing.

(E. R. KIEHL, CHARLES CROMER, J. C. GRADY).

Highlights of some relationships thus far discovered include the following:

a) As the volume of meat handled per store increases the labor cost per pound tends to decrease.
b) Effective use of floor space in meat department increases as the volume of meat handled per store increases.
c) As the volume of meat sales per store increases the percentage that wages and salaries one of total sales decrease.
d) As the physical volume of meat handled of stores increase gross margins tend to decrease.

The general relationships suggests that there are real opportunities in reducing the cost of the retailing function in the marketing of meat and meat products. Most of these economies are associated with increasing scale of business in which the more efficient techniques can be utilized *(Project 150 B).*

The Dairy Demand-Supply Relationship.

(S. F. WHITTED, J. N. SMITH).

All of the milk processing plants in the Northwest Missouri Area were visited during the summer months and information was secured from 66 of these plants; 93% of the total:

Preliminary conclusions:

1. The percentage of dairy product sales from farms in Northwest Missouri which were in the form of whole milk has increased from 36% in 1939 to 56% in 1949.
2. The average size of farm in the Northwest Area has increased from 140 acres in 1930 to 169 acres in 1950.
3. The increase in the average number of cows per farm in the Northwest Area was from 3.85 in 1940 to 4.39 in 1950, but the proportion of the state's dairy cows found in this area has been decreasing since 1928 *(Project 167 A)*.

Grain Storage Studies.

(J. W. MCKINSEY, NORMAN TEMPEL).

Work on this project was concentrated along lines suggested by a study outline and questionnaire prepared by a sub-committee of the Regional Grain Marketing Research Committee. This was an inquiry into the nature of legislative control exercised over grain warehousing in Missouri, and it's administration. Sources from which information was sought suggest the type of information collected.

Information obtained from laws and regulations:

A. Basis of legal control
B. Licensing requirements
C. Bonding requirements
D. Responsibilities assumed by the warehouseman
E. Warehouse receipts and registration

Information obtained from state officials charged with the administration of grain storage regulations:

A. Organization of regulatory agencies
B. License requirements
C. Bonding requirements
D. Insurance requirements
E. Reports and examinations

Information was obtained from the Farm Credit Administration, St. Louis, regarding the use and acceptance of warehouse receipts as collateral by the Production Credit Associations and Banks for Cooperatives *(Project 179 A)*.

Agricultural



M.M. Jones, Chairman

Some Costs in the Making of Crops.

(C. L. DAY, D. B. BROOKER).

The problem was to determine (1) whether or not it is feasible to convert a gasoline tractor to burn propane, (2) if converted, what basic changes are necessary, and (3) how many hours of use per year are necessary before the expense of the conversion is justified by savings in fuel costs.

In order to burn propane most efficiently in a tractor designed to burn gasoline the following modifications are necessary: (1) raise the compression ratio, (2) install a cold manifold, (3) install a suitable LP-Gas tank on the tractor, and (4) install a suitable type of vaporizing and carbureting equipment.

With the prevailing prices at the time of the analysis it appears that the total cost of service from a large tractor would be less when burning propane than when burning gasoline if the tractor is used at least 400 hours per year.

Watt-hour meters were connected to two waterers and two water bowl type waterers during the winter of 1952-53 and again during the winter of 1953-54.

The tank type waterer consists essentially of a watering tank or vat holding about 10-15 gallons of water located in the top of a base or housing. The water level is controlled by a float valve and the water is kept ice free by thermostatically controlled heating elements located underneath the tank. The thermostat

Engineering

is adjustable. The housing is lined with a 1-inch layer of fiberglass insulation. Following is a summary of the results of the tests on the tank type waterers:

Month	*Thermostat setting*	*Average energy used (KWH) per day by each waterer*
January 1953	56°F	4.8
February 1953	48°F	3.0
December 1953	47°F	2.0
January 1954	46°F	2.7

As originally installed the setting of the thermostats was about 56° F. As the tests proceeded the thermostat setting was lowered. With an average setting of 46°F during January 1954 the tanks were ice free at all times.

The water-bowl type waterer consists of a drinking bowl holding about one gallon of water mounted in the top of a cylindrical shaped housing. The water level is controlled by a float valve and the water is kept ice free by a thermostatically controlled heating element. The housing has no insulation and the thermostat is not adjustable. The water in the bowls was maintained at a temperature of about 53°F. A summary of the results of the tests on the water bowl type waterers follows:

Month	*Average energy used (KWH) per day by each waterer*
January 1953	2.3
February 1953	2.3
December 1953	1.6
January 1954	1.8

(Project 15 E).

Studies in Small Grain Rotations Following Corn.

(J. S. McKIBBEN, M. M. JONES).

The corn was picked the first week of September from stalks that were still quite green. Kernel moisture about 55% at picking time. The corn was placed in a bin and dried with unheated air.

It was not necessary to pick the corn so early in order to prepare a good seedbed for wheat, but it was desired to find how high the moisture content of corn could be and yet be successfully harvested and dried. The picker did a good job. The ears were well cleaned of husks and hardly any shattering of the kernels took place in the high moisture corn. Some of the kernels on the butt end of the ears were damaged as the snapping rolls separated the ear from the tough green shank. Under normal conditions it appears best to let the kernel moisture reach about 35% or lower before attempting to harvest and dry corn.

The stalks were shredded with a horizontally rotating blade shredder which did a good job on all the stalks that got into the blade, but the stalks that were lying flat were most all missed. The heavy stalk cover was chopped up enough, however, to allow a good seedbed to be prepared for wheat with a disk *(Project 15 F).*

Grain Drying.

(D. B. BROOKER).

The study brought out the following facts:

Corn at 40 percent moisture can be harvested with present picking equipment with a minimum of corn loss, but with considerable damage to kernels at the butts of the ears.

There is considerable gamble in drying corn at 40 percent moisture with natural air early in the picking season when the nights are not cool enough to retard mold growth.

Electrical costs of drying ear corn from 40 to 12 percent by continuous fan operation will be as high as 9.0 cents per bushel. (Electric energy at 3 cents per KWH.)

A method of determining air distribution in a grain mass has been used to study air flow in a farm size grain storage structure. Results of these tests indicate that "average" air flow data in terms of cubic feet per minute per bushel based on total air flow has no real significance *(Project 15 G).*

Fertilizing Permanent Pastures.

(GEORGE SMITH, J. S. McKIBBEN, NELSON TRICKY, SAM GOWING).

Progress has been made toward development of suitable equipment to apply nitrogen solutions along with normal tillage operations such as plowing, disking, or cultivating. Several different methods of applying nitrogen solutions were tried (in the development of the unit we are now using.) The first unit used a light gauge vented aluminum tank from which the solution could flow by gravity through a strainer to vane pump. The pump used aluminum vanes which wore out with only 58 hours of pump service.

For the second machine a special aluminum tank was manufactured to order to withstand 30 pounds per square inch working pressure. A small air compressor was fitted to be driven from the power takeoff of the tractor. An air regulator was used to control the air pressure delivered to the tank. With this equipment the solution was forced out of the tank through a strainer then on to a boom fitted with nozzles which

metered the nitrogen. Plastic tubes were fitted over the nozzles to carry the solution on to the point of application at the implement. Difficulty was experienced in getting an even rate of flow from each nozzle on the boom so that an aluminum manifold was made with a stainless steel strainer in it. All nozzles and a pressure gauge were mounted on the manifold. The solution was carried fom the nozzle to the point of application at the implement by means of a plastic tube fitted over the nozzle .

All fittings and parts should be aluminum or stainless steel to prevent corrosion and clogging of the system.

An aluminum or stainless steel check valve must be located between the tank and the compressor. An air regulator or adjustable bypass type air valve must be used. To regulate pressure in the tank a quick operating shut-off valve between the tank and the manifold is convenient. A sight gauge on the tank is desirable to determine the amount of solution in the tank. A bleeder valve is needed to open when filling the tank. A pressure gauge should be located on the tank.

The tank must have a pressure release valve or rupture disk to protect the tank from excessive pressure *(Project 15 B).*

Climatic Factors as they Relate to Reactions of Dairy Cattle.

(R. E. STEWART, H. J. THOMPSON, R. G. YECK).

These results appear to indicate that within the velocity limits imposed by the tests there is little effect of air movement at the lower air temperatures.

At high air temperature (80°–95°F) it was observed that increasing air velocity tended to inhibit the rise in body temperature usually associated with such air temperatures. This effect was also somewhat anomalous since little difference in skin temperature was observed at the high, intermediate and low air velocities *(Project 66 A).*

Radiations on Animals with Different Color.

(R. E. STEWART, H. D. JOHNSON).

The results suggested that the lightening in hair color caused by elevated environmental temperature may be due to decreased thyroid secretion rate. Apparently the deposition and withdrawal of pigment is linked to the general metabolic rate as governed by thyroid behavior.

Some irradiation experiments with rats showed that the thermal stress induced by radiation was proportional to the color of the hair coat *(Project 66 B).*

Effect of Radiations on Dairy Cattle.

(R. E. STEWART).

Six Holstein, four Jersey and two Brahman cattle were irradiated in the Climatic Laboratory. The animals were maintained successively at air temperatures of 45°, 70° and 80° F; at each air temperature they were irradiated successively by five radiant intensities: 5, 40, 80, 130 and 180 Btu per hour per square foot, measured at 52 inches above the stall floor.

It was found that the skin and hair temperatures increased to high levels with increasing radiation, with the effect specially marked at the higher rate temperatures. The respiration rates of Jerseys and Holsteins were approximately doubled at all air temperatures by increase in radiant intensity from the minimum to the maximum value. The respiration rate of cattle has been shown to follow the Van't Hoff principle by doubling with an 18°F rise in air temperature. This suggests that shading animals from the sun in summer will have a physiologically equivalent effect of reducing the air temperature by about 18°F.

It was found that the thermal behavior of the cattle with respect to radiation was governed to some extent by the nature of the pigmentation in their hair coats. The black animals showed increased stress as a rule. The relation, however, was rendered complex by factors such as size and structural configuration *(Project 66 C).*

Yard Facilities Designed for Livestock Farms.

Although there has been for some time a number of quite satisfactory types of loading and squeeze chutes in use there has been a lack of information and illustrative material on just how this equipment might be incorporated into practical and existing layouts. One very workable arrangement was developed by J. C. Wooley. This combination of holding pen, holding and cutting chute and loading chute can be adapted to one end of most any existing yard layout. The holding chute can be located on either side of the alley depending on which would be most convenient for a particular setup.

The construction of movable feed racks for self-feeding silage from horizontal silos is included in this project. Experiences and observations to date indicate a great possibility for self-feeding silage in this manner. Two types of feeders have been observed during satisfactory operation in a number of installations. Requirements for satisfactory operation are as follows: the movement of the feeder must be controlled by the

operator; the rack must be sturdy enough to withstand the pressures of the cattle while feeding; the bottom of the rack must be solid for a height up to at least 12 inches to minimize waste; the construction of the gate must be quite open to allow the animal vision to the rear but with small enough openings to prevent small animals and young stuff from going through into the silage *(Project 71 B)*

Improving Farm Building Service Plans.

(M. L. ESMAY, J. C. WOOLEY, M. M. JONES).

This is a report on farm buildings which have been added to the Missouri Farm Building blue print service plan. The new building plans include a sheep barn for 36 ewes; 52 x 216 foot broiler house; 40 x 80 machinery storage building and a slaughterhouse or abattoir.

A set of working drawings have been developed for the housing and equipment needed for a 36-ewe flock of sheep. The sheep barn is of the pole type with an open front preferably to the east. The plan of the barn allows for maximum flexibility in rearrangements for the different seasonal requirements. The plan shows how the building may readily be rearranged for fall feeding, lambing time, shearing time, and for loading and cutting.

The working drawings for the broiler house were developed in collaboration with the Poultry Department and a broiler grower who built a house according to these plans. The plan utilizes to the maximum, standard size lumber as stocked by lumberyards. The plan provides for a low cost structure having a pole frame closed in with 1-inch waterproof fiber insulation board.

The machinery storage building features clear-span forty-foot roof trusses designed for saving in lumber and spaced four feet on centers. The foundation wall is four feet above grade. In order to save on construction costs of concrete formwork, it is recommended that the part of the wall above floor level be constructed of concrete blocks.

Heretofore no suggested plan has been available in this state for the construction of a small abattoir, or slaughter house, which could meet the minimum specifications of the State Health Department and the College of Agriculture. The Animal Husbandry Department asked the Agricultural Engineering Department to work with them in cooperation with the State Health Department in preparing such a plan *(Project 71 E).*

How Terraces Effect Yield and Income.

(R. P. BEASLEY, G. E. SMITH).

In this study records were kept of yield and income from areas that are handled the same in all respects except that one-half of the area is terraced and the remainder is farmed on the contour.

The corn was harvested from the east area on the Agricultural Engineering Farm south of Columbia in the fall of 1952, and the area planted to wheat. In 1953 the wheat yield was 31.9 bushels per acre on the terraced area and 32.0 bushels per acre on the unterraced area.

Three of the areas in this study are located on the James D. Christie experimental farm in Andrew county. With the completion of construction work on the terraces, comparisons of yields and income on all areas will be started in 1954.

An area on the Agricultural Engineering Farm at Midway has been selected for a study of this type. The grass outlet for the terraces was constructed and seeded in the fall of 1953. The terraces to be constructed as soon as a sufficient stand of grass is established in the outlet *(Project 98 A).*

Terrace Design Improvement.

(R. P. BEASLEY) .

Tests to determine the hydraulic characteristics of several different types of morning glory and vertical riser type tube structures have been completed. Tests were run on scale models as well as full size structure. These tests together with recommendations for construction and structure capacities are given in detail in a Research Bulletin No. 544. A study is being made of terrace outlet design on the Midway Farm to reduce the number of point rows and increase the farmibility of the terraces without appreciably increasing the cost *(Project 98 B).*

Supplemental Irrigation.

(R. P. BEASLEY).

A field survey was made in the fall of 1953 to obtain results of irrigation. This survey was conducted in twenty counties in southern Missouri, and information of cost, operation, and returns were secured from twenty-nine different irrigators. Two had records for 1952, twenty-seven for 1953, and three for 1952 and 1953.

The irrigator was in some cases able to give an estimate of the increase in yield and the value of the irrigated crop compared to the same crops not irrigated. Following is a tabulation of this data and also the cost of irrigation and harvesting the extra yield and the net value of irrigation.

TABLE 1

Crop	Number of Irrigators	Increase in yield per acre by irrigation	Increase in value per acre by irrigation	Cost of irrigation per acre plus cost of harvesting the extra yield	Estimated net increase in value of crop per A. due to irrigation
Corn	11	35 bu.	$ 52.50	$20.50	$ 32.00
Alfalfa Hay	5	2 ton	64.00	36.50	27.50
Cotton	1	1 bale	165.00	57.00	108.00
Pasture	8	160 pasture days plus 0.7 ton day	126.00	35.00	91.00

A small plot of Lincoln variety soybeans on the Agricultural Engineering farm at Midway was irrigated by rotary sprinklers.

Three irrigators totaling 5½ inches of water were made. One irrigation on June 11 of 1½ inches was made to assist in germination of the seed. Subsequent irrigations of 2 inches each were made on July 3 and August 19.

The following gives the results of the irrigation:

TABLE 2

	Yield		Size of beans
	Bu. per acre	Grade	No. of Beans per lb.
Irrigated	38	No. 1	2,475
Not Irrigated	19	No. 2	2,885

The unirrigated beans were smaller, contained more shrivelled beans and there were more green beans.

The irrigated beans set more pods than the non-irrigated beans. The first irrigation did not affect the stand to any great extent and in taking the final samples, sections in each area were selected where the stands were equal *(Project 98 C).*

Water Management and Soil Conservation.

(R. P. BEASLEY).

The objective of this project is to determine the suitability of design and performance of water management structures if subjected to a severe test by weather conditions.

Because of the very limited amount of rainfall in 1953, there was very little runoff and the water management structures were not loaded to the extent that any information of value could be obtained *(Project 98 D).*

Measuring Heat and Moisture in Dairy Barns.

(M. L. ESMAY, R. G. YECK, M. M. JONES).

For best results the barn needs to be one in which the dairy cattle are confined for a continued period of time through the winter weeks. All of the possible dairy enterprises in the near vicinity are operated either under the loose housing system of management or as a stall barn in which they are only milked and fed concentrates. In these latter cases the cattle are turned out daily to eat roughage and exercise. Personnel with time available for field studies has been at a premium during the last year therefore, limiting these activities considerably. Therefore the securing of a suitable barn for this study has been the main problem up to this time *(Project 136 A).*

Open Housing for Calves.

(M. L. ESMAY, B. E. GUYER, M. M. JONES).

Preliminary observations were made on the somewhat semi-open type young calf housing at the University Foremost Dairy Farm. This calf structure is divided in the center and would readily lend itself to a comparative study by operating one-half as a closed structure and the other an open type. It has not, however, been feasible to operate this calf enterprise in this manner in order that unbiased results might be obtained and an analysis of the effectiveness of the types made through growth rate and health records. Such information would confirm or reject field findings and be more reliable if carried on under controlled conditions; however, it would still not supply any information on the why of the problem or furnish any information on the environmental limits for optimum conditions. This will only be supplied from the laboratory where the environment can be controlled closely and precise engineering and physiological measurements made. Preliminary preparations are now being made for this study in the Climatic Laboratory *(Project 136 B).*

Portable Scale for Field Use.

(M. L. ESMAY, B. E. GUYER, R. G. YECK, M. M. JONES).

Three approaches to this problem have been pur-

sued. They are a portable insensible weight-loss scales, a remote measurement type insensible weight-loss scales, and a vaporization chamber for individual cows.

A portable platform type mechanism scales is being adapted for weighing the insensible loss of an animal with an electronic chainamatic mechanism. Effort is directed toward the development of the measuring and recording features of the apparatus at this time. The unit at present is nearing the preliminary testing stage.

An attempt was made to record remotely in a room other than where the cows are located, in order that the cows could be weighed in the test chambers under their experimental environments. Previously they were taken into the alleys of the laboratory for measurements but similar environments are difficult to maintain outside of the test chamber and consequently the measurements would not then be a true index of the cows response to the chamber environment.

Preliminary tests have been run with this mechanism and encouraging results obtained; however, some problems remain which must be eliminated before it will have practical applications to insensible weight loss measurements.

Inasmuch as through insensible weight loss measurements we are mainly concerned with the moisture losses from the body by respiration and from the skin surface, a one-cow chamber was devised in which the pickup of the circulated air could be measured. The one-cow chamber was made to enclose one stall. The volume of air exchange is measured with a calibrated orifice on the air outlet duct. Preliminary test data taken with the vaporization chamber indicate that the results are comparable to measurements taken by other methods in the past *(Project 136 C).*

Positional Calorimeter for Cattle.

(R. E. STEWART).

During the past year considerable work has been done on the design of the calorimeter. It is to be a small, air-conditioned room, designed to permit variation of interior air temperatures independently of the enclosure wall temperatures. The animal, such as a cow, under test stands on the scale platform of a sensitive device to measure the time rate of moisture vaporization (the insensible weight loss is a function of this). An open-circuit metabolism apparatus is adjusted to the animal, to secure the total heat production. These two measurements result in knowledge of the nonevaporative heat loss. The remainder of the heat is dissipated by radiation, conduction and convection.

Preliminary designs for the calorimeter have been drawn up. The size, materials of construction, method of heating and cooling, and other pertinent factors have been decided upon *(Project 136 D).*

Temperature and Radiation Effecting Cattle.

(R. E. STEWART).

In the Climatic Laboratory the following series of diurnal variations in air temperature are being used in this study:

Midwest normal, 40° to 70°F
Midwest cold, 10° to 30°F
Midwest hot, 70° to 100°F
Imperial Valley, 50° to 110°F

The experiments are being conducted on three Holstein and three Jersey cows. The skin and hair temperatures are taken on the back, side and belly of the animals by use of special copper-constantan thermocouples in conjunction with an electronic-balance potentiometer used as an indicator.

The results so far available appear to reveal one reason why cattle and other animals are able to withstand climatic extremes for short periods. At 110° in the diurnal cycle the highest average skin temperature was about 104°, but the trend was upward. However, the decreasing air temperature after the peak, arrests the upward trend in skin temperature and finally causes it to turn downward also. If 110° were maintained for a longer period, say six or seven hours, the skin temperature and general body temperature would inevitably approach the air temperature and death would probably result. Therefore, it appears that a short time at 110° is not harmful in the least because of the thermal lag of the animal's mass. Presumably this conclusion would apply in lesser degree to calves and other small animals since they have a lesser physical mass *(Project 136 E).*

Design of Grass Silage Structures.

(M. L. ESMAY, D. B. BROOKER, M. M. JONES).

The trend toward the utilization of grass silage in horizontal silos will again diminish if practical construction techniques, economical design information and methods to minimize spoilage are not soon provided for the farmers to replace the haphazard approach that is now being taken to the problem.

Liquid equivalent pressure characteristics have been assumed for design purposes in the past. This study indicates that there is little similarity between any assumed liquid equivalent pressure and the empirical characteristics. Minimizing spoilage in above ground horizontal silos is also a problem which needs considerable future study. Observations of grass and

legume silage in plank walled silos indicates a high proportion of spoilage. Inadequate packing along the sides produces much spoilage. Possibly the flexibility of a wall of this type has something to do with allowing entrance of air and eventual spoilage. Low moisture content and associated advanced maturity is particularly adverse to adequate packing with grasses in the long form. Above ground concrete walls designed do not appear to be near as conducive to sidewall spoilage as the plank walls. More data is needed on spoilage in above ground silos *(Project 138 A).*

Handling Silage.

(D. B. BROOKER, M. L. ESMAY).

A study of methods of feeding from horizontal silos was made on sixteen farms. The farmers were interviewed and asked to keep a record of the time required to feed. The records cover a feeding period varying between farmers from one week to three weeks.

Methods used to feed the silage:

1. Scooping the silage into a trailer or truck, hauling it to the feed bunk, and scooping it into the bunk.
2. In the same manner as (1) except a special built box fastened to the mounted implement brackets on the tractor was used in place of a trailer or truck.
3. Loading directly from silo to the feed bunk with a tractor manure loader.
4. Placing a feed rack in the silo.

A summary of the study shows:

1. The Silorator Hayter silage harvester needs to be modified to handle heavier hay crops.
2. Machines and methods of unloading and spreading long grass silage without excessive hand labor need to be devised.
3. It is extremely difficult to pack a horizontal silo filled with long grass silage that is overly mature or low in moisture content.
4. Long grass silage can be self-fed without the necessity of loosening the stack for the cattle *(Project 138 B).*

Harvesting and Feeding Forage as Hay.

(J. S. MCKIBBEN, D. B. BROOKER, J. E. COMFORT).

Due to the hot dry weather during the summer of 1953, lespedeza which was to be used, did not get tall enough to make hay. Failure of the hay crop, of course, made it impossible to continue the rolled bale feeding study.

It was planned also to continue trials on drying baled hay with forced ventilation. Hay was cut but due to hot dry weather and to a breakdown of the baler just before it arrived at our job, the hay was completely field cured by the time the baler arrived one day after cutting.

Analysis for carotene content at the time of cutting and later at time of baling gave the following results:

TABLE 3

	Carotene content, milligrams per 100 grams of dry hay
At time of cutting	10.35
At time of baling, about 30 hours after cutting	3.36
At time of baling, about 96 hours after cutting	2.59

(Project 138 C).

Spray Control for Weeds and Brush.

(R. E. LARSON, J. D. CRUMPACKER).

The new techniques include the use of nursery stock to screen treatments and the tagging and maintaining of life histories of individual trees in field plots. Translocation is an important aspect of the herbicidal action and is being studied through the use of gall like wrappings and through the use of radio isotope tracers. A new item of equipment being studied is the probe type applicator for the application of herbicide adjacent to the stem portion below the ground surface. This method has shown good results under certain conditions. There are relatively few new herbicides being used or showing good results for brush control but those meriting mention are CMU and the use of undiluted 2,4-D and 2,4,5-T.

Investigations were conducted to study the possibility of using a roller to break up the lumps and pack the soil over the planted row and thus provide a smooth surface for the application of the pre-emergence herbicides. The roller which was used was a concrete-filled rubber-covered steel roller 18 inches in diameter with a rim 12 inches wide. The chemical treatments included in this test were three rates each of CIPC, DNOSBP, phthlamic acid and sodium PCP. These tests were repeated at two locations.

The results at one location indicated that where the top soil was fairly dry at the time of planting and remained dry until the emergence of the crop, the rolling was equal to, but no better than, the unrolled plots. On the trial at the location where a rain came between the time of treatment and the time of emergence, the rolling caused crusting of the soil surface, resulting in reduced stand and yields.

The use of rolling and smoothing equipment as an aid for pre-emergence application of herbicides was

tested for the second year. The beans were planted at the rate of 45 pounds per acre, one-half to one inch deep, with a 2-row planter. At the time of planting, the right-hand row was rolled with a roller 18 inches in diameter and 12 inches wide, weighing approximately 250 pounds.

It was indicated that rolling was of no particular aid in pre-emergence treatments. In checks with no chemical treatments, the rolled plots had more weeds than the unrolled plots; however, in plots given chemical treatment, the weed control was equal.

Work has been started in studying the various methods and equipment used for brush control on rights-of-way and in pastures. Included in this investigation are the following treatments: basal treatments including oil can, knap-sack and hand gun; the foliage treatments including hand gun, boomless nozzle, and mist blower, and a cut and stump treatment. All of these will be applied at the best presently known rates. At the present time the basal and cut and stump treatments have been completed with indications that in all of the methods used, there is need for improvement of equipment *(Project 153 A).*

Farm Water Supplies.

(M. L. ESMAY, B. E. GUYER, M. M. JONES).

Work has continued on the development of an effective slow sand filter for the treatment of surface water supplies on the farm for domestic use. The previous year's field study of a number of existing horizontal slow sand filters indicated that although they can be depended upon to quite consistently clarify the water, they are not effective in reducing the level of harmful bacteria satisfactorily. In these field installations the sanitation of the sand trench and the storage cistern was found to be difficult to maintain.

Three experimental filters were designed and constructed. The filters were put into operation under somewhat controlled field conditions where water flow rate could be measured and periodic samples taken for analysis.

Two of the experimental filters were of the vertical type. The third filter was a horizontal type .Of the two filters one was a 36" diameter cylindrical type and the other a 24" by 24" square type. Both were six feet deep. The horizontal filter consisted of a cylindrical drum three feet in diameter and 18 feet long. The horizontal filter was patterned after the trench type filters which are in existence in quite large numbers on Missouri farms, although it was incased in an impervious drum instead of an unlined dirt trench.

Both of the vertical filters were charged with nine inches of gravel over the under drain system and thirty inches of washed Missouri sand over that. Both were filled to equal depths with sand in order to establish control information and the difference if any between the functioning of the two.

The horizontal filter had a vertical type under drain in the end of the drum and was filled completely full with the same type of river sand. The sand at the entrance which constituted the filtering surface was left with the natural slope.

Some observations included:

Three weeks of filter operation was required to form an effective filtering scum on the surface of the sand. The average time lapse prior to clogging of the filter was from six to seven weeks with a flow rate of 40 gallons per day per square foot of filtering surface. This amounted to a total flow of 17,700 gallons for an assumed three feet by three feet family size filtering unit.

Although approximately 1400 gallons of water per square foot had to run through the filters to form an initial effective scum, only 800 gallons were required to set up a subsequent filtering scum after the first one had been removed.

Complete sterilization was not obtained in all of the filters by the initial 200 parts per million chlorine solution. The horizontal filter in particular showed evidence of incomplete sterilization.

Gradation limits have been set up quite precisely in the past and these tests indicate that the limits are justifiable. Most natural river sand does not fall within this range unless some of the coarser material is screened out.

Considerable time was spent at the out-set of the laboratory study in developing testing techniques and procedures, however, most of the associated problems have now been overcome and the tests are under way. Comparative studies on sand gradation, filter sand depth, rate of flow, and filtering head are now being made *(Project 155 A).*

Creep Feeding in Producing Light Beeves.

(A. J. DYER, J. E. COMFORT, J. MCCALLUM).

Thirty head of bred Shorthorn cows were secured in November 1953. Each has been graded, tattooed, branded, photographed and weighed and all have been fed a ration of corn silage, protein concentrates and minerals. Some cows have calved; others may not calve until April. This wide range in calving dates may cause all calves to be creep fed and comparing the performance of those dropped early in the year with calves dropped in March and April.

Complete results will not be available until calves have been weaned and marketed *(Project 16 C).*

Animal Husbandry



L.A. Weaver, Chairman

Basal Roughage Ration Comparison for Feeder Calves.

(A. J. DYER, JOHN MCCALLUM).

Three basal roughage rations are being compared, utilizing 3 lots of 8 head each of weanling steer calves. All lots of cattle are being fed to make approximately the same rate of gain and the rations are as follows:

Lot 1 Corn silage (limited intake)
Cottonseed meal
Wheat Straw
Mineral mixture

Lot 5 Alfalfa hay
Mineral mixture

Lot 6 Ground corn cobs
Cottonseed meal
Blackstrap molasses
Vitamin A concentrate
Mineral mixture

These cattle will be grazed during the summer of 1954. Final results, therefore, will be available at the end of the grazing season *(Project 16 D).*

A Study of Farm Animal Reproduction.

(D. T. MAYER, J. F. LASLEY, A. GOWIENOWSKI).

A preliminary study was made of the protein-bound iodine (PBI) of 20 young purebred Hampshire gilts and barrows, slaughtered at an average weight of 215 pounds. The average daily gain, backfat thickness, left hind leg growth and body length growth were recorded and their relation with the PBI determined. The correlation between the PBI and the average daily gain was negative and proved to be highly significant (P 0.01). There was a trend for the body lengths to decrease as the PBI values increased; also for the length of the hind leg and the average backfat thickness to decrease as the PBI increased, but the correlations were not significant. The PBI method used was an alkaline ash procedure modified in this laboratory to facilitate its use in studies of this nature *(Project 38 A).*

Endocrine Secretions in Reproduction.

(D. T. MAYER, BETTY GLASGOW, HENRY BREDICK, A. GOWIENOWSKI).

Significant in this study are the factors involved in embryonic mortality and the maintenance of viable embryos in farm animals. Since the reproductive hormones responsible for the maintenance of pregnancy are influencing uterine environment through their effort on enzyme activity, the uterine acid and alkaline phosphatase concentration and its relation to number and weight of embryos were observed. It was found that number of embryos and uterine weight were significantly correlated. In 57 determinations the uterine acid phosphatase was higher than the alkaline phosphatase. An increase in uterine weight was paralleled by an increase in acid phosphatase and a decrease in alkaline phosphatase. A highly significant positive correlation between the weight of uterine contents and the acid phosphatase concentration was obtained, whereas the alkaline phosphatase was negatively correlated, but the correlation was not significant. The same degree of relationship between the two types of phosphatases and the number of viable embryos at the thirteenth day of gestation was observed. In rats there is an embryonic death loss of 28 percent *(Project 38 B).*

Factors in Natural and Artificial Breeding.

(D. T. MAYER, C. P. MERILAN, J. T. SMITH, MRS. MARTA ENGLAND, W. L. RYAN, R. L. KAMPSCHMIDT, R. S. LIPE, C. M. ISE).

During the three-year period that this project has

been in effect, the research under the title, "The Biochemistry and Physiology of Mammalian Spermatozoa" has covered a number of subdivisions of the major field. They include:

A. Viability of bull spermatozoa as influenced by various sugars and electrolytes in the storage medium.
B. Lipid and lipoprotein constituents of egg yolk in the resistance and storage of bull semen.
C. A comparison of the ability of certain egg yolk diluents to maintain optimum osmotic conditions during the storage of bull semen.
D. Osmotic pressure of extended bovine semen during storage.
E. A comparison of four counting fluids with special emphasis on their use for evaluation of spermatozoan concentration by the haemacytometer.
F. A quantitative study of an acidic protein of boar spermatozoa.
G. A comparative study of the chemistry of the nuclei of ova, spermatozoa, and liver cells in the frog (rana pipiens).
H. The lipids of boar spermatozoa.
I. A metabolic study of cold shock in mammalian spermatozoa.

The latter investigation showed that the liver cells and bacteria are not susceptible to cold shock. It was found that the damage to spermatozoa increased with increasing periods of exposure to the low temperatures. Data were obtained showing that anaerobic glycolysis, aerobic glycolysis and respiration were all decreased by cold shock, and that aerobic glycolysis was most markedly affected. A bicarbonate buffer in the medium protects spermatozoa from cold shock as measured by anaerobic glycolysis. Subsequent experiments showed that bicarbonate stimulates the endogenous respiration and the oxidation of pyruvate. Both crude and purified lecithin will protect spermatozoa from cold shock. Cold shock produces metabolic changes in spermatozoa similar to those found in injury, aging and fertilization *(Project 38 C).*

Storing Bull Spermatozoa.

(D. T. MAYER, C. P. MERILAN, J. T. SMITH).

A new diluter had been developed and is now being manufactured by a commercial company. This past year this laboratory has made tests on samples sent by this company. The company is Armour & Co., and have aided in obtaining fertility data with this new diluter.

The title and scope of this project will be changed so as to include work on low temperature freezing of semen and other methods of semen preservation. This plan will also include an investigation of by-products of certain manufactures which may replace egg yolk or lecithin in semen diluters *(Project 38 D).*

Strain Crosses in Swine Improvement.

(J. F. LASLEY, D. T. MAYER, L. F. TRIBBLE, L. A. WEAVER, F. J. RICE, D. HILLIARD, E. JOHNSON, D. E. BRADY, A. A. CASE).

The program of recurrent selection was continued during 1953 according to plans outlined in 1952. The plans for this year called for the production of a new generation of breeding boars and gilts in each of the Poland and Landrace lines from parent stock that had been progeny-tested on the basis of the performance of their crossbred pigs (Landrace x Poland) the previous year. In addition, Duroc boars were progeny-tested on the basis of the performance of their pigs produced by Landrace x Poland sows.

Four Duroc boars were tested in the spring of 1953, but one of these proved to be of low fertility and sired only one litter out of 5 gilts that were mated to him. Three other Duroc boars were saved for testing in the fall of 1953, but one of these suffered from an arthritic condition of the front legs and could not be used for breeding purposes. Thus, only 5 Duroc boars were actually tested during the year.

During 1953 there was a good demand for breeding stock from the breeding herd used in this project. One of the reasons for this was that good breeding stock was scarce in the state and breeders were anxious to obtain animals that were considered to be disease free. Considerable interest has been shown recently in producing meat type hogs, and as a result Landrace boars have been in great demand. A summary of hogs from the breeding project that were sold to farmers and stations during 1953 has been prepared. It will be possible to obtain data on the progeny of several of these sows and boars which should add valuable information to other data collected on the project. Several farmers have expressed an interest in using the boar rotation of Poland, Landrace and Duroc developed in this project on selected crossbred gilts from their own herds. One farmer who produces at least 500 head of hogs per year for the market, has obtained some Landrace sows and a boar and plans to reproduce this line in close cooperation with the University *(Project 39 A).*

Developing Practical Performance Measures.

(J. F. LASLEY, L. A. WEAVER, D. E. BRADY, S. ZOBRISKY, L. F. TRIBBLE).

Live hog backfat probes were obtained on 174 of

the pigs farrowed in the spring of 1953 when the pigs weighed approximately 200 pounds.

These data were obtained on all of the purebred Landrace and purebred Poland boars and gilts from the spring litters, and were used in a selection index along with the dam's productivity index, the growth rate of each pig to 154 days, and their conformation score at 200 pounds for selecting animals for the breeding herd. These data were also obtained on crossbred Landrace x Poland x Duroc pigs which were slaughtered at the usual market weight of 200 to 225 pounds.

The data on these hogs were used for developing a formula for estimating the percentage of lean and fat cuts in the live breeding animals.

The probes were taken in 3 different locations on the live hogs. One was taken near the shoulder, a second near the hip and a third on the hip about 6 inches anterior to the tail head. All of the probes were taken about 1 to 1½ inches to the right of the back bone.

Studies of slaughter data have shown that the live hog probes are nearly as accurate as backfat measurements in the carcass for determining the degree of fatness of an animal.

The study shows that Landrace and Poland boars and barrows had thinner backfat on the average than did gilts at a similar weight. The boars and barrows also apparently contained less fat and more lean at this weight than did the gilts.

Crossbred barrows (Landrace x Poland x Duroc) were considerably fatter than the Poland or Landrace males, but there was little difference between purebred and crossbred gilts in this respect. The data suggest that possibly castration of the pigs is responsible for the presence of more fat in the carcass at a weight of 200-225 pounds.

Body measurements and conformation scores were also taken on 172 of the pigs farrowed in the spring of 1953. A study will be made later to determine if these measurements are correlated with the performance and carcass quality of boars and gilts and with similar measurements in their offspring.

The investigations showed that purebred Polands and purebred Landrace had a higher conformation score than the crossbred (Landrace x Poland x Durocs) pigs, and that the latter were more variable in this respect as a group. This would seem to support the view that crossbreeding increases variation in body conformation within a population.

During 1953 a preliminary study was made of the correlation between certain measurements of the reproductive tracts, ovulation rate and number of embryos present in the tract of gilts bred and slaughtered 25 to 30 days after breeding. Some evidence was obtained that indicated that the length of the vagina might be correlated with ovulation rate and number of embryos present in the reproductive tract of gilts at the time of slaughter.

Another study is being conducted of the protein-bound iodine found in the blood of swine. Protein-bound iodine is considered to be a measure of thyroid activity, and the secretion of this gland is probably correlated with performance and carcass quality in swine. A preliminary study showed a significant correlation between the rate of gain and the PBI content of the blood of pigs at a slaughter weight of 200 to 225 pounds *(Project 39 D)*.

Breeding Improved Performance in Beef Cattle.

(J. E. COMFORT, J. F. LASLEY, A. J. DYER, L. A. WEAVER, C. J. HEIDENREICH).

During 1953, 58 purebred and 22 grade calves were weaned in the herd at Weldon Springs. One hundred fifty-nine high quality grade Hereford heifer calves from two Nebraska Sand Hill herds were added to this grade herd in 1953.

The percentage of calves born and weaned in each of the 11 different lines together with birth weights, weaning weights and weaning scores were ascertained. Considerable variation was noted in birth weights of calves in the various lines. Some of the differences may have been due to the genetic make-up of the lines and some due to chance. In general, heifer calves were lighter than bull calves at birth.

Weaning weights were corrected to a 182 day basis for all the calves and the average was 384 pounds. Weaning weights of calves ranged from 370 to 423 pounds. Weaning conformation scores of calves also were quite variable in the different lines, ranging from 69 to 80 for the 1953 calf crop. The variation within and between the lines is a good indication that they differ in their genetic makeup.

Three bulls sired all but 4 of the calves produced in the herd during 1953. Thirteen calves sired by Bull H were the heaviest, averaging 426 pounds on a 182 day basis. Calves sired by Bull B were the lightest, and averaged 368 pounds. Eighteen purebred calves from this same bull scored only 70 as compared to 75 for calves sired by Bull H. Nineteen calves sired by Bull C had an average weaning score of 76. These data illustrate that bulls may vary considerably in their ability to sire heavy weight good quality calves at weaning time.

Nine bulls from the 1952 calf crop which were sired by two different bulls were fed individually for a period of 154 days. The bulls were fed six weeks before they were started on the test. The data show that the bulls varied greatly in their ability to make rapid

and efficient gains.

Before the breeding season began in March of 1953, the foundation females and their heifers that were of breeding age were divided into four equal groups according to size, conformation scores and breeding performance. Two of the groups will be combined to make up a closed herd to be used for testing the effectiveness of inter-herd selection of both sires and dams based on their performance under the same conditions. The other two groups will be maintained as a control herd and will be mated to bulls carefully selected from representative herds of purebred Herefords. The breeding plan followed in this herd will be similar to that ordinarily used by purebred breeders in which inbreeding is avoided and a new bull of good quality is purchased to breed to heifers as they reach breeding age. It is the purpose of this study to compare the two systems of breeding *(Project 82 A).*

Fresh and Frozen Meat Deterioration.

(D. E. BRADY, N. T. GRABAU).

This study relates to the effectiveness of the antioxidant, Butylated Hydroxyanisole (BHA), in prolonging the rancid-free life of fresh pork bellies stored at 0° F. and subsequently cured and stored as sliced bacon. The BHA was applied to pork samples in a solution of lard oil. Organoleptic and peroxide tests were made at monthly intervals on the samples in the various treatments.

It was found that when ordinary precautions are used with regard to the packaging and prompt freezing of fresh pork there was no advantage in adding the antioxidant.

Samples of fresh pork receiving various treatments prior to storage at 0° F. were subsequently cured, smoked, sliced, packaged in cellophane, and displayed in an open refrigerated display case for one, two and three week periods. The temperature of the case was 43° F. ± 5° F. The samples were under constant lights (25 ± 5 foot candles) during the entire display period.

In August, October, 1953 and January 1954 a total of three replicates consisting of various treatments were applied to fresh pork bellies secured from carcasses of known history. After six months storage samples will be tested organoleptically and chemically for rancidity development. The samples will then be cured, smoked, packaged in pliofilm and displayed in a lighted, refrigerated display case for two weeks after which they will be tested organoleptically and chemically for rancidity development. The carrier for the BHA is Lard Oil, Sucrose and Corn Sugar in each succeeding replicate respectively. Data on this phase are incomplete *(Project 101 C).*

Preserving and Utilizing Beef Quality.

(D. E. BRADY, H. D. NAUMANN, HAROLD HEDRICK).

Meat quality may be thought of in relation to certain physical, chemical and organoleptic properties. The physical and chemical factors, to a large extent, are used as indices to predict the organoleptic properties. The sensory reactions of the consumer toward the product consumed is the accumulation of many sensations. In fact, many of the factors that influence the perception and evaluation of these sensations, unfortunately, are from extrinsic sources. Even though conscious of these disturbing influences one is often unable to exclude them from evaluations of sensory stimulation. Hence, it behooves us to continually search for means of evaluation that are outside the influence of human behavior. While idealistic procedure to accomplish this may be proposed, the development of applicable methods is difficult. The work here reported was an effort to determine under limited conditions the applicability of substitutionary objective methods for more generally accepted subjective methods of evaluation.

This study utilized the carcasses from thirty-eight two-year-old steers that were a part of a Missouri Station Project to determine ways to use maximum amounts of pasture and other roughage in the production of slaughter cattle. The experiment covers a two year period with nineteen steers being available each year. The first year the carcasses graded U. S. Commercial, U. S. Good, U. S. Choice, and U. S. Prime. The following year all but one of the carcasses graded U. S. Choice, the other grading U. S. Good. The steers were marketed at the National Stock Yards and were slaughtered by packers in that area. Carcass grades, carcass scores, and measurements were obtained forty-eight hours after slaughter. The grading and scoring of the carcasses was done by a panel of Federal meat graders. The ribs from those carcasses were then used for the laboratory determinations.

The right 9th-10th & 11th rib section from each carcass was used for physical separation of the tissues and for chemical analysis. The left 9th-10th & 11th rib section was cooked for organoleptic evaluation, Warner-Brazzler shear readings, and chemical analysis of the cooked meat. The 12th rib was used for color determinations.

Some results of this work would indicate:

1. Frozen grinding of meat samples increase to a marked extent the accuracy of chemical analysis.
2. The objective measures reported herein to evaluate certain organoleptic properties of meat have low relationships with taste panel scoring.

3. A three-filter reflectance meter may be used to characterize the color of meat *(Project 101 D).*

Preserving and Utilizing Pork Quality.

(STEVE ZOBRISKY, D. E. BRADY, JOHN LASLEY, L. A. WEAVER).

The 207 hogs slaughtered for this study consisted of 122 Landrace-Poland crosses, 76 Hampshires, and 9 Durocs of approximately 206 pounds live weight. The hogs were fasted 24 hours prior to slaughter with access to water.

Each carcass was graded and scored. The four preferred cuts: hams, loins, shoulders and bellies, were scored as processed by the author and his two coworkers. The method of processing suggested in the Proceedings of the 1952 Reciprocal Meat Conference was followed.

Some specific and general conclusions have been reached.

1. A reasonably accurate estimate of the live hog's value can be determined from the live hog backfat probes or carcass backfat measurements. Yield of fat is more easily and accurately determined than the yield of lean.
2. Internal carcass measurements (for example, the cross-section area of the loin eye) gave the highest correlation with the yield of lean.
3. The yield of any one component of the carcass (or live hog) is influenced by several factors.
4. This study suggests that if further improvement in pork carcass (or live hog) evaluation is desired there is a great need for standardized technical procedures which will readily measure the internal characteristics (composition) of the carcass (or live hog) without mutilation. These procedures should be such that they can be applied to a large number of carcasses (or live hogs) within a reasonable time *(Project 101 G).*

Dehydrated Pork Deterioration.

(D. E. BRADY, C. W. GEHRKE, E. E. PICKETT, R. L. HENRICKSON, LEONARD KAMM, MARVIN BARNETT, HENRY FUKUI).

Objectives

(a) To improve the shelf-life of vacuum dehydrated pork by determining the chemical changes occurring during storage under controlled conditions.

(b) To improve the stability and desirability of vacuum dehydrated pork by conducting studies on the inhibition of the undesirable changes which occur during storage. The primary objective being to improve the shelf-life of the product.

Of the several methods of preparing dehydrated pork of lowered glucose content, fermentation with yeast appears to offer the greatest feasibility followed by the use of the glucose enzymes. Particle size (grind), concentration of yeast or enzyme, length of fermentation and enzyme reaction time, and cooking are important factors which should be considered in the commercial production of dehydrated pork for the military.

Glutamic acid gave the best overall performance. It was not as effective, however, as the method of separating the meat juices from the residue after cooking and dehydrating each part separately *(Project 101 H).*

Unrecognized Nutrients and Vitamins in Swine Nutrition.

(A. G. HOGAN, W. H. PFANDER, L. F. TRIBBLE).

Pigs reared by a sow on a synthetic diet were carried through a gestation and lactation period on a synthetic diet and raised litters comparable to sows on practical rations, under the same conditions. Weanling pigs were fed a semi-purified type diet to 100 pounds in a test of soybean oil meal, casein and liver as sources of protein and unidentified nutrients. All pigs made good gains and there was no indication that the most rapidly gaining pigs received a vitamin or nutrient that has not been recognized.

TABLE 4 -- RATIONS FOR BRCOD SOWS

Lot	1	2	3
Ground yellow corn %	79.5	79.5	82
Linseed oil meal %	5	5	5
Tankage %	10	10	--
Liver meal %	--	--	7.5
Alfalfa meal %	2.5	2.5	2.5
Minerals %	2	2	2
Vit. A & D supplement %	1	1	1
Riboflavin mg.	--	80	80
Pantothenic Acid mg.	--	450	450
Nicotinic Acid mg.	--	500	500
Vitamin B_{12} mg.	--	0.63	0.63

The animals were kept on concrete floored pens throughout the experiment. Each sow and her litter was fed separately, and the pigs had access to a good creep ration.

There was no improvement in survival or growth of the pigs which could be attributed to changes in the basal ration. The low performance of the group of sows which received the vitamin supplement as compared to the basal ration cannot be explained as it is believed that this ration is deficient in one or more of these vitamins. There was some indication that the addition of liver meal improved the ration, as the best

litters produced were on this ration.

The number of pigs weaned per litter and the weaning weights of the pigs were slightly higher for the group which received the liver meal. No absolute conclusions can be drawn from this experiment but it indicates that much work needs to be done with brood sows *(Project 141 A).*

Proteins and Amino Acids in Hog Nutrition.

(A. G. HOGAN, W. H. PFANDER, L. F. TRIBBLE).

On the the basis of the two tests conducted in 1953 a ration of corn, shorts, tankage and soybean meal containing 18, 16 or 14% crude protein will support faster daily gains with a lowered feed cost if supplemented with lysine or methionine. The response is not additive, and there is reason to believe that the combination actually depresses growth, but feed efficiency is high.

Rations containing corn and soybean meal at 18, 16, or 14% crude protein are not markedly improved by the addition of methionine or lysine, but the combination seems to support a faster rate of gain an a higher feed efficiency than the basal ration. The improved feed efficiency can be attributed to the lysine addition.

The amino acid requirements of the pig should be expressed as a percent of the total protein ration.

Some observations:

Pigs on a supplement composed of soybean oil meal, tankage, wheat shorts and aureomycin made faster gains than pigs on other supplements.

Pigs on a ration composed of corn and tankage supplemented with antibiotic made very efficient gains and required only 274 pounds of corn and 39 pounds of tankage per 100 pounds gain.

Pigs in lots 2 and 4 consumed more protein supplement than they required as they consumed a ration that averaged 18% and 19% protein respectively which is higher than is necessary when the ration consumed by lots 1 and 3 contained an average of 15% and 16% protein respectively.

There was no advantage to adding the B vitamin supplement, and there is no explanation for the difference in results between the pigs in lots 3 and 4 *(Project 141 B).*

Nutritional Requirements and Feeding of Pigs.

(A. G. HOGAN, J. F. LASLEY, W. H. PFANDER, L. F. TRIBBLE).

Two trials were conducted during 1953 in a study of the effect of sugar and various flavors on the consumption of creep rations and weaning weights of the pigs.

The study shows that the sow does not produce enough milk for her litter to make maximum gains during the eight week lactation period. The milk production of the sow reaches a peak at about three weeks and declines rather rapidly during the latter part of the lactation period. The nutritive requirements of the pigs continue to increase as they become older; therefore it is necessary to supplement the milk of the sow with a good creep ration in order to obtain maximum weaning weights.

The addition of sugar or flavors and a combination of these were of no benefit when added to a pelleted creep ration *(Project 141 C).*

Nutrition Influence on Swine Carcass Desirability.

(J. F. LASLEY, D. E. BRADY, W. H. PFANDER, S. E. ZOBRISKY, L. F. TRIBBLE).

The surplus of lard, its low price, and the decreased demand for fat pork make it necessary to improve the meatiness of our hogs. One way in which this might be accomplished would be to limit the amount of feed to the growing-fattening pigs. Growth takes precedence over fattening when an animal is on a restricted diet.

Purebred Hampshire hogs were used. Treatments were subdivided into (a) barrows and (b) gilts.

Barrows on all treatments made faster gains than did the gilts but the gilts were more efficient on all but one treatment. Carcass data were obtained on all animals except a few of the gilts which were kept for breeding.

Although there was considerable variation in dressing percent within feeding levels, the tendency was toward a lower dressing percentage as the level of feeding was decreased. Barrows dressed slightly higher than did the gilts in all treatments.

The percent of fat varied directly with the level of feeding while the percent of lean varied inversely with the level of feeding *(Project 141 D).*

Large and Small Type Breeding Animals Study.

(A. J. DYER, G. B. THOMPSON).

Measuring the impact that size of breeding animals has upon sheep production is the objective of this test wherein small type "Texas" ewes are being compared with big type "Northwestern" ewes. Half of each group of ewes has been bred to the same, small type Hampshire ram and the other to the same, large type Hampshire ram. All phases of their production

will be studied. This test was initiated in November, 1953 and complete results will not be available until lambs are marketed *(Project 142 A).*

Producing Late Lambs on Roughage and Pasture.

(A. J. DYER, G. B. THOMPSON).

Fescue pasture and mineral mixture are the only feeds being provided small and large type ewes which will raise late lambs. The nutritional adequacy of this and other pastures will be measured in this test wherein fat lambs may be raised without the feeding of grain to either ewes or lambs. This test was initiated in November, 1953 and complete results will not be available until lambs are marketed. *(Project 142 B).*

Sheep on Small, Fertile, Irrigated Areas.

(A. J. DYER, ROBERT BEASLEY).

Plot layout, fertilizer treatment and seedings have been made, but the latter failed because of dry weather. The seedings will be made again this spring and with proper irrigation, grass stands should be established and some grazing results accomplished *(Project 142 C).*

Cattle Pasture.

(J. E. COMFORT).

The Department of Animal Husbandry has been cooperating with the Department of Field Crops on this project by furnishing the number of steers needed for pasturing at Columbia and Sikeston fields and marketing them to the best advantage at the end of the grazing season.

Twenty-one steers (mostly Shorthorn and Shorthorn crossbreds) averaging 936 pounds were purchased February 21, 1952 @ $33.00 per cwt. The total weight of the 21 steers was 19,600 lbs. and total cost, $6487.00.

From February 21, to April 16, these steers were on winter pasture with stack timothy-lespedeza hay. They were on grazing experiments at Columbia until October 17, and made an average gain of 307 lbs. per head from February 21, to October 17. Cattle prices had made a very drastic decline during the summer and fall of 1952.

The total cost of these steers including the original cost and feed cost was $7250.99. The total return was $5460.64, making a net loss of $1790.35 on the 21 steers. This was the first year that there was a net loss on steers purchased for these grazing experiments. These steers made an average net gain of 471 lbs. per head from purchase weight to the market,with most of this gain made on pasture and good quality roughages.

For the Sikeston Field, 20 choice grade Hereford steers of very uniform sort, averaging 867 lbs. per head were purchased on April 8, 1952, for $33.50 per cwt. The total weight on the 20 steers was 17,345 lbs. with the cost delivered by truck to the experiment field totaling $5810.37. The drouth terminated the grazing tests August 11, and the price of cattle declined much more than the contracted resale price. The cattle totaled 21,020 lbs. on August 11, and the resale value was $6200.90 giving a difference of $390.33 to pay for the rental on the pasture land or other expenses. Between April 8, and August 11, the steers made an average gain of 184 lbs. per head *(Project 154 A).*

Consumer Acceptability of Pre-Packaged Meats.

(D. E. BRADY, STANLEY HUNTER, ELMER KIEHL, EUGENE BIRMINGHAM, J. C. GRADY).

A study was conducted in April, 1953, to determine consumer preference for leaness of pork. Approximately 600 suitable households were selected for the survey. Of this number, 361 households cooperated. Fresh loin chops, cured ham slices, and sliced bacon from U.S.D.A. Choice No. 1 and Medium carcasses were used. The carcasses weighed approximately 150 pounds. The Choice No. 1 carcass had an average back fat thickness of 41.5 mm, had no appreciable fault in firmness, in color or conformation. The Medium carcasses had an average back fat thickness of 35 mm, were appreciably deficient in color or firmness or slightly deficient in both. The respondent was not informed as to the grades of the cuts but indicated her preference for either the cored or uncored sample. Chemical analysis showed that the Medium cuts had a higher percentage of moisture and a lower percentage of fat as compared to the Choice No. 1 cuts.

The Medium bacon and pork chop were preferred by 55% of the respondents while 49% preferred the Medium ham. Preference for the Choice No. 1 cuts was as follows: bacon, 42%; ham, 47%; and chop, 38½%. Leanness was the characteristic most often mentioned in the selection of the Medium cuts. "Apparent" freshness (each cut was equally fresh) was more important to those selecting the Choice No. 1 cuts. Respondents preferring the Choice No. 1 cuts before cooking changed their preference to the Medium grade after cooking as follows: bacon 43%, ham 48%, and chop 39%. Those preferring the Medium before cooking changed to the Choice after cooking as follows: bacon 33%, ham 34%, and chop 37%.

Beef was given as first preference by 75% of the respondents. Pork was mentioned 20% of the time. Most of the respondents indicated that they preferred

the popular pork cuts—bacon, chops, ham, and roasts. Meat was purchased by 62% of all respondents once or twice a week (1 time 37%, 2 times 25%). On the basis of weekly expenditures 71% of the respondents spent $10.00 - $30.00 for groceries including meat, and 65% spent between $2.50 and $10.00 for meat. Meat was served by 91% of the respondents 7 days a week. Meat was served at least twice a day by 55% of all respondents.

Regardless of preference, the results showed that 87% saved the drippings from cooked meat and 55% used some lard.

This study indicates that the consumer wants lean pork. The question remains—can the meat-type hog be produced to meet consumer demand? Assuming that it will be produced, will this type of hog be adaptable to the current processing procedures? *(Project 165 A).*

Micro-Flora Affecting Pre-packaged Meats.

(R. F. BROOKS, R. L. HENRICKSON, D. E. BRADY).

Perhaps the outstanding single observation made in connection with the qualitative bacterial analysis of the samples used in the study was the almost complete absence of pathogenic types.

The general conclusions to be drawn from the study are: (1) The qualitative bacterial content of prepackaged luncheon meats is quite diverse, but appears to consist almost exclusively of harmless saprophytic types. (2) The quantitative flora is extremely variable and would seem to have little effect on the general quality of the products except in cases of extreme initial contamination or subsequent growth during storage. The responsibility of the packer and retailer in producing, transporting, storing, and merchandising the product under refrigerated conditions is of paramount importance, and is worthy of much greater attention than it appears to receive in some cases *(Project 165 B).*

Testing Ruminant Digestion Techniques.

(C. C. BROOKS, E. F. EBERT, W. C. ELLIS, C. W. GEHRKE, W. H. PFANDER).

The artificial rumen proved to be a satisfactory screening device for testing the effect of various compounds on cellulose digestion.

Individual stalls and feeders were constructed which make it easy to obtain samples of rumen fluids from fistulated sheep. Plastic poultry freezer bags can be clipped on wethers to make a very satisfactory collection bag for fecal material.

Several methods for the determination of lignin have been tested. All methods give a very high lignin value for cottonseed hulls. The nature of the lignin present in cottonseed hulls is now being investigated.

Additional studies have been made with the silk bag technique of Van der Wath. The results obtained do not agree well with the results obtained from a digestion trial. The surgical techniques for adrenalectomy and portal cannulation have not been reduced to routine methods.

Some progress has been made in fractionating rumen ingesta with chromatographic techniques *(Project 168 A).*

Chemical Compounds and Ruminant Digestion of Roughages.

(C. C. BROOKS, W. C. ELLIS, G. B. GARNER, C. W. GEHRKE, M. E. MUHRER, W. H. PFANDER).

Those compounds that produced interesting effects in the artificial rumen were added (using a Latin square design) to the daily rations of yearling wethers fed a basal ration of 2 pounds cottonseed hulls and .2 pounds casein, with a mineral mixture (limestone, bonemeal, salt and Co Cl_2) *ab lib.*

Fecal collections were made and here are the conclusions:

1. To obtain maximum utilization of the cellulose in high fiber rations the following compounds should be present:
   a. 3-5% of soluble carbohydrate
   b. A very soluble nitrogen source (urea or casein) and a relatively insoluble source of N (corn proteins and soybean meal)
   c. Low levels of diethylstilbestrol (if the animal can tolerate them)
   d. Some fresh forage or good quality silage.
2. Cellulose utilization is held back by the addition of corn oil, lard, more than 10% of molasses or by a combination of molasses and ash *(Project 168 B).*

Rumen Flora by Inoculation.

(C. C. BROOKS, A. J. DYER, G. B. GARNER, M. E. MUHRER, W. H. PFANDER).

The effect of inoculating three groups of ruminants has been studied.

Yearling steers wintered on corn cobs or corn silage were divided into two groups and one-half of each group was given two 100 ml. inoculums before they were taken to pasture. The inoculums were obtained from a steer wintered on fescue pasture.

There was no apparent benefit from the inoculation, but the dosage used may have been inadequate. The experiment should be repeated using 5 inoculums of 500 ml. at three day intervals.

One half of the lambs born as twins in March and

April were inoculated weekly with 10 ml. of fresh rumen fluid obtained from a fistulated ewe on pasture. The other twins served as controls.

The inoculated lambs made slightly faster daily gains from birth to seven weeks of age, but a number of the control lambs gained faster than their inoculated twins. Since all lambs were confined with the ewe flock at night and the water supply often contained cuds from the ewes, the control lambs had an excellent chance of getting natural inoculums early in life. Under these conditions it does not seem to be advantageous to inoculate young ruminants.

Trios of yearling wethers were fistulated and given one million units of penicillin (1 M). One wether in each unit was given fresh rumen inoculum, one was given lypholyzed rumen contents and one served as a control. Samples of rumen contents were drawn from the sheep at intervals, examined for microflora and analyzed for volatile fatty acids. The data are incomplete *(Project 168 C).*

Alfalfa and Alfalfa Ash Studies on the Rumen Flora, etc.

(C. C. Brooks, W. C. Ellis, G. B. Garner, M. E. Muhrer, W. H. Pfander, E. E. Pickett).

There seem to be two factors in alfalfa ash which aid in cellulose digestion. One factor helps overcome the depressing effect of fat on the rumen organisms and is probably due to the buffering and surface effects of the ash. This response has been found in all samples of ash that have been tested.

The second effect is probably due to the presence of a mineral or minerals other than those now known to be essential for ruminant nutrition or a better balance of known minerals and is only shown by ash from fertile soils.

The data obtained indicate that a balance of minerals is more important than the presence of any one mineral element in rations for ruminants *(Project 168 D).*

BOTANY



Edward M. Palmquist
Chairman

Development of Tomato Varieties from Hybrids.

(C. M. Tucker, G. M. Hall, R. A. Schroeder).

During the past year continued crossing, selecting, and testing were made to improve the performance of hybrid tomato lines. The plots consisting of five replications of ten plants each were located near Rocheport, Missouri. Thirty-five varieties were included in a plot of non-staked and non-pruned plants.

Because of the hot dry winds and severe drouth the yields were less than usual. The maturity of the plants was delayed so that the early yields (August 17) were small and the size of the fruit was smaller than fruit produced later in the season. Eleven hybrid varieties exceeded the highest yielding commercial variety, Indiana Baltimore.

Varieties with factors for early maturity, uniform ripening and determinant type of growth yielded very well. A few yellow fruited lines resistant to wilt were in the test. These lines may be acceptable for garden use where Fusarium wilt is frequently a limiting factor, although they are frequently inferior to red lines for commercial use. The fruit of the Rutgers tomato was taken as standard. Seed of all these lines was increased.

Thirty commercial varieties and hybrid progenies, staked and pruned to two stems, were grown in plots of ten plants each replicated five times. Because of the early hot, dry winds and extreme drouth the plots were abandoned.

Approximately 100 additional lines were grown in observation plots of three replications of 15 plants each. Commercial lines were included for comparison with experimental lines. Approximately 90 individual plants were observed and separate records made of the number and quality of the fruit. Seed from these plants were harvested and packaged separately. Progeny of each selected plant was tested in the greenhouse under highly infected conditions to eliminate any that might be susceptible to wilt. Twenty-four commercial varieties and hybrids, some resistant to Fusarium wilt and to leaf mold *(Cladosporium fulvum)* and some only to wilt, were tested in the greenhouse. Each variety was grown in four replications of three plants each. The hybrids were inoculated at both the first and second transplantings with a virulent isolate of the wilt fungus. The commercial varieties were not inoculated and in general remained free from infection. Leaf mold

did not develop because of the warm, dry conditions in May and June. Eight lines produced yields greater than the highest yielding commercial lines, Michigan State; Break O'Day was the lowest in yield *(Project 41a).*

Oak Wilt Studies.

(C. M. TUCKER, T. W. BRETZ, T. W. JONES, D. W. MORISON, W. D. BUCHANON).

A simplified technique for the isolation of the fungus from infected wood has been developed. This involves the use of sterile distilled water as the medium for the growth of the fungus from infected wood chips, instead of the usual nutrient agar media. Recovery of the fungus is more readily accomplished and positive identifications can be made more quickly in water than on nutrient agar media.

The host range has been extended to include 14 species of *Quercus,* one species of *Castanopsis* and one species of *Lithocarpus* not previously known to be susceptible. Most of these are species of exotic origin, a few of which have been introduced into the United States for ornamental use. Three species are native to California. A specimen of *Quercus veluntina* has been found which possesses considerable resistance to the disease.

Investigations on the role of certain insects in the spread of the disease are in progress. Particular attention is being given to a bark beetle which is known to infest trees in early stages of the disease. However proof that this insect is involved in the dissemination of oak wilt has not yet been obtained.

Studies have shown that the survival of the fungus in small diameter material (twig samples) is relatively short at temperatures above 20° C. - 25° C. There was no recovery from samples held at 30° C. after 6 days, nor from samples held at 35° C. after 3 days.

Investigations on the local control of oak wilt in timber stands are in progress. These have not yet been carried on for a sufficient time to give any indication as to the degree of control that might be accomplished by these methods *(Project 52a).*

Identification of Plant Diseases.

(C. M. TUCKER, M. E. MICHAELSON).

Approximately 450 inquiries were received from Missouri growers and people from other states concerning plant diseases and their control. Letters were written following examination of diseased specimens received; a number of county agents and others came in to consult on disease problems and their control. Stewart's disease of corn was again common following a mild winter; a number of sweet corn plants were received early in the summer and later field corn samples came in. Stewart's disease on field corn is one of the more important diseases of this crop in Missouri. Aspergillus ear rot was common on inbred lines and single crosses for hybrid seed production. Bacterial blight and bacterial pustule were common on soybeans. In the northern part of the state on heavy soils a blight of soybeans was reported late in the season. The causal organism has not been definitely determined, but it appears to be soil borne *Fusarium* sp. Damage in some fields caused as much as 30% reduction in yield. There were no epiphytotics on soybeans. Other crops had no unusual diseases.

There was, however, a considerable amount of covered smut of barley and smut of oats, diseases which can be controlled by proper seed treatment *(Project 57a).*

Studies of the Genus Phytophthora.

(C. M. TUCKER).

This project was maintained as a service to plant pathologists throughout the world for identification of species of the genus *Phytophthora.* No identifications were made this year although several requests for information and cultures of *Phytophthora* species were received and honored *(Project 58a).*

Virus Diseases of Stone Fruits.

(C. M. TUCKER, D. F. MILLIKAN, A. D. HIBBARD).

Over 700 individual trees of *Prunus* were tested for ring spot virus infection in 1953 and of these, 24 or approximately 4% were found to be infected and were destroyed. Thirteen infected trees were found in a scion orchard of 363 trees but only two were found in a *Prunus Mahaleb* seed orchard composed of 201 trees. Four infected trees were found in a third block of 34 trees. The remaining infection was detected in replants or new varieties which were discarded.

The Botany department again cooperated with the U. S. Bureau of Plant Quarantine in the surveys of phony peach and peach mosaic virus. Three nurseries were examined for peach mosaic and no infected trees were found. Twelve trees infected with phony peach were detected and were removed.

In a study of ring spot in peach, 23 one year-old nursery trees representing 16 varieties were selected at random and indexed on Montmorency. Only three varieties were found to be infected with ring spot. A more extensive indexing of these varieties is planned for the coming season to determine the seriousness of ring spot in those varieties *(Project 68a)*

Pertinent Range Species Study

(C. L. KUCERA, CLARK MARTIN).

The figures (%) below indicate the number of quadrats in which grasses were found out of one hundred randomly distributed quadrats:

Little bluestem	85
Annual dropseed	30
Switch grass	17
Indian grass	5
Panic grass (tenn.)	3
Dropseed (clan.)	3
Sideoats grama	3
Big bluestem	3

Although the grasses are the most important group, the little bluestem being the main one, many other plants occur as part of the normal composition of the glade vegetation. Including the above grasses, 125 different plant species were collected at one time or another in this area, however most are very infrequently distributed (less than 5%). The highest frequency for a non-grass plant was 22% *(Houstonia).* It is of interest to note that while broomsedge is quite common in old fields and along roadsides, it was observed only once in the glade vegetation. This is due presumably to the vigorous competition of little bluestem in arresting its spread.

The bottomland forest is most favorable for early grazing, although it is not typed by specific plant groups. Opening buds, twigs, rosettes, domestic and native grasses provide a greater variety of early forage than in the other grazing areas. Utilization of acorns by cattle was observed in upland oak woods in March and April *(Project 79a).*

Corn Diseases.

(M. E. MICHAELSON, M. S. ZUBER).

Sixty inbred lines replicated three times were inoculated with *Diplodia zeae* and *Gibberella zeae* by the toothpick method about ten days after pollination. Three weeks later the stalks were sliced longitudinally to observe the extent of rot. The inbreds differed considerably in their reaction; some were extremely susceptible whereas others were moderately resistant. Some inbreds were resistant to one organism and not to the other, but a few were resistant to both.

Ten inbred and five hybrid lines of corn from Minnesota and five inbred and five hybrid lines from Missouri replicated three times were inoculated with a culture of *D. zeae* and *G. zeae* from each state. The lines differed in their susceptibility to the different isolates regardless of the source of the isolates.

Ninety inbred lines were tested for resistance to leaf blight. Artificial inoculations were made with *Helminthosporium turcicum* but an epiphytotic did not develop; however, there was a natural epiphytotic of bacterial blight. Some lines were very resistant, but others were extremely susceptible. Smut ratings were made on certain of these lines. Some lines extremely susceptible to leaf blight were also susceptible to smut; this was by no means a general rule, however.

Two commercial hybrids, Kan 1639 and US 523w, grown on two levels of nitrogen and two levels of potassium were inoculated with *D. zeae* and *G. zeae* as in other experiments. Both hybrids appeared to be slightly more susceptible to both pathogens at the higher level of nitrogen than at the lower level; there was little or no difference at the two levels of potassium. Sand culture tests in the greenhouse gave similar results.

Three groups of about ten inbred lines of corn crossed in all possible combinations within each group were subjected to a cold test. Not only did the different inbred and single crossed differ in their reaction, but in the single crosses there appeared to be a difference with regard to which inbred was used as the seed bearing parent *(Project 127a).*

Diseases of Small Grain.

(M. E. MICHAELSON, J. M. POEHLMAN).

The work on diseases of small grains is chiefly routine testing of new lines for resistance to given diseases. Spreader rows of susceptible wheat were inoculated with *Puccinia rubigo-vera tritici* to determine the resistance to leaf rust of approximately 3000 lines of wheat. An epiphytotic did not develop so no readings were made. Loose smut ratings were made on wheat in ten different yield tests each having approximately 30 different lines and varieties. Clarkan was the most susceptible variety; many lines showed no loose smut, but infection was light throughout the tests.

Spreader rows of susceptible oats were inoculated with *Puccinia graminis avenae* race 7 and *P. g. avenae* race 8 in separate nurseries to determine the resistance to stem rust of approximately 1200 lines of oats. Both nurseries were also inoculated with *P. coronata avenae* race 45 to determine crown rust also. Approximately 100 lines of oats were inoculated with smut by the partial vacuum method. Most of the lines showed good resistance to smut; a Woodward selection was the most susceptible. About 25 lines of different parentage backcrossed to Mo. 0-205 to improve stem rust resistance to Mo. 0-205 were inoculated with race 8 in the greenhouse. All susceptible plants were discarded, but further crosses were made with the resistant material *(Project 127b).*

Enzymes of the Mammary Gland.

(C. W. TURNER, C. R. HOOVER, J. I. RAESIDE, W. F. WILLIAMS, W. R. KIRKHOM, J. R. ELLIOTT, M. B. SIGEL, A. J. OLSON).

METABOLISM OF THE MAMMARY GLAND

Study of the *in vitro* cellular metabolism of the rat mammary gland was continued. An *in vitro* system for studying oxidative phorphorylation in lactating mammary gland homogenates was defined and compared with liver homogenates while ATP synthesis associated with oxidation of Krebs cycle intermediates by liver homogenates was easily observed, this oxidation by mammary tissue consistently failed to carry out such reactions especially with succinate oxidation. Furthermore, rates of oxidations of such compounds by mammary tissue was trivial compared to liver. However, ATP synthesis was demonstrated to by very active in presence of glycolytic intermediates and mammary gland tissue. Some of these observations were also made on lactating cat and rabbit tissues.

In vitro influence of triiodo thyronine on glucose oxidation of rat liver and kidney slices indicated a small increase in oxidative rate in presence of this compound (liver only). No effect could be observed with hypothyroid animals although the control oxidative rate was well below that observed in tissue from normal animals. In all cases thyroxine was without effect. Certain *in vitro* concentrations of triiodo thyronine increased ATP synthesis (liver) without altering the oxidative rate *(Project 28a).*

Cultured Cream Salad Dressing Manufacture.

(WM. H. E. REID).

Several large milk distributing plants were visited for the purpose of consulting with their managers, production managers, and laboratory directors in regard to details of our methods and technique since they were interested in making Cultured Cream Salad Dressing available to their consumers.

They cooperated with the National American Dairy Association in organization and merchandising program which it proposes to use in several major markets as a means of introducing this new product to local milk plant distributors and consuming public.

A very large number of copies of reprint of "Sour Cream", by W. H. E. Reid and J. H. Gholson, and copies of "Procedure of Manufacturing Cultured Cream Spread and Salad Dressing and Its Uses" were furnished in reply to a very large number of inquiries received from many states, Canada, Cuba, Chile, India, and Australia *(Project 37b).*

Dairy Husbandry



A.C. Ragsdale, Chairman

Meltdown Qualities of Ice Cream.

(WM. H. E. REID).

The data show that the factors studied influence the meltdown qualities of ice cream from consumer viewpoint:

Increasing the butterfat, serum solids or total sugar content of the mix increased the rate of melting, however, the meltdown of all samples would be acceptable to the consumer. The use of condensed milk caused the ice cream to be slightly more resistant to melting than when non-fat dry milk was used. The effect of homogenization pressures and overrun upon the meltdown was such that consumer acceptance would not be affected. The different series in which stabilizers and emulsifiers were studied show that these products may impair the melting qualities from standpoint of the consumer. The texture of all ice creams was improved when the amount of free water in the mix was decreased and replaced with any solid in the mix or by being taken up as water of hydration by constituents of the mix. The data indicate that the quality of the flavor and body are related to the quality of the meltdown. A desirable mix should contain 10 to 12 percent butterfat, 10 to 13 percent serum solids, 15 percent sugar, overrun range should not exceed 70 to 100 percent, homogenization pressure should be 1500 to 1000

pounds and emulsifier used should be representative of the three general types *(Project 37c).*

Quality of Milk Received at Dairy Plants.

(WM. H. E. REID).

The quality of milk received at 64 different cheese factories, evaporated and dry milk plants was observed. Studies were made of transportation facilities of milk from farm to plant, sanitation and housekeeping of each plant, attitude of personnel toward quality of product.

Total number of sediment tests taken was 66,934; average number of tests per plant 1,046; number of plants inspected 64; total gallons of milk inspected 425,121; total gallons of Class I milk 7,338; total gallons of Class II milk 372,946; total gallons of milk rejected (Class III) 44,837; average percent Class I milk 1.73; average percent Class II milk 87.72; average percent Class III, rejected, 10.55 and total number of caution tags issued 10,107. There has been a continued improvement in quality of milk received at Missouri milk products plants *(Project 37d).*

Methods In Efficient Dairy Operation.

(H. S. PEET, A. C. RAGSDALE).

The improvement of dairy cattle through breeding continues to be a primary objective. Twenty-one years of Herd Improvement Registry testing and Official Type Classification have provided a background for a constructive breeding program. In this study, fifty-seven acres of improved bluegrass pasture, twenty-one acres of alfalfa and alfalfa-brome, and six acres of sudan grass provided adequate pasture for forty-five head of Jerseys, including twelve head of heifers over one year old, from April 27 to July 3, 1953. After July 3 extreme drouth conditions made it necessary to supplement these pastures with hay. Sanitary practices such as washing the udders with chlorine, rinsing test cups after milking each cow, use of strip cup, diagnostic tests (Hotis) and controlled milking order have been practiced in this study of methods and techniques in the efficient operation of a dairy farm *(Project 64a).*

Endocrine Genetics of Milk Secretion.

(C. W. TURNER, J. I. RAESIDE, W. F. WILLIAMS, W. R. MILLER, M. B. SIGEL, G. W. PIPES, A. J. OLSON).

Seven pairs of identical twin heifers were used in part of this study. One of each of the pairs was bred and the milk and fat production was compared with the production which was induced experimentally in the non-pregnant mate. The non-pregnant animals were injected daily for 160 days before the normal mate was expected to calve with estrogen and progesterone at a ratio of 1:1000 parts by weight of hormone. The amount of progesterone injected daily was gradually increased from 50 mg. daily for 60 days, 75 mg. for 30 days and 100 mg. for 60 days. The progesterone was then stopped and estrogen administered for a period to initiate lactation. From 50 to 70% of the normal lactation was induced experimentally. One of the conclusions reached is that progesterone is metabolized to an androgen in the bovine. The possibility that progesterone stimulates the source of androgen production must also be considered. These observations open the door to an entirely new approach to a study of steroid metabolism and the role of progesterone in reproductive physiology in the bovine *(Project 80a).*

Inbreeding and Outcrossing on Dairy Production.

(C. P. MERILAN, P. R. CORNELISON, H. S. PEET, A. C. RAGSDALE, H. A. HERMAN, H. A. BALL).

Milk and butterfat records have been kept on the Station Holstein and Jersey herds for a study on the effect of the inbreeding and outcrossing. Inbred and outcrossed lines are being developed and studied for growth, body conformation, production and reproduction characteristics with observations on the development of cow families.

Production records have been completed on 76 animals. Forty-eight animals have been classified for type and blood typing has been applied to 45 Holsteins and 34 Jerseys. Tentative production proving has been completed on 3 Holstein bulls. Eight sires are now being production proved. Of their daughters in the herd, 21 are in lactation but have not completed records and 74 have not yet freshened.

Compilation of production and reproduction records on the Foremost Guernsey herd is now in progress. These records cover the period from 1920 to date and will provide valuable information on the effect of inbreeding and outcrossing on milk and butterfat production *(Project 84a).*

Transmitting Ability of Certain Jersey Sires.

(C. P. MERILAN, P. R. CORNELISON, H. S. PEET, A. C. RAGSDALE, H. A. HERMAN, H. A. BALL).

The degree of selection practiced in the University of Missouri Jersey herd for butterfat production over a fifty year interval has been determined. Selection has been limited due to involuntary removal of cows, a 28.1% death loss of female replacements before

freshening age and attempts to increase the herd size. The selection practiced within heifer replacements was 9.2%. Selection has been rather heavy against cows which averaged below 325 pounds of butterfat. The selection differential, despite these limiting factors, has been small but positive.

The average annual culling of milking cows in the herd has been 28.2% of the average number of cows in the herd during the year. Differences in first lactation records appear to be 28% hereditary for this particular herd.

The production of the daughters of unproved sires used in the herd was studied. Eight of the sires increased the production while eleven sires decreased production. Prediction indexes based on pedigree estimates were computed on eleven sires with comparable production records.

Using the production of all the ancestors of a bull with production records in three generation pedigree, rather than just his progeny's production and the sire's dam's production regressed to the herd average increased the correlation between the predicted and the daughter's actual production. The number of sires which were compared on this basis was too small to make more definite conclusions *(Project 84b).*

Factors Effecting Dairy Cattle.

(C. P. MERILAN, P. R. CORNELISON, H. A. HERMAN, A. C. RAGSDALE, K. W. BOWER, H. A. BALL).

Reproductive efficiency of 790 cows that produced 2,368 living calves in the Missouri Station Dairy herd over a 50-year period, 1900-1949, was studied. Of total pregnancies (2,569), 168 or 6.54 percent were climaxed by abortion. Incidence of abortion due to Brucellosis has been reduced markedly since the advent of the blood test. Abortions ran high during the last 35 years but were due to factors other than Brucellosis infection. Only 73 or 2.84 percent of the total pregnancies resulted in birth of dead calves.

Three hundred and ten Jerseys remained in the herd 14,993 reproductive months, producing 968 calves, or average equivalent in pregnancies of 15.48 months per calf, with a reproductive efficiency of 77.51 percent. Four hundred and sixteen Holsteins remained in the herd 17,642 reproductive months, producing 1,221 calves, or average equivalent in pregnancies of 14.45 months per calf, with a reproductive efficiency of 83.04 percent. Sixty-four Guernseys remained in the herd 2,606 reproductive months, produced 185 calves or equivalent in pregnancies for an average of 14.11 months per calf, and had a reproductive efficiency of 85.05 percent. Average reproductive efficiency for the entire herd during this 50-year period was 80.86 percent. One hundred and fifty-one cows, or 19 percent of those studied, aborted one or more times and had an average calving interval of 18.75 months with a reproductive efficiency of 64.0 percent. This is in contrast to the 640 non-aborting cows which had an average calving interval of 13.77 months and a reproductive efficiency of 87.22 percent. Thus due to abortion there was an increase of almost 5 months in calving interval and a decrease of 23 percent in reproductive efficiency.

Incidence of abortion in the Missouri Station herd due to Brucellosis has been markedly reduced since the advent of the blood test. Over 40 percent of all recorded abortions occurred between 1900 and 1916 *(Project 84c).*

Histochemical Study of Bovine Reproductive Tract.

(C. P. MERILAN, H. A. HERMAN).

A report is given of the history and dissection findings concerning an acardiac monster born twin to a bull calf from a grade shorthorn cow. The monster was a spherical mass covered with hair. A sagittal section revealed an undifferentiated mass of tissue containing blood vessels, fat, and connective tissue *(Project 84d).*

Transmitting Ability of Sires in D. H. I. A.

(W. H. CLONINGER, C. P. MERILAN).

The records of sires proved in Missouri Dairy Herd Improvement Associations in 1953 may be summarized as follows:

TABLE 5

Breed	Bulls	Dtr.-Dam Pairs	Dtr's. Avg. M.	Dtr's. Avg. F.	Dam's Avg. M.	Dam's Avg. F.	No. Sires Increasing M.	No. Sires Increasing F.
Jersey	50	445	7,381	395	7,565	400	17	22
Holstein	24	240	13,193	486	12,688	458	17	18
Guernsey	15	150	8,269	305	7,851	381	9	10
Brown Swiss	9	90	10,951	460	11,035	444	5	7

(Project 84e)

Transmitting Ability of Brown Swiss Sires.

(C. P. MERILAN, H. A. HERMAN).

An analysis was made of the production records of ancestors in the first three generations of the pedigree of 864 proved Brown Swiss sires, as reported by the Bureau of Dairy Industry, U.S.D.A. from 1942 to 1950, in an effort to determine the most accurate prediction index for the transmitting ability of an unproved sire.

This study shows little evidence of assortative mating in the breed. Both high and low producing dams were mated with bulls that have prediction indexes for milk and fat of about the same level. The breeding of low producing cows to sires of high inherent production is a responsible factor for the upward trend in the breed's average production *(Project 84f).*

Dairy Bull Semen and Fertility.

(C. P. MERILAN, K. W. BOWER, P. R. CORNELISON).

Further studies have been made on the relationship of storage time of dairy bull semen and the conception rate under field conditions. A total of 2725 semen samples, collected from approximately 100 sires in the Station dairy herd and artificial breeding associations, have been examined. According to breed, the percentage of samples were: Jersey 29.0; Guernseys 19.4; Holstein 23.8; Brown Swiss 6.3; Milking Shorthorn 9.9; Angus 11.1; and Hereford 0.5. A summary of the storage time at a "2" motility or better by breed by month indicated maximum storage time for Jerseys and Brown Swiss during the months of April and May. For all other breeds the maximum survival time in storage occurred in May and June. Over 90,000 cows were artificially inseminated by the two artificial breeding associations cooperating in this study. A study was made of the effect of various diluting media upon storage time of semen collected from station herd sires *(Project 89a).*

Studies in Conception Rate for Artificial Insemination.

(C. P. MERILAN, H. A. HERMAN, T. E. PATRICK, P. R. CORNELISON, A. C. RAGSDALE, H. A. BALL, RAY RUMONS).

A study was made of the effect of the site of insemination in the reproductive tract on reproductive efficiency of 5,422 dairy cows in Louisiana artificial breeding associations. Sixteen cooperating technicians assisted in the study. Semen from 49 bulls was used. Records compiled by the Louisiana Artificial Breeding Cooperative, Inc., were used in computing breeding efficiencies. Efficiency of reproduction was based on the percentage 60 to 90-day non-returns to first service.

Semen showed a steady decline in fertility with advancing age. The percentage daily increases in breeding efficiency ranged from 1.4 to 5.9 percent with a mean of 3.27 percent. It was considered significant that fertility declined only 1.4 percent between the first and second day.

A significant upward trend in breeding efficiency was observed where cows were inseminated at increasing intervals up to 135 days after parturition. A gradual decline in conception rate occurred for those serviced at later intervals. Only 57 percent of the cows inseminated less than 37 days after calving conceived from one service, compared to 76 percent for those bred 106 to 135 days postpartum.

Breeding efficiency based on 94,935 first services was studied by months and seasons for a year period. The mean conception rate was highest in June and lowest in August and February. When the data were summarized by seasons, the average percentage non-returns was highest in spring with summer, fall and winter showing little difference.

The percentage of bulls producing inferior quality semen was lowest during spring and highest during summer months, with fall and winter being intermediate *(Project 89b).*

Techniques in Dilution and Preservation of Semen.

(C. P. MERILAN, K. W. BOWER, J. T. SMITH, F. J. GRUNFELD).

The lipid portion of a lipid-protein complex which occurs in egg yolk, and which can be extracted in rather pure form, will protect the spermatozoa from temperature shock. This lipid portion consists mainly of the phospholipids, lecithin, and cephalin, and these obtained from a variety of sources were effective in protecting bull spermatozoa from cold shock. The protection from temperature shock, in the presence of phospholipids, is more satisfactory in citrate or phosphate solutions than it is in solutions of non-electrolytes such as glucose.

The results of this investigation show that other substances, in addition to those required for the protection of the spermatozoa from temperature shock, are needed during the prolonged storage of bull spermatozoa at low temperatures *(Project 89c).*

Study of Bacteria Found in Bovine Semen.

(C. P. MERILAN, J. E. EDMONDSON, K. W. BOWER).

Increased survival time of spermatozoa has been

found to be associated with the presence of micrococci, yeast and non-hemolytic streptococci. To date heated cultures, filtrates and heated filtrates of these organisms have not shown a significant effect upon survival time or motility rate of spermatozoa *(Project 89d).*

Diurnal Rhythms on Milk Production, etc.

(SAMUEL BRODY, C. R. BLINCOE, C. BURGE, H. E. DALE, H. D. JOHNSON, H. H. KIBLER, O. J. MILLER, A. C. RAGSDALE, D. M. WORSTELL).

Although changing the rate of air movement affected some of the physiological reactions, the European-evolved cows adjusted themselves so that no appreciable effect of air movement was observed on milk production, water consumption, and body weight at environmental temperatures 18°, 50°, 65°, and 80° F. While the feed consumption data do not show it *directly,* indirect evidence suggests that increasing air velocity at 18° F increases feed consumption as well as heat production.

These observations indicate that the outer body surface of cattle has little moisture to vaporize, else the evaporative cooling would be higher (instead of lower) at higher wind velocity. Indian-evolved cows *(Bos indicus)* lagged behind the European-evolved cows by about 15° F in the initial rise in rectal temperatures and related reactions, presumably because of their greater specific surface area (great dewlap, navel flap, large ears) and lower heat production, but approached the European in stress level on increasing the ambient temperature to 105° F. Dairy cattle exposed to high environmental temperatures and varying radiation intensities developed a respiratory alkalosis, characterized by an increase in blood pH and a decrease in the carbon dioxide content of venous plasma. The concentration of ketone bodies in the blood or the excretion of ketone bodies in the urine showed no change that could account for a decrease in the alkaline reserve or in CO_2 — combining power *(Project 125a).*

Cleaning Pipeline Milkers.

(J. E. EDMONDSON, R. G. JENSEN, P. L. TYE).

The method which was adopted after proving satisfactory over an eight weeks test period is as follows:

a) Immediately after milking flush the milk lines with warm water (90-100° F).
b) Wash by recirculating hot water (140-145° F) containing a good dairy detergent or cleaner for at least 15 minutes.
c) Rinse with hot water (145° F) and drain pipelines. Sanitizing of pipelines was carried out just prior to use by circulating a 200 ppm solution of Sodium Hypochlorite (chlorine). An alkaline detergent was used for four days followed by one day use of an organic acid cleaner, this alternating of cleaners prevented the build up of milkstone *(Project 133a).*

Public Health and its Relation to Milk Production.

(J. E. EDMONDSON, J. H. GHOLSON, R. A. BRAZIS).

Limestone aggregate with diameters of 1⅓" to 2½" were used as the filter medium in treatment of dairy wastes. A tile column 6 feet high and with a foot diameter embodies the filter aggregate. The column is suspended on top of a 28 gallon reservoir tank and the waste is recirculated from the reservoir by way of water pumps to the top of the filter at the rate of 0.5 gallon per minute.

Temperature is the most important condition to be kept constant in this study. Temperature appears to have a direct result upon the efficiency of the filter, growth of organisms and ability of waste to become septic. The result in the experimental filter have been higher in efficiency due to addition of a nutrient broth containing psychrophilic bacteria. pH also seems to play an important part in these studies. Dairy waste effluent of a dairy processing plant when kept at a slight alkaline pH seem to have a better chance of remaining non-odorous. Use of alkaline and acid cleaners during the day's operation appears to keep the waste slightly on the alkaline side of pH 7 *(Project 133b).*

Lactobacilli in Milk.

(J. E. EDMONDSON, R. G. JENSEN).

128 species of lactobacilli have been isolated from 561 samples of milk and cream by the enrichment and direct plating methods. The cultures are being identified, according to their morphological and physiological characteristics. Lactobacilli have been found in 46 samples of pasteurized milk. Salt tolerance, developed acidity and pasteurization resistance are being checked as part of the classification schemes. Several more gas-forming lactobacilli (about 15%) were found than was at first expected *(Project 133c).*

Detection of Fat Adulteration.

(J. E. EDMONDSON, R. G. JENSEN, C. O. SMITH).

Using such separation methods various amounts of foreign fats may be detected in mixtures of butterfat and other fats. Present years work has been confined

to developing procedures to detect the various sterols which occur in animal and plant fats. Difficulty has been experienced in securing clearly defined separation of some sterols. Variation of present procedures are now being tested for better chromatography separation of fats. No results available; however, preliminary trials with some sterols gave promising results *(Project 133d).*

Testing of Dairy Cattle and Goats.

(P. R. CORNELISON).

This project is a cooperative enterprise involving the National Dairy Cattle Breed Associations, purebred breeders and the College of Agriculture, Department of Dairy Husbandry. Each month official testing service was made available to an average one hundred thirty-five Missouri herds as follows:

52	Jersey Herds	— involving 1153 cows
50	Holstein Herds	— involving 1309 cows
20	Guernsey Herds	— involving 400 cows
10	Brown Swiss Herds	— involving 214 cows
2	Ayrshire Herds	— involving 26 cows
1	Goat Herd	— involving 8 goats

Complete Butterfat and Milk records were tabulated for the 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 Registry plan.

During 1953 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 *(Project 134a).*

Roughage Studies on Growth and Milk Production.

(C. P. MERILAN, P. R. CORNELISON, A. C. RAGSDALE, K. W. BOWER, J. W. BUCKALEW, H. A. BALL, H. A. HERMAN).

Satisfactory growth is being obtained when approximately 55% of the total protein and TDN are secured from roughages. The effect of aureomycin upon tissue metabolism is being investigated. Preliminary results indicate that the antibiotic decreases the rate of aerobic phosphorulation in the tissue. There also appears to be a change in the rate of anaerobic glycolysis in tissue exposed to the aureomycin. Tentatively it would seem that the response is associated with the age of the animal. When completed, this work will be compared with antibiotic feeding data in an effort to determine the most effective route of administering antibiotics to calves and the type of physiological response to the various antibiotics. Over 350 milk samples were collected from cows in the climatic laboratory and analyzed for butterfat, total solids, total nitrogen, specific gravity, freezing point, lactose and chloride content. The results of these chemical analyses are being studied in an effort to determine the effect of varying types of environmental stress upon the composition and quantity of milk production *(Project 139a).*

Leonard Haseman, Chairman



Entomology

Improved Methods of Insect Fighting.

(H. E. BROWN, W. R. ENNS, M. C. GRABAU, LEONARD HASEMAN, LEE JENKINS, STERLING KYD, P. J. SPANGLER, P. C. STONE, G. W. THOMAS, SHIRLEY THORP, C. W. WINGO).

Federal funds combined with those from the Missouri State Department of Agriculture and the Agricultural Extension Service and the Agricultural Experiment Station provided for one full time field survey man who, working with our Extension Entomologist, covered every section of the state and prepared weekly reports on insect abundance and activity. This enabled farmers and others to be better prepared to fight armyworm, cutworm, chinch bugs, cotton pests and other insect scourges. It also brought to light the recent in-

vasion of the Southwest corn borer in some twelve counties in the state. The parallel fruit and vegetable insect surveys and weekly newsletters likewise rendered their usual service during the year. A second new line of service to Missouri farmers under this project was the use of television programs. Programs on "Preparing Bees for the Winter" and "Control of Termites" were presented. Also the radio and the press were used much more freely than usual during the year. In addition, several thousand personal letters on insect control were written during the year, and innumerable phone calls answered *(Project 30a).*

Habits and Control of Orchard Insects.

(LEE JENKINS, W. R. ENNS, G. W. THOMAS, P. J. SPANGLER, M. C. GRABAU).

Spray tests to determine relative effectiveness of insecticides to control codling moths were set up. Insecticides tested included DDT alone; DDT plus parathion; Perthane; Ryanicide 100; and Ryanexcel 96-3. Analysis of the results indicated the following degree of control: DDT - 62.6% clean fruit; DDT plus parathion - 95.0%; Perthane - 77.2%; Ryanicide 100 - 67.0%; Ryanexcel 96-3 - 69.3%.

Harvest counts were made in commercial orchards. Percent control ranged from 36% clean fruit in an unsprayed orchard; 1% clean fruit in an orchard sprayed with Nicosol; to 96.5% clean fruit in an orchard sprayed with DDT plus parathion.

Four materials were tested for mite control; results were good with all materials tested including Aramite, Ovotran and Chlorobenzilate. Cage tests in an effort to find an effective insecticide for control of Green June Beetles were set up. Thirteen insecticides were tested, none of which would be acceptable for field use. It was concluded that insects were not involved in blackberry sterility. Screening tests of Perthane and Sabadilla were run on beans for control of Mexican Bean Beetle and on broccoli for control of Harlequin Cabbage Bug. Control was negative. Toxaphene was shown to be effective in control of Fall Armyworm in gardens and lawns whereas chlordane was not satisfactory. Weekly Reports to Fruit Growers were sent to 500 orchardists in 1953 *(Project 31a).*

Biology and Control of Vegetable Insects.

(LEE JENKINS, W. R. ENNS, G. W. THOMAS, P. J. SPANGLER, M. C. GRABAU).

The effectiveness of Perthane and Sabadilla for control of Harlequin Cabbage Bug and the Mexican Bean Beetle were tested. Neither of these materials was satisfactory. Further evaluation tests of a general-purpose insecticide-fungicide mixture on garden crops were carried out. It was found to be generally effective, but a new combination of fungicides will be included in a new mixture to be tried next season *(Project 31b).*

Collecting and Identifying Mosquitoes.

(PHILIP C. STONE).

During the spring months *Simulium vittatum* was reared in the laboratory from the spillway leading from the University of Missouri Wildlife pond in Ashland, Missouri. The black fly was found to be the dominant species in the spillway and has continued breeding throughout the year. There is seepage through the dam into the spillway making possible this isolated black fly habitat. The emphasis of this project on the black flies of brooks in the vicinity of Columbia has been delayed for lack of running water in the brooks. All larval Simuliidae require running water for survival because they derive all of their oxygen from the water and their nourishment from food particles captured in flowing water.

Collections of adult mosquitoes from central Missouri were identified and added to the University collection, including the collection of the late Dr. C. F. Adams of Jefferson City. The mosquito collection consisted of 501 identified and 207 unidentified mosquito specimens *(Project 34a).*

Sulfa Drugs in Controlling Foulbrood.

(LEONARD HASEMAN).

The feeding of sulfathiazole in sugar syrup to protect colonies against A.F.B. infection was continued with the usual effective results. Studies were also initiated in which powdered sulfathiazole was mixed with either powdered sugar or fine salt and the mixtures sifted into the brood cells and over the frames and combs, as a simpler means of supplying the bees with the sulfa drug. Some beekeepers report they find this simple method fully effective in preventing foulbrood infection *(Project 45a).*

Control of Livestock Insects.

(C. W. WINGO, LEONARD HASEMAN).

Investigations during the 1953 season with a new phosphate compound O, O-diethyl-O-[2-isopropyl-4-methyl-pyrimidyl (6)] thiophosphate indicated that the compound may be useful in fly control in the future.

Additional use of Diazinon under field conditions showed that sprays of 1% Diazinon applied to fly-resting places about the barns every 35 days will give excellent fly control for the period if sanitation meas-

ures are good to excellent.

Tetraethyl pyrophosphate-molasses-water mixture was tested in the swine physiology barn under conditions of heavy fly populations and heavy influx of flies from adjoining breeding areas. Baits are efficient in significantly reducing flies only in areas where populations are low, extreme sanitary precautions are possible and the treated area is not subject to continual reinfestation from outside sources. It was noted throughout the experiments involving baited sprays and baits of all kinds that the factor of competition of the baits with attractive natural substances in and around barns was the chief limiting factor in deciding the efficacy of the particular bait substance employed. Failure of baits to adequately control house flies may be entirely for the most part attributed to failure to provide a more attractive substance than may be present naturally.

Field tests to control the short nosed ox louse *Haematapinnus eurysternus* and the chewing cattle louse *Bovicola bovis* with a single application of 0.5% chlordane spray had been initiated in the fall of 1952. A subsequent reading of these tests made during the winter and spring months of 1953 showed that under Missouri conditions these two species of lice may be controlled with a single application of chlordane if the spray is thoroughly applied. The investigation revealed that the eggs are killed by the spray and fail to hatch *(Project 46a).*

Soil Mineral Influence on Insects.

(PHILIP STONE, LEONARD HASEMAN, H. E. BROWN).

The nymphs hatching each day in 100 jars of crickets were removed and recorded. The daily egg hatching record of each cricket was of importance because it also indicated those days on which no hatching occurred. There was a definite correlation between the number of offspring produced by a female and the number of days on which eggs hatched. In most of the 100 tests there were but a few days during which there was no hatch.

All egg deposition jars were retained for 20 days following the death of both adult crickets in order to allow sufficient time for all eggs to hatch. This extended incubation period suggests that in large cricket cultures there is the possibility that females may lay eggs which have been partly incubated. This may also account for the constant hatching of eggs day after day over an extended period in most of the 100 cricket egg deposition jars.

The reproductive potential of all of these crickets which had been fed as nymphs on the "check" food and then transferred to the nine different foods as adults was rather high. The largest number of offspring produced by a pair of crickets in this experiment was 3129 while the lowest was 172. There was a considerable range between the highest and lowest number of nymphs produced by the crickets fed on each of the ten foods. However, the average of the total offspring of the eight highest producing pairs in all ten food tests varied only from 755 to 1056 nymphs *(Project 74a).*

Field Crop Insects—Biology and Control.

(H. E. BROWN, PHILIP STONE, LEONARD HASEMAN).

Under this project studies were carried out on the following insects affecting field crops: Corn earworm, Potato leafhopper, Angoumois grain moth (grain protectant study), and continued to cooperate on the U.S.D.A. Hessian fly plant resistance studies underway.

A feeding trial of the corn silks from two resistant and two susceptible strains was made. Eggs were collected from silks in the field and brought into the laboratory where they were allowed to hatch. Just prior to hatching the larvae were placed in vials (one per vial) containing the fresh silks for food from each of the four strains. Twenty larvae were started on each of the strains or a total of eighty larvae for the feeding experiment. Each day the old silks were removed and fresh silks added. The results are given below.

TABLE 6

Strain No.	Average No. Days Fed	End of Exp. Av. No. Larvae	End of Exp. Av. Av. Wt. gm.
Dixie 18 (Resistant)	8.5	13	.1466
L501 (Resistant)	7.2	18	.1604
Means	7.9	16	.1535
L317 (Susceptible)	9.0	11	.4265
38-11 (Susceptible)	8.1	19	.2890
Means	8.6	15	.3578

In the leafhopper study the first occurrence at Columbia in 1953 was May 9. It was not possible to make surveys in southeast Missouri on schedule and so first occurrence there was missed. On May 19 a survey up the Mississippi River valley showed that the leafhopper had penetrated as far north as New London and was quite common on legumes south of there. It seemed to be absent from there on north.

A start was made in a study of the insects important in Missouri in the production of legume forage and seed. Red clover plots were laid out in two fields close to Columbia and collections were made at intervals through the summer. Insecticidal tests were carried out in two fields of red clover to study the effect on seed production. Toxaphene and Systox were used. The latter insecticide is a systematic material. The drouth completely eliminated both stands of clover and prevented a seed crop *(Project 102a).*

Harmful Mites of Missouri.

(PHILIP C. STONE).

Mites and ticks of Missouri were collected, identified and placed in the Acarina collection. Adult mites of the family Trombiculidae were collected and placed in specially prepared oviposition vials with the hope of rearing a generation of them on the eggs of Orthoptera. The female Trombiculid mites which had been collected during the first warm days of spring were found to be mated and they laid viable eggs without taking any food in the laboratory. This preliminary rearing of these grasshopper parasites will be continued in 1954.

Information about the eleven known ticks of Missouri was brought together. It is quite possible there are other species of ticks infesting wild birds and animals in this state, and it is hoped that this report, when published later, will stimulate public interest and perhaps the discovery of other species of these important pests of man and animals *(Project 131a).*

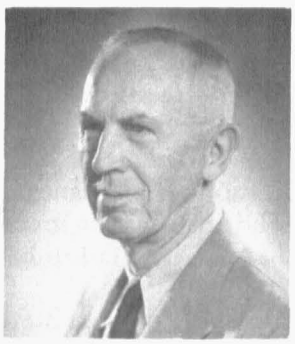
Field Crops

W.C. Etheridge, Chairman

Improving Missouri Farm Seeds.

(C. A. HELM, W. A. ASLIN, L. E. CAVANAH).

During 1953, 426 seed growers, located in 88 counties in Missouri, planted 23,653 acres under certification. This included varieties of corn, cotton, soybeans, sorghums, rice, wheat, rye, winter barley, oats, grasses, and legumes. Certification is restricted to those crop varieties recommended by the Missouri Agricultural Experiment Station. Field inspections of seed in standing crops were made during the growing season. The fields of seed were thoroughly examined for the qualities best seen in actual crop growth, such as general purity, healthiness, and freedom from objectionable weeds.



Of the 23,653 acres field inspected, 22,720 acres were approved and accepted for certification subject to the approval of seed inspection completed on the 1953 crops is as follows:

TABLE 7

Crop	Growers	Acres Inspected	Acres Accepted	Bushels Inspected	Bushels Certified
Wheat	45	2,035	1,783	31,891	30,089
Barley	17	430	409	12,070	12,086
Rye	2	93	93	1,284	1,284
Oats	171	5,145	4,983	142,136	135,903
Grasses	22	1,253	1,115	305,659*	263,229*
Legumes	4	195	195	16,400*	16,400*
Sorghums	6	103	103	81,780*	81,780*

* Pounds

Crop acres of corn, cotton, soybeans, and rice grown under certification were as follows:

TABLE 8

Crop	Growers	Acres Inspected	Acres Accepted	Est. Bushels Certified
Corn	54	3,356	3,280	82,000
Cotton	30	3,351	3,271	719 T
Soybeans	144	7,592	7,388	84,900
Rice	1	100	100	none

Of the 7,592 acres of soybeans, 1,186 acres were planted to the Clark variety and 963 acres were planted to the Dorman variety. These two varieties were increased from very limited amounts of seed in 1952. From the 1953 production there will be sufficient certified seed to plant in 1954, 25,000 acres of Clark and 15,000 acres of Dorman soybean *(Project 19a).*

Soft Wheat Resistant to Rust, Smut and Hessian Fly.

(J. M. POEHLMAN, M. E. MICHAELSON, LETA MAHARG, E. T. JONES).

Nine yield tests of soft wheat were grown at Columbia in 1953 and in addition one test was grown at each Bethany, Pierce City, and Sikeston.

The high yielding varieties in 1953, in order of yield, are as follows: Saline, 35.2 bu.; Royal, 34.5 bu.; Clarkan, 34.2 bu.; Vigo, 32.7 bu.; Ponca, 32.1 bu.; and Pawnee, 31.6 bu. The high yielding Experimental strains are W6014, 41.0 bu.; W6229, 40.1 bu.; and W6027, 39.4 bu. A total of 14 strains were superior in yield to Saline, the best variety. Yield, test weight, date headed, height, lodging, loose smut, Hessian fly resistance, and pearling percentages were obtained on all of these strains.

Five hundred and twenty new strains were grown in increase rows of which 138 were harvested. These were selections from crosses made to combine earliness and short, stiff-straw, with resistance to leaf rust, loose smut, and the Hessian fly. Most of these strains were tested in the field and greenhouse for fly resistance.

Thirty bulk hybrids, ranging from the F_2 to the F_5 generation were advanced in 1953 and head selections were made from many of them. Eighteen F_1 progenies were grown and 10 new crosses were made. For the new crosses two high yielding strains, W5868 (Clarkan-Vigo) and W6185 (Kawvale-Hard Federation-Mo. Early Premium-Clarkan-Mediterranean) were each crosses with early, short-strawed, high yielding strains which are resistant to leaf rust, loose smut and the Hessian fly.

Artificial inoculations were made to establish a leaf rust epiphytotic throughout the nursery, but seasonal conditions were unfavorable for the development of the rust.

A Hessian fly nursery was grown at Columbia under the supervision of Elmer T. Jones, Entomology Research Branch, USDA , Manhattan, Kansas. Seed for all entries in the yield test and in increase rows was divided (where strain had fly resistant parentage) and a row planted in the fly nursery.

Wheat quality studies of leading varieties and strains were continued in cooperation with the Scott County Milling Company and the Department of Home Economics. Seventeen samples from the variety test plots were milled on an experimental mill by the Scott County mill, and the flour transmitted to the Department of Home Economics for baking and quality tests *(Project 20a).*

New Oat Strains for Missouri.

(J. M. POEHLMAN, M.E. MICHAELSON, C. L. KOEHLER).

The Mo. O-205 variety of oats which was distributed in 1952 is fast becoming the leading oat variety in Missouri. Its high yield and test-weight, resistance to prevailing diseases, and strong straw has contributed to its popularity. It appears to be the first variety to be a real challenge to the long superiority of Columbia in the southern Corn Belt. In addition to Missouri, O-205 is a recommended variety in at least a dozen other States demonstrative of a wide adaptive capacity.

Four variety tests, in which 130 varieties and experimental strains of spring seeded oats were tested, were grown at Columbia. In addition 30 varieties and strains were grown in tests in Harrison County, at Pierce City, and at Sikeston. Yield, test-weight, height, and lodging observations were recorded on all tests. Disease resistant and maturity notes were also obtained at Columbia. A total of 988 increase and head rows were grown in disease nurseries in 1953. Superior lines were harvested for yield testing in 1954. Three disease nurseries were grown in 1953 as follows: (1) Smut and race 8 stem rust, (2) crown rust, and (3) Race 7 stem rust. All entries in the yield tests were included in all three nurseries. Other increase and head rows were grown in the appropriate nursery according to the type of resistant each possessed. No winter oats breeding work is in progress, although USDA uniform yield nurseries were grown at Pierce City and Sikeston, and a uniform winter hardiness nursery was grown at Columbia. Seventeen F_2 bulk hybrids received from Mr. Coffman, USDA, were increased *(Project 21a)*

Testing and Improvement of Pastures.

Stands of bromegrass, seeded at Sikeston in 1950 and measured in 1953, varied from a low of 81 percent for Manchar and Oklahoma No. 1 to a high of 95 percent for Lancaster. At Sikeston, ordinary Korean produced 1365 pounds per acre of hay, while Climax, the outstanding variety, produced 2047 pounds, or 50 percent more than Korean. At Columbia, Rowan produced 26 percent more hay and 53 percent more seed than Korean in broadcast plots, while Climax produced 46 percent more hay, but essentially the same amount of seed. Two new strains of *L. striata* were less aggressive than Korean this year in bluegrass, whereas previously they have been more aggressive.

New methods of inoculating lespedeza with bacterial wilt have been developed in this project and were used effectively this year to test the resistance of different strains and varieties, and to determine the dam-

age done by the disease. Ordinary Korean was reduced 45 percent in hay yield by a heavy infection of wilt; the reduction in nutritive value was even greater because of leaf defoliation in infected stands. In contrast: A new resistant strain showed only 5 percent reduction in hay yield in the same test. Certain experimental hybrids, under test this year for the first time, outyielded ordinary Korean by a considerable margin *(Project 47a).*

Interaction Between Species and Mixtures.

(HALE FLETCHALL, MARIAN BROWN).

A comparison of stands of ladino measured April, 1953, with stands measured April, 1951, in the same plots of grass seeded to ladino either in April or in August, 1949, showed that the clover had survived best where sown in old sods of bromegrass or of redtop, but that good stands of ladino (45 to 56 percent) had persisted in tall fescue. Surviving stands of ladino were poorer (25 to 42 percent) in orchard grass, and the clover had been killed completely, partly by field mice, in Kentucky bluegrass. All plots had been mowed during 1951 and pastured during 1952 *(Project 47b).*

Pastures of Southeast Missouri Lowlands.

(E. M. BROWN, NORMAN BROWN).

The most severe drouth of record occurred in Southeast Missouri. Under these conditions, 15 steers which pastured two 5-acre pastures of orchard grass and ladino and one 5-acre pasture of tall fescue mixed with small amounts of birdsfoot trefoil and Korean lespedeza gained 211 pounds an acre and 1.79 pounds daily from April 3 to July 7. The fescue was pastured in conjunction with the orchard grass-ladino mixture to check bloating which was severe on the orchard grass-ladino mixture during April. The same 15 steers gained 79 pounds an acre and 1.26 pounds on two 5-acre pastures of Korean lespedeza which they grazed alternately from July 7 to August 18. Five steers gained 215 pounds an acre and 1.72 pounds daily on 5 acres of bromegrass mixed with a sparse stand of alfalfa which they were on continuously from April 3 to August 14 *(Project 47c).*

Improving Permanent Pastures with Legumes.

(E. M. BROWN, J. D. BALDRIDGE).

Steers gained 82 pounds an acre and 1.73 pounds daily on bluegrass and *Lespedeza striata* from April 27 to July 6; 152 pounds an acre and 1.83 pounds daily on tall fescue and ladino from April 17 to June 26; and 125 pounds an acre and 1.81 pounds daily on orchard grass and ladino.

At another location, steers gained 89 pounds an acre and 1.48 pounds daily from June 15 to August 14 on orchard grass-ladino-red clover-alfalfa from which 1.7 tons of cured hay an acre had been harvested June 2; 236 pounds an acre and 1.97 pounds daily on tall fescue-ladino; 120 pounds an acre and 1.23 pounds daily on bluegrass-ladino; 195 pounds an acre and 1:41 pounds daily on bluegrass fertilized in March with ammonium nitrate; 117 pounds an acre and 1.70 pounds daily on bluegrass and lespedeza; and 146 pounds an acre and 1.35 pounds daily on bromegrass and ladino. Grazing began April 21 and ended August 14 *(Project 47e).*

Developing Superior Birdsfoot Trefoil.

(J. D. BALDRIDGE).

Commercial varieties of birdsfoot trefoil are being studied for adaptation to geographic areas, soil conditions, and methods of farm usage. On the basis of limited observation, the crop seems better adapted to northern than to southern Missouri. Empire seems superior as a pasture variety, while European seems superior as meadow variety; however, each can be used as a dual purpose variety. Uniform variety tests are being conducted to evaluate new varieties. None was superior to Empire or European in the 1953 test. Large numbers of selections and their progenies were evaluated for superior seed production and superior forage.

Trefoil is a promising permanent legume; it could be used in Missouri on 2.5 million acres of pastures and 0.5 million acres of meadows to increase production 50 percent. The development of improved varieties and of successful establishment and maintenance practices is needed to hasten adoption of this crop *(Project 47f).*

Improving the Missouri Soybean Crop.

(L. F. WILLIAMS, D. A. NEELY, W. C. ETHERIDGE).

There was a tendency in north Missouri for early soybean varieties to yield more than late ones. Clark continued to show a wide range of adaptation and was outstanding in seed holding and seed quality under drouth conditions. The Canadian variety, Harosoy, looks promising. It is earlier than any of the commonly grown varieties but has equalled or exceeded Lincoln and all earlier varieties even as far south as Columbia.

Date-of-planting studies at Columbia were continued. Under the hot, dry conditions in 1953, optimum planting dates tended to be later than in previous years.

Yields of Chief and Adams were decreased most

by early planting, and Perry most by late planting *(Project 49a)*

Breeding Hybrid Corn for Missouri.

The 1953 Corn Investigations can be classified in the following categories:

1. Development of new white and yellow inbreds.
2. Identification of superior performing new lines by the means of top crosses.
3. Breeding for resistance to the corn earworm.
4. Breeding for resistance to such diseases as the leaf blight and stalk and ear rots.
5. Breeding for improved starch quality such as increased amylose content of starch.
6. Developing new hybrids especially suited for white corn milling.
7. Continuation of the breeding of hybrids with cobs suited for cob pipe production.

The corn nursery was located near Huntsdale, Missouri where inbreeding and selection for new inbreds was continued as well as the making of newly developed inbreds into top, single, and double crosses for testing in the area of the state where they are believed to be best suited *(Project 85a).*

Preserving Open Pollinated Seed Stocks.

(M. S. ZUBER, B. J. BEARD, W. A. CRONE).

Approximately forty-five open pollinated varieties that were grown in the major corn production areas of the state were collected and are being preserved. Arrangements have been made to store these varieties at the Regional Plant Introduction Station at Ames, Iowa where cold storage facilities are available. This makes it possible to increase different varieties about every four to seven years. Germination percentages are determined each year and whenever a variety's germination falls below seventy percent, it is increased by hand pollination of about 150 to 300 plants. In 1953 the following open pollinated varieties were increased:

Iowa Goldmine
Gundy Special Yellow
Jarvis Golden Prolific
Oklahoma Large Southwestern Dent
Improved Reid's Yellow Dent
White O. P. Strain
Delta Prolific
Dills White Dent
White Surcropper
Neal Paymaster
Iowa Silvermine
Pipe Corn O. P.

(Project 85b).

Testing and Breeding Winter Barley.

(J. M. POEHLMAN, M. E. MICHAELSON).

The B-400 variety of winter barley, continues to increase in popularity. It is the most widely grown variety in Missouri. Its merits are high yield, winter hardiness ,stiff straw, and smut resistance. An experimental strain, B-575, from the cross Admire x Missouri Early Beardless led the barley variety nurseries in yield again in 1953. A comparison of the performance of B-575 with that of Mo. B-400, Reno, and Missouri Early Beardless in 23 tests in Missouri during the six-year period 1948 to 1953 was made *(Project 90a).*

Weeds in Pastures and Meadows.

(D. L. KLINGMAN, O. H. FLETCHALL).

A date of spraying compared to date of mowing experiment was initiated in the spring of 1952 in which two 2,4-D treatments are compared with mowing and no treatment as sub-plots in four dates of application as main plots. No results as yet.

In one study a comparison of dates of spraying and mowing for selective control of lance-leaved ragweed from a bluegrass-lespedeza pasture was made. A farmer's pasture was secured for this study which was heavily infested with lanceleaved ragweed. The experiment was a split plot design with dates of treatment as the main plots and six weed control treatments as sub-plots. There were eight dates of treatment. This experiment will have to be repeated under more nearly normal climatic conditions before definite conclusions can be drawn.

Selective control of weedy grasses and broad-leaved weeds in legume seedlings and a screening test for selective nimblewill control in bluegrass sod were made (Project 156).

Control of Weeds in Crops.

(O. H. FLETCHALL, D. L. KLINGMAN, R. E. LARSON, D. J. MORRE, NORMAN BROWN, CHESTER FOY).

Fifteen chemicals were applied pre-emergence to soybeans on paired rolled and unrolled plots at three locations in Missouri. Rolling significantly reduced the stands of soybeans as compared to the unrolled plots, but stands were not significantly different in one of the experiments. Yields were not significantly affected by rolling treatment at either location.

In this dry year the study showed 2,4-D was not very effective for weed control in corn. The amine form tended to control the weeds better than the ester as a pre-emergence herbicide; however, the ester was slightly more effective than the amine as a post-emergence herbicide.

Rolling and dragging as preparations for pre-

emergence spraying were compared with no preparation. Where 2 pounds of 2,4-D, ester, per acre were applied, and relatively better weed control was obtained, some benefit was derived from smoothing the land and dragging tended to be slightly more effective than rolling.

Twenty chemical treatments were applied to a mixed stand of weeds, including giant foxtail, on the University of Missouri Poultry Farm, Columbia, Missouri. Dalapon showed some promise for controlling giant foxtail; however, under the conditions of this experiment none of the chemical treatments gave satisfactory control. In general, treatments which controlled the dominant broad-leaved weeds resulted in an increase in the stand of weedy grasses, which were mainly giant foxtail *(Project 156).*

Testing of Cotton Varieties.

(NORMAN BROWN, GENE HILL).

Results at Sikeston, Mo., showing top five varieties grown in 1953:

TABLE 9

Variety	Pounds per Acre: Seed Cotton	Pounds per Acre: Lint	Lint %	Staple Length 1/32"	Bolls per Pound	Lbs. Lint at First Picking (Sept. 14)
Empire	1672	639	38.2	32	61	410
Plains	1651	634	38.4	32	74	383
Stoneville 62	1657	633	38.2	32	83	440
Delfos 9169	1661	624	37.6	33	70	335
Tenn. 818	1633	619	37.9	32	71	403

Planted May 22 on Lintonia Sandy Loam soil. Fertilized with 300 lbs. 0-20-20 and 100 lbs. ammonium nitrate per acre. Total rainfall from planting to harvesting: May, 0; June, 1.31; July, 2.04; August, 1.22; September, .47 inches. Harvested on September 14 and October 16.

Results at Holcomb, Mo.:

TABLE 10

Variety	Pounds per Acre: Seed Cotton	Pounds per Acre: Lint	Lint %	Staple Length 1/32"	Bolls per Pound	Lbs. Lint at First Picking
Cobal	1168	425	36.4	32	74	396
Plains	1130	419	37.1	32	78	361
Empire	1069	406	38.0	32	62	364
Coker 54 BRS	1092	399	36.5	32	79	315
Stoneville 62	1024	386	37.7	31	83	365

Planted April 28 on fine sandy loam soil infected with Fusarium wilt. Part of the test was severely injured by blowing sand during the month of May.

Results at East Prairie, Mo.:

TABLE 11

Variety	Pounds per Acre: Seed Cotton	Pounds per Acre: Lint	Lint %	Staple Length 1/32"	Bolls per Pound
Deltapine 15	2135	828	38.8	33	75
Stoneville 62	2180	767	35.2	32	64
Tenn. 818	2100	741	35.3	33	61
Plains	2026	723	35.7	33	68
Rowden	2106	716	34.0	33	51

Planted May 19 on fine sandy loam soil. Harvested October 22.

(Project 160 A)

Breeding of New Cotton Varieties.

(NORMAN BROWN).

Crosses were made, using Coker 100 Wilt variety as the male parent, on ten different commercial varieties containing desirable characters. F_1 plants of crosses between Fox, Stoneville 2B, Cobal, Rowden, and Coker 100 Wilt were grown and compared for yield and hybrid vigor. Selections were made from F_2 plants from crosses between Fox x Cobal and Fox x Coker 100 Wilt. Selections were made from 50 progeny rows of Bobshaw x Fox and Bobshaw x Hibred crosses in the F_3 generation. Forty-seven strains in the F_4 generation were tested for earliness, yield, staple length, fiber uniformity, and fiber strength. Fifteen of these selections will be tested for the same factors in 1954 *(Project 160 B).*

Testing Cotton Fertilizers.

(E. M. BROWN, NORMAN BROWN).

Yields of seed cotton obtained in 1953 from differently fertilized plots on the Southeast Missouri Experiment Field at Sikeston were:

TABLE 12

Pounds Applied Annually Per Acre: N	Pounds Applied Annually Per Acre: P_2O_5	Pounds Applied Annually Per Acre: K_2O	Pounds Seed Cotton Picked Per Acre: 1st Picking	Pounds Seed Cotton Picked Per Acre: Total
0	0	0	606	1888
0	60	60	619	1691
40	0	60	929	1977
40	60	0	993	1992
40	60	60	948	2020
80	60	60	893	2021
40	0	0	826	2008

In the very dry, hot growing season, applying phosphorus and potash without nitrogen depressed cotton yield and applying either 40 or 80 pounds of N with or without phosphorus and potash increased yields, but not much. Moisture deficiency or a soil deficiency in some other element besides N, P, or K

may have limited yields, but the 1½ bales of cotton an acre produced by the untreated plots indicates that there was no seriously limiting factor on this particular soil *(Project 160 C).*

Weed Control in Cotton.

(NORMAN BROWN, GENE HILL).

All trials were conducted on a moderately fertile sandy loam soil known as Lintonia. Land was prepared by stalk-cutting, flat-breaking, and harrowing. All plots received 0-20-20 fertilizer before planting at a rate of 300 pounds per acre. Ammonium nitrate was applied at planting at the rate of 100 pounds per acre.

All pre-emergence materials were either dissolved, emulsified, or suspended in water, and were sprayed on when planting at a rate of 40 gallons total volume per acre. Sizes 8002 and 8003 Tee Jet and 95.3 Spray Jet nozzles were used.

Weed counts in all tests were taken over the entire length of the plots by use of a ten-point quadrat over 12 inch bands. Fifty ten-point trials or 500 points per plot were averaged and recorded. Hoeing times are actual for entire plot considered.

CIPC, DNOSBP, CMU, PDU, and naphthyl phthalamic acid gave satisfactory weed control without serious injury to the cotton. The best rate for CIPC and DNOSBP appears to be in the range of six to nine pounds per acre as pre-emergence herbicides in cotton. One test was designed to compare the effectiveness of CIPC and DNOSBP as pre-emergence herbicides in cotton planted on five different dates.

In general there was little effect of the chemicals on the yield or maturity. Yields were highest for the earliest dates of planting and gradually diminished with succeeding dates.

In another experiment it was found there was no significant difference in cotton emergence, weed control, nor yield of cotton due to type of press wheel used. CIPC gave decided control of crabgrass but did not affect the nutgrass.

In one experiment it was found there is no signficant difference in yield between cultivation methods, nor between chemical treatments. There was a highly significant difference in yield at first picking when comparing cross plowed with drilled. This seemed to be due to the thin spacing in the cross plowed plots which delayed maturity *(Project 160d).*

Cotton Defoliation.

(NORMAN BROWN, GENE HILL).

Calcium cyanamid defoliant was applied to cotton on September 15 at a rate of 30 pounds per acre in a replicated experiment:

TABLE 13

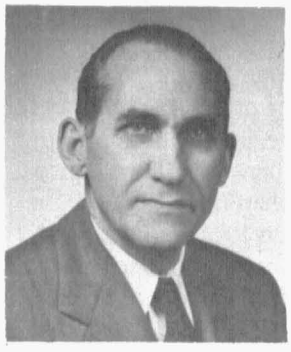
Treatment	Yield in Pounds Seed Cotton/Acre	
	First Picking	Total
Defoliated	1025	1454
Not Defoliated	980	1388

Because of the extremely dry weather the plants were not in an active state of growth. The leaves were tough and leathery-like and there was an unusual high rate of natural leaf shedding. The leaf drop due to action of the defoliant was approximately 20 percent. Statistical analysis showed no significant difference due to chemical in maturity nor in total yield *(Project 160e).*

Field Studies of Rice Breeding Material.

(J. M. POEHLMAN, C. L. KOEHLER).

A rice variety test, consisting of 40 varieties and experimental strains was grown in Marion County, Missouri, in 1953. Colusa and Cody, early, short-grain varieties ranked second and fifth, in the test with yields of 80.8 bushels and 74.1 bushels respectively. Early maturing strains selected at Missouri Agricultural Experimental Station ranked first, third, and fourth, respectively, in this test. Cody has been the leading variety in yield during the six-year period, 1948 to 1953. A direct relation was found between earliness and yield, with the late varieties which headed after September 20 yielding less than 20 bushels per acre *(Project 173a).*



R.H. Westveld, Chairman

Forestry

The Cultivation of Christmas Trees.

(R. B. POLK, J. M. NICHOLS).

New studies undertaken last year included the establishment of an experiment designed to measure separately and in combination the cumulative influence of deer and tip-moth damage on the quality of a

Christmas tree crop. This study involves four split blocks, with deer excluded from one-half of each block by a 10-foot fence. In addition two species (jack and Scotch pines), three seedling grades (large, medium, and small), and the best known chemical means for tip-moth control are included.

In addition to the 10-foot exclosures referred to above, two other kinds of deer fencing have been erected around Christmas tree plantings at Ashland to minimize deer activity as a disturbing factor in measuring treatment effects. Also, this affords an opportunity to determine what kind of fence is necessary for a satisfactory control of deer movement. Each kind of fence protects several acres. One is 6 feet high utilizing four strands of barbed wire and one charged wire; the other fence uses the same amount of wire over an 8-foot height *(Project 9a).*

Fire Studies.

(L. K. PAULSELL, J. M. NICHOLS, R. H. WESTVELD).

The fire studies are composed of two series of six 0.4 acre plots each. One series was established in 1948 and the other, in 1950. In each series, two plots are burned annually; two are burned every five years and two are control plots.

During 1953, the four designated plots were burned. In addition, the two plots in the 1948 series received the five year burn.

The milacre reproduction quadrats were examined and tallied on all plots of both series. Measurements were taken on all trees 1.6 inches d.b.h. and over on the 1948 plots. Measurement of the height of tagged trees was partially completed. These data have nor been fully analyzed and no definite findings can be given *(Project 75c).*

Pruning of Oaks.

(P. Y. BURNS, R. H. WESTVELD).

On two study areas in Bollinger and Wayne Counties near Puxico, pin oak and willow oak trees were measured and marked for pruning. A total of 40 trees were selected for the experiment, half of which will be pruned. In Butler County, 450 oak trees were pruned in one stand. Pruning time averaged 5 minutes per tree, representing a cost of only 6 cents. Scarlet oak trees pruned in 1950 were examined. Pruning wounds were almost healed. There were fewer epicormic branches on pruned boles than there were the previous year. White oaks pruned in 1952 were examined. Epicormic branches were present on 80 percent of the trees. There was an average of 4 of these sprouts per tree *(Project 75e).*

Decay in Missouri Trees.

(P. Y. BURNS, J. M. NICHOLS).

Merchantable trees in a timber sale area in St. Charles County were examined for the presence of decay. Over 90 percent of the trees were completely sound. Decay originated from fires scars, which were uncommon, and from broken tops. Preliminary results show that abundance of decay is related to site quality—good sites have less rot than poor sites. An analysis of the rate of spread of decay associated with fire scars showed that rot spread upwards at the rate of 1 to 2 inches per year *(Project 75f).*

Converting Hardwood Stands to Conifers.

(J. M. NICHOLS, L. K. PAULSELL, P. W. FLETCHER, R. H. WESTVELD).

The survival data indicate that prior removal or deadening of the competing overstory is essential to high survival.

A survival study made February 24, 1954 indicates the following trends:

The killing and poisoning treatment of the overstory combined with the cutting of the small sized hardwood trees on the plot prior to planting generally results in a higher survival than subsequent release.

The prior release by poisoning and cutting generally results in a higher survival than the treatment using the small bulldozer to remove the understory. The highest survival was on Eastern redcedar, loblolly pine and scotch pine in that order.

Considering the 1953 planting with the treatment of bulldozing the understory, the highest survival was on Eastern redcedar, scotch pine and shortleaf pine in that order.

Due to extreme drouth conditions and drifting leaves, the direct seeding of the isolation strips shows little prospect for success *(Project 75g).*

Species Survey of Forest Plantations.

(R. H. WESTVELD, R. W. DINGLE, P. Y. BURNS, P. W. FLETCHER).

The average survival for 9 trees species was 44 percent. Black locust and green ash had the highest average survival. Catalpa, osage orange, and shortleaf pine had survivals between 40 and 50 percent. Eastern redcedar, black walnut, jack pine, and ponderosa pine had survivals between 25 and 35 percent. With good planting practices *in every respect,* all species except black walnut and ponderosa pine had average survivals greater than 50 percent.

Fastest average height growth was made by black locust and green ash, the other species being, in order, catalpa, shortleaf pine, black walnut, osage orange, eastern redcedar, and ponderosa pine. Height growth of most species studied was less on eroded than on non-eroded sites, and less on grazed than on non-grazed plantings.

All species had an appreciably higher average survival on the cool, moist, north and east-facing slopes than on the warm, dry, south and west-facing slopes.

Forty-three percent of the shortleaf pine plantations were infested to some extent by tipmoth. Sixty-eight percent of the black locust plantations were noticeably damaged by the locust borer. Serious damage was most prevalent on sites too poor for optimum growth and vigor of the trees *(Project 103a).*

Forest Plantation Site Studies.

(R. H. WESTVELD, R. W. DINGLE, P. Y. BURNS, P. W. FLETCHER).

An intensive study of soil conditions as related to the growth of 12 to 16 year-old planted shortleaf pine was conducted in 1952 at the Ashland Wildlife Research Area in Boone County. The soils of the study area were largely silt loams derived from loess. Twenty-eight plots were established in 7 plantations. Average annual growth in height was determined at each plot and used as a measure of site quality. Samples of soil from the A and B horizons were taken separately for measurement of soil properties; distribution of roots in the soil profile was recorded. Some of the results include:

Seventy-two percent of the site quality variation was associated with differences in (1) thickness of A horizon, and (2) percentage of clay in the A horizon.

Differences in subsoil characteristics were not related to site-quality variation.

The best sites had the lowest organic matter and pH in their A horizons, probably because rapid pine plantation growth promoted soil acidity and decreased incorporation of organic matter into mineral soil.

The numbers of fine roots in the A horizon and in the B horizon were related to thickness of A horizon. Apparently no other soil property of those studies appreciably affected the number of fine roots.

These results constitute further evidence of the importance of certain soil properties to tree growth. They demonstrate that it is possible to predict site quality in some cases upon the basis of a few, relatively simple soil measurements *(Project 107a).*

Marketing of Farm Woodland Products.

(R. C. SMITH).

A study of timber marketing was made in Franklin, Gasconade, and Osage Counties, where timber marketing facilities were believed to be inadequate. Three phases were considered, (1) inventory of timber resources, (2) farm use and sales of timber, and (3) use of wood by industries. Although timber in this area is somewhat better than for the state as a whole, it is essential that growing stock be built up and improved greatly. Farmers used and appreciated woodlot products for home use, but sales were relatively few and woodlot owners do not know timber values. Sales were principally white oak stove bolt stumpage; markets for saw logs were inadequate. Wood-using industries were small, inadequately financial, and intermittent in operation. A comparison of growth and drain showed that a greater annual harvest is possible *(Project 107a).*

Preservation of Posts and Farm Timber.

(W. J. O'NEIL).

After 14 years, the twelve species of posts that were not treated showed results that definitely divided them into three categories: Durable, (lasting at least 14 years) —catalpa, eastern redcedar and black locust; Moderately-durable, (lasting at least 10 years)—white oak, chinkapin oak, black oak and shortleaf pine; Non-durable, (lasting less than 5 years)—hackberry, hickory, slippery elm, American elm and basswood. There was no apparent relationship between durability and the number of annual rings in the outside inch or total number of growth rings. Practically the same relative rating was found with the treated posts. The most durable were black locust, eastern redcedar and black oak, while the least durable were the elms, hackberry, hickory and basswood. Painting posts with hot creosote or hot carbolineum was not successful in increasing length of life. Untreated fence posts to be durable should have at least 3 inches of heart at the butt end *(Project 120a).*

Effect of Lumber Grading on Sale Value.

(W. J. O'NEIL).

A preliminary reconnaissance has been made in the selection of mills to be used for the study. The problem has been discussed with farm foresters and a representative of the National Distillers Products Corporation *(Project 120b).*

Uses for Defective Oaks.

(R. C. SMITH).

A flooring study as contemplated could not be

followed through without disrupting the ordinary manufacturing process and the results would find limited use, if any; therefore, it is recommended that the flooring phase of the project be abandoned. The paneling phase shows considerable promise. Conferences with Columbia architects indicated there is currently a consumer demand for a luxury item such as interior paneling. With their help, specifications for oak paneling were prepared which permit manufacture of an acceptable product. Trees for use on this project have been located at University Forest and plans for logging and milling have been prepared *(Project 120c).*

Cottonwood Thinning.

(P. W. FLETCHER).

Completed establishment of study plots at the DuPont State Forest and at the Weldon Spring Experimental Farm, made the prescribed thinnings, and took the prescribed initial measurements of the trees which were cut and those which were left *(Project 122a).*

Effect of Partial Cutting.

(R. C. SMITH).

At Weldon Spring Experimental Farm 15 one-fifth acre plots were established in Block 13, which was cut over in the fall of 1952. Measurements of present tree diameters were recorded in three areas in which the average percentages of basal area removed was 30.6, 43.2, and 51.9 sq. ft. The number of stems by species of existing tree reproduction was tallied on 60 mil-acre sub-plots *(Project 122b).*

Timber Management at Weldon Springs.

(R. B. POLK, J. M. NICHOLS).

Two tracts of timber were marked for cutting. On one area of 80 acres, 250,000 board feet of hardwood sawlog material was sold on bid for $2525. Marked for cutting were mature trees, trees of inferior species, trees of poor form, and trees with a high percentage of defect. Good, thrifty white oak and northern red oak trees were retained for growing stock. On another tract of 60 acres, 89 mature white oak trees of veneer quality were marked and sold on bid for $5578. The cutting is being carefully supervised to insure that only designated trees are cut and to minimize logging damage to the growing stock remaining *(Project 122c).*

Improvement of Stands of Immature Oaks.

(L. K. PAULSELL, P. Y. BURNS, J. M. NICHOLS, R. H. WESTVELD).

The objective of this study is to determine the methods of stand improvement that will be most effective in producing the greatest amount of high-quality timber with the greatest net income. Approximately 100 crop trees were designated on 9 plots. Three of these plots were marked for a light thinning. Three were marked for a moderate thinning and three plots to be used for checks are to be marked for both light and moderate thinning. The remaining three of the twelve plots are to be clearcut. Since this is a long-range project, no results of the various treatments are available *(Project 122d).*

Acorn Production.

(R. E. MCDERMOTT).

Initial work has been started in field survival of sound acorns. One-quarter milacre plots have been laid out along a transect 37 chains long on the Ashland Wildlife Area. In some plots naturally occurring acorns have been introduced. The location of those acorns are recorded and a check will be made this spring to determine the effectiveness of the tagging and to see if individual acorns germinate or are destroyed. From the subsamples that are being stored, three species of insect grubs and two species of caterpillars have been isolated *(Project 123a).*

Study of Bottomland Hardwoods.

(R. E. MCDERMOTT).

Phytosociological investigations have been completed on small floodplains of streams of the southeastern Missouri Ozarks. These results coupled with controlled greenhouse studies have indicated that seedlings of sycamore, which are representative of the early woody stages of primary and secondary succession, are at least as light tolerant as elm of the succeeding reproduction development.

Permanent plots have been established on the Mingo Wildlife Refuge near Puxico, Missouri. Basal area and reproduction by species have been recorded for comparison with the cumulative effects of fire protection and high water tables by 1958 *(Project 123b).*

Eastern Red Cedar Silvies.

(R. E. MCDERMOTT).

Closely controlled experiments have been completed with cedar seedlings to measure the effects of soil fertility levels and sunlight intensities on growth of tops and roots and winter color of foliage. Regardless of fertilizer combinations, seedlings in full sunlight develop strong anthocyanin pigmentation, and seedlings grown in one-third and one-tenth sunlight remain green through midwinter. These results substan-

tiate field observations of cedar foliage color as related to vigor of growth and color in bright and diffused light *(Project 123c).*

Effect of Forest Grazing.

(R. E. McDERMOTT).

A comparison of three reproduction tallies in fenced and unfenced plots in a timber area adjacent to a pasture, indicates that despite drouth conditions there is little or no grazing pressure on tree reproduction at the Weldon Spring Experimental Farm *(Project 123d).*

Income From Producing Timber.

(P. Y. BURNS).

Farm Foresters of the Missouri Conservation Commission were urged to cooperate in this project by obtaining records of costs and returns from farm woodlot management *(Project 124a).*

Growth and Yield Studies.

(P. Y. BURNS, RICHARD C. SMITH).

Analysis of the field data on the first measurement of 30 sample plots established at the University Forest in Butler and Wayne Counties was completed. An estimate was made of expected annual growth on this forest of 58 cubic feet per acre *(Project 124b).*

Locating Land Areas for Studies.

(R. B. POLK, J. M. NICHOLS).

In view of immediate needs and the several areas now available, this sub-project of the forestation research has remained relatively inactive. Several days have been given to the examination of old-field sites scattered widely over the Weldon Spring Experimental Farm, St. Charles County, in view of entering into an agreement with the Animal Husbandry Department, University of Missouri, whereby certain old-field sites would be set aside specifically for forestation research *(Project 157a).*

Effect of Insecticides, etc., on Black Walnut.

(R. W. DINGLE).

Small scale pilot test plantings made in the spring of 1952 were observed and tended through two growing seasons. Although survival was uniformly high in all treatments,growth was likewise uniformly low in all treatments. Failure to obtain significant treatment results for either survival or growth, however, was probably due to the confounding influence of the following factors:

Insufficient planting stock was on hand at the outset to permit the careful selection of a uniformly good grade of seedlings which this study required. Machine cultivation between the rows of seedlings caused both lateral root pruning and excessive mounding of soil around the plant *(Project 157b).*

Propagation From Woody Cuttings.

(R. W. DINGLE, P. W. FLETCHER).

Initial trials were destroyed by heating failure of a greenhouse. Nevertheless, sufficient rooting had taken place to indicate that the technique, under better environmental controls, has promise for several ornamental horticultural woody plant varieties (Pfitzer and Andorra creeping juniper, American yew, and American Holly) as well as Osage-orange and black locust *(Project 157c).*

Direct Seeding.

(L. K. PAULSELL, J. M. NICHOLS).

Scarlet oak acorns gathered and stratified in November 1952 were planted on ten 1/10 acre plots in early March of 1953. The plots had been burned in the fall of 1952 as a rodent repelling measure. A hole was made about one inch deep with a trowel and the acorn covered. This was done because some radicles were over one inch long. In addition to 110 seed spots staked on the ten burned plots, 50 seed spots were seeded and staked on an unburned area around the burned plots. A survival study made May 22, 1953 indicated a survival of 67% on the burned plots and 88% on the unburned spots. A second survival study made October 8, 1953 indicated a survival of 25.5% on the burned plots and 20% on the unburned spots. The low survival is at least partly due to the severe drouth of 1953 *(Project 157d).*

Timber Species Site Adaptability.

(R. B. POLK).

Some of the eleven species studied, particularly sycamore and sweetgum, may have an appreciably higher survival than indicated. Close inspection showed that, although the tops were completely dead, the stems of some trees were still living at or near the ground line. Many of such trees will doubtless sprout, and given more favorable conditions than the 1952-53 drouth afforded, will live. None of the species, how-

ever, regardless of survival, has made even fair growth during the drouth. Vigor is generally lacking. The planting site, because it has much rock in the subsoil and is located near an intermittent stream bed, drys promptly and severely during periods of drouth. This study has provided a severe test of drouth tolerance for the species represented *(Project 157e).*

Hydrologic Studies in Relation to Forest Cover.

(P. W. FLETCHER, W. L. DECKER).

Weighted mean monthly precipitation for the five southeastern Ozark drainage basins was computed from existing Weather Bureau Records for the period 1921 through 1951.

Mean monthly river discharge records for these five drainage basins were summarized. Preliminary relationships between rainfall and runoff were established for the thirty-year period for the months of March and April, when monthly runoff was assumed to be most responsive to monthly rainfall *(Project 158a).*

Effect of Timber Cutting on Soil Moisture.

(P. W. FLETCHER, L. K. PAULSELL).

First year results for the 1953 drouth year show that by mid-July the upper three feet of soil had the greatest range in soil moisture as a result of the treatments. These differences, negligible in the spring, were also negligible again by late October. In midsummer, however, the soil moisture, relatively speaking, was very dry beneath the full overstory, full understory and undisturbed leaf litter. On the other hand the soil profile was still near field capacity on this date beneath the undisturbed litter on clear-cut plots. The other treatment variations ranged between these two extremes *(Project 158b).*

Wood Technology Problems in Industries.

(LAWRENCE LENEY).

The plants visited have been primarily other than in Kansas City or St. Louis. These two metropolitan areas present a different problem as the industry is using a wide variety of woods and making a greater number of different products, mostly using "out-of-state" lumber. A complete coverage of any one industry type was not intended. A wide sampling was attempted with greater emphasis on the more prominent secondary industries such as, flooring, handles, furniture, and preservation plants. This study pointed up a fact that is quite common throughout the wood-using industry. The problems are not all new. In many cases the information is available for their solution. This indicated possible need of extension work in this direction. There are also the problems common to the entire industry but for which there is no answer at present; while others are local problems due to conditions within the state or general area *(Project 159a).*

Brush Control Studies.

(J. M. NICHOLS, L. K. PAULSELL).

A study was initiated to test the effectiveness of 2,4,5-T and ammate, each in two concentrations, in treatment of second year scarlet oak sprouts which appeared following foliage applications made in 1951. The severe drouth in 1953 caused much early foliage discoloration and no attempt will be made to evaluate results until summer, 1954.

A cost study in timber stand improvement was carried out during the year. Undesirable trees were treated on one-acre plots in May 1953, October 1953, and February 1954, using ammate, 2,4,5-T, sodium arsenite, and CMU in different concentrations and different methods of application to compare costs and results with axe girdling. The total costs of labor and chemicals per acre (treated trees totaled 500 diameter inches per acre) were as follows:

Chemical	*High Frill (2.5 ft. above ground)*	*Low Frill (0.5 ft. above ground)*	*Axe Girdle (no chemical)*
2,4,5-T—8 lbs./100 gal. water	— —	$1.64	
2,4,5-T—8 lbs./100 gal. kerosene	$1.56	1.75	
Ammate—4 lbs./gal. water	— —	2.08	$1.48
Sodium arsenite (Atlas A —full strength)	— —	1.98	
Sodium arsenite (Atlas A—mixed with equal amount water)	1.41	1.69	
*CMU—0.5 lb./gal. water	— —	3.00	

(*When applied directly to the soil around trees at a rate of 2.5 lbs. per acre, the cost was $8.75 per acre). The results on effective kill of the different treatments will be taken in 1954 *(Project 166a).*

Use of Mechanical Blender In Food Preparation.

(MARIALICE CUNNINGHAM, MARGARET MANGEL).

The bulletin, "Foods the Blender Way", written in popular style gives suggestions for use of the mechanical blender and recipes and suggestions for preparation of milk drinks, sherbets and other desserts, fruit and vegetable puree's, meat and other main dishes and sandwich fillings. Suggestions for preparation of foods for infant and special diets are included in the bulletin which was written as a result of this study *(Project 18a).*

Home

Studies in Ground Beef in Storage.

(MARGARET MANGEL, KATERINA SINGLETON).

Analysis of data obtained in the past two years and preparation of a manuscript on the behavior of meat pigments in solution are under way. Evidence seems to point to the presence of a sulf-myoglobin compound which may account for variation from expected myoglobin estimates at wave lengths of 560 millimicrons *(Project 87a).*

Study of Diet Contents of Older Women.

(MARGARET MANGEL, JEAN SPRINGER, SARA FRANCES MADDEN).

Data have been collected for some time and are being analyzed at Wisconsin along with data from other Stations in the region *(Project 95a).*

Nutrition of Older Women.

(MARGARET MANGEL, JEAN SPRINGER, SARA MADDEN, MARTHA RICHARDSON, JOAN CROSBY, FRANCES MCKELVY).

The amino acid content with respect to the 4 amino acids, isoleucine, valine, phenyl alanine and methionine has been determined on the mixed diet for twelve subjects for two 5-day periods. Analyses indicate values well within the range of those reported by Futrell, Mertz, and others. Calcium and phosphorus analyses for the thirty day balance study included 95 on food and 15 on urine and 15 on feces. Calcium retention patterns followed rather closely those for phosphorus and the two were positively correlated



Starley M. Hunter, Chairman

(0.49 P 0.01). The retention patterns appeared to reflect variations of intake on a mixed diet. Calcium retention was highly correlated with intake and data indicated that the value needed to insure equilibrium in this subject, 11 milligrams per kilogram body weight, was in agreement with those values cited in the literature. Phosphorus intake although only approximately one and one half times the amount of calcium ingested, was metabolized to yield a net positive balance, while calcium, at the level of intake ingested (0.578 grams), resulted in negative balance. Missouri is analyzing data on creatinine for the region. These data include urinary creatinine on self-selected,

Economics

improved and controlled diets. Creatinine excretion during long and short term weight losses is also being studied. Creatinine excretion increases with calorie and with nitrogen intake and appears to be related to both age and size *(Project 95b).*

Energy Intakes and Expenditures of Older Women.

(MARGARET MANGEL, MARTHA RICHARDSON, KATERINA SINGLETON, SARA MADDEN, JOAN CROSBY).

Energy determinations on food intakes for 22 subjects for two five day balance periods and on food intakes and excreta for one subject on 30 day daily balance study were made. The caloric intake (for the 30 day balance study) as determined in the bomb calorimeter, corrected for urinary and fecal excretion, was for most determinations higher than values calculated by the short method of Leichsenring. The mean difference in these values was 144 calories. A similar relation appears to hold for the other 22 subjects *(Project 95c).*

Testing Flours for Different Cooking Uses.

(LETA MAHARG).

Tests have not been completed on the 1953 flours, but will be available later *(Project 97a).*

Kind of Meat Demanded by Consumers.

(TREVA C. KINTER, ELMER KIEHL, JAMES RHODES).

Household consumers in Metropolitan St. Louis will be interviewed in fifteen grocery stores handling fresh meats. The field work is to be done during the week of February 1 through February 6, 1954. It was estimated that a sample of 1400 interviews would give a sufficient degree of reliability. The probability sample of stores was selected from a carefully prepared list of 3304 stores located in Metropolitan St. Louis. Schedules were developed in cooperation with the Department of Psychology. A pre-test of schedules and procedures was conducted in three stores in St. Louis on December 10, 1953. Schedules and procedures were revised as a result of this test. The nature of the study will require rigid controls of beef cuts used in the displays in the stores *(Project 109a).*

Bacterial Growth in Cooked Egg Products.

(TREVA C. KINTER, MARGARET MANGEL).

Vanilla (12-25% sugar), butterscotch and chocolate puddings and stirred and baked custards were prepared from egg suspensions inoculated with food poisoning strains of Staphylococci and Salmonellae. The temperature necessary to thicken the egg reduced the bacterial population to a minimum so that no growth was detectible in less than four hours at room temperature in any case. The high sugar puddings and the custards showed no growth of the test organisms in twenty-four hours at room temperature. Refrigeration effectively inhibited growth up to twenty-four hours in all products *(Project 130a).*

Recipes Using Non-Fat Dry Milk Solids.

(MARGARET MANGEL, LETA MAHARG).

Recipes have been developed and tested using non-fat dry milk solids in sauces, soups, creamed dishes, and casseroles, meat dishes, yeast rolls, desserts, and milk drinks. The level of non-fat dry milk solids was increased to make products of high nutritive value and acceptable quality *(Project 130b).*

Use of Enzymatic Meat Tenderizing Compounds.

(MARGARET MANGEL, LETA MAHARG, JOAN CROSBY).

Data are in the process of being evaluated and no results are available *(Project 130c).*

Textiles That Have Proved Unsatisfactory.

(ADELLA GINTER, DOZIL MONDAY).

A survey of fifty homemakers in the Springfield, Missouri area on their dissatisfactions with the textile products they had purchased indicated a need for better products as well as better informed homemakers. The producer sometimes was at fault. In some instances the homemaker knew she was at fault; in other instances she did not realize that poor judgment in the selection, use or care of the product had been the cause of her dissatisfaction.

Nearly one-third of the dissatisfactions listed by the homemakers pertained to the discoloration of textiles. A large percentage of these pertained to white nylon becoming discolored. None of these dissatisfactions were blamed to a commercial laundry but were the results of home laundry procedures. The survey showed that homemakers more frequently did their laundering rather than making use of a commercial laundry. Complaints pertaining to new fibers and fabrics were made. Many dissatisfactions were found with the wear-life of nylon hose. Since the trend in hose has been toward sheerer products, it is necessary to emphasize the need for a more sensible selection. Consumers must realize that they cannot expect the impossible from any product. Complaints pertaining to the pilling of nylon sweaters and socks indicate a need for better labeling of textile products. Dimensional change, especially in knitted garments, was high on the list of dissatisfactions. Such dissatisfactions are not the fault of the homemaker; they can likely be attributed to lack of standards for knitted products. The study shows that producers and consumers need to do a better job; the home economist needs to teach better laundry practices along with the properties, use and care of fabrics made of the new fibers *(Project 172a).*

Serviceability of Curtain Fabrics.

(ADELLA GINTER, BERNICE BLUE).

A bulletin has been published covering this study. It is entitled: "A Study of Curtain Marquisettes," Research Bulletin 495, University of Missouri, College of Agriculture Experiment Station, 1952 *(Project 13a).*

Study of Fire-Resistant Qualities.

(ADELLA GINTER, KATHRYN DETRING).

Two cotton fabrics, sail cloth and outing flannel, were treated with a fire retardant solution made of borax and boric acid. The treatment was given in a

washing machine with a spinner attachment. The cotton fabrics were divided into as-purchased and laundered lengths half of which were treated with the fire retardant solution and the other half left untreated for comparison. Some lengths were vertically dried and some were dried in an electric dryer. Add-on weights and char lengths were measured from both the top and bottom sections of all the treated fabrics using the same method of random sampling for all. The results indicated that the as-purchased fabrics added on more of the retardant results as measured by the length of char. Slightly less effective results were found in the fabrics dried in an electric dryer than were produced by drying the fabrics vertically. The fire retardant effects were better in the outing flannel than in the sail cloth. The method used for the application of the fire retardant solution in this experiment tended to produce shorter char lengths than the hand immersion process as carried out in the earlier set of experiments *(Project 13c).*

Study of Cotton Fabrics.

(Adella Ginter, Betty Weiser, Mary Leach).

The unfinished and finished fabrics have been laundered 20 times. The flatness of the seams have been measured on the as-purchased fabrics and after the laundering intervals. Measurements for shrinkage have been made after the various laundry intervals. The crease recovery has been determined for the as-purchased fabrics as well as after the laundering intervals *(Project 13d).*



R. A. Schroeder, Chairman

HORTICULTURE

Nutrition Status of Missouri Orchards.

(A. D. Hibbard, I. J. Wahba).

Leaf samples were collected from apple and peach orchards in the major fruit growing areas of the state. When the leaf analysis data from Missouri orchards is compared to standards of adequate lines recognized in most fruit growing states it is evident that under the conditions of 1953 most orchards indicated a very low level of leaf phosphorus. In only a few orchards were low levels of the nutrients calcium, potassium and boron found. No orchards indicated a low level of leaf magnesium.

The relationship between moisture level and nutrient adsorption was studied in pot cultures of rapidly growing young plants of several species. Non-fruit plants were used in these studies because of their rapid development. In these studies the moisture levels were allowed to fall to 75-50-25 and 0 percent of field capacity before water was applied. In general the plants grown at the higher moisture levels had a higher concentration of phosphorus and potassium in their tissues than the plant grown under the drier conditions while the concentrations of calcium and magnesium were mostly unaffected. The plants with a high moisture level made more total growth and the total uptake of all nutrients per plant was increased. These results indicate that the moisture levels have an effect on nutrient uptake *(Project 4a).*

Nutrition of Strawberries.

(D. D. Hemphill).

In an old field at Steelville, Missouri, fertilizer treatments were applied in February prior to the 3rd picking. Plants were small and rows were over-crowded with plants. Yields were increased by 237 percent by an application of 250 #/acre of 8-24-8. Color and size of plants were improved. Number of pickings and size of berries were increased. Only two pickings were made on control plots due to failure of later flowers to set and develop fruits.

An application of 200 ammonium nitrate resulted in a very rank foliage growth. Berries were soft and tended to rot. Although harvested yields were more than double that of control plots, none of the fruit was marketable due to softness.

At Sarcoxie, Missouri, on a new field of Cherokee Silt loam testing 3.8% O.M., 66 lbs. P_2O_5, 108 lbs. K_2O, 185 lbs. Mg. 4704 Ca and pH 6.6, yields were increased 20 percent by application of potassium.

Nitrogen, phosphorus, magnesium and boron

did not improve yields. The application of 5 lbs. of boron per acre reduced yields by 25 percent *(Project 4b).*

Grape Nutrition.

(H. G. SWARTWOUT).

Soil analysis of vineyards at different production levels continue to show that 40 to 50 lbs. of available phosphorus is necessary for high yields, that is, 4 to 5 tons annually. With the available phosphorus below 20 lbs. production almost invariably is low. There also was an indicated relation between the depth of dark colored top soil (that containing organic matter) and production. With less depth of top soil yields in general were less. No relations were indicated between other mineral elements and yield in the soils examined. These results are for upland soils in the Ozark region which are generally low in organic matter and phosphorus but for the areas studied other major mineral elements are not unusually low.

Due to the late spring freeze which destroyed most of the crop in 1954 no records were taken of the yields in the fertilizer plots *(Project 4c).*

Fruit Thinning with Hormone Sprays.

(A. E. MURNEEK, F. G. TEUBNER).

Determination of the most effective time to thin apples by means of a "hormone" spray. —Naphthalaneacetic acid sprays were applied at 5-day intervals, from 5 days to 30 days after full bloom, to vigorous heavily blooming Winesap trees. The fruit set was determined by counts on 4 representative branches on each tree at 7day intervals and, as a final set on July 17. The results showed an increase in effect up to 15 days after bloom (Increased thinning) and then a decrease *(Project 23a).*

Some Effects of Synthetic Plant Growth Regulators.

(A. E. MURNEEK, F. G. TEUBNER).

When pollination and fertilization occur there is a conspicuous increase in the young fruit of reducing sugars and starch and a decrease in sucrose. A quite analygous carbohydrate metabolisms occur in parthenocarpic fruit produced as a result of application to the ovaries of either naphthaleneacetic acid or ethyl ester of indoleacetic acid. Fertilization or treatment with a synthetic growth-regulator induced a significant increase in hexose phosphates, which seems to indicate a probable relationship between growth and rate of phosphorylation of carbohydrates, with a hormone-induced activation of respiratory enzymes *(Project 50a).*

Softening Effects of "Hormone" Sprayed Tomato Fruit.

(D. D. HEMPHILL, A. E. MURNEEK).

CIPP did not prove as effective as CIPA in increasing fruit set. Cluster sprays were more effective than whole plant sprays, but these sprays caused the same fruit softness as CIPA. Whole plant sprays did not cause any serious foliage modification or fruit softening, but were not effective enough in increasing fruit set.

MTPA shows considerable promise as a fruit-setting "hormone" for tomatoes. In tests in the green house and the field this chemical proved more effective than any other chemical in fruit setting. There was some fruit softness in plants receiving cluster sprays, but was not as serious as CIPA-treated fruit. It appears that this chemical can be used as a whole plant foliage spray without foliage modification effects or serious fruit softening effects *(Project 50b).*

Balanced Farming of Vegetable Crops.

(C. R. CUNNINGHAM, A. D. HIBBARD, J. D. MILLER, A. E. GAUS, R. A. SCHROEDER).

In correlating market suitabilities and production suitabilities for certain vegetables crops, the tomato was selected for study with the following as some of the conclusions:

> The Kansas City market is an important diversion market while St. Louis is mainly a terminal or consuming market. The time of planting and the variety grown partially determine when tomatoes will be ready for harvest. Within limits the higher the temperature and the greater the amount of light the fewer days required from fruit set to harvest. It requires approximately 3,200 degrees of accumulated minimum field temperature from the time of fruit set in the producing areas before tomatoes will arrive on the market. By knowing the minimum field temperature tomato harvest can be predicted with a relatively high degree of accuracy. Tomatoes do not begin to set fruit until the minimum daily temperature approaches 60° F. *(Project 63c).*

Movement and Distribution of Missouri Apples.

(A. E. GAUS, R. A. SCHROEDER).

Data is in process of being analyzed *(Project 69a).*

Apple Diseases and Effect of Pesticides on Apples.

(H. G. SWARTWOUT).

A phenyl mercury fungicide (Puratized Agr.

Spray) was used alone at ¾ pt.-100 gals., and at the same dosage rate with 3 different thiocarbamate fungicides for the eradication of apple scab after the disease had become established on apple foliage. Puratized alone was by far the most effective and the Puratized combinations were the next most effective. Sulfur paste ferbam was the least effective and captan alone was the second poorest. In cedar rust tests captan gave some control of cedar rust but showed questionable efficiency for commercial use. Ferbam and zineb gave good and about equal control of both quince rust and apple rust. Fruit finish was better on both Jonathan and Golden Delicious with zineb than with ferbam. Sulfur in the prebloom sprays followed by captan later, gave fruit finish equal to or nearly equal to a full captan program. A full zineb program during the scab period gave a fruit finish on Golden Delicious comparable to that given by a captan program. With a dry summer no sooty blotch developed to give an evaluation of the fungicides used for its control *(Project 69b).*

Downy Mildew and Black Rot on Grapes.

(H. G. SWARTWOUT).

Due to a late spring freeze which destroyed the grape crop for 1954 no black rot control tests were conducted this year. Dry weather prevented the development of mildew on the foliage and tests which were started for its control were discontinued as soon as it became evident there was little chance of obtaining any information *(Project 69e)*.

Peach Scab and Peach Brown Rot Control.

(H. G. SWARTWOUT).

Captan and microfine sulfur paste (Magnetic 70) were used alone, in several combinations and in split schedules on Belle of Georgia peaches, but with an unusually dry season no brown rot developed and so no information was obtained on the control of this disease. Some peach scab developed on the unsprayed controls. On replicated check trees the percentages of scab affected fruit were 97.6, 68.8, 61.3 and 24.0. The intensity of infection in general was light with the number of lesions per fruit ranging mostly from 1 to 6. In all sprayed plots there was less than 0.1 percent scabbed fruit. There was little difference this year in the finish of captan and sulfur sprayed fruit *(Project 69f).*

Fire Blight and Its Control.

(R. N. GOODMAN).

Streptomycin and Terramycin, alone or in combination provided complete and lasting control against both artificial and natural innoculation with the "organism". Both antibiotics were found to be systemic in action, provided a temporary immunity of at least 24 hours. Field results indicated that these antibiotics act not only as "systemic protectants", but also possess an eradicative potential. The organic chemicals, methyl cellosolve and carbowax 4000 proved to be effective penetrants for the antibiotic spray. Their inclusion in the spray formulation increased the effectiveness of the antibiotic treatments. The minimum concentration at which control was obtained was 100 ppm Streptomycin alone. Excellent results were obtained when sprays were applied at 3-4 day intervals. Best results were obtained where the antibiotic spray schedules were initiated early in the bloom period. Schedules begun late in the bloom or at calyx did not provide blossom blight control, but did markedly reduce shoot blight (secondary infection). Phytotoxicity was not apparent nor were there any indications of reduced fruit set as a result of the low concentration antibiotic sprays (100 ppm Streptomycin). Antibiotic spray formulations containing 100 ppm indole-3-acetic acid increased fireblight control from 25-87% in green house experiments. It appears that auxin has a synergistic effect upon the disease inhibiting properties of antibiotics *(Project 69g).*

Yield and Quality of Vegetables to Fertilizer.

(LAURA FLYNN, E. E. PICKETT, C. W. GEHRKE).

The results indicate a statistically significant yield response with soil type and source of potash. Lettuce growth was better where the sulfate form of potash was used. Although the F value for "linear" response to potash level was not significant, the F value for "deviations" from linearity was significant at $P = 0.5$, indicating substantial deviations from a linear response curve. Although there were some suggestions of a quadratic regression of yield with levels of potash this hypothesis could not be tested. That heavy fertilization with K_2SO_4 (up to 10.8% of the base exchange capacity), however, is not unfavorable for lettuce growth is clearly shown.

Although onions did not respond to potassium fertilization above 3% of the base exchange capacity, significant increases were obtained by liming above the 60.5% base level. No consistent differences due to fertilizer treatment were found among the short-term vegetables *(Project 96a).*

Production of Systemic Disease-Free Carnation Cuttings.

(J. E. SMITH, JR.).

Continuation of testing of named varieties of car-

nations for their possible resistance to Fusarium wilt strains collected from different sections of Missouri.

Ten rooted cuttings each of 21 varieties were planted in each of three (3) infected soils, and ten in a steam-sterilized soil as a control. The varieties were: Topper, Mohawk, Boston, Patton's Yellow, Coral, Desert Sun, Saugus Pink, Gordon, Canary Queen, Peppermint Stick, Baby Bronze, Butterscotch, Mrs. E. F. Guba, Raspberry Ice, Eros, Cupid, Achilles, Pandora, Cassandra, Titan and Siren.

Results: Resistance was not 100% in any variety, but seven (7) or more of the ten survived of the varieties: Topper, Gordon, Peppermint Stick, Raspberry Ice, Cupid, Achilles, Eros, Titan and Siren *(Project 114b).*

Storage of Cut Flowers.

(J. E. SMITH, JR., J. L. BENNETT).

The storage life of pompon chrysanthemums, variety Corsair, was prolonged by the use of maleic hydrazide at 800 ppm. as a submersion treatment prior to dry-pack storage. Roses were satisfactorily stored for 22 days in the 40° F. refrigerator when sealed in dry-pack after submersion treatment in a 1500 ppm. solution of maleic hydrazide. Dowcide M-12 (DHA-S formulation M-12) in a 0.1% concentration was found satisfactory to control storage molds on roses in the dry-pack when the flowers were submerged prior to packaging. The storage life of carnations was not improved by submerging the flowers in a solution of maleic hydrazide or naphthaleneacetic acid prior to dry-pack storage. No treatments to snapdragons improved the keeping qualities, as abscission of the florets accompanied all treatments. Insfficient evidence is available to warrant widespread publication of possible applications. Indications show promise of greater consumer satisfaction in the longer keeping of flowers so treated *(Project 114c).*

Gladiolus Cut-Flower and Corm Production.

(J. E. SMITH, JR.).

Additional nitrogen side-dressings, originally calculated at 290.4 #/A., 654#/A and 835#/A were found too heavy in the largest amount of 835 as evidenced by injury to the growing plants and therefore cut to a maximum of 726#/A. by reduction in the amounts applied at the last two applications. Total production and quality of flowers was not significantly improved with any of the side-dressing nitrogen treatments. Side-dressings of nitrogen were not beneficial in increasing corm size or number of corms. The greater the addition of nitrogen as a side-dressing, the greater was the delay in flowering up to 10 days for some varieties. Mist nozzles (Spraying Systems No.) installed and operated 7 hours daily added the same amount of water on a given area as did the irrigation system operating 15 minutes daily. The moisture in the soil, as indicated by moisture blocks in the soil, was 85 to 90% continuously even to the 24-inch depth, under both systems. Quality of the flowers under the mist nozzles was better for most varieties. More and larger corms were produced from the earlier plantings. Fall planting averaged 3 to 4 weeks earlier than the April 10 planting, but April 10 is considered a very late spring planting date. No mulch, and corn cobs as a mulch, had about the same effect on flowering date, giving the earliest flowers on the fall-planted corms. Rye cover crop delayed flower maturity 4 days and cotton hulls (4-6" deep) delayed flowering 1 week as compared to the unmulched. Market prices received for the flowers at the various seasons indicate that the drop in price as the season progresses renders the crop unprofitable after any but the earliest markets. The average for the 1953 season on 413 dozen shipped was 33.8¢ *(Project 114d).*

Soil Test for Greenhouse Flower Crops.

(J. E. SMITH, JR.).

Analyses and interpretations of over 300 greenhouse samples from sixteen establishments in various parts of the state were reported. Soils were tested for Nitrates, Phosphate, Potash, Magnesium, Calcium, Organic Matter, Soluble Salts and pH.

Results:

1. Chief problems continue to be excess soluble due to:
   a. Excessive applications of fertilizers.
   b. Improper watering that fails to remove accumulations of fertilizer or salts dissolved in the irrigation water.
2. High acidity (low pH) during the fall months is a problem for special study.
3. Data is being accumulated from tests analyzed, recommendations made and reports received from the grower as to results achieved *(Project 114e).*

Development of Horticultural Farm.

(R. A. SCHROEDER).

In the development of the new horticultural farm located near New Franklin, Missouri, the work to date includes clearing of wooded areas and construction of grass waterways as a part of a complete water management plan for the farm *(Project 116a).*

Varietal Trials with Strawberries.

(D. D. HEMPHILL).

Yields in 1953 were extremely low due to poor stand of plants resulting from hot dry conditions prevailing in 1952. No variety produced a satisfactory row of plants. Armore, Blakemore and Empire produced more runner plants than other varieties under these adverse conditions. Yields were determined for most part by the plant stand with Armore, Blakemore and Empire giving highest yields. Empire appears very promising as a variety for northern Missouri.

With the everbearing varieties Superfection gave better production than Red Rich but neither variety produced enough fruit to warrant their growing *(Project 119a).*

Study of Clean Cultivation and Mulch Systems.

(D. D. HEMPHILL).

Everbearing strawberries failed to produce any volume of fruit during the hot dry summer even though grown under a permanent sawdust mulch. Very few berries were produced during July and August and only a low yield of small seedy berries during remainder of season. A satisfactory row of raspberries could not be established under the hot dry conditions of this year when clean cultivation was practiced. With a deep sawdust mulch satisfactory rows of black and purple raspberries were produced. Blackberries, both erect and trailing were more hardy than raspberries but much more vigorous plants were produced under a sawdust mulch than under a clean cultivation system. In a planting of highbush blueberries established for 3 years, 5 of 15 plants growing under clean culture died during the season and remaining plants made little growth. All plants under sawdust mulch survived drouth and made considerable growth. Fruit on plants under clean culture shriveled before ripening *(Project 119b).*

Causes of Sterility in Blackberries.

(D. D. HEMPHILL, D. F. MILLIKAN, W .R. ENNS).

Plants of a sterile variety, a partially sterile variety and a perfect fruiting variety were brought into the greenhouse and fruited under insect-free conditions. All varieties produced fruit similar to that produced under field conditions. This seems to eliminate insects as a possible cause of the sterility problem in blackberries. Three applications of DDT to a completely sterile variety and a partially sterile variety did not improve fruiting. Sprays were applied weekly with third spray being applied at early bloom. Survey of insect population showed no tarnished plant bugs, an insect that causes deformed fruit in strawberries, present at beginning or at completion of spraying. Sterile wild plants were root grafted to Early Harvest plants in an effort to determine if sterility condition is transmissable by grafting. Results not evident until plants fruit this summer. Root cuttings of three sterile varieties immersed in hot water 50° F. for periods 1-8 minutes for possible inactivation of causative agent. A few cuttings survived treatment and produced plants but not of sufficient size for fruiting this season.Plants from these cuttings will be propagated and fruited in 1955. Examination of canes producing sterile berries revealed a reddening of the canes and a mosaic pattern in the leaves of many plants *(Project 119c).*

Strawberry Improvement by Breeding.

(D. D. HEMPHILL).

Crosses were made involving fifteen varieties best adapted to Missouri conditions . Fairland, Sparkle, Temple and Vermillion were used as sources of resistance to Red Stele (Phytophora fragariae). Dunlap, Missouri 154, Premier, Temple and Vermillion were used as sources of resistance to the foliage diseases: Leaf Spot, Leaf Scorch and Leaf Blight. Armore and Blakemore were used for productivity and Aroma and Tennessee Beauty were used for their shipping qualities. Missouri 154, Midland and Red Rich were for their high quality. Approximately 2,000 seedlings were grown from these crosses. These seedlings will be fruited this spring *(Project 119d).*

Supplemental Irrigation of Vegetable Crops.

(V. N. LAMBETH, A. D. HIBBARD, F. H. TUCKER).

Irrigation treatments were established on Lintonia fine sandy loam for Rutgers tomatoes and Porto Rican sweetpotatoes to provide differential rates and frequency of irrigation applications.

Considering the efficiency of water use, however, it appears that the most practical guide in this case was to wet the major portion of the root zone to field capacity when the available soil moisture dropped to the 50% level. In the case of tomatoes, for example, the extra 5 ½" of water required above that for the 50% treatment was effective in increasing the tomato yield only 3 tons per acre. Very frequent irrigation of sweetpotatoes (75% treatment) for example, also resulted in vigorous vine growth and a lower percentage of No. 1 to No. 2 sized roots. Cracking of tomato fruit, sweetpotato roots, etc., did not occur where the available soil moisture was maintained at a favorable relatively constant level *(Project 121a).*

Study of "Salting Out" Vegetable Greenhouse Soils.

Much of the plant injury and poor yields reported were found to occur on soils with conductivities of 180 x 10^{-5} MHOS, or above, with a corresponding nitrate concentration of 70 to 95 ppm. These concentrations of soluble salts and nitrate concentrations, respectively appeared critical for Grand Rapids lettuce.

In a replicated greenhouse pot experiment, a study was made of the comparative values of several carbonaceous materials in temporarily reducing excess nitrate concentrations. Generally these materials were effective in reducing the available nitrates only for a period of approximately two weeks. Sawdust at 4 ounces per square foot. although not as quick acting, was effective for a longer period of time and gave still greater lettuce yields. A significant increase in soil pH was observed with all treatments *(Project 121b).*

Lima Bean Culture.

(V. N. LAMBETH, R. E. WEBSTER).

In the 1953 National lima bean nursery trials 6 varieties and selections of the Fordhook type and 9 of the small-seeded type were tested under critical drouth conditions of high temperatures during initial pod set, deficit of soil moisture and low atmospheric humidity throughout the season. Therefore, the yields, although low, are indicative of the comparative pod-setting abilities under the most unfavorable conditions. No evaluation of nematode resistance was made as the soil was not infested *(Project 121c).*

Improving Commercial Sweetpotato Production.

(V. N. LAMBETH, C. E. STEINBAUER).

In 1953 preliminary trials of 9 newly introduced selections, 3 were considered worthy of further testing in this area. Okla. 50, Okla. P-89 and Ga. 9-18-6, Okla. 29 x 46-1, Miss. HM-18 and Ga. T-5 did not size roots sufficiently. Miss. HM-36 yielded well but skin-checked and shriveled excessively in storage. La. O-123 also produced good yields but cracked badly. Okla. 50, a nematode resistant and wilt tolerant line formed much better than Okla. 46, one of its parents. While Okla. P-89 does not appear to yield as well as Okla. 50, it has the nematode and wilt resistance of this variety and may have promise in strictly Jersey type areas of production.

Results of the variety - spacing - nitrogen level study showed increasing yields of graded roots (U. S. No. 1 and No. 2) with closer plant spacing (8" as compared to 12") for B4570, B5941 and Early Port, no significant difference for Porto Rico and inconsistent results with Gold Rush, depending upon the nitrogen supply.

Supplemental irrigation increased the marketable yield of Porto Rico roots (U. S. No. 1 and No. 2) from 201 to as much as 427 bu./A. Where the available soil moisture in the major portion of the root zone was maintained at 75% of field capacity or above, however, there was a tendency for excessive vine growth and stringy roots. Very little root cracking occurred where the available soil moisture was maintained relatively constant by irrigation *(Project 121d).*

Cultural Practices for Processing Tomato Crop.

(V. N. LAMBETH).

Several new varieties of the general-purpose type tomatoes were evaluated under conditions of light wilt infection.

Of the canning varieties, Urbana appeared promising, significantly outyielding Rutgers and Stokesdale under very adverse conditions of temperature and soil moisture.

Valiant was the most productive of eight early market varieties and with a sufficiently open habit of growth, appears well adapted as an early stake type in this area. Victor, an extra early determinate variety, appears to be very susceptible to wilt and to be limited to regions with shorter growing seasons. Although the yields from unstaked plantings of Homestead and Southland were satisfactory, they were, in these tests, inferior to Rutgers. The response of the Queens variety was disappointing.

Application of the recommended spray program gave adequate control of insects and diseases. Differences in the degree of control of the foliage diseases among several fungicides tested were not apparent, however, Captan, (N-trichloromethylthiotetrahydrophthalimide), appears to have a wide spectrum with respect to tomato diseases *(Project 121e).*

Practices to Improve Irish Potato Yields and Storage Quality.

(V. N. LAMBETH).

The yielding ability of four red varieties: Waseca, Red Pontiac, Desoto and LaSoda and five white varieties: Irish Cobbler, White Cloud, Cherokee, LaSalle, and Ontario were evaluated under comparable but very adverse conditions in the Courtney commercial section and at the Campbell Vegetable Experiment Field Station. Although commercially profitable yields were not obtained at either location due to the abnormally high

June temperatures and severe drouths, significant differences in yield between varieties were apparent.

Of the red skin varieties Waseca was again the highest yielder and showed the highest percentage of Size A (1⅞" diam.) tubers. As in the 1952 preliminary test, DeSota set heavy but failed to size the tubers sufficiently. LaSoda did not respond well enough to warrant further trial in this section. Of the white skin varieties, White Cloud was outstanding in yield, especially on medium to heavy loam soil. Yield of LaSalle was slightly lower than Irish Cobbler, the standard white variety. Cherokee and Ontario both appeared to be too late for this section *(Project 126a).*

Thinning Peaches with Hormone Sprays.

(A. D. HIBBARD).

The study of growth regulators for thinning peaches was continued. Naphthylene acetamid was ineffective. The action of naphthyleneacetic acid was erratic depending upon very exact timing for satisfactory results. The herbicide 3 CLIPC was very effective at concentration of 500 ppm, gave 96 to 99% thinning on seven commercial varieties without foliage injury when applied one month after full bloom. The material was without effect where applied in concentrations up to 700 ppm at 50 days after flowering but gave no foliage or detectable injury of any kind.

A color-stimulating growth regulator 2,4,5-TP was used as a preharvest spray to stimulate red or over-color development in peaches. The effect on color was pronounced as shown by the work of the two previous seasons. The chemical at the concentration used had adverse effects on fruit maturity, rate of softening and shape. These were possibly associated with the abnormally high temperature and moisture deficiency primarily during the preharvest period. The chemical was also applied too far in advance of the harvest date. The harvest date was delayed possibly because of the adverse weather conditions prevailing during the final fruit stages of fruit maturity *(Project 126b).*

Development of Watermelon Varieties.

(A. D. HIBBARD, DANIEL MILLIKAN).

The varieties Black Diamond, Dixie Queen, Fairfax, Ironsides, Congo and U.S.D.A. 51-57 were grown in replicate yield plots. The variety Dixie Queen was most productive under 1953 conditions. The U.S.D.A. 51-27 was a close second, both varieties averaging 21 lbs. in weight with yields of 13.4 and 11.8 tons per acre respectively. The other varieties were slightly larger averaging 22 lbs. each. The variety Fairfax is the most promising of the newer introductions. Twenty other varieties were in the observation trials. The most promising were U.S.D.A. W453-1-6, Watson's Cannon Ball and Missouri lines B1-1-9, BD 3-14-18 and B3.

Over 200 hand pollinated melons were hand cut and the seed saved. Detailed notes were made on their quality including rind-thickness, skin toughness, skin color and shape. Selected lines from this seed have been secured for planting in 1954. Several new crosses in their F_2 generation were grown on artificially inoculated wilt infected soil. From greenhouse screening studies the crosses Mo. C.W.R. strain X Ironsides appear to carry the most resistance.

Further selection in lines resulting from crosses of Black Diamond and Missouri Queen was made. Of these the lines BD 1-17-16-2, BD 3-14-18-13 and BD 2-13-16 appear most promising. They very nearly approach a melon of the Black Diamond type with resistance to fusarium wilt. The F_2 generation of line GL x New Hampshire Midget was grown on wilt inoculated land. The second generation of this cross was surprisingly uniform for a F_2 watermelon cross. Several apparently highly resistant ice box size selections of 10 to 14 lbs. each were secured. These will be further selected in 1954. New crosses combining Fairfax with the most promising Missouri line were made and will be planted directly on wilt infected soil since both parents carry factors for disease resistance *(Project 128a).*

Onion Variety Testing.

(V. N. LAMBETH).

The yields and mature bulb size of 14 onion varieties were compared in a randomized field experiment involving 4 replications. Although the yields of all varieties were markedly reduced by the abnormally high temperatures in June, significant yield and size differences were apparent. Yields of the early maturing varieties such as Crystal Wax Hybrid were very low, apparently the result of their tendency to start bulbing earlier (shorter photo-period requirement) before a vigorous plant was established. The greatest yield and largest bulb size was produced by Sweet Spanish (Utah Strain) but was closely followed by the Early Globe Hybrids, Asgrow 7 and Y 41. These hybrids yielded approximately 35% more than the corresponding standard variety. The superiority of these varieties appeared to be associated with greater plant vigor at the time bulbing started. The yield and bulb size of the Southport Globe varieties was not materially different from that of the regular Yellow Globe varieties *(Project 128b).*

Elimination of Chemical Residues.

(M. R. JOHNSTON).

The insecticide, Lindane (gamma isomer of ben-

zene hexachloride), is being studied as to its effect on "pickling" cucumbers. Specifically its effect on the fermentation of the salt stock and on the flavor of the processed sour, sweet and dill pickles.

Three replications (20 gal. lots) each of the sprayed and control (no Lindane spray) have been fermented and are presently in the final stage of curing as salt stock. Salt stock from last year's work was processed into sour, sweet and dill pickles. Chemical analyses for Lindane was made on the samples at three points in the process (raw cucumbers, fermented salt stock and finished pickles). The pickles were presented to a taste panel (by the paired comparison method) for flavor evaluation *(Project 135b).*

Irish Potato Evaluation and Cold Storage Treatments.

(M. R. JOHNSTON).

After four months storage the cobbler variety in polyethylene bags was completely rotten. Mold growth and evaporation of moisture are the two agents which caused the observed difference between mesh bags and polyethylene bags. The potatoes in polyethylene bags did not lose weight by evaporation but they did contain potatoes which were decomposed by mold. Loss due to mold growth was much greater in the mesh bag than in the polyethylene bag *(Project 135c).*

Potato Product Technology.

(M. R. JOHNSTON).

A study was made of the effect of certain preparation unit operations on the texture and flavor of frozen mashed potatoes. The unit operations studied were blanching (precooking) and mashing. Live steam was used as the heating agent and three periods of heating were used. Various degrees of mashing the blanched potatoes was produced by forcing the potatoes through screens with different diameter sieves. The mashed potatoes were frozen in moisture-vapor-proof plastic containers and stored at 0° F. for two months.

The samples were analyzed by objective physical tests and subjective sensory tests. The penetrometer was used to indicate differences in consistency and the number of whole cells per unit weight were counted with the aid of a microscope to indicate differences in texture. The samples were served to a taste panel for flavor and texture evaluation.

Scoring of the samples by the panel indicate the following:

Effect of blanching time prior to mashing with a 0.033" (hole diameter) finishing screen, was that the flavor and texture of the 8 minute was preferred to the 12 and 18 minute treatment. In the case of the 0.045" screen, the flavor and texture of the 8 minute was preferred. In the case of the 0.60" screen, the flavor and texture of the 12 minute treatment was preferred, and similar findings were indicated for the 3/32" screen.

When the various screen sizes with the 8 minute blanch were compared, the panel indicated no preference for flavor and texture of the samples. When the 12 minute blanch was held constant and screen size varied, the panel indicated a preference for the texture of the 3/32" screen and for the flavor of the 0.033" screen *(Project 135d).*

Unit Operations for Horticultural Processing.

(M. R. JOHNSTON, D. B. BROOKER).

In order to develop a continuous mechanical device for extracting the juice from apples which would be better than present presses with respect to yield and quality, the problem is being approached in two ways. Basic data on the effect of variety, maturity and storage time on juice yield and the effect of particle sizes, thickness of pulp layer, size of screen opening, style of screen, weave, pressure, time and temperature on juice yield and quality are being obtained. Existing extractors in other industries are being studied as to their apple juice extracting ability.

A small press was built and used for obtaining the basic data. It was composed of a metal housing (6" on side and 8" deep) with a wax impregnated wooden plunger which was driven by a hydraulic press.

The pulpy nature of the apples did not lend itself readily to a screw pressing, being reduced to soupy mixtures under pressure and affording no resistance to the shaft worms of the press *(Project 135e).*

Apple Cider Technology.

(M. R. JOHNSTON).

The objective of this study is to develop a technique for making a good quality frozen concentrated apple cider which will appeal to the consuming public generally. Quality factors of relative sweetness (sugar to acid ratio), color, flavor and aroma were determined for the juice of the more popular commercial varieties of apples in Missouri. Yield of raw juice from several varieties was determined.

Fermentation as a means of improving the flavor of apple juice has been tried. Three strains of saccharomyces ellipsoideus (American Type Culture Collection No's. 4097, 4123, and 8256) were used. After fermentation the juice had lost all the flavor characteristics of the fruit and it had developed a distinct vinous flavor.

Enzyme preparations which have been tried have

not been found to improve the flavor of the apple juice or the fermented material. The preparations are mold derivatives and are classed as a Pectinol A, Pectinol 10M, Lipase B, Enzyme 19 and Pectin esterase *(Project 135f).*

Weed Control in Horticultural Crops.

(D. D. HEMPHILL).

Grapes: Dinitro fortified oil is the only material recommended at present for use against weeds. It is not effective enough against grasses. Several sprays must be applied during the season.

Both CMU and PDU were very effective in controlling grasses and broadleaved weeds. Weed infestation was reduced by 85 and 96 percent respectively.

No injury to grape vines was evident. These chemicals are low-soluble materials and 1953 was below normal in rainfall, therefore, they must be observed under wet conditions before they are suggested for trial by growers.

Strawberries: Sodium 2,4-dichlorophenoxyethyl sulfate (SES), 2,4-dichlorophenoxyethyl benzoate (SESIN) and Sodium 2,4,5-trichlorophenoxyethyl sulfate (NATRIN) were applied as post-planting sprays. No evaluation could be made of these materials because of the hot, dry conditions. Irrigation facilities were not available and a row of plants could not be established.

Several chemicals were evaluated for pre-emergence and/or post-emergence use in our leading vegetable crops *(Project 146a).*

Promotion of Horticulture.

(R. A. SCHROEDER).

Report of Research findings and recommendations were sent to Horticultural producers of state in the Horticultural News, Floricultural News, Vegetable News, and Weekly Spray Letter.

Various trips and meetings were attended by staff members to speak to groups seeking horticultural information. There was a mailing of a weekly letter to commercial apple "Buyers" informing them of those in Missouri having apples for sale *(Project 169a).*

Poultry Husbandry

H. L. Kempster, Chairman



Protein Level Effect on Egg Production, Egg and Body Weight.

(Q. B. KINDER, T. W. DAY).

Eight-hundred White Leghorn and Crossbred pullets were used in four replications. There was no difference in egg weight, body weight or mortality rate on the two types of rations. Egg production favored the 20% protein mash with hand fed grain by 2.3% or 6.35 eggs over the ten months period. This was significant statistically at the .05 level. Average protein level of the total ration of birds on the 20% laying mash and hand fed grains was 15.02% as compared to 17.13% with birds on the 24% mash and grain. A study of the first years data on these feeding trials for egg production indicate: Egg production was significantly higher on the 20% protein mash and hand fed grains. The difference was 2.3% or 6.35 eggs per hen over the 10 months period. Egg production was very good on both types of rations averaging 58.2% and 55.9% respectively. The White Leghorns were superior to the Crosses for egg production by about 8.9% on this test. No measurable difference on egg weight, body weight or mortality was observed. An additional year's date is needed to validate this work *(Project 118a).*

Relation of Refrigeration etc., on the Farm Quality of Shell Eggs.

(E. M. FUNK, JAMES FORWARD).

Eggs produced by 800 pullets from April 20 to July 14, 1954, were shipped to St. Louis and sold by grade after being held under different holding conditions; (1) refrigerated cooler, (2) basement room, (3) sales room, (4) oiled processed and held in basement. The eggs were gathered daily and three times daily and marketed weekly or twice weekly. Some practical method for holding market eggs on the farm will be of much value to Missouri's poultry industry *(Project 161a).*

Value of B_{12} and Antibiotics in Chick Rations.

(Q. B. KINDER, MIKE KELLY).

The addition of extra "B" vitamins (niacin, choline and pantothenic acid) to chick rations had little or no effect on growth rate or feed efficiency with the type of rations used. As natural feedstuffs were used in all experiments it appears that these are marginal factors depending on the particular lots of the natural feedstuffs used. Addition of 2 percent dried whey improved growth rate 2.1 percent over a basal all soybean meal ration with no change in feed efficiency. A 5 percent fish meal improved growth rate 3.8 percent and resulted in a 9.8 percent improved feed efficiency. Four percent fish meal and 2 percent whey improved growth rate 3.0 percent and feed efficiency 5 percent. Substitution of 7¼ percent of corn gluten meal for an equivalent amount of soybean meal decreased growth rate 4.5 percent. Feed efficiency was slightly better on the corn gluten meal at the lower growth rate. Birds fed on both a broiler mash and semi-solid milk in batteries for a 10 day period after 8 weeks of age gained 18.9 percent faster with an improved feed efficiency of 13.9 percent over birds on the same ration without the milk product. The only difference in feed consumed was the additional milk product *(Project 24a).*

Cleaning Soiled Hatching Eggs.

(E. M. FUNK, JAMES FORWARD).

Investigation of the cleaning of soiled turkey hatching eggs was continued in 1953. Hatchability records on turkey eggs produced and incubated by Fitch and Hedrick (Columbia Mo.) were obtained for 6,535 clean eggs and 1,134 soiled eggs cleaned by washing the day laid in quaternary ammonium solution (800 ppm). The percentage of hatch of all eggs set was for clean eggs 74.0 and for washed eggs 70.2. It was established in 1952 that soiled turkey eggs cleaned by washing hatched as well as soiled eggs dry cleaned with steel wool. Turkey eggs have very little value except for hatching purposes. Many become soiled. A practical method for cleaning such eggs will be of value to the industry *(Project 40a).*

Care of Hatching Eggs During Incubation.

(E. M. FUNK, JAMES FORWARD).

These studies indicate that turning hatching eggs during incubation 45° or 40° give increased hatches over turning 30°. Multiple plane turning has been found to improve hatching results, especially if the eggs are only turned 30°. Our investigations show that eggs must either be turned 40° or 45° or 30°, plus extra tilting in another plane for best hatching. These results will point the way to better incubators. Some machines turn eggs only 30° *(Project 40b).*

Preventing Losses in Storage Eggs.

(E. M. FUNK, JAMES FORWARD, MARTHA LORAH).

Spoilage in shell eggs held in cold storage was effectively minimized by using sufficient heat to pasteurize the contents of such eggs. Surface cleaning was not effective. Green whites were practically eliminated by immersing shell eggs for 15 minutes in water held at 130° F., or 5 minutes at 140° F. These heat treatments were also effective in preventing sour eggs, musty eggs and other rots. A method was also developed for removing stains from white shelled eggs by dipping them in warm water containing 0.5 percent perborate (a substance contained in dentifrices) *(Project 62a).*

Study of Thyroxine Secretion Rate of Growing Turkeys.

(H. V. BIELLIER).

This study was devoted to the determination of thyroxine secretion rate of growing turkeys by the use of I^{131}, a radioactive isotope. The secretion rate was estimated to be 56.2 micrograms of D, L-thyroxine per poult daily or 1.35 micrograms per 100 grams body weight for the Broad Breasted Bronze poult at three months of age. Results show that certain modifications of technique are necessary before adoption as a standard assay method. The use of tracers in the form of I^{131}, a radioactive isotope, is a practical method of assaying the secretion rate of the thyroid gland *(Project 72a).*

Feed Purchasing Power of Eggs Layed by a Hen.

(H. L. Kempster).

In 1953 egg prices averaged $0.394 per dozen or 8.27 cents more than for 1952. Feed prices declined from $3.15 per 100 pounds (corn 5., oats 3., wheat 3.) to $2.75 for last year. Based on a production of 122 eggs per hen the eggs would purchase 146 pounds of feed as compared to 100 pounds for 1952. Using the 1910-14 basis, egg prices were 235 percent of normal, feed 215 percent of normal and the feed purchasing power of eggs 109 percent of normal *(Project 73a).*

Intra-Flock Selection with Minimum Inbreeding.

(Q. B. KINDER, A. B. STEPHENSON, H. L. KEMPSTER, W. F. Krueger).

A general comparison of the test-crosses with the

mean of the parental intra-flock breeds shows consistent differences in some traits but not in others. Age at sexual maturity is a week or more earlier for the test-crosses. The progeny of Leghorn males start to lay from 1 to 2 weeks earlier than their reciprocal crosses. Viability from 8 to 22 weeks is consistently better from the test-crosses by about 4 percent. Egg production from 154 through 300 days was about 7 percent higher for the test-crosses, due to earlier sexual maturity. The intra-flock birds, over a 4 year period, have produced eggs with approximately 9 percent higher fertility. These birds seem to be definitely superior in this respect. Adult viability favored intra-flock over test-crosses by about 2 percent. No apparent differences were observed in rate of production after 300 days of age or in body weight at 44 weeks. In general, the test-crosses are superior to the mean of the intra-flock parental populations. However, this can not be taken as a general recommendation for any cross-strain or cross-breed mating. Data from specific test-crosses show higher egg production for Leghorn males on both New Hampshire and White Plymouth Rock females than for either parental intra-flock group *(Project 83a).*

Recurrent Selection for Maximum Performance.

(A. B. STEPHENSON, Q. B. KINDER, H. L. KEMPSTER, W. F. KRUEGER).

Age at sexual maturity is a week or more earlier for the test-crosses. The progeny of Leghorn males start to lay from 1 to 2 weeks earlier than their reciprocal crosses. Viability from 8 to 22 weeks is consistently better from the test-crosses by about 4 percent. Egg production from 154 through 300 days was about 7 percent higher for the test-crosses, this being largely due to earlier sexual maturity. The intra-flock birds, over a 4 year period, have produced eggs with approximately 9 percent higher fertility. Adult viability favored intra-flock birds, over a 4 year period, have produced eggs with approximately 9 percent higher fertility. Adult viability favored intra-flock over test-crosses by about 2 percent. The test-crosses may have a slight advantage in hatchability of fertile eggs, viability through 8 weeks, body weight at 8, 12, and 22 weeks, and egg weight. No apparent differences were observed in rate of production after 300 days of age or in body weight at 44 weeks. Data from specific test-crosses show higher egg production for Leghorn males on both New Hampshire and White Plymouth Rock females than for either parental intra-flock group. Specific combining ability may make certain combinations superior to both parents while crosses in general, although better than the parental mean, will not exceed the better parent *(Project 83b).*

Rural

Rural-Farm Morbidity.

(C. E. LIVELY, R. L. MCNAMARA, J. B. MITCHELL, J. H. LOVE, JR.).

From the illness experience of more than 100,000 farm people, the study has established that at least 5 percent of the adults are unable to work on a given day because of disabling illness. Farm operators lose on the average about 3 weeks of time annually because of illness.

Missouri has suffered a net loss of 1,000 doctors since 1912, while the population has increased by 600,000 persons. During this time the number of doctors in the larger cities of the State has been steadily increasing. Nearly three-fourths of all Missouri M.D.'s are located in four counties; Jackson, St. Louis, Buchanan, and Greene.

Of the 5,000 physicians in Missouri, only about 3,800 are in private practice and available to the public. As many as 37 of Missouri's counties have more than 2,000 persons per physician, and almost half of these counties have more than 3,000 persons for each physician. It has been demonstrated that it is possible to do a continuous study of general morbidity by means of small sample methods *(Project 25a).*

Sociology



C.E. Lively, Chairman

Social Structure of Clarence, Missouri.

(H. F. LIONBERGER, C. E. LIVELY, C. F. COUGHENOUR, EDWARD HASSINGER).

The study, through interviews with people in the Clarence rural community, established the fact that "making an honest living" was rated highest in importance as a factor in determining prestige standing in the community. Following in close order were: being a good neighbor, willingness to help others, and doing good things for others. Characteristics rated as most likely to lower one's standing in the community (prestige) in descending order of importance were drunkenness, sexual unfaithfulness in marriage, habitually straining the limits of the law, being a gambler, being a braggart, and driving a hard bargain with neighbors. Making a living by trading, and accepting an old age pension were of much less importance as factors rated as contributing to low prestige *(Project 29a).*

Social Area Description and Trends.

(C. E. LIVELY, C. L. GREGORY, EDWARD HASSINGER).

Data have been assembled from a sample of persons in six core areas and comparisons have been made with respect to systems of motivational orientations existing in these various sections of the State. Preliminary tabulations from these sample data indicate that a reasonable working hypothesis for further development can be drawn by placing these areas on a Gemeinschaft-Gesellschaft continuum as set forth in the works of the German Sociologist Toennies.

The further development of this hypothesis can be made in other research projects in related topics and by using the areas as a basis of classification since this research has resulted in delineation of the State into homogeneous areas that have proved to be valuable in stratified sampling *(Project 91a).*

Problems of the Missouri Rural Church.

(L. M. HEPPLE, C. E. LIVELY, C. M. COUGHENOUR, G. T. BLUME, J. S. HOLIK).

The coding of schedules and punching of IBM cards for the field work of 1952 was completed by June, 1953. The schedules for the attitude and opinion poll and the additional information needed for the analysis of the six ecological areas were completed during the first five months of 1953. The field work during the summer of 1953 consisted of taking 100 attitude and opinion poll schedules in each of the six ecological areas, a survey of services available in the areas, some additional information on religious groups, and the collection of data on church leadership positions. The analysis of the data on religious groups in the 8 percent random sample was started in September. During the fall preliminary work was started on the development of an index of religious groups, the material on ecological relationships was edited and preliminary tabulations started, and the analysis of the data on clergymen was begun *(Project 143b).*

Soils



W.A. Albrecht, Chairman

Characteristics of Heavy Clays in Soils.

(C. E. MARSHALL, C. M. WOODRUFF, D. O. HOWE).

Activity measurements were made on soils from various plots of Sanborn Field, both in the original condition and after the preparation of K and Ca soils by two methods, electrodialysis and titration with bases, and salt leaching followed by alcohol washing. Homionic soils prepared by these methods give K and Ca activities in good agreement with one another.

The incidence of four rules is examined, using data from studies of cationic activities in clay systems. Graphical data is available for Wyoming bentonite, Arizona bentonite (montmorillonite) and Putnam clay (Montmorillonite group); illite, kaolinite and attapulgite.

The clay membrane technique for potentiometrically measuring cation activities was applied to whole soil samples using Putnam Silt Loam with results available.

The Geiger-counter x-ray spectrometer has been used in a quantitative study of the clays from a Lindley soil profile, i.e. glacial parent material. It was felt that this would be a complex mixture and would provide a good test of available methods. This has proved to be

the case. The clay fractions have been subdivided according to particle size and examined when saturated with different cations and with different heat treatments. The results are still in process of evaluation. A study of recent river deposits at various points along tributaries of the Missouri river and in the main stream has been completed. Interesting variations in the feldspars have been found. The study of the silt and sand fractions of the Lindley profile has been undertaken. Quantitative results are now being evaluated and further improvements in technique are being made *(Project 6).*

Soil Survey and Land Classification.

(H. H. KRUSEKOPF, M. E. SPRINGER, C. L. SCRIVNER).

Continuation of a project to further the knowledge on the character and qualities of the soils in Missouri. It is a project that must be continued until the soils in all parts of the state have been studied and classified. Field work in each survey area reveals new information as to the cause for abandoned land, variation in erosion for different soil conditions, varied response to soil fertilization, possibilities for irrigation, ecological plant adaptation, etc. A survey of Howard County in response to petition by farmers and landowners and other work is planned, such as continued participation in the preparation of a large soil map of the North Central State, participation in the forest soil site studies, evaluation of the relation of forest growth to the fertility, and moisture capacity and other features of the soils *(Project 22a).*

Mechanisms of Nutritive Uptake by Plants from Soil.

(E. R. GRAHAM, A. C. MATHERS).

A study of the Mechanisms of Nutritive uptake associated with the ionic saturation of plant roots, as revealed by chemical analysis of the leaves and exchange solutions from the roots showed a positive relationship between the bonding energy of the colloid, the ionic saturation of the root and the final concentration of the nutrients in the leaves of the plant.

Since all the colloids were saturated to the same level, 85% C, 12% Mg, and 3% potassium, it is believed that the variation of the ionic saturation of the plant roots and the cation content of the tops of the plants is caused by the bond associated with the calcium ion. The results show that the hydrogen ion associated with the roots of the plants grown on amberlite colloid was higher when expressed as M.E. per 100 grams of roots than it was on the plants grown on the Putnam colloid. This may be due to the fact that the nutrient ions (especially calcium) are more tightly held on the Amberlite and the hydrogen concentration must be higher to effect an exchange *(Project 51a).*

Mineral Reserve's Relation to Nutrients in Uptake by Plants.

Experimental results showed that the amount of phosphorus weathered was related to hydrogen bonding at the outset and to calcium bonding energy of the colloidal system. H amberlite, which has the highest bonding energy for calcium of the systems studied, was most effective in weathering phosphate minerals. H humus, which has the lowest bonding energy for calcium was least effective as a weathering agent. The clay minerals weathered according to the relative energy levels resulting from the consideration of both hydrogen and calcium bonding energies. Bentonite clay was the most effective weathering agent, Putnam clay intermediate, and Kaolinite the least effective. Bentonite clay saturated with potassium or sodium was effective as a phosphate mineral weathering agent.

A study of the availability of natural phosphates to oats showed that amount of phosphorus harvested by the plants was related to the relative driving energies of the different colloidal systems which were mixed with the rock phosphate.

H-amberlite, mixed with rock phosphate, was the most effective system for increasing the availability of the phosphorus. The other colloidal systems were decreasingly effective in the following order: H-bentonite, H-Putnam, and H-humus. The study of the total energy changes associated with pH, total hydrogen, active calcium, and total calcium, calculated into bonding energy and then into relative driving force revealed that the weathering of the phosphorus in the apatite was related to the energies of the systems. The colloidal systems arranged in order as effective weathering agents were as follows: Amberlite IR-120, Wyoming bentonite clay, Putnam clay, Kaolinite clay, and humus *(Project 51b).*

Plant Root Penetration.

(W. A. ALBRECHT, C. M. WOODRUFF).

Results of the deep treatment study at McCredie, Mo. (yields in bushels per acre):

TABLE 14

	Check Plot	Shattered Subsoil	Shattered and Treated Subsoils
Corn	62	63	64
Soybeans	17.1	17.6	19.9
Wheat	39.8	40.7	44.0

(Project 51c).

Chemical Studies and Bio-Assays of Forage Feeds

(W. J. UPCHURCH, W. A. ALBRECHT).

Heavy applications of nitrogen on corn and wheat have altered the feeding qualities of the grain as shown by animal assay studies.

Corn grown on Putnam silt loam which had been treated according to soil test and received 0, 120, and 250 pounds of nitrogen per acre was fed to weanling rabbits for periods of 92 to 171 days.

From the results obtained in the 12,440 rabbit days study, it may be concluded that the 250 N corn was inferior to the 0 and 120 N corn. The no nitrogen corn was considerably inferior to the 120 N during the initial phases of the study when the young weanling rabbits were in their crucial stages of growth. The variations in the three corns were much greater as "growing feeds" than as "fattening feeds."

Boron deficiencies in alfalfa were the most commonly observed trace element deficiency in the state. The boron deficiencies in alfalfa stands appears to be more prevalent during adversely dry seasons typified by the past summer (1953). Alfalfa responses to boron treatments were observed in all sections of the state during the summer of 1953. The ground work was laid during the fall (1953) for an extensive study of the boron status of Missouri soils as well as their response to boron treatments. In cooperation with the Agricultural Extension Service 10,000 pounds of borax was distributed over the state and were used to establish demonstrations of boron treatments on alfalfa *(Project 92a).*

Animal Assays of Soils' Trace Elements.

(G. E. SMITH, W. J. UPCHURCH).

Wheat and lespedeza were grown on Hanceville sandy loam, (Bent County), which had been treated with an array of major and minor element treatments. Two sections of the field were limed excessively in an attempt to aggravate the low level of trace element in the soil, by suppressing their availability and imposing a deficient or limiting level of the various trace elements on the plant. Trace elements were applied as soil treatments, foliage sprays, and combinations of soil treatments, and spraying. Variations in yields according to treatments with trace elements were small except in one of the areas which was limed excessively.

The yields were influenced more by the major elements than the minor. This illustrates the fact that in most of Missouri soils, trace element deficiencies and limitations will be associated with heavily fertilized soils, where major element deficiencies have been corrected *(Project 92b).*

Compiling and Summarizing Weather Data.

(W. L. DECKER, D. L. COOK).

The card file library now contains fifty-one weather stations with records ranging from 62 years to 35 years. In all there are nearly 700,000 daily weather records on these cards.

In order that new weather summaries may include all of the data monthly summary cards have been prepared for all of the new records. This includes the records for the new weather stations punched by the Experiment Station and for the records obtained from the Weather Bureau.

A temperature summary has been designed for estimating the probabilities of the lowest temperature and highest temperature for each month. From this it is possible to determine the probability of unusual temperature anomalies occurring during each month.

Records from four additional weather stations have been added to the Experiment Station card file. The records from each of these stations have been processed for the years 1918 through 1948. These locations are: St. Charles, Fulton, Arcadia, and Trenton.

In addition to these stations the records for all stations previously punched have been brought up to date by securing from the Weather Bureau the daily cards for the years 1948 through 1952 *(Project 94a).*

Water Utilization of Crops

(C. M. WOODRUFF, W. A. ALBRECHT).

Yields of corn prior to the introduction of modern fertility practices in 1950 amounted to 78 bu. per acre with adequate moisture and each inch of moisture deficiency reduced the yield by 8.7 bu. per acre. After the introduction of modern fertility practices yields of corn followed a trend of 150 bushels per acre with adequate moisture and each inch of moisture deficiency reduced the yield by 13 bushels per acre.

On the average the moisture deficiency of the soil was 4.5 inches representing a potential yield of 39 bu. per acre for the period before fertilizer was used whereas with modern fertility practices such a deficiency represents a potential yield of 91 bushels per acre.

As part of this study the average daily consumption of water by summer-growing crops of 0.14 inches per day has been used to compute the maximum moisture deficit that might occur during July and August as a result of consumption of water by corn through June, July and August for the past 64 years of records *(Project 94b).*

Determining Freeze Hazards to Tender Crops.

(W. L. DECKER).

The dates of the last spring freezes and first fall freezes have been tabulated, checked, and placed on I.B.M. cards. These cards have been processed and, at present, hand tabulations are in progress. No further progress may be reported until these tabulations are completed *(Project 94c).*

Collection of Soil Temperature Data.

(W. L. DECKER).

The analysis of the data in this study indicated that the mean temperature of a plot on a given day has a variance of about .4° F. This indicates that one is 95% certain that an interval of .8° F. on either side the computed mean of a particular plot on any day will contain the true mean temperature for that plot. It is advantageous to reduce the variance of mean to as low a value as practical. This reduction may be accomplished by increasing the number of observations.

On the basis of the observations taken at Columbia, Sikeston,and Conception, it is possible to make comparisons of the soil temperatures over a wide area. When the three locations are compared, they remain in order by latitude. Sikeston had the warmest temperatures at all depths, while Conception had the coolest temperatures. In the case of the Sikeston location, there is undoubtedly a confounding of latitude with effects of soil factors. The sandy soil of this area, with its low water retention capacity, should contribute to the high soil temperatures *(Project 94d).*

Study of Winter Injury to Winter Barley.

(D. L. COOK, J. M. POEHLMAN).

Observations on the amount of winter injury to barley were made at bi-weekly intervals during the 1952-53 winter season. These were made by sampling a series of plots and determining the percentage of leaf tissue, tillers, and plants that had been killed. By this method progressive injury throughout the winter could be recorded.

The 1952-53 winter was the mildest on record with a minimum temperature of 8° F. being recorded. Leaf tissue was killed by this temperature but no tillers or plants were killed. Winter injury as a result of heaving occurred in late December of 1952, and accounted for the major injury during this season *(Project 94e).*

Variations in Micro-Climates under Missouri Conditions.

(W. L. DECKER, D. L. COOK).

Preliminary observations of the dry and wet bulb temperatures were made within and near a corn plot at the University of Missouri South Farms during the summer of 1952. The observations were taken with an aspirating psychrometer at the 1, 2, 3, 4, and 5 foot levels.

In general, it was discovered that there were significant differences between the temperatures recorded on different days, at different times, at different locations in and around the field, and at different heights. The studies indicate that air temperature changes with height are not too great. These data indicate that although the temperature differences were statistically significant and reflected real meteorological gradients, crop response to these temperature differences is probably negligible *(Project 94f).*

Permanence of Grass-Legume Sod.

(G. E. SMITH, W. J. UPCHURCH, MELTON BROWN, SAMMY LEE GOWING).

In the dry season of 1953 fall applications of nitrogen fertilizer produced both higher yields and higher protein contents than the same amount of nitrogen applied in the spring. It is doubtful that some of the spring applications received sufficient rain to carry the nutrients into the root zone of the grasses before temperatures became so high as to retard growth. Results obtained at Lathrop in northwestern Missouri indicated that fall applications were superior to spring applications on old established bluegrass sods.

In experiments in Columbia where different pasture mixtures are compared under different systems of soil treatments, nitrogen was the only element that gave significant increases in yield. The survival and recovery of alfalfa and fescue where adequate treatment had been applied was striking following the dry weather of the past summer *(Project 99a).*

Nitrogen in Organic Matter.

(W. A. ALBRECHT, M. E. SPRINGER, V. L. SHELDON).

The need to measure the proteins produced by forages in terms of the respective amino acids rather than the total nitrogen is shown in this study. The effects of the supply of sulfur, calcium, phosphorus, boron and magnesium in the growth medium are shown to change the feeding quality of forages *(Project 105a).*

Controlling Erosion on Eroded Land.

(C. M. WOODRUFF).

The plots comprising this study are upon subsoil that was exposed by removing the topsoil. Two plots were in lespedeza in 1953 but because of the drouth did not produce enough to warrant harvesting it. The four remaining plots in corn heavily fertilized yielded only 20 bu. per acre. The heavy clay cracked during dry weather and lacked the capacity to furnish water through long periods without rain. The results of the study when compared with yields of 60 to 70 bu. per acre for corn on Sanborn Field emphasize the importance of the Silt Loam Texture of the surface soil in preventing cracking which tears apart the roots and exposes the deeper layers to evaporation of water *(Project 106a).*

Phosphorus Studies on Eroded Sub-Soil.

(C. M. WOODRUFF).

This study consists of a series of pots of soil that are very low in phosphorus. The treatments include a comparison of superphosphate and rock phosphate at different rates of application on a soil that was limed to neutrality. To date very little response has occurred to the rock phosphate treatments. However, evidence during 1953 suggests that the heavy treatments of rock phosphate are beginning to be effective. The treatments of superphosphate have been very effective. The results are bringing to light an aspect of phosphate fertilization not fully appreciated. The low rates of fertilization were very effective in the beginning but lost their effectiveness with time. The heavy rates of application have continued to produce high yields. The treatments of 160 lbs. of P_2O_5 and less have ceased to be effective and the yields per pound of phosphate were fairly constant, at about .54 gms. per pound. Clover still grows well where greater amounts of phosphate were applied and the yields have always been well above those from the pots with lighter applications even in the early phase of the study. The results suggest that all of the phosphate that was applied was recovered eventually and that in the process the rate of recovery was far greater when the soil was well supplied with phosphorus *(Project 106b).*

Runoff in Erosion from Eroded Lands.

(C. M. WOODRUFF).

No additional investigations were made in 1953 *(Project 106c)*

Continuous Cropping Vs. Crops in Sequences.

(G. E. SMITH, W. J. UPCHURCH, R. A. STEFFENS, MILTON BROWN, S. L. GOWING).

The dry summer season of 1953 furnished information on cropping and soil treatment practices that have never before been obtained. The shortage of moisture throughout the summer growing season gave emphasis to the necessity of adequate soil fertility. Cropping sequence showed relatively little difference in effect on crop yields in 1953. Where corn or wheat is being grown continuously with full soil treatments yields were about as high as where crops were grown in rotation with the same fertilization. Yields obtained on Sanborn Field in 1953 showed the importance of adequate nutrient reserves, regardless of the cropping system.

Differences in crop yields obtained with different crop sequences are influenced by the nutrient removal of the preceding crop and the composition and amount of residue retained. Where wheat followed oats (no soil treatment) and the land was summer plowed, the yield was nearly nine bushels higher than where wheat followed corn. However, where 6 tons of manure or full soil treatment was applied, the difference in yield was less than two bushels per acre. Where wheat had been grown continuously for 65 years with full soil treatment, the yield was 33.7 bushels, while the highest yield of 38.2 bushels was produced in a 4 year rotation of corn, oats, wheat, red clover, with approximately the same soil treatment.

It is of interest that this highest yield of corn produced in 1953 was 72.8 bushels per acre on soil that had been in continuous corn for the past 4 years with full soil treatment. Before this period the fertility of this area was too low to produce more than a 20 bushel yield in a favorable season *(Project 117a).*

Soil Treatments in Different Cropping Systems.

(G. E. SMITH, W. J. UPCHURCH, R. A. STEFFENS, MILTON BROWN, S. L. GOWING).

In a three year rotation experiment where the effects of legumes are measured by corn and small grain, sweet clover continued to give the highest yields of all legumes where the mineral level was adequate but no nitrogen was applied. However where 66 pounds of nitrogen was plowed down before the corn in addition to the legume residue,the difference in residual value of the legumes was less marked. The amount of nitrogen retained in the legume residue appears to be an important effect on following crop yields. However, it appears that there are other benefits

of legumes since legumes plus added nitrogen are producing higher yields of grain crops than is grass with increased amounts of added nitrogen.

The second year effect of legumes, as measured by the wheat crop, was greatest following the sweet clover. The residual effect of the nitrogen applied to the corn largely eliminated differences due to legumes in the second year *(Project 117c).*

Development of Methods for County Soil Testing.

The keeping qualities of polyninyl alcohol used in the exchange magnesium soil test (Mo. Ag. Cir. 345) have been investigated. The results revealed that the reagent had excellent keeping qualities and could successfully be used after a period of 8 months. There was a tendency for the reagent to layer fractionate on standing. This fraction was not related to any physical change and could be determined only by chemical analysis. The original properties of the solution mixture could be restored by vigorous shaking. It was concluded that the reagent could be used even though the reagent was several months old. "Shake Well Before Using" stickers were attached to all bottles containing this reagent *(Project 170a).*

Soil Testing Reagents and Equipment for Soil Testing.

(E. R. GRAHAM, ROY REEVES).

High quality chemicals were purchased by the department of soils and compounded into test solutions which were aged and packaged for shipment on request of the county agent. Each batch of reagents are checked for quality, before shipment. Standard solutions and check soil samples are prepared and made available. This activity requires enough reagents to make analysis on approximately 100,000 samples annually *(Project 170b).*

Effect of Soil and Crop Management on Run-Off, etc.,

(D. D. SMITH, D. M. WHITT).

High level soil treatments with good crop management enabled corn to develope a more dense and deeper root system to secure the soil moisture and nutrients necessary for a yield of 79 bushels or 4.5 times the yield of unfertilized corn. Evapo-transpiration from May 19 to September 2 under fertilized corn totaled 16 inches or 5600 gallons for each bushel of corn produced in contrast to 14 inches or 21,000 gallons for the unfertilized corn.

Soybean yield was almost doubled by one irrigation at the Midwest Claypan Experimental Farm near McCredie in 1953. All plots have sufficiency-level soil treatments according to soil tests. Acre yield was 30.6 bushels with 4.7 inches of irrigation and 16.6 bushels without extra water. The irrigated beans were 50% larger and contained 11% more soil. A total of 11.00 inches of irrigation raised soybean yield from 3.5 to 9.8 bushels per acre on sandy loam soil of Southeast Missouri. All beans were damaged by hot, dry winds in June and July *(Project 171a).*

Comparison of Rates etc. of Fertilizer on Different Crops.

(G. E. SMITH, W. J. UPCHURCH, RAY STEFFENS, MILTON BROWN, J. A. ROTH, S. L. GOWING).

This study embraced 282 experiments with cotton conducted in Southeast Missouri during the past five years. Most of this information is contained in a bulletin: "Fertilizing Cotton in Southeast Missouri", by R. Q. Brown, J. A. Roth, and G. E. Smith *(Project 178a).*

Soil Tests and Fertilizer Response.

(G. E. SMITH, E. R. GRAHAM, W. J. UPCHURCH, J. A. ROTH, R. I. STEFFENS).

Phosphorus tests using three different extracts were made on soils where eight complete fertilizer experiments of wheat were conducted in 1953. In all of these tests, less phosphorus was removed as the strength of the extraction solution was reduced. It would appear that the method now in use is satisfactory, but that it may be necessary to make a different calibration for interpretation of the phosphorus needs of some crops.

Results from cotton experiments indicated that the potash tests are giving satisfactory correlation but in a number of cases a response was obtained from phosphate when the nitrogen level was raised, even though the soil showed a high content of available phosphate. This would suggest that the cotton plant is a weak feeder and it may be necessary to recalibrate the readings of tests or possibly adopt a different extracting solution *(Project 178b).*

Soil Treatment for Maximum Crop Yields.

(G. E. SMITH, W. J. UPCHURCH, R. I. STEFFENS, J. A. ROTH, S. L. GOWING).

With the exception of wheat yields which were some of the highest on record, the season of 1953 was very dry and experiments where heavy applications of fertilizers had been made to obtain maximum yields failed to give significant response over some lower

rates of application. Yields of wheat in excess of 35 or 40 bushels per acre were common on the heavier soil treatments on most of the experiment fields. On most soils there was a significant increase in yield from the application of more nitrogen than in preceding years. The 1953 results indicate that an application of 30 pounds of nitrogen at time of seeding was most effective. Yields were further increased by an additional 30 pounds in the spring. Application of nitrogen beyond this amount did not influence the yields. However, applications of 130 pounds per acre of nitrogen did not cause wheat to lodge in 1953.

Corn yields were greatly reduced by the shortage of moisture and high temperatures during the past summer. The highest yield recorded in any of the experimental trials was about 85 bushels of corn. The principal results from these experiments of heavy nutrient addition was the demonstration that heavy rates of chemical fertilizer improved yields rather than produced injury under drouth conditions *(Project 178c).*

Improving of Soil Fertility Through Nitrogen and Organic Matter.

(G. E. SMITH, W. J. UPCHURCH, MILTON BROWN, S. L. GOWING, J. A. ROTH).

Results obtained the last four years indicate that many sources of organic matter may be used to improve soil fertility provided adequate nutrients are added to balance the carbon in these organic materials. In experiments at Columbia, corn yields following 20 ton applications of such material as sawdust, straw, or corn cobs have been as high as where none of these materials have been added. In all cases it has been necessary to add sufficient nitrogen to produce a carbon nitrogen balance of about 1-10. It appears that with cheaper nitrogen it may be possible to use such materials as sawdust and other organic wastes to improve the physical condition and productivity of eroded soils of high clay content.

Experiments have been conducted in Southeast Missouri with different treatments on cotton hull waste. It was found treatments that included wetting of the hulls and the addition of nitrogen greatly reduced their volume and made them easier to handle. It appears that it will be possible to make a satisfactory compost of this cotton gin waste and increase soil organic matter rather than follow the present practice of burning *(Project 176d).*

Deep Fertilizer Placement on Eroded Soils.

(G. E. SMITH, MILTON BROWN, W. J. UPCHURCH).

Two new experiments were established on Putnam silt loam where soil treatments placed deep in the subsoil are compared with surface treatments. In both cases soybeans were planted in 1953 and the effects of the different treatments were so small as to not warrant any conclusion based on one years results. It appears questionable that the expense involved in deep tillage will be paid for by the increasing crop yields.

It was apparent that if subsoiling is done the work should be accomplished when the subsoil is dry *(Project 178e).*

Veterinary Medicine



A. H. Groth, Dean

Studies of Vaccination and Natural Infection.

(CECIL ELDER, D. E. RODABAUGH).

In an effort to differentiate between natural infection and vaccination blood titers for brucellosis in cattle, we studied 14 infected and 11 vaccinated cattle. All 11 of the vaccinated cows showed a marked increase in blood titer one week after injection with some increase on the 2nd and 4th weeks. The vac-

cinated cows were tested four days after the injection and 4 of the cows showed titer increase. This problem of differentiation between naturally infected animals and vaccinated animals is extremely important because of the great bearing it has upon the control of brucellosis in cattle and its relationship to human health. Plans have been made to study large field herds but so far suitable herds have not been located *(Project 8b).*

Internal Parasites of Sheep and Cattle.

(CECIL ELDER, D. E. RODABAUGH).

We have been able to pass some of the more important bovine parasites through sheep and to prove that after this passage they still had the ability to infest calves.

We collected material from naturally infested sheep, cultured it and developed infective larvae which were given to parasite-free calves. In due course of time the calves started passing parasitic ova which we collected, cultured and put back into parasite-free lambs. When these lambs were autopsied the following parasites were found: Haemonchus contortus, Cooperia curteicii, Cooperia onchophora, and Trichuris ovis giving evidence of the transmission of sheep parasites to cattle and the ability of these parasites after living in calves to again infest lambs.

Although this work was done under artificial conditions, it does show that bovine parasites can pass to and infest sheep and that sheep parasites can do the same with calves and both of them retain their ability to infest their normal host species *(Project 108b).*

Hog Cholera Immunization.

(CECIL ELDER, D. E. RODABAUGH).

An attempt was made to see if the low protein ration had any effect upon the immunity produced when that immunity was challenged with a large dose of potent hog cholera virus.

Of the 21 pigs on a low protein ration that received Swivax vaccine plus anti-hog cholera serum, 11 developed temperatures of 105° F. or higher. Although no pigs died, several showed symptoms of scouring, weakness and anorexia.

Had these pigs been put under conditions of stress, it is thought that they probably would have succumbed. The question is raised as to how much the anti-cholera serum interfered with the production of immunity. Pigs on the good ration plus pasture did not show serious effects of challenge as indicated by absence of scouring, anorexia and marked temperature rise. It was indicated here that the low protein in the ration or some other factor or factors missing in the diet interfered somewhat with the production of a complete and solid immunity to hog cholera *(Project 140a).*

Studies in Pregnancy Disease in Sheep.

(CECIL ELDER, H. H. BERRIER).

The report is on some experimental work done using Ketogestin (a cortisone-related hormone) on 14 field cases of Pregnancy Disease. Doses used ranged from 500 mg. to 1 gm. Although this treatment is expensive and rather time consuming in administration, it seemed to be of some value as a therapeutic agent. The results were encouraging enough to warrant further work with the cortisone related hormones both as a therapeutic and prophylactic agent.

At the time of this report, only 1 ewe had died and 12 were apparently doing satisfactorily. Definite conclusions regarding adrenal steroid cannot be drawn until the close of the 1954 lambing season. *A complete summary will be made at that time (Project 144a).*

Pullorum Testing and Production on Pullorum Antigen.

(A. H. GROTH, P. M. NEWBERNE, H. C. MCDOUGLE).

A few more samples (68,394) were tested this year than shown (67,962) last year. However, the percent (0.013) of positive birds this year was lower than last year (0.115). Most of the samples tested in this diagnostic laboratory are from turkeys. Antigen production for use in 3 hatcheries and our laboratory was sufficient to test 418,144 samples. The amount of antigen on hand will test 176,500 samples *(Project 145a).*

Disease Transmission from Carrier Sows to Baby Pigs.

(A. A. CASE, C. J. BIERSCHWAL, LOREN KINTNER, JOHN LASLEY, E. J. PENROD, DONIPHON HILLIARD).

A group of sows in the breeding herd was treated with 120,000 u penicillin and 4,800 u bacitracin (CSC List 995), intrauterine, 5 or 6 days before the onset of oestrus and ALL of them settled the first time.

A sow that was a problem breeder was treated with 240,000 u penicillin and 9,600 u bacitracin also settled.

Fifty percent of the group of sows, slaughtered 25 days after breeding showed perfect correlation between the number of ova shed and the number of embryos developing.

The antibiotic was too strong in the first series and upset the normal equilibrium of the reproductive tract, as evidenced by only partial success in settling

the sows and it took three oestral periods for some to settle. There was a trend to more pigs per litters in the sows given the intrauterine medication than in the ones not so treated *(Project 175a).*

Reaction in Turkeys When Agglutination Test is Used.

The greatest difficulty with all of the rapid antigens was the positive and granular (or suspicious) reactions on blood of negative birds. *When S. pullorum was recovered,* the previous test records show that rapid antigens are effective for detecting the carrier birds *(Project 176a).*

Publications



Elmer B. Winner, Editor

Agricultural Information—Administration.

(E. B. WINNER).

One new staff member was added January 1, 1954. This resulted in some shifting of duties among staff members, so that division of responsibility is now as follows:

Two staff members — bulletins;
One staff member — radio;
One staff member — television;
One staff member — news;
One staff member — administration and organization, development of new phases of program, and assisting with present ones. *(Project 174a).*

Radio Releases and Radio Tape Service.

(B. M. PHIFER).

New radio programs started for 31 county and home agents. Two-page daily farm news service provided all radio stations in the state. Daily five-minute tape recorded farm program of useful farm and home information provided to 30 stations throughout the year *(Project 174b).*

Publications.

(PAUL GWIN, A. A. JEFFREY, ROSE FLOREA).

All manuscripts submitted by Experiment Station staff and approved for Station Publications were edited and processed *(Project 174c).*

News Releases, Periodicals, and Special Publications.

(E. B. WINNER, A. V. EDWARDS, RICHARD LEE).

Research data was 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 as available, and tips to staff writers of the various publications. In addition, periodicals such as the monthly Announcer, and special publications were edited and published *(Project 174d).*

Television.

(A. V. EDWARDS, E. B. WINNER).

A 15-minute weekly television show was presented over WDAF-TV, Kansas City, up to December 1. Two 30-minute shows were presented weekly on KOMU-TV, Columbia, starting in late December. Pictures and slides were furnished to 3 other television stations starting in October. Programs 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 *(Project 174e).*

PROGRESS REPORT

24 Soils of Taney County, Missouri, by C. L. Scrivner, J. A. Frieze, July 1953, 8 pages, 2000 copies.

Station Bulletins (Reprints of Station Publications for the year July 1953 through June 1954)

547 Good Pastures Pay, by E. Marion Brown, July 1953, 24 pages, 3500 copies.
443 Measuring the Productive Value of Pastures, by H. J. L'Hote, July 1953, 36 pages, 1000 copies.
591 The Place of 4-H Club Work in Urban Areas, by T. T. Martin, July 1953, 32 pages, 1500 copies.
508 Winter Barley in Missouri, by J. M. Poehlman and C. A. Helm, Aug. 1953, 20 pages, 3500 copies.
580 Hybrid Seed Corn Production in Missouri, by M. S. Zuber, Sept. 1953, 24 pages, 2000 copies.
571 Using Nonfat Dry Milk Solids in Home Prepared Foods, by Leta Maharg and Margaret Mangel, Sept. 1953, 16 pages, 2000 copies.
527 Internal Parasites of Sheep, by Cecil Elder and D. E. Rodabaugh, Oct. 1953, 12 pages, 2000 copies.
569 B-400 a New Early Variety of Winter Barley for Missouri, by J. M. Poehlman, Oct. 1953, 12 pages, 2000 copies.
542 Success with Strawberries, by A. D. Hibbard and D. D. Hemphill, Nov. 1953, 32 pages, 2000 copies.
568 Chemical Weed Control in Horticultural Crops, by D. D. Hemphill, A. E. Murneek, J. E. Smith, Nov. 1953, 28 pages, 2000 copies.
546 Corn Hybrids Adapted for Missouri, by M. S. Zuber and C. O. Grogan, Jan. 1954, 12 pages, 3500 copies.
593 Rearing Orphan Pigs, by V. F. McRoberts and A. G. Hogan, Feb. 1954, 4 pages, 2000 copies.
559 Buildings for the Dairy Enterprise, by J. C. Wooley, K. B. Huff, R. E. Stewart, A. C. Ragsdale, Jan. 1954, 24 pages, 1200 copies.
597 Common Parasites of Swine, by G. C. Shelton and O. S. Crisler, Feb. 1954, 20 pages, 2000 copies.
579 The Chemical Analysis of Grass, Silage, Hay, Straw, Concentrates and Miscellaneous Feedstuffs, by L. D. Haigh, Feb. 1954, 20 pages, 500 copies.
587 Pork Production in Missouri, by John F. Lasley, Jan. 1954, 56 pages, 3500 copies.
607 (Regional Publication 41) Quality Losses in Market Eggs, by A. R. Winter, March 1954, 16 pages, 3500 copies.
619 Research for Better Farm Living, by J. H. Longwell, March 1954, 36 pages, 3500 copies.
596 Agriculture and the People, by M. F. Miller, May 1954, 52 pages, 5000 copies.
616 Effects of Supplemental Water on Field Crops, by D. M. Whitt, May 1954, 8 pages, 3500 copies.
595 General-Purpose Spray Mixtures for Home Fruit Plantings, by H. G. Swartwout and Lee Jenkins, June 1954, 8 pages, 2000 copies.

Reprints of Station Circulars—July 1953 through June 1954

333 Our Teeth and Our Soils, by W. A. Albrecht, May 1954, 16 pages, 2000 copies.
345 Testing Missouri Soils, by E. R. Graham, April 1954, 24 pages, 1000 copies.
330 Let's Look at the Soil, by M. F. Miller, May 1954, 48 pages, 7000 copies.
360 Farming as an Occupation, by M. F. Miller, May 1954, 36 pages, 3000 copies.
189 Testing Milk and Cream, by H. A. Herman, J. H. Gholson and J. E. Edmondson, Sept. 1954, 20 pages, 3500 copies.

Reprints of Research Bulletins

498 The Relationship of Certain Factors to County Agent Success, by Ivan Nye, Feb. 1954, 44 pages, 600 copies.
555 Comparative Methods of Cleaning Meat Cutting Tables, by R. L. Henrickson, R. F. Brooks, E. Birmingham, D. E. Brady, Oct. 1954, 8 pages, 1500 copies.

Unnumbered Publications

Research for Better Farm Living, by J. H. Longwell, Nov. 1953, 36 pages, 4000 copies.
Ten-Year Objectives in Research, Resident Instruction and Agricultural Extension Work, by J. H. Longwell, June 1954, 16 pages, 2000 copies.

RESEARCH BULLETINS*

524 A Study of the Transmitting Ability of Brown Swiss Sires, by Chase C. Wilson and H. A. Herman, July 1953, 42 pages, 1500 copies.
525 Experiments in Chick Feeding 1947-1952, by Q. B. Kinder and H. L. Kempster, June 1953, 24 pages, 1500 copies.
526 Study of Some Factors Affecting Efficiency of Reproduction in Dairy Cattle Serviced by Artificial Insemination, by T. E. Patrick and H. A. Herman, Sept. 1953, 44 pages, 1500 copies.
527 Young Dairy Calf Housing in Missouri, by M. L. Esmay, H. F. Williams, B. E. Guyer, August 1953, 20 pages, 1500 copies.
528 Reproductive Efficiency in Dairy Cattle, by H. A. Herman, R. W. Spalding, K. W. Bower, August 1953, 12 pages, 1800 copies.
529 Factors Affecting Length of Gestation Period in Dairy Cattle, by H. A. Herman, R. W. Spalding, K. W. Bower, August 1953, 14 pages, 1800 copies.
530 Survival of Pathogenic Bacteria in Foods Prepared with Whole Egg Solids, by Treva Kintner and Margaret Mangel, Sept. 1953, 20 pages, 1500 copies.
531 Environmental Physiology and Shelter Engineering, by H. J. Thompson, D. M. Worstell, Samuel Brody, August 1953, 28 pages, 1500 copies.
532 The Effect of Tannins in Korean Lespedeza and Other Feeds on Milk Production, by H. A. Herman, G. W. Graham, K. W. Bower, August 1953, 8 pages, 1800 copies.
533 Study of Composition of Missouri Grown Roughages, by W. H. Cloninger and H. A. Herman, Oct. 1953, 52 pages, 1500 copies.
534 Influence of Environmental Factors on Streptococcus Alalactiae Isolated from Active Cases of Bovine Mastitis, by James H. Gholson, H. A. Herman, Sept. 1953, 39 pages, 1500 copies.
535 Effects of Carbohydrate Feeding Levels on Roughage Digestion in Dairy Cattle, by C. F. Foreman, H. A. Herman, Oct. 1953, 56 pages, 1800 copies.
536 Machinery Use and Investment on Missouri Farms, 1951, Oct. 1953, 56 pages, 1900 copies.
537 The Mammary Gland Spreading Factor, by J. R. Elliott, C. W. Turner, Dec. 1953, 52 pages, 1500 copies.
538 Osmotic Pressure of Extended Bovine Semen During Storage, Dec. 1953, 20 pages, 1500 copies.
539 Marketing Cream in Missouri Through Cooperative Buying Stations, by C. C. Erwin, D. N. Harrington, Dec. 1953,

35 pages, 1500 copies.

540 Development of Methods for Use of Antibiotics to Control Fireblight, by R. N. Goodman, Jan. 1954, 16 pages, 1500 copies.

541 Relationship of Shortleaf Pine Growth to Soil Properties, by R. W. Dingle, P. Y. Burns, January 1954, 11 pages, 1700 copies.

542 Environmental Physiology and Shelter Engineering XXIV with Special Reference to Domestic Animals, by H. J. Thompson, March 1954, 28 pages, 1675 copies.

543 Value of Antibiotics in Swine Rations, by J. F. Lasley, L. F. Tribble, A. G. Hogan, April 1954, 55 pages, 1500 copies.

544 Hydraulic Test of Erosion Control Structures, by R. P. Beasley, H. J. Hall, March 1954, 24 pages, 2500 copies.

545 Environmental Physiology and Shelter Engineering XXV with Special Reference to Domestic Animals, by S. Brody, A. C. Ragsdale, H. J. Thompson and D. M. Worstell, April 1954, 20 pages, 1500 copies.

546 Adaptations and Limitations of Ring Test for Bovine Brucellosis, by K. L. Tallman, H. A. Herman, May 1954, 44 pages, 1500 copies.

547 The Effects of a Borax-Boric Acid Solution on Cotton and Rayon Fabrics, by Adella E. Ginter, Kathryn Detring, Shirley Titus Henley, Emma Livingston, April 1954, 23 pages, 1500 copies.

548 Environmental Physiology and Shelter Engineering XXVI with Special Reference to Dairy Cattle, by H. J. Thompson, R. G. Yeck, D. M. Worstell and S. Brody, June 1954, 28 pages, 1500 copies.

549 Fatness of Pork in Relation to Consumer Preference, by E. Birmingham, D. E. Brady, S. M. Hunter, J. C. Grady, E. R. Kiehl, May 1954, 23 pages, 1500 copies.

550 Maintaining Quality in Shell Eggs by Heat Treatment, by E. M. Funk, James Forward, Martha Lorah, June 1954, 22 pages, 1500 copies.

551 Evaluation of Selection in Developing Inbred Lines of Swine, by G. E. Dickerson, C. T. Blunn, A. B. Chapman, R. M. Kottman, J. L. Krider, E. J. Warwick, J. A. Whatley, Jr. in collaboration with M. L. Baker, J. L. Lush, L. M. Winters, May 1954, 60 pages, 3500 copies.

552 Environmental Physiology with Special Reference to Domestic Animals XXVII, by H. H. Kibler and S. Brody, June 1954, 40 pages, 1500 copies.

553 Trace Elements in Missouri Soils, by E. E. Pickett, R. H. Dinius, May 1954, 20 pages, 1500 copies.

554 Pork Carcass Evaluation, by S. E. Zobrisky, J. F. Lasley, D. E. Brady, L. A. Weaver, July 1954, 60 pages, 1500 copies.

555 Comparative Methods of Cleaning Meat Cutting Tables, by R. L. Henrickson, R. F. Brooks, E. Birmingham, D. E. Brady, June 1954, 8 pages, 1500 copies.

STATION BULLETINS

600 Sweet Potato Production in Missouri, by Victor N. Lambeth, July 1953, 24 pages, 3500 copies.

601 Soils of Moniteau County Missouri, by J. A. Frieze, C. L. Scrivner, July 1953, 16 pages, 3000 copies.

602 Fertilizer Inspection and Analysis; Fall, 1952, by J. H. Longwell, R. C. Prewitt, C. W. Gehrke, E. W. Cowan, July 1953, 54 pages, 6500 copies.

603 Let's Study Your Farm Business, by James E. Dillion and Robert C. Suter, May 1953, 12 pages, 3500 copies.

604 Soils of Daviess County, Missouri, by H. E. Grogger, J. A. Frieze, H. H. Krusekoph, July 1953, 24 pages, 3000 copies.

605 Cane Vs. Wood Molasses, Used as Preservatives for Grass Silage, by H. S. Peet, A. C. Ragsdale, August 1953, 8 pages, 3500 copies.

606 Sale of Missouri Hatching Eggs, 1941-1952, by E. M. Funk, August 1953, 8 pages, 3500 copies.

607 Quality Losses in Market Eggs (Part of a Regional Study), by E. M. Funk, September 1953, 16 pages, 16,000 copies.

608 Teaming Up Town and Country, A Study in Rural-Urban Relations, by Elmer R. Kiehl, October 1953, 28 pages, 3500 copies.

609 Direct Seeding of Oak in Missouri, by J. M. Nichols, January 1954, 4 pages, 3500 copies.

610 Feeding Livestock, by A. G. Hogan, January 1954, 24 pages, 3500 copies.

611 Acorn Production in the Missouri Ozarks, by P. Y. Burns, D. M. Christisen, J. M. Nichols, January 1954, 8 pages, 3500 copies.

612 Tests on Treated Fence Posts, by W. J .O'Neil, January 1954, 8 pages, 3500 copies.

613 Missouri Hybrid Corn Yield Tests for 1953, by M. S. Zuber and B. H. Beard, January 1954, 20 pages, 4000 copies.

614 Compare Your Dairy Business—With an Analysis of 56 Central Missouri Farms 1953, by R. C. Suter, January 1954, 8 pages, 3500 copies.

615 Controlling Woody Plants with 2,4,5-T; 2,4-D and Ammate, by S. Clark Martin, J. M. Nichols, D. L. Klingman, January 1954, 8 pages, 4300 copies.

616 Supplemental Water on Field Crops, by D. M. Whitt, February 1954, 8 pages, 3500 copies.

617 Vegetable Plants for Home and Commercial Growers, by A. D. Hibbard, V. N. Lambeth, March 1954, 20 pages, 3500 copies.

618 Improving Livestock Through Breeding, by J. F. Lasley and F. J. Rice, April 1954, 24 pages, 3500 copies.

619 Research for Better Farm Living, by J. H. Longwell, March 1954, 34 pages, 4000 copies .

620 Rural-Urban Population Change and Migration in Missouri 1940-1950, by R. L. McNamara, Peter New, Donnell Pappenfort, April 1954, 32 pages, 3500 copies.

621 Production, Marketing Advance Through Research, (annual station report for 1951-1952), by J. H. Longwell, April 1954, 72 pages, 3500 copies

622 Increasing Size and Color of Fruit, by A .E. Murneek, May 1954, 12 pages, 3500 copies.

623 Marketing Farm Woodlot Products, by Richard C. Smith, Ross Horton, W. J. O'Neil, May 1954, 26 pages, 3500 copies.

624 Father and Son Agreements, by Robert C. Suter, May 1954, 24 pages, 3500 copies.

625 Trends in Missouri Poultry Prices, by J. D. Miller, May 1954, 12 pages, 3500 copies.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS

1365 The Acid-Base Balance of Dairy Cattle in Relation to the Environmental Temperature, by Homer E. Dale and Samuel Brody, Departments of Veterinary Physiology and Dairy Husbandry. Submitted July, 1953, to be presented at the Toronto Convention of the American Veterinary Medical Association.

1366 Effect of Thiouracil on Hair Color of Yellow Rats, by R. E. Stewart and Samuel Brody (Introduced by C. W. Turner), Departments of Agricultural Engineering and Dairy Husbandry. Submitted July, 1953, for publication in Proceedings of the Society of Experimental Biology and Medicine.

1367 Identification of the Auxin Present in Apple Endosperm,

by F. G. Teubner, Department of Horticulture. Submitted July, 1953, for publication in Science.

1368 Eperythrozoonosis Transmitted In-Utero from Carrier Sows to Their Pigs, by H. H. Berrier, Jr., and R. E. Gouge, School of Veterinary Medicine. Submitted July, 1953, for publication in Journal of American Veterinary Medical Association.

1369 The Mammary Gland Spreading Factor in Normal Pregnant Animals, by J. R. Elliott and C. W. Turner, Department of Dairy Husbandry. Submitted July, 1953, for publication in Endocrinology.

1370 Bovine Mammary Gland Carcinoma, by Cecil Elder, Loren D. Kintner, and Richard E. Johnson, School of Veterinary Medicine. Submitted August, 1953, for publication in Journal of the American Veterinary Medical Association.

1371 A study of Composition of Missouri Grown Roughage, by W. H. Cloninger and H. A. Herman, Department of Dairy Husbandry. Submitted August, 1953, for publication in Journal of American Society of Animal Production.

1372 A Method for the In Vivo Determination of the Thyroid I^{131} of Dairy Cows, by Clifton Blincoe, Department of Dairy Husbandry. Submitted August, 1953, for publication in Nucleonics.

1373 A Comparison of the Ability of Certain Egg Yolk Diluents to Maintain Optimum Osmotic Conditions During the Storage of Bull Semen, by John T. Smith, Dennis T. Mayer, and H. A. Herman Departments of Animal Husbandry, Agricultural Chemistry, and Dairy Husbandry. Submitted September, 1953, for publication in Journal of Dairy Science.

1374 A Geotropic Response of Snapdragon to Treatment with Trichlorophenoxypropionic Acid, by Joseph L. Bennett and James E. Smith, Jr., Floriculture Department. Submitted September, 1953, for publication in the Proceedings of the American Society for Horticultural Science.

1375 Effects of Certain Growth Regulators on Storage and After Storage Life of Certain Cut Flowers, by Joseph L. Bennett and James E. Smith, Jr., Department of Floriculture. Submitted September, 1953.

1376 Blood Concentration of Sulfisoxazole Following Administration of a Standard Dose to Cattle, by H. E. Dale and A. W. Uren, Department of Veterinary Physiology and Pharmacology. Submitted September, 1953, for publication in Veterinary Medicine Magazine.

1377 In Vitro Metabolism of the Rat Mammary Gland: Respiration, Aerobic Glycolysis, and Carbon Dioxide Production, by Charles R. Hoover and C. W. Turner, Department of Dairy Husbandry. Submitted September, 1953, for publication in the Proceedings of the Society for Experimental Biology and Medicine.

1378 A New Species of Water Beetle from Michigan (Coleoptera, Haliplidae), by Paul J. Spangler, Department of Entomology and the Michigan Biological Station. Submitted September, 1953, for publication in Entomological News.

1379 Amino Acid Deficiencies of Casein as a Source of Protein for the Chick, by A. W. Wiellake, A. G. Hogan, B. L. O'Dell and H. L. Kempster, Departments of Agricultural Chemistry and Poultry Husbandry. Submitted October, 1953, for publication in Journal of Nutrition.

1380 An Evaluation of the Production and Economic Returns from Pastures on a Midwestern Claypan Soil, by D. M. Whitt, Department of Field Crops. Submitted October, 1953, for publication in the Proceedings of the American Society of Agronomy.

1381 Sterile Distilled Water as a Medium for the Isolation of the Oak Wilt Fungus, by T. W. Bretz, Department of Botany. Submitted October, 1953, for publication in Plant Disease Reporter.

1382 Abstract for the Corn Section of the 1953 NCWWC Research Report, by Fletchall, O. Hale, Department of Field Crops. Submitted October, 1953, for publication in the Tenth Annual (1953) Research Report of the North Central Weed Control Conference.

1383 Preliminary Trials with Dalapon on Weedy Annual Grasses and Johnson Grass, by O. Hale Fletchall and Dayton L. Klingman, Department of Field Crops. Submitted October, 1953, for publication in the Tenth Annual (1953) Research Report of the North Central Weed Control Conference.

1384 The Relative Toxicity of Phenyldimethylurea and CMU, by Dayton L. Klingman and O. Hale Fletchall, Department of Field Crops. Submitted October, 1953, for publication in the Tenth Annual (1953) Research Report of the North Central Weed Control Conference.

1385 Crude Protein of Corn Grain and Stover as Influenced by Different Hybrids, Plant Populations and Nitrogen Levels, by M. S. Zuber, G. E. Smith, and C. W. Gehrke, Departments of Field Crops, Soils, and Agricultural Chemistry. Submitted October, 1953, for publication in Journal of American Society of Agronomy.

1386 Changes in Corn Production as Associated with Different Nitrogen Levels, Plant Populations, and Hybrids, by G. E. Smith and M. S. Zuber, Departments of Soils and Field Crops. Submitted October, 1953, for publication in Soil Science of America Proceedings.

1387 Selective Chemical Weed Control in Sweet Potatoes, 1953, by D. D. Hemphill, Department of Horticulture. Submitted November, 1953, for publication in the Research Report of the Tenth Annual North Central Weed Control Conference.

1388 Pre-emergence and Post-emergence Weed Control in Sweet Corn, by D. D. Hemphill, Department of Horticulture. Submitted November, 1953, for publication in the Research Report of the Tenth Annual North Central Weed Control Conference.

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1391 Chemical Weed Control in Onions, by D. D. Hemphill, Department of Horticulture. Submitted November, 1953, for publication in the Research Report of the Tenth Annual North Central Weed Control Conference.

1392 Chemical Weed Control in Green Beans, by D. D. Hemphill, Department of Horticulture. Submitted November, 1953, for publication in the Research Report of the Tenth Annual Weed Control Conference.

1393 Availability of Natural Phosphates According to Energy Changes by E. R. Graham, Department of Soils. Submitted November, 1953, for publication in the Proceedings of Soil Science Society of America.

1394 Soil Fertility and the Organic Composition of Plants, I. Diversity of Amino Acid Array in Forages, by Wm. A. Albrecht, Department of Soils. Submitted November, 1953, for publication in the Proceedings of Soil Science

Society of America.

1395 Fertilizer Use in Missouri Based on Soil Tests, by George E. Smith, Department of Soils. Submitted November, 1953, for publication in Proceedings of Soil Society of America.

1396 Soil Fertility and the Organic Composition of Plants. II. Tryptophane and Methionine in Forage Crops, by V. L. Sheldon, Wm. G. Blue, and Wm. A. Albrecht, Depart- of Soils. Submitted November, 1953, for publication in the Proceedings of Soil Science Society of America.

1397 Ionic Equilibria In Dilute Electrolytes, by C. M. Woodruff, Department of Soils. Submitted November, 1953, for publication in the Proceedings of Soil Science Society of America.

1398 A Comparison of the Effects of Starvation and Thermal Stress on the Acid-Base Balance of Dairy Cattle, by Homer E. Dale, Cecil K. Goberdhan, and Samuel Brody, Departments of Veterinary Physiology and Pharmacology, Agricultural Chemistry, and Dairy Husbandry. Submitted November, 1953, for publication in the American Journal of Veterinary Research.

1399 Weathering According to the Cationic Bonding Energies of Colloids, by E. R. Graham, Department of Soils. Submitted November, 1953, for publication in the Bulletin of The Geological Society of America.

1400 The Solubility of Silica in Hydrogen Beidellite, by C. M. Woodruff, Department of Soils. Submitted November, 1953, for publication in the Bulletin of The Geological Society of America.

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1402 The Mammary Gland Spreading Factor, by J. R. Elliott and C. W. Turner, Department of Dairy Husbandry. Submitted December, 1953, for presentation at the American Society of Animal Production meetings.

1403 The Intracellular Localization of I^{131} Tagged Lactogenic Hormone in the Mammary Gland of the Rabbit, by W. F. Williams and C. W. Turner, Department of Dairy Husbandry. Submitted December, 1953 for presentation at the American Society of Animal Production meetings.

1404 A Study of Quality, as Measured by the Pearling Test, in Crosses Between Hard and Soft Wheats, by Benjamin H. Beard and J. M. Poehlman, Department of Field Crops. Submitted December, 1953, for publication in Agronomy Journal.

1405 Climatic Factors in Animal Production— With Special Reference to Dairy Cattle, by Samuel Brody, Department of Dairy Husbandry. Submitted December, 1953, for publication in Physiological Reviews.

1406 The Effects of Indole-3-Acetic Acid on the Disease-Inhibiting Properties of Antibiotics, by R. N. Goodman and D. D. Hemphill, Department of Horticulture. Submitted December, 1953, for publication in Science.

1407 Deperitonealization of the Wall of the Rumen, by Edgar F. Ebert, Benjamin B. Roseboom, and Homer E. Dale, School of Veterinary Medicine. Submitted December, 1953, for publication in the Journal of the American Veterinary Medical Association.

1408 Dracunculiasis in a Dog Reported in Missouri Case Report, by Cecil Elder, Department of Veterinary Pathology. Submitted December, 1953, for publication in Journal of the American Veterinary Medical Association.

1409 The Gene, by L. J. Stadler, University of Missouri and United States Department of Agriculture. Submitted December, 1953, for publication in Science.

1410 Horse Fly Control With Diazinon, by Curtis W. Wingo, Department of Entomology. Submitted January, 1954, for publication in the Journal of Economic Entomology.

1411 The Ventricular System in Hydrocephalic Rat Brains Produced by a Deficiency of Vitamin B_{12} or of Folic Acid in the Maternal Diet, by M. D. Overholser, J. R. Whitley, B. L. O'Dell, and A. G. Hogan, Departments of Anatomy and Agricultural Chemistry. Submitted January, 1954, for publication in the American Journal of Anatomy.

1412 Soil Fertility and the Organic Composition of Plants III. Lysine, Arginine, and Aspartic Acid Variations, by Lester W. Reed, Victor L. Sheldon, and William A. Albrecht, Department of Soils. Submitted February, 1954, for publication in the Proceedings of the Soil Science Society of America.

1413 Characterization of Some Lactobacilli Found in Milk, by J. E. Edmondson and R. G. Jensen, Department of Dairy Husbandry. Submitted February, 1954, for presentation at June meeting of the American Dairy Science Association.

1414 The Effect of Wind on Holstein, Brown Swiss, Jersey, and Brahman Cows, by Samuel Brody, Department of Dairy Husbandry. Submitted February, 1954, for presentation at the June meeting of the American Dairy Science Association.

1415 Case of the Differences in the Productivity of Dairy Cattle, by C. W. Turner, Department of Dairy Husbandry. Submitted February, 1954, for presentation at the June meeting of the American Dairy Science Association.

1416 Stimulation of Growth and Function of the Rat Mammary Gland, by W. R. Kirkham, Postdoctoral fellow of the National Cancer Institute, and C. W. Turner, Department of Dairy Husbandry. Submitted February, 1954, for presentation at the June meeting of the American Dairy Science Association.

1417 The Intracellular Localization of I^{131}-Tagged Lactogenic Hormone in the Mammary Gland of the Rabbit, by W. F. Williams and C. W. Turner, Department of Dairy Husbandry. Submitted March, 1954, for publication in the Proceedings for the Society of Experimental Biology and Medicine.

1418 Problems of Gene Structure. III. Relation of Unequal Crossing-Over to the Inter-Dependence of R Elements (S) and (P), by L. J. Stadler and Margaret Emmerling, U. S. Department of Agriculture and University of Missouri. Submitted March, 1954, for publication in Science.

1419 Farm Reservoirs as a Source of Irrigation Water, by Dwight D. Smith, Department of Agricultural Engineering. Submitted March, 1954, for presentation at the Mid-Central meeting of the American Society of Agricultural Engineers and publication in Agricultural Engineering.

1420 Reducing Weed Control Costs in Missouri Cotton by the Combined Use of a Pre-Emergence Herbicide and Cross-Cultivation, by Chester L. Foy and Norman Brown, Department of Field Crops. Submitted March, 1954, for publication in Soils and Crops.

1421 Hormonal Induction of Lactation in Identical Twin Dairy Cattle, by John Hancock, P. J. Brumby, and C. W. Turner, Department of Dairy Husbandry. Submitted March, 1954, for publication in the English Journal of Dairy Research.

1422 Rumen Temperature: I. Temperature Gradients During Feeding and Fasting, by Homer E. Dale, Robert E. Stewart, and Samuel Brody, Departments of Veterinary

Physiology, Agricultural Engineering, and Dairy Husbandry. Submitted March, 1954, for publication in the Cornell Veterinarian.

1423 The Embryo and Endosperm in Relation to Fruit Development With Special Reference to Malus Sylvestris, by A. E. Murneek, Department of Horticulture. Submitted March, 1954, for publication in Transactions of Botanical Congress.

1424 Soybean Irrigation Studies in Missouri, by D. M. Whitt, Department of Field Crops and Agricultural Research Service, United States Department of Agriculture. Submitted March, 1954, for publication in the Soybean Digest.

1425 Congenital Malformations as Related to Deficiencies of Riboflavin and Vitamin B_{12}, Source of Protein, CA:P Ration and Skeletal Phosphorus Metabolism, by Robert B. Grainger, Boyd L. O'Dell, and Albert G. Hogan, Department of Agricultural Chemistry. Submitted April, 1954, for publication in the Journal of Nutrition.

1426 2,4,5-Trichlorophenoxypropionic Acid as a Preharvest Spray for Apples, by A. E. Murneek, Department of Horticulture. Submitted April, 1954, for publication in the Proceedings of the American Society of Horticultural Science.

1427 Significant Relationships in Pork Carcass Evaluation I. Lean Cuts and Total Lean as Criteria for Live Hog Value, by S. E. Zobrisky, D. E. Brady, J. F. Lasley, and L. A. Weaver, Department of Animal Husbandry. Submitted April, 1954, for publication in the Journal of Animal Science.

1428 Apple Fruits a Source of Overwintering Fireblight Inoculum, by Robert N. Goodman, Department of Horticulture. Submitted April, 1954, for publication in the Plant Disease Reporter.

1429 The Effect of Some Steroid Compounds on Ovine Rumen Function, by C. C. Brooks, M. E. Muhrer, and W. H. Pfander, Departments of Animal Husbandry and Agricultural Chemistry. Submitted April, 1954, for publication in Science.

1430 Studies on the Microflora of Prepackaged Table-ready Meats I. Introduction, Sources of Experimental Samples, and Analytical Methods, by R. F. Brooks and R. L. Henrickson, Department of Animal Husbandry. Submitted May, 1954, for publication in Food Technology.

1431 Sugar Maple-Basswood Studies in the Forest-Prairie Transition of Central Missouri, by C. L. Kucera, and R. E. McDermott, Departments of Botany and Forestry. Submitted May, 1954, for publication in American Midland Naturalist.

1432 Antibiotic-Like Substance and Cellulose Digestion Stimulator Found in Fermented Feeds and in Rumen Fluid, by G. B. Garner, M. E. Muhrer, W. C. Ellis, and W. H. Pfander, Departments of Agricultural Chemistry and Animal Husbandry. Submitted May, 1954, for publication in Science.

1433 Studies on the Microflora of Prepackaged Table-ready Meats. II. Bologna and Pickle-Pimiento Loaf, by R. L. Henrickson and R. F. Brooks, Department of Animal Husbandry. Submitted May, 1954, for publication in Food Technology.

1434 The Effect of Added Fat on the Digestion of Cellulose and Protein by Ovine Rumen Microorganisms, by C. C. Brooks, G. B. Garner, C. W. Gehrke, M. E. Muhrer, and W. H. Pfander, Departments of Animal Husbandry and Agricultural Chemistry. Submitted May, 1954, for publication in the Journal of Animal Science.

1435 A Comparison of Four Counting Fluids with Special Emphasis on Their Use for Evaluation of Spermatozoan Concentration by the Haemacytometer Method, by John T. Smith and Dennis T. Mayer, Departments of Animal Husbandry and Agricultural Chemistry. Submitted May, 1954, for publication in Fertility and Sterility.

1436 Establishment of Ladino Clover in Grass Sods, by O. Hale Fletchall and E. Marion Brown, Department of Field Crops. Submitted May, 1954, for presentation at the 1954 Annual Meeting of the American Society of Agronomy.

1437 An Ion-Exchange Resin-Contact Time Method for the Study of Inorganic Equilibria in Milk, by J. M. Baker, C. W. Gehrke, and H. E. Affsprung, Department of Agricultural Chemistry. Submitted May, 1954, for publication in the Journal of Dairy Science.

1438 Fecal Androgen, A Progesterone Metabolite in the Female Bovine, by William R. Miller and Charles W. Turner, Department of Dairy Husbandry. Submitted May, 1954, for publication in the Proceedings of the Society of Experimental Biology and Medicine.

1439 Home Applied Starch-Like Finishes, by Adella E. Ginter, Department of Home Economics. Submitted June, 1954, for publication in the Journal of Home Economics.

1440 An Application of Scaling Techniques to the Study of Religious Groups, by C. M. Coughenour, Department of Rural Sociology. Submitted June, 1954, for publication in Rural Sociology.

1441 Significant Relationships in Pork Carcass Evaluation—II. Fat Cuts and Total Fat as a Criteria for Live Hog Value, by S. E. Zobrisky, D. E. Brady, J. F. Lasley, and L. A. Weaver, Department of Animal Husbandry. Submitted June, 1954, for publication in the Journal of Animal Science.

1442 Significant Relationships in Pork Carcass Evaluation—III. Dressing Percent as a Criterion for Live Hog Value, by S. E. Zobrisky, D. E. Brady, J. F. Lasley, and L. A. Weaver, Department of Animal Husbandry. Submitted June, 1954, for publication in the Journal of Animal Science.

1443 Significant Relationships in Pork Carcass Evaluation—IV. Loin Equivalents as Criteria for Live Hog Value, by S. E. Zobrisky, D. E. Brady, J. F. Lasley, and L. A. Weaver, Department of Animal Husbandry. Submitted June, 1954 for publication in the Journal of Animal Science.

1444 A Direct Ethylenediamine Tetraacetate Titration Procedure for Calcium in Biological Substances. Anion Exchange Separation of Phosphate, by Charles W. Gehrke, Harold E. Affsprung, and Yung C. Lee, Department of Agricultural Chemistry. Submitted June, 1954, for publication in Journal of Agricultural and Food Chemistry.

1445 Neighborhoods as a Factor in the Diffusion of Farm Information in a Northeastern Missouri Farming Community, by Herbert F. Lionberger and Edward Hassinger, Rural Sociology Department. Submitted June, 1954, for publication in Rural Sociology.

1446 A Direct Disodium Dihydrogen Ethylenediamine Tetraacetate Titration Procedure for Magnesium in Limestone, by Charles W. Gehrke, Harold E. Affsprung, and Yung C. Lee, Department of Agricultural Chemistry. Submitted June, 1954, for publication in the Journal of Analytical Chemistry.

RESEARCH GRANTS AND GIFTS

U. S. Public Health Service

For study of the project "Relation of Nutrition to Hydrocephalus in Infant Rats".

Merck and Company, Incorporated

In support of research on the nutritional requirements of swine.

Office of Naval Research

For continued support of a project on the investigation of the influence of climatic factors and muscular work in large animals (sweating species).

Atomic Energy Commission

For a research project pertaining to the "Determination of Thyroid Activity in Farm Animals by the Use of Radioactive Tracers."

Quaker Oats Company

For research in the breeding of white hybrid corn.

Missouri Conservation Commission

For farm forestry research.

American Potash Institute

For research dealing with the relationship of potash to soil fertility.

Pacific Coast Borax Company

For the support of research in connection with trace elements.

Tennessee Corporation

For research on the function of the so-called trace elements, copper, manganese, and zinc.

Herman Frasch Foundation

For research dealing with the composition of food and the accumulation of calcium phosphate in animal tissue.

United States Public Health Service

For a research project entitled "The Biochemistry and Physiology of Mammalian Spermatozoa."

United States Army—Quartermaster Food and Container Institute

For support of a research project pertaining to "protein changes occurring during storage of dehydrated pork".

United States Army—Quartermaster Food and Container Institute

For research on "The Relationship of Ionic Concentration to the Stability of Evaporated Milk."

National Oak Wilt Research Committee

To help support investigation of oak wilt disease in Missouri.

Atomic Energy Commission

For a research project pertaining to a study of "Effect of Irradiation upon the Frequency and Type of Mutation of Specific Genes and to Differentiate between Mutations Induced by Radiation of Different Types."

Charles Pfizer and Company

For research in connection with new sprays.

Nation Grape Cooperative Association Inc.

For Concord Grape research work in connection with plant nutrition and new sprays.

American Plant Food Council

For research work in connection with possible effects of sulphur, in its various forms within the soil, as this relates itself to plant production and the resulting organic materials.

Norden Laboratories

For research in connection with the preservation of rumen culture and research work in connection with rumen culture.

United States Forest Service

For research to determine the nutritive values of important Ozark range plants at different times during the year and under different growing conditions.

Missouri Farm Bureau Federation

For research entitled "Nutritional Aspects of the Consumption of Filled Milk Products".

Red Comb Pioneer Mills, Incorporated

For research in connection with the study of the influence of nutrition and other factors embryonic death loss, reproduction and performance of inbred and crossbred swine.

Charles Pfizer and Company

For research on the effect of estrogen and progesterone in stimulating (a) growth of the udder of sterile animals, and (b) initiation and maintenance of milk secretion.

U. S. Public Health Service

For the support of research on "Investigations 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".

The Ethyl Corporation

For research in connection with an evaluation study of Lindane as an insecticide to control insects attacking cucurbits.

Missouri Farmers Association (Seed Division)

For research in connection with hybrid corn investigations, including the breeding of disease and insect resistance into new, high yielding hybrids that are adapted to the various areas of the state.

National Soybean Processors Association

For research in connection with the breeding of improved disease resistant varieties of soybeans adaptable to Missouri soils and climate.

Scott County Milling Company

For the purchase of special equipment to be used on the Sikeston experimental field.

Columbia Southern Chemical Corporation

For research in connection with the reduction of weed damage to crops by the use of chloro I.P.C.

Carbide and Carbon Chemical Company

For research concerning a herbicidal evaluation of sodium 2, 4, 5 trichlorophenoxyethyl sulfate, 2, 4 bichlorophenoxyethyl benzoate and dichloral urea on certain vegetable crops.

Poultry and Hatchery Federation

For research in connection with the effect of various methods of turning eggs during incubation.

Nitrogen Division, Allied Chemical and Dye Corporation

For research in connection with soil fertility and plant nutrition.

International Minerals and Chemical Corporation

For research in connection with studies of magnesium requirements of soils and crops in the state of Missouri.

International Minerals and Chemical Corporation

For research in connection with the maintenance and improvement of the fertility level of Missouri soils which includes an investigation of 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.

Upjohn Company

For research on the effects of cortisone and ketogestin on clinical cases of acetonemia.

Changes In Station Staff For The Year Ending June 30, 1954

Appointments

Georgia M. Amick, Associate Professor of Home Economics
Mary R. Bonwell, Assistant in Rural Sociology
Adolph R. Brazis, Assistant in Dairy Husbandry
Thomas A. Burns, Assistant Analyst in the Department of Agricultural Chemistry
Charles M. Coughenour, Assistant Professor of Rural Sociology
Joe D. Crumpacker, Assistant in Agricultural Engineering
Wayne C. Freeark, Assistant Analyst in the Department of Agricultural Chemistry
Edward W. Hassinger, Instructor in Rural Sociology
Carl Hayward, Instructor in Field Crops
Harold B. Hedrick, Assistant in Animal Husbandry
Harold D. Johnson, Assistant in Entomology
Harry H. Johnston, Assistant in Soils
William R. Kirkham, Research Associate in Dairy Husbandry
Richard L. Lee, Assistant Agricultural Editor
Clifton W. Loomis, Assistant Professor of Agricultural Economics
John J. MacCullum, Assistant in Animal Husbandry
Charles P. Merilan, Assistant Professor of Dairy Husbandry
L. Donald Meyer, Assistant in Agricultural Engineering
Billie S. Morgan, Assistant in Horticulture
Tommy Sue Moxley, Instructor in Home Economics
Frances A. McKelvey, Assistant Professor of Home Economics
Lowell M. McRoberts, Assistant Analyst in the Department of Agricultural Chemistry
Frederick L. Neumann, Assistant in Agricultural Economics
Robert E. Nevins, Assistant in Horticulture
Daniel I. Padberg, Assistant in Agricultural Economics
Lee Kent Paulsell, Instructor in Forestry
Erlis J. Penrod, Instructor in Agricultural Chemistry
William O. Regan, Instructor in Agricultural Chemistry
James V. Rhodes, Instructor in Agricultural Economics
Louay E. Shariff, Assistant Analyst in the Department of Agricultural Chemistry
Paul J. Spangler, Instructor in Entomology
Stanley W. Spangler, Assistant in Agricultural Economics
Dennis G. Spelman, Assistant in Agricultural Engineering
Alfred B. Stephenson, Associate Professor of Poultry Husbandry
Lloyd C. Stuber, Assistant in Agricultural Economics
Norman F. Temple, Assistant in Agricultural Economics
Fred Tucker, Assistant in Horticulture
William J. Upchurch, Assistant Professor of Soils
Allen Wallace, Assistant in Soils
Joan E. Walsh, Assistant Instructor in Home Economics
Steve E. Zobrisky, Instructor in Animal Husbandry

Resignations and Withdrawals

Jean Goodall Balham, Instructor in Home Economics
Benjamin H. Beard, Instructor in Field Crops
Adolph R. Brazis, Assistant in Dairy Husbandry
Coy C. Brooks, Instructor in Animal Husbandry
Robert F. Brooks, Assistant Professor of Botany
M. D. Cannon, Assistant in Agricultural Engineering
Richard Wm. Dingle, Instructor in Forestry
Chester L. Foy, Instructor in Field Crops
Arthur E. Gaus, Assistant in Horticulture
Buford E. Guyer, Assistant in Agricultural Engineering
Paul Guyer, Instructor in Animal Husbandry
Harry A. Herman, Professor of Dairy Husbandry
Charles R. Hoover, Instructor in Dairy Husbandry
David O. Howe, Assistant in Soils
Leonard Kamm, Assistant in Animal Husbandry
William R. Kirkham, Research Associate in Dairy Husbandry
Willie F. Krueger, Assistant Professor of Poultry Husbandry
John H. Lane, Jr., Assistant Professor of Rural Sociology
William H. Longstaff, Assistant in Soils
Sarah Frances Madden, Assistant in Home Economics
Mearl Mills, Assistant in Agricultural Chemistry
John B. Mitchell, Instructor in Rural Sociology
Byron S. McDaniel, Supervisor, Photo Service
Lowell M. McRoberts, Assistant Analyst in the Department of Agricultural Chemistry
H. D. Naumann, Instructor in Animal Husbandry
Frederick L. Neumann, Assistant in Agricultural Economics
Peter K. New, Assistant in Rural Sociology
Dorothy Lewis Pearson, Assistant Professor of Home Economics
Erlis J. Penrod, Instructor in Agricultural Chemistry
Margaret Ally Pfander, Instructor in Home Economics
Bryan M. Phifer, Assistant Agricultural Editor
James I. Raeside, Instructor in Dairy Husbandry
Martha Richardson, Instructor in Home Economics
Louay E. Shariff, Assistant Analyst in the Department of Agricultural Chemistry
Katerina I. Singleton, Assistant in Home Economics
Billy Ray Smith, Analyst in the Department of Agricultural Chemistry
Dennis G. Spelman, Assistant in Agricultural Engineering
Lewis J. Stadler, Professor of Field Crops (deceased)
Lloyd C. Stuber, Assistant in Agricultural Economics
Robert C. Suter, Assistant Professor of Agricultural Economics
Frederick G. Teubner, Assistant in Horticulture
Harold J. Thompson, Research Associate in Agricultural Engineering
Clarence M. Tucker, Professor of Botany (deceased)
Fred Tucker, Assistant in Horticulture
Joseph M. Vandepopuliere, Assistant in Agricultural Chemistry
Allen Wallace, Assistant in Soils
Joan E. Walsh, Instructor in Home Economics
William Wyss, Assistant in Agricultural Economics
Steve E. Zobrisky, Instructor in Animal Husbandry

FINANCIAL STATEMENT
University of Missouri
Agricultural Experiment Station
July 1, 1953 to June 30, 1954

	Hatch Fund	Adams Fund	Purnell Fund	Bankhead-Jones Sec. 5 Fund	Bankhead-Jones 9 b 1 & 2 Fund	Bankhead-Jones 9 b 3 Fund	AMA Fund	State Appropriations	Fertilizer Fees	Station Sales	Station Grants	TOTAL
Balance from 1952-53	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	210,727.19	229,089.63	55,494.10	495,310.92
Receipts from the United States Treasury, Appropriation for the Fiscal Year ended June 30, 1954	15,000.00	15,000.00	60,000.00	78,849.57	121,398.40	28,500.00	5,000.00	xxxxx	xxxxx	xxxxx	xxxxx	323,747.97
Receipts from State Appropriations for the Fiscal Year ended June 30, 1954	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	309,397.97	xxxxx	xxxxx	xxxxx	309,397.97
Cash Receipts for the Fiscal Year ended June 30, 1954	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	43,145.09	215,933.49	124,511.42	383,590.00
Total Receipts	15,000.00	15,000.00	60,000.00	78,849.57	121,398.40	28,500.00	5,000.00	309,397.97	43,145.09	215,933.49	124,511.42	1,016,735.94
Personal Service	11,245.91	10,745.35	50,528.33	65,233.02	101,864.54	20,418.01	3,834.46	203,725.47	122,361.30	93,022.51	97,175.52	780,154.42
Travel	1,320.47	11.62	448.46	963.52	2,908.60	2,513.33	744.18	15,224.73	12,805.99	7,078.79	5,930.61	49,950.30
Transportation of Things	217.39	258.50	187.40	55.50	494.77	6.02	-----	715.63	1,408.38	485.39	483.67	4,312.65
Communication Service	63.00	7.95	2.30	65.30	113.27	10.15	6.15	3,225.31	1,959.42	998.18	207.45	6,658.48
Rents and Utility Service	233.76	43.85	370.46	402.30	427.14	144.76	-----	4,269.57	3,867.14	1,455.54	581.74	11,796.26
Printing and Binding	72.90	-----	-----	129.70	5.75	-----	-----	12,671.07	10,088.73	3,973.66	280.73	27,222.54
Other Contractural Services	667.78	207.47	1,105.22	1,104.05	4,176.70	213.85	-----	15,556.44	12,995.96	16,142.46	2,613.30	54,783.23
Supplies and Materials	1,020.46	3,689.59	7,326.52	10,667.32	10,959.79	1,923.81	75.43	40,162.29	60,945.56	33,712.80	12,375.72	182,859.29
Equipment	158.33	35.67	18.31	228.86	447.84	1,656.00	240.48	(1)	(1)	(1)	(1)	2,785.49
Land and Structures	-----	-----	13.00	-----	-----	1,614.07	99.30	13,835.62	21,620.62	48,245.33	4,017.88	89,445.82
Other	-----	-----	-----	-----	-----	-----	-----	11.84	5,819.18	3,724.40	-----	9,555.42
Total Expenditures	15,000.00	15,000.00	60,000.00	78,849.57	121,398.40	28,500.00	5,000.00	309,397.97	253,872.28	208,839.06	123,666.62	1,219,523.90
Unexpended Balances June 30, 1954	-----	-----	-----	-----	-----	-----	-----	-----	-----	236,184.06	56,338.90	292,522.96

(1) Included with Land and Structures