

*Wisdom's New Product . . .*

# TODAY'S RESEARCH



The Birthplace  
of Aureomycin  
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**ANNUAL REPORT**

UNIVERSITY OF MISSOURI AGRICULTURAL EXPERIMENT STATION  
1957-1958

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### OUR COVER—

The cover of this annual report, for the year 1957-1958, dramatically tells the story of the birthplace of Aureomycin. The following is from a plaque, erected at the entranceway to Sanborn Field, June, 1959:

"The fungus, *Streptomyces aureofaciens*, strain A 377, was isolated by Dr. B. W. Duggar from a soil sample from this field, Plot 23, in timothy continuously without soil treatment since 1888.

"The sample was one of a dozen sent to the Lederle Laboratories, Pearl River, New York, in August, 1945, by W. A. Albrecht. The isolation from Plot 23 was made the 'type' for the original description, and the ancestral parent of all improved strains used by the American Cyanamid Company in production of aureomycin, now in world-wide distribution.

"This reference soil sample was placed in the Smithsonian Institute, Washington, D. C., with special ceremonies on the tenth anniversary of the announcement of the discovery of this compound, October 15, 1958."

At the entrance (see photograph on the cover) there are shown the first and second chairmen of the Department of Soils in charge of this field since that department was established in 1914, namely, M. F. Miller (right), W. A. Albrecht (left), respectively. Dean Emeritus Miller was also the first and only chairman of the Department of Agronomy from its establishment in 1904 until its division in 1914 into two departments, one of soils and the other of Field Crops. He was Dean of the College of Agriculture and Director of the Mis-

souri Agricultural Experiment Station from 1938 to 1945, the time of his retirement.

The forty-four plots on Sanborn Field, under various kinds of treatment and management since 1888 (with later modifications in many cases) when Professor J. W. Sanborn laid out the field, have been reporting the changes in the soil fertility; the variations in the chemical compositions of the crops; the advent of weeds; the invasions of plant diseases; the attacks by insects; the survival capacity of crops in terms of seed production; the choice of plots by birds; and more recently the differences in the nutritional values of their products when fed to test animals for biological assay; all according to the degree to which the creative power of the soil has been exploited or conserved. It has been revealing the laws of nature according to which the well-fed and healthy plants survive and the ill-fed do not.

Sanborn Field has been the means of measuring our management of the soil for either weal or for woe. It has suggested problems for refined laboratory study. It has demonstrated the validity or error of the suggestions coming from laboratory research. Work on this field has expanded the soil studies to the South Farms, and more recently to the four corners of the state as Missouri Research Centers; but is itself the Mecca of basic principles which the farmers come to learn and follow in practice if our soils are to be conserved in more significant measure. Sanborn Field is a bit of hallowed ground, now that its detailed records let it speak as the sage with authority representing seventy years of farming experience. Each plot may well be considered "Sacred Earth."

## "On Being Ourselves"

CLYDE H. DUNCAN

Victoria Lincoln, the writer, says: "We go through life incapable of understanding the wisdom of old Rabbi Susya who said, 'In the coming life they will not ask me, 'Why were you not Moses?' They will ask, 'Why were you not Susya?'"

There. There you have it. Missouri was made to be Missouri, and not California, or Texas, or Arizona. So often we hear the reports about Missouri being crowded out of the market place. We hear often how she has lost markets to a state or a region more advantageously placed, geographically, or more endowed with those virtues that grasps time by the forelock and not the fetlock.

It hasn't been too long ago since we heard often that Missouri had "lost" much of her once thriving strawberry business to California. Then came the story cotton production in the far West, and Southwest, would soon take care of our country's need, posing a real threat to one segment of our state's economy. The latest report is to the effect that the day is not too far distant when valuable land now devoted to cotton, a cellulose, will be used for foodstuffs. Forested areas, so the reports say, will be expected to produce our national cellulose requirements.

One day we have lost our egg market to states more able to furnish a uniform quality product. The next day comes distressing news that diseases, and low markets, have had tornadic effects upon what was once the state's pride and boast, the big red Missouri apple. This is made worse by the fact that Washington and Oregon have reduced our market opportunities.

Pessimists say that fresh quality vegetables, on a quantity basis, large enough to supply the state's domestic demand, cannot be produced in suitable quantity in Missouri. To avoid this, we rely on Texas, Florida, and California for help. This causes some to wonder if maybe we are not neglecting those crops which could be more profitable insisting on hanging on to those which are less profitable. These are things to think about, and if the need justifies it to do something about.

It is well to realize, despite losses and pessimism, that there is nothing wrong with Missouri's agriculture that honest facing of the facts and taking the necessary action cannot solve or at least help. Not being ourselves, as the Rabbi indicated, could be our greatest sin. Willingness to learn could be our greatest virtue.

Those who study markets at the Missouri Experiment Station say that the problems of the Missouri farmers have become aggravated because of a shift in the na-

tion's population. For several years, there has been a gradual movement of people from the midwest to the coastal areas. As population has moved, so have markets. This puts the farmers of this section at a disadvantage market-wise. Heavy transportation costs must be added to the local market price which can help take a local commodity out of the competitive race for distant major markets.

Other strong forces are at work. They include the swing over to the big operation with its greater efficiency, all operating to the disadvantage and too often inefficient smaller farmer. There are still those who say there is room for both the large and the small operator, especially if the latter improves his efficiency.

Those who strive for efficiency in their operations know that on this problem there can be no holidays. Even though the unit cost has been amazingly reduced through mechanization, soil improvement practices, and improved varieties in recent years, still the profit margin has not been enough even to justify a mild enthusiasm.

Those who calculate along the lines of future improved farm income point out that if other states, such as California in the matter of strawberries and Washington and Oregon in the matter of apples, we have been out competed where once we were strong, there are good reasons for our falling behind. The laws of economics know no state boundaries. We must not stop with the latest production techniques, but also learn and put to use the best ideas of merchandising.

The surface may not tell all the story. We may be weak where actually we think we are strong. An honest facing of facts, and a genuine attempt to do something about righting ourselves in planning our agriculture's future will be the best course we can chart. In the end it will be the most sensible and profitable. This is a team job and our willingness to make a farm-to-farm adjustment throughout the state could well be a master stroke of great magnitude with far-reaching and worth-while results.

If in facing our problems we find the advantages of other states—production and market-wise—are no greater than ours, then we should calculate the risks necessary to win back that which we have lost. To continue the production of a commodity which has now a distinct market disadvantage, and faces a greater one in the future, forebodes no small disaster. Such a course if pursued by many of us would in time damage all of us.

In making plans for the future we must pitch our

program on a note of optimism. How can one be optimistic if he has been robbed of his purse, you ask? At least we can be thankful that we were not the robber. Even the man who has been robbed still has much to be thankful for. He has his life. So have we much to be thankful for here in Missouri. The opportunities have not diminished.

Take the matter of a wide range of climatic conditions about which we hear so much, often in a derogatory manner, but which in itself is a real blessing. This fact alone allows for a wide choice of crop enterprises scarcely matched by any other state in the nation.

We have in Missouri untold and untapped mineral wealth which in this atomic age will center great interest in our state, and result in great activity in time within our boundaries. The growing importance of mining will result in the stimulation of steel and associated fabricating industries which will greatly increase employment opportunities and expand our local product market.

We are situated advantageously as regards to navigable waters. Rivers and the further development of river transportation will improve Missouri's position in transporting minerals and coal to service our future heavy industries, as well as to move our farm products to market. Yes, outdistanced in some areas in the past, Missouri is still a great state, limited in future opportunities only by the thinking of its people.

To see clearly ahead, to keep the picture in sharp focus, every person in the state has all of the facilities of the Experiment Station, the College of Agriculture and

its Extension staff to assist him. If we are doing something when we should be doing something else, now is the time to find out. "For of all sad words of tongue or pen, the saddest are these, 'it might have been,'" was spoken poetically by John Greenleaf Whittier but clothes a brave warning nevertheless.

The role of your Missouri Agricultural Experiment Station is predicated on pure optimism—the optimism of the discoverer of new things, new crops, new methods and improved machinery. All this for what purpose? To take advantage of our new opportunities in the agriculture of tomorrow. Fitting into this program of a new day the Missouri Experiment Station blasts hardest on problems where we are weakest.

The motto of Missouri, *Salus populi suprema lex esto*—"Let the welfare of the people be the supreme law" is the spirit of the experimenter. He is a sentinel, really, always alert to changing things in a changing world. On his work he knows that what is new today is literally ancient history tomorrow. For the scientist the sun never sets. He is an optimist.

So, we can say now that nothing is wrong with Missouri which Missourians cannot correct themselves following in the wake of their long history of willingness to learn and to adjust. As we adjust to our problems, and find their solutions, we will be applauded, as suggested by Rabbi Susya, not because we tried to copy California's methods but because we acted as Missourians, solving our own problems through the majesty of our own ingenuity, based on a priceless ingredient, common sense.

# Agricultural Chemistry

M. E. Muhrer, Chairman

## Hemorrhagic Conditions in Farm Animals

M. E. MUHRER

### Objectives:

A. To determine the specific effects of nitrates on blood coagulation.

B. By the use of an ion-exchange column to further characterize quantitatively the amino acids in the antihemophilia factor.

C. By use of the thromboplastin generation test to characterize the coagulation factor.

Internal hemorrhages have been observed in farm animals that have died from nitrate poisoning. The effects of nitrate on hemostasis was studied using animals from our bleeder herd. The data are not complete. However, preliminary data indicate that nitrate injections cause vasodilation and some increase in bleeding time.

The feeding of nitrate at high levels results in a decrease of blood fibrinogen and an increase in fibrin precipitation time. Animals with a hemorrhagic tendency are more susceptible to the nitrate effect. Animals with a good coagulation mechanism are more resistant to the adverse nitrate effect.

The ultimate goal in the fractionation of coagulation factors by various investigators has been to gain a more intensive insight into the blood coagulation mechanism and finally synthesis of these compounds.

Further characterization of coagulation components are needed to facilitate the comprehension of all the mechanism and modes of inheritance of the various coagulation factors.

Commercial cephalin was substituted for platelets in some tests, with the results indicating a slightly faster initial thromboplastin generation rate than with platelets. (Project 56)

## Some Aspects in Natural and Artificial Breeding

D. T. MAYER, G. V. HOOK, FRANK ORSINI,  
R. E. BERRY, AND L. D. MILLER

### Objectives:

A. A thorough study of the chemistry and/or biochemistry of the male and female germ cells.

B. The characterization and isolation of certain factors present in egg yolk, boiled milk, chick embryos, and other biological tissues which aid in the preservation of the viability of spermatozoa and protect these cells against adverse environmental effects.

An initial approach to the characterization of the lipoprotein fraction was the development of a purification

procedure in which the fraction was repeatedly precipitated from alkaline solution with dilute acetic acid with no apparent alterations in the original material.

*Protein and lipid content*—Hydrolysis of the purified lipoprotein complex with 6 N HCl yielded a lipid and a protein fraction. The lipid fraction constituted about 32 percent of the complex. However, the presence of other components of the complex were indicated including cholesterol, carbohydrate and possibly other substances.

The lipoprotein complex in the frog ova ranged from 12.2 to 13.8 percent, with an average content of 13.0 percent. This is in close agreement with results obtained by Thomas and co-workers on the nuclei of the cells of a number of tissues. Interestingly, the ova nuclei of the gold fish (*Carassius auratus*) had approximately the same quantity of the lipoprotein complex as mammalian spermatozoa (42.3 percent). Work is also in progress on micro-techniques which will require a minimum quantity of materials.

The lipoprotein of bovine spermatozoa was extracted from washed cells with 0.01 N sodium hydroxide solution, precipitated with dilute acetic acid at pH 6, then purified.

The superiority of egg yolk or of the testicular preparation may be due to one or more contaminants. The results obtained with sesame oil plus spermatozoan lipoprotein and with ether extracted thymus lipoprotein would confirm the postulate that at least two, if not more, factors are responsible for the protection of spermatozoa under the conditions of these tests. (Project 81)

## Proper Proportions of Amino Acids Required by Chickens

A. G. HOGAN, B. L. O'DELL, WENDELL WOODS

### Objectives:

A. To determine whether or not there is an unrecognized nutrient required by growing chicks.

B. Report of Progress.

A large proportion of chicks fed a purified diet composed chiefly of an isolated soybean protein and glucose developed an enlarged proventriculus which had an atrophic musculature and grossly dilated and hypertrophied submucosal glands.

In some cases the glands had undergone degeneration and sloughing. This syndrome starts soon after chicks are fed such diets and is clearly evident at one week of age. Associated with it is a poorly developed gizzard and a tendency toward a pendulous crop.

The hypertrophic proventriculus developed when all

the ingredients of the diet were finely divided, and was prevented by corn meal, corn grits or ground wheat, but not by sand or grit. Although the syndrome appears to have no practical significance in the growth of the chick, it was suggested that the texture of the ration may be important in prevention of pendulous crop in fowl. (Project 137)

### Factors Affecting the Stability of the Colloidal Casein in Milk

C. W. GEHRKE, I. S. VERMA

#### Objective:

*The major objective of this investigation is to clarify the mechanism of action in the enzyme rennin on casein in milk.*

These experiments confirm the earlier observations (1, 11) that the increase in non-protein nitrogen content of rennet treated milk is directly due to the enzymic phase of rennet action on casein.

It was further demonstrated that the enzymic action caused an increased association of the casein particles to give larger aggregates as suggested by Lovenhart (10) in 1904.

It was also shown that the enzymic phase did not alter the calcium and phosphorus content of the caseinate complex, nor were the molar ratios changed for the colloidal inorganic calcium and phosphorus in the sediment. (Project 148)

### Critical Nutrients in Guinea Pig Nutrition

B. L. O'DELL, E. R. MORRIS, W. O. REGAN

#### Objectives:

*A. To determine the optimum mineral balance for growth and reproduction in the guinea pig.*

*B. To identify the natural occurring antistiffness factor.*

*C. To isolate and identify the growth stimulant in green foods.*

A deficiency of magnesium in the diet of guinea pigs results in poor growth, soft tissue calcification, stiffness in the hind quarters, erosion of the incisors and finally death. The requirement for magnesium is increased by high levels of both calcium and phosphorus. Analyses show that in a magnesium deficiency the ash, calcium, and phosphorus contents of the liver were increased. At the same time there was an inverse relationship between magnesium intake and the magnesium content of the liver.

Stigmasterol, the so-called "antistiffness" factor, failed to cure "wrist-stiffness" under our conditions. Citrus products were effective in reversing the syndrome in part of the animals and still more effective in preventing "stiffness" in females.

Some of the biflavonoids, particularly rutin, possessed antistiffness activity. Female guinea pigs are more amen-

able to treatment than males, and testosterone aggravates "wrist-stiffness" in females. Estrone and diethylstilbestrol show some activity in the reversal and prevention of stiffness. It is possible that oranges and rutin owe their activity to their estrogenic properties.

Cabbage is unique in its ability to stimulate the growth rate of guinea pigs. The activity of cabbage is partially retained if cooked before drying.

Guinea pigs do not reproduce well on synthetic diets, but the performance is improved by cabbage supplementation. (Project 149)

### Maternal Nutrition and Congenital Abnormalities in Infant Rats

B. L. O'DELL, PAUL NEWBERNE, A. G. HOGAN,  
AND B. A. ERICKSON

#### Objectives:

*A. To investigate the effect of maternal nutritional deficiencies on the anatomy and function of brain and other organs.*

*B. To study the physiological and biochemical functions of various vitamins as related to the cause of congenital malformations.*

It should be pointed out that rats used in this study were partially depleted at the start of the growth study in as much as they were produced by dams fed a deficient diet and in that their weaning weights were subnormal. In general the animals whose diets were supplemented with vitamin B<sub>12</sub> grew markedly more rapidly than their litter mate controls. The B<sub>12</sub> supplement stimulated the growth rate of males considerably more than it did the growth of most females, but this was not the case for the low protein and the high soybean meal diets.

The best rate of growth in the presence of vitamin B<sub>12</sub> for both sexes occurred on the high fat diet and this type diet also gave the greatest difference due to B<sub>12</sub> supplementation.

The data indicate that the type diet which will give the maximum response to vitamin B<sub>12</sub> supplementation is one high in calories from fat. A comparable response can be obtained with a high protein diet, but the supplemented animals do not grow at a maximum rate. (Project 151)

### Rumen Culture

M. E. MUHRER, G. B. GARNER, E. J. CONELL,  
AND RICHARD BLOOMFIELD

#### Objectives:

*A. The effect of extract of rumen content and of silage on cellulose digestion and nitrogen utilization using the artificial technique.*

*B. Factors in corn silage and corn silage extract affecting urease activity by rumen micro-organisms in vitro.*

*C. Changes that occur in the artificial rumen that would*

*improve a ration for non-ruminants with major emphasis on roughage utilization.*

In all cases, consumption and gains were about one-half those normally expected from animals at similar weight. It was concluded that silage did not prove to be an acceptable swine feed and was not appreciably improved by further fermentation by rumen organisms. (Project 152)

### Nutrients in Grains and Forage Crops in Rations Of Ruminants, in an Artificial Rumen

Laura M. FLYNN, M. S. ZUBER, J. D. BALDRIDGE,  
C. W. GEHRKE, AND G. B. GARNER

#### Objectives:

A. *Factors that affect the nutritive value of corn. Effects of time of planting and level of nitrogen treatment on nutritive value of corn grain and corn forage; changes in nutrients in corn forage if plant does not produce grain.*

B. *Effects of time of harvest on nutritive value of legume forage.*

C. *Optimum amino acid distribution in poultry rations.*

Corn plants produced in 1955 showed little response to added nitrogen; probably the soil on all plots was high in nitrogen after several drouth years.

In comparison with plants produced in 1953, the 1955 plants had higher concentrations of ash and of protein. The favorable growing season of 1955 produced enormous yields of both forage and corn grain as compared to the 1953 season.

Plants which did not produce grain in 1955 (because shoots were bagged) were similar in composition to the 1954 corn forage, also without grain. The leaves dried early, and were low in fiber, in ash and in carotene, as compared to leaves on normal plants.

The plants without grain were low in nitrogen-free extract and in fat, and their leaves, stalks and the whole plant were high in protein. Lack of normal grain production did not increase percent  $KNO_3$  in the stalks in 1955, when the rainfall was ample. Percentages of calcium and phosphorus were high in the plants which had no grain, as contrasted with normal plants.

Tests on two hybrids, Kansas 1639 and US 523 W showed marked variations in performance at Sikeston (which had a late, rainy spring) and at Columbia. Acre yields at Sikeston were lower, percent protein in the grain grown there (6.69-9.69 percent) was lower than at Columbia (10.19-11.25 percent). Late planting dates resulted in lower yields. Corn with higher percent protein contained more zein in the protein.

Corn grown at McCredie at four levels of added nitrogen (0-240 lbs./A.) showed little variation in percent protein in the seed. One assumes that soil was high in nitrogen at all the plots.

Determination of carotene in green forages at time

of harvest gave averages as follows, (in milligrams per 100 grams dry matter): Alfalfa-26, Crown Vetch-29, Lespedeza-26. Drying the forages at room temperature for hay, and storing the hay resulted in marked losses in carotene.

Analyses of hay in October showed retentions as follows of the carotene found at time of harvest: Alfalfa (1) cut in July—3.67 percent (2) cut in September—17.43 percent; Lespedeza (1) cut in July—29.48 percent, (2) cut in September—47.97 percent. It appears that carotene is retained better in Lespedeza than in Alfalfa where the forage is not dried with artificial heat; carotene is lost during storage at summer temperatures.

Sulfur determinations have been made on zein concentrates, non-zein fractions of corn protein, and on corn products in which the protein was concentrated by de-starching the samples by ptyalin digestions.

Zein is low in sulfur, containing 0.61 percent. Three-fourths of sulfur in zein is in methionine, about one fourth in cystine. In contrast, the non-zein protein in corn contains from 1.5 to 1.7 percent organic sulfur, over half of which is in the form of cystine. In comparison with the protein in low-protein corn, protein in high-protein corn is high in zein, and accordingly is low in organic sulfur, particularly in cystine sulfur.

In addition to data on organic sulfur in corn, data from oxidation procedures were secured for total sulfur, cystine sulfur, and methionine sulfur in bovine fibrin, liver protein and Drackett soybean protein. The data show higher contents of cystine sulfur in these proteins than are listed in published data from determinations on hydrolysates which have lost cystine sulfur. (Project 212)

### Hormones in the Activities of the Reproductive Organs

D. T. MEYER, ROBERT E. BERRY, MIKE MILICEVIC,  
AND FRANK ORSINI

#### Objectives:

A. *Co-operation with Animal Husbandry Department on all phases of the work described in the Progress Report of Project 222.*

B. *To study the fundamental anatomy, physiology, chemistry, and biochemistry of the reproductive organs of the female during the puberal age and the gestational periods.*

C. *An intensive investigation of the role of reproductive hormones and the mechanisms through which they provide an optimal uterine environment for embryonic development and survival.*

D. *A study of the effect of carbohydrate metabolism with associated hormonal and other factors upon the growth and reproductive processes in swine.*

The ultimate aim of this project is an increased litter size in swine.

*Growth potentialities in swine*—An investigation, the pur-

pose of which is to explore the possibilities of utilizing hormones and blood analyses for the development of tests for growth potentialities in young swine, is being continued. It is too early to draw definite conclusions. The results to date include:

1. Injections of insulin caused a rapid hypoglycemia (low blood sugar) in all sows studied.
2. Higher dosages of insulin prolonged the duration of hypoglycemia, which is considered to be a measure of the insulin sensitivity of an animal.
3. Durocs were found to be more sensitive to administered insulin than were the Landrace and Poland crosses.
4. In another study, blood analyses revealed that glucose varied throughout the entire gestation period. The blood sugar reached its lowest level just prior to parturition. This finding may be of significance in investigations on the induction of parturition or the synchronization of parturition in number of females.
5. Blood sugar in these females rises again during the period of lactation. A similar trend was also observed in the total leucocyte count. (*Project 223*)

### Forage Poison Caused by Drouth

M. E. MUHRER, GEORGE GARNER, B. L. O'DELL  
W. O. REGAN AND L. M. FLYNN

#### Objectives:

*A. Continued study of physiological activity of nitrate fed or injected below the established lethal dose.*

*B. To investigate the interrelationship between nitrate in feeds and the utilization of vitamin A and carotene.*

*C. To characterize the toxic factor in red clover hay.*

*D. To study ensiling methods aimed at eliminating toxic principles and improvement of feed value.*

#### Objective A

It can be concluded from this experiment that nitrate and nitrite exert some influence on the rate of vitamin A depletion. However, most of this influence may be due to the toxicity of nitrate or nitrite *per se*.

#### Objective B

This objective was not carried out because the adaptation of existing nitrate methods gave unreliable results.

#### Objectives C and D

No further advances on the chemical characteristic have been made. The unstable nature of the compound makes storage impossible and no new supply has been found to date. (*Project 247*)

# Agricultural Economics

E. R. Kiehl, Chairman

### Efficiency of Livestock Marketing in Missouri

E. R. KIEHL, DURWARD BREWER, C. L. CRAMER

The major emphasis this year has been on preparation of Station Bulletin 712—Why the Early Week Market?

Results of the study clearly show a concentration of cattle and hog receipts at the first of the week, with cattle receipts being more concentrated than hogs. While packer purchases of livestock at public stockyard markets are concentrated at the first of the week the volume of slaughter tended to be uniform throughout the week.

An analysis of daily prices failed to reveal any important difference in prices on the various days of the week, although the Average Monday price for 200-220 pound hogs at Kansas City was statistically significantly higher than the Tuesday or Wednesday price. Livestock trucker and commission firm personnel pointed to greater buying activity at the first of the week as the cause of the present receipt pattern and also were generally in favor of attempts to make the receipts pattern more uniform.

### Land Resource Investigations

FRANK MILLER, O. R. JOHNSON, S. C. TURNER  
AND CLAUDE BRADSHER

#### Objectives:

*A. To inventory the present use of resources; to determine levels and sources of income and the kind of adjustment problems that confront farm families.*

*B. To reveal alternative methods of increasing the productivity and incomes of people in selected areas of the state through increased efficiency in the use of farm, forest, mineral, recreational and industrial resources.*

Records obtained from 269 farm and 516 non-farm families who were living in the open country of the Eastern Ozarks were studied. The analysis showed that 32 percent of the farmers and 27 percent of the rural non-farm families had incomes of less than \$1,000 in 1955.

One apparent reason for low incomes was limited ability of family heads to work. In 54 percent of the farm households with incomes below \$1,000, the head

was either more than 58 years of age, was ill a high percentage of the time, or had some other disability.

Other factors contributing to low income are: (1) the rugged topography and stony nature of the land that makes it unsuited to cultivation and very poorly adapted to grazing, (2) small acreages of irregularly shaped plots of bottomland where crops can be grown, (3) fertility of low quality, (4) inadequate farm operating units, and (5) lack of industry to provide job opportunities.

The rural resident segment of the population is also well advanced in age. Young people have found better economic opportunities outside the area. Very few men and women between 20 and 39 years of age are seeking jobs in the area.

The economic problem is one of adjusting enterprises on farms and job opportunities to the work capabilities of the very young, the very old, and people between these ages who have disabilities that limited their opportunities outside the area.

Only 22 percent of the incomes of farm families receiving less than \$1,000 came from the sale and use of farm products. Two percent came from work on other farms, 31 percent from non-employment sources such as pensions and gifts, and 45 percent from non-farm employment.

Among non-farm households having incomes of less than \$1,000, about 73 percent of the returns were derived from non-employment sources, such as old age pensions and Social Security.

The study accomplishes only a part of the second objective. The inventory data can be used to develop patterns of farm organization that will raise the level of income in the area. This phase of the work will be undertaken in 1959. (Project 44)

## Real Estate Price and Assessment Trends

FRANK MILLER

### Objectives:

A. To keep a record of land price trends in the major type-of-farming areas of Missouri and to make the information available to land owners, prospective buyers, borrowers and lenders.

B. To compare the valuation of land for tax purposes with the legal framework outlining assessment procedures.

C. To find out whether or not the practices being followed result in equitable assessment within counties and between counties.

D. To develop standards, manuals and procedures that can be used to improve assessment practices, if changes are needed.

E. To isolate the factors that influence the land market, and to determine why land values go up and down.

The study shows that location, land class and farm income influence the market price of farm land. The price of medium grade land (Class III) advanced more during the 1947-56 ten-year period than did the other grades. The principal reason was level topography which made it easy to operate power equipment and the favorable response from fertilizer when applied to this land.

In Audrain County where both buyers and sellers were interviewed, the principal reasons for selling land were old age, poor health, settlement of estates and to get out of farming because of the low returns in relation to income in other occupations.

No single factor dominated decisions to buy land. In approximately one-fourth of the transactions, the buyer came into the market because a well-located tract was offered for sale. Another one-fourth bought because the tract possessed some special feature that the buyer wanted. About 18 percent of the buyers were from other states.

They were looking for land that could be purchased and improved in productivity to the point of high yields, but at lower cost than they would have to pay for land in their home community. One-fourth of the buyers purchased the land to expand their operations. (Project 61)

## Study of Cotton Marketing in Missouri

D. N. HARRINGTON, J. W. MCKINSEY, L. G. KIZER

### Objectives—to study:

A. The relationship between local prices and quality of cotton received in those markets.

B. The relationship between local prices and Memphis terminal prices for the same quality of cotton.

C. The relationship between the prices and the full markets from one day to the next in the four years.

D. The relative variation of the quality of cotton received at the four Markets. The analysis is incomplete.

Results indicated prices in markets where cotton was sold on the basis of Smith-Doxey cards, or on the basis of competitive bids, reflected central market differentials for grade and staple rather accurately. In markets where growers did not have or did not use reliable quality information, local prices reflected little, if any, of the central market differentials.

Local prices in markets where cotton was sold by brokers on the basis of competitive bids reflected central market differentials as accurately as the first group. However, as in the first group, there were several marked exceptions to this general relationship.

The size of market, as well as availability and use of quality information, appeared to influence the extent and accuracy of the reflection of central market differentials in local prices of individual lots. (Project 65)

## Consumers' Preference and Acceptance for Meat And Meat Products

E. R. KIEHL, B. H. FRAME, O. R. JOHNSON, V. JAMES  
RHODES, G. C. HANKINS, M. F. JORDON,  
H. A. SULLIVAN, DELMAR HATESOHL

The leaner the grade the poorer its overall acceptability and the more heterogeneous the acceptability of carcasses within the grade. The acceptability ratings of Prime and Choice were so overlapping that they might have been combined with little loss in eating homogeneity.

On the other hand, Good and, especially, Standard carcasses were so heterogeneous that a redefinition into two or more homogeneous grades might be useful. Use of shear measurements in conjunction with grades would improve the homogeneity grouping of these leaner carcasses, but an easier and more efficient grouping method appears desirable.

Evidence from these experiments is largely based upon means of carcasses each of which were tested by 12 to 14 households. There is evidence that the variation between carcass means was largely a result of variation in product rather than in consumer likes or preferences.

A panel of 40 households evaluated 24 "quarters" composited from Choice, Good, and Standard grades; 8 Good grade quarters and 8 Standard grade quarters. All quarters were very acceptable except for those from one of the six Standard carcasses. Numbers of complaints by cuts were:

Loin	2
Sirloin	2
Top Round	10
Bottom Round	5
Rib Steak	4
Short Ribs	5
Arm Roast	3
Blade Roast	2
Total	33

Thirteen of these 33 complaints were from the one poor Standard carcass. The chief source of dissatisfaction was toughness.

These results appear generally consistent with previous work—i.e., most beef is very acceptable except for a small proportion of the leaner carcasses.

This exploratory study is apparently the first consumer test of all important cuts in the beef carcass at any Station. The technique of compositing quarters from different grades was innovated at the Missouri Station and shows definite promise as a consumer research tool. (Project 86)

## Farm Enterprise Cost and Return

B. H. FRAME, O. R. JOHNSON, S. W. SPANGLER,  
CLAY MOORE, AND MAC ALLEN EDWARDS

### Objectives:

A. To summarize fertilizer cost and yield data for corn on Putnam and Mexico soils for the crop years of 1953, 1954, and 1955.

B. To summarize data to determine the carry-over effects of fertilizer on crops that followed corn.

C. To summarize data on the effects of factors other than fertilizer on corn yields, date of planting, rate of planting and preceding crops were among the factors studied.

D. To summarize the labor and machinery costs for the various tillage and harvesting operations used in corn production.

In 1953 and 1955, application of phosphate and potash gave no significant increase in corn yields on the farms studied.

The results obtained in these two years revealed 40 pounds of nitrogen to be the intensive margin with the price assumptions of corn selling for \$1.00 per bushel, and nitrogen costing 13 cents a pound. Applications of 50 pounds of N were not profitable under dry weather conditions of these two years.

Results obtained by the soils department show that the intensive margin of nitrogen use on Putnam soils is reached at 130 pounds when corn is worth \$1.00 a bushel and the nitrogen costs 13 cents a pound. These experimental data were adjusted by the author to field conditions, and the 90 pound level of nitrogen application was found to be the intensive margin. When 1953 and 1955 yields in Monroe County were adjusted to average weather conditions, applications up to 65 pounds of nitrogen were found to be profitable.

Analysis of the yields of soybeans on these farms disclosed that the carry-over effect of fertilizer applications on corn raised soybean yields the subsequent year 2.06 bushels per acre for each 100 pounds of plant nutrients (N. P. K.) applied to the previous crop. Thus, if applications go beyond the intensive margin because of dry weather, a considerable part of the cost can be recovered through increased yields of subsequent crops.

Rates of planting had little effect on corn yields under field conditions in 1953, 1954, and 1955. Average yields varied only .7 bushels per acre for stands under 10,000; 10,000 to 14,000; and over 14,000 stalks per acre. In years of optimum rainfall, stands up to 18,000 give the highest yields where ample fertilizer is applied.

Analysis of weather conditions at critical growth periods shows that planting corn between May 1 and 15 normally will bring the crop to the critical stage when chances of drouth are lowest.

The average machinery and labor cost of growing an acre of corn to maturity was \$15.20. However, costs varied

widely with the type and size of equipment used. Harvesting costs varied from \$5.57 where two-row pickers were used to \$8.84 per acre where the work was done by hand. (Project 110)

#### Factors Affecting Individual Farm Earnings

B. H. FRAME, O. R. JOHNSON, S. W. SPANGLER,  
CLAY MOORE, F. E. JUSTUS, H. D. FRIESE,  
CHARLES BURLISON, EUGENE LEONARD

In addition to the cooperative study listed above, two analyses are under way on data obtained in 1955 and 1956 on approximately 80 dairy farms. Another analysis is under way on the effects of land use, size of business, and degree of intensification upon the net farm incomes of record keeping Missouri farmers.

A field survey has been made on 50 farms in Northwest Missouri with feeder cattle enterprises. The survey data are being tabulated and analyzed. (Project 112)

#### Effects of Public Policies Upon Producers Marketing Agencies and Consumers

E. R. KIEHL, GORDON NANCE, O. R. JOHNSON,  
LEONARD VOSS

##### Objectives:

A. To compile Missouri and U. S. data on farm production, prices and price controls.

B. To measure the influences of production and price controls and changes in production and price controls and changes in production and prices on each other.

All of the data on cash receipts from major farm products for Missouri and the United States found to date, representing about 80 percent of the data desired, have been tabulated and most of the necessary statistical calculations for them have been made. The next effort will be to find either the missing data or determine that it cannot be found. Then data will be prepared for publication. (Project 115)

#### Marketing Meat and Meat Products

E. R. KIEHL, C. H. BRASCHLER, V. JAMES RHODES

The survey covered non-federally inspected wholesale slaughterers and a sample of 48 custom slaughterers. Personal interviews of management were conducted from January to April, 1956. Data were largely based upon operations during the 1955 calendar year.

Wholesale packers varied considerably in volume of slaughter. Fifty percent of the total hog slaughter and 75 percent of the total cattle slaughter were in 16 plants located in St. Louis, Springfield, and Cape Girardeau. The year's cattle slaughter by plants ranged from 500 head to a little more than 30,000 head while hog slaughter ranged from nothing in 10 plants to a little more than 30,000 head.

Plants bought approximately 82 percent of the cattle

and 47 percent of the hogs from public stockyards and approximately 13 percent of the cattle and 46 percent of the hogs directly from the farm. Several low efficiency plants paid some of the highest wage rates so labor costs of slaughter varied widely.

Generally, the firms anticipated expansion in the next five years and stated that plants and livestock sources would permit expansion readily. Several plants used federal grading and several more anticipated using it. Lack of an adequate state inspection system was considered by several progressive packers to be disadvantageous.

There was considerable non-price competition. However, only 22 of the 40 firms used brand names. Advertising expenditures in 1955 varied from nothing to \$42,000. Almost all output was sold direct to retailers.

The efficiency of utilization of labor and fixed resources were studied in one of the larger non-federally inspected meat packing plants of the state. Findings indicated several possible improvements in the efficiency of processing and marketing meat.

The analysis of the demand for meats by Columbia's 6,000 negroes is still in progress. These results indicate that negroes consumed as much chicken as beef and as much pork as chicken and beef combined. (Project 150)

#### Demand-Supply Relationships of Dairying In Missouri

S. F. WHITTED, F. LASLEY, J. N. SMITH

##### Objectives:

A. Ascertain the extent and direction of the development of the dairy industry in northwest, southeast, and northeast, Missouri.

##### A. Northwest Missouri Dairy Markets

The number of farms in Northwest Missouri declined by 20 percent from 1920-1950. During the same period, size of farms increased 24 percent. Even though cash grains and fattening animals have a comparative advantage in the area, the number of milk cows increased 12 percent during the years 1920-1950.

Over half of the dairy plants in the area maintain at least one fieldman to promote a quality production program. Only four plants had country collection routes in 1940 as compared to 20 in 1952. This all adds up to an expanded market for farm milk production in the Northwest area. The shift from sales of farm-separated cream to whole milk has not been as rapid in Northwest Missouri as in the Southwest part of the state.

##### B. Northeast Missouri Dairy Markets

Dairying is not a major farm enterprise in this part of Missouri. Milk production per cow is below the state average and has been falling further behind during recent years: 1940-3.8 percent below; 1950-5.9 percent below. The number of dairy cattle in this area is increasing but at a very slow rate; an average rate of 1/5 percent per year

since 1900. The number of beef cattle in the area is increasing at about the same rate as in the state; at an average rate of a little over one percent per year since 1900. Since 1939, the sale of dairy products has been contributing a smaller percent of the total farm income in the area. Since 1920 the number of farms reporting milk cows has declined but the number of cows on each reporting farm has increased 37 percent. More of the dairy production of the area is being marketed as whole milk and less as cream. In line with this trend, the number of pick-up routes in the area is increasing; in 1945 there were 73 routes in the area, in 1954 there were 98.

The average size of farm is increasing more rapidly in the area than in the state as a whole. From 1920 to 1950 the average size of farm in the state increased from 132.2 acres to 152.7 while in the area for the same period the increase was from 138.3 acres to 182.9.

During the period 1920 to 1950 the population of the area *decreased* 18 percent, compared to an *increase* of 27 percent in the state.

#### *C. Southeast Missouri Dairy Markets*

Although dairying is an important source of farm income in the area, it is unlikely that it will become a major enterprise. Cash crops yield a higher return on the delta lands of the bootheel area, and the grazing lands of the Ozark upland area are used more for beef production. Most of the milk cows in the area are in the tier of counties along the Missouri River.

Population in the rural portion of the area is increasing at about the same rate as for the state as a whole, while the population of the St. Louis urban area is increasing at a more rapid rate.

Production per cow is lower in this area than the average for the state as a whole. Farm bulk tanks and bulk handling are beginning to be used in this area. In 1954 there were 5 bulk tank pickup trucks. This number increased to 11 in 1955. In 1955, one plant in the area received 100 percent of its milk in this form. (*Project 167*)

#### **Economic Problems of Grain Marketing and Storage**

J. W. MCKINSEY, O. R. JOHNSON, B. H. FRAME,  
D. N. HARRINGTON

The 546 country elevators in Missouri handled 97.4 million bushels of corn, oats, wheat, barley, soybeans and grain sorghums in 1954. Forty percent of this grain was resold in the local trade area, and sixty percent was sold to processors and other grain handlers outside the trade area of the country elevators.

Of the 26 million bushels of wheat handled that year, 94 percent was moved from country elevators to points outside the trade area, while only 25 percent of the corn handled moved outside the trade area. Practically all of the soybeans moved to out-of-trade area destinations.

Movement of grain from other grain handlers to country elevators for resale to farmers and other consumers within the trade territory was important in all crop-reporting districts.

Eighty-one percent of such grain received from other grain handlers was transported by truck. Rail transportation remains the chief method of transportation for grain from country elevators to terminal markets, but trucks handled 11 percent of the wheat and 15 percent of the soybeans shipped in 1954. On the other hand, 52 percent of the corn, 88 percent of the oats and 75 percent of the sorghum grains shipped from country elevators to terminals or other consumer markets were transported by truck in 1954.

The total storage space available in Missouri country elevators was 11,552,000 bushels. This space would accommodate only a fraction of any of Missouri's leading grain crops and little more than 10 percent of the total volume of grain handled by country elevators in Missouri in 1954. This emphasizes the importance of the role that country elevators have as points of concentration and merchandisers of grain for farmers as compared to the role of storehouses.

The utilization of storage space during peak inventories ranged from 70 percent of capacity during peak wheat storage to 3 percent of capacity during peak grain sorghum storage. (*Project 179*)

#### **Import of the Expansion of Milk Distribution Areas**

B. H. FRAME, O. R. JOHNSON, J. N. SMITH, S. F.  
WHITTED, F. LASLEY, R. W. HOOKER

##### *Objectives:*

*A. Identify and appraise factors responsible for changes in milk distribution areas.*

*B. Investigate technological innovations in assembly of milk and attempt to formulate means whereby these may be most effectively integrated by the industry.*

*C. To develop information and analyses which will aid dairy companies, producers' cooperatives and others in evaluating the desirability of various methods of providing facilities and institutional arrangements for efficient handling of surplus milk.*

The current trend in Missouri is toward fewer but larger herds and plants. Bulk handling will speed up this trend.

Before investing in bulk handling equipment, the producer should consider: (1) alternative opportunities in endeavors other than dairying; (2) his age, health, and number of years he can and intends to milk cows; (3) his financial resources against the higher investment required; (4) whether a bulk milk hauler and market are available; (5) whether the market for his milk in cans will disappear in the future; (6) changes required in his buildings, equipment etc; (7) health regulations; (8)

amount of premium paid for bulk milk and reduction in hauling rate. (*Project 199*)

### The Feasibility of Retail Distribution of Frozen Meat

E. R. KIEHL, B. H. FRAME, O. R. JOHNSON, V. J. RHODES AND R. C. MAXON

Approximately 10 percent of the supermarkets which account for over 90 percent of the total retail food volume in the Kansas City area were surveyed early in 1957 and again in 1958. The 1957 survey disclosed that both chain and independent supermarkets devoted nearly 4 percent of their frozen display space to frozen meats. Independent supermarkets tended to carry a greater variety and number of brands of frozen meats than did chain stores.

During April and May of 1957, 310 interviews were obtained from customers of two suburban Kansas City supermarkets to determine the characteristics of families who purchase frozen meats. Approximately 93 percent of those interviewed could identify one or more of the brands of frozen meats carried by the store and 63 percent of the respondents had purchased one or more brands of frozen meats in the previous year.

Of the nine family and other characteristics investigated, only income, size of family, and the number of children under 12 years of age were significantly different between purchasers and non-purchasers of frozen meats. The greater the number of children under 12 years of age the greater the purchasing of frozen, sandwich-type meats. High price was generally the principal complaint about frozen meats.

A panel of 30 families evaluated 15 sides of Good grade beef fabricated into six boneless "cuts." Preliminary analysis suggests that this re-orientation in cuts would accomplish three purposes: (1) Simplify the inventory problems for the frozen meat processor and merchandiser; (2) aid consumer selection and, by reducing the possibilities of incorrect cooking, increase consumer satisfaction; (3) "upgrade" several muscles conventionally sold as economy cuts and thereby probably increase the value of the carcass.

A panel of 66 households in St. Louis County is evaluating composite beef quarters. Each "quarter" is composited from a Choice side, a Good side aged at high temperatures and the other side of that Good carcass aged by conventional methods.

There is evidence suggesting that Good grade has the leanness and high yield that will appeal to processors of frozen beef. However, our studies have shown a few Good carcasses are not sufficiently tender. This panel is testing the hypothesis that all Good carcasses will be as acceptable as Choice when the former are aged by high temperature methods. Results are not yet available.

The relative prestige of various conventional beef

cuts, the number of different cuts consumed by the typical household and consumer knowledge of cuts were the objectives of an interviewing study with 50 faculty members and a sample of 50 Columbia townspeople. Analysis is incomplete, but the technique does appear useful.

Partial analysis of several Kansas City studies indicated most shoppers were aware of frozen meats, a majority had tried them, and few people bought very much. In general only the sandwich-type of convenience items are important sellers and even they move rather slowly. (*Project 215*)

### Pork Grades In Relation to Consumer Acceptability

E. R. KIEHL, O. R. JOHNSON, V. J. RHODES, LLOYD BENDER AND R. C. MAXON

Analysis was completed of the 1956 sales study in Kansas City involving cuts from some 9,000 hogs. When "lean" and "regular" cuts were priced the same, sales were about 3:2 in favor of the lean ham shanks and rib end loin roasts. When the lean cuts were priced 4 cents above the regular cuts, sales were in a 1:1 ratio.

The major research effort was a preliminary evaluation of the consumer acceptance of pork cuts from very light weight hogs. Conventional cuts from 10 hogs in live weight groups of 125, 150, 175, and 200 pounds, were sold to a panel of 40 families.

Preliminary analysis indicates that there might be some difficulty in consumers adjusting to cuts from the 126 pound hogs, but little difficulty concerning cuts from 150 or 175 pound hogs. The size of bacon from the smallest hogs was quite satisfactory.

While these results demonstrate again the consumer desire for lean pork, they also indicate some other relevant aspects of the problem. Consumers are not likely to swing decisively to buying a lean grade or brand of pork without a considerable promotional and educational campaign. Since very light weight hogs have proportionately less fat, these so-called "broiler pigs" might have favorable consumer acceptance. However, there is still a problem of intermuscular (seam) fat in certain cuts as they are now fabricated. (*Project 216*)

### Consumer Preference for Standard Egg Quality

O. R. JOHNSON, Q. D. BANKS, LLOYD BENDER, H. R. FRANKLIN AND LEONARD VOSS

#### *Objectives:*

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

B. To determine the grade preferred by those consumers expressing a preference.

C. To determine whether or not those consumers with definite preferences are able to identify by visual inspection the grade preferred.

A preliminary test substantiated the hypothesis that there is no difference between the visual single and multi-stimulus methods of obtaining rankings and ratings. There appeared to be a difference, however, in the awareness of consumers to attributes, depending upon the method used. Subsequently, the multi-stimulus display was used for maximum potential awareness as contrasted to single-stimulus which had obtained average awareness.

The analysis of a St. Louis survey has been partially completed. Results generally complement those obtained in a study at Marshall and Windsor.

The major attributes of eggs which consumers consider in selection are (1) albumen thickness, (2) yolk shape, (3) yolk color and (4) the presence of the chalaza. The rate of substitution between grades is determined, in part, but (1) the awareness of consumers to these product attributes, and (2) the weight (positive or negative) given to each attribute.

Delivery from the farm or purchase directly from the farm was the source of egg supply for 53 percent of the housewives.

Deliveries from farm sources were made once a week to 68 percent of the homes purchasing eggs from this source. Purchases at the farm were less frequent, every other week or every third week.

Eggs were secured from the same store or supplier for 8 or more years by 37 percent of the consumers.

The dozen size purchase was most popular at food stores. Farm purchases were usually made in greater quantities. Larger purchases from farm sources were expected, but 60 percent of the purchases made in food stores were in lots of 2 dozen or more.

Housewives in Marshall and Windsor indicated White shell color was their first preference but no particular color was an outstanding choice.

The normal shell shape was definitely preferred. The spherical shaped egg was acceptable. The oblong shaped egg was not rated favorably but not disliked.

The normal textured shell was a definite first choice. The slightly abnormal shell such as permitted in the B grade was rated down. The abnormal textured shell as may appear in C grade eggs was rated a definite "dislike."

Consumers interviewed wanted clean eggs. Eggs with the stains permitted in B grade or the larger more numerous stains in C grade eggs were equally unacceptable to the respondents. The amount of stain or dirtiness of the shell did not appear important in acceptability. Any dirt or stain was objectionable.

Housewives do have some preferences in regard to shell characteristics of eggs. These preferences are reflected with only a relative degree of accuracy in the present grade standards for shell eggs according to this limited study. (*Project 228*)

## Extent of Use of Farmer's Cooperatives, Services Performed, Problems Confronted

J. N. SMITH

### Objectives:

A. To ascertain the use of cooperatives by farmers.

B. Services Performed by cooperatives

C. Financing of local cooperatives

A total of 420 farmers were interviewed to determine the nature and extent of use farmers make of their local cooperatives. Also, to determine the knowledge and opinions that members have of their organizations.

Seventy-four percent of those interviewed stated that they were members of a cooperative. Of those who were members, 79 percent had attained membership by participating in the work or activity of the cooperative rather than paying directly a membership fee.

The organizations located in the sample areas in which farmers mentioned most often as having membership were, in order: electric power distributing cooperatives, purchasing and marketing associations, insurance (mutuals), grain elevators, dairy marketing associations, livestock marketing cooperatives and petroleum purchasing associations.

Fifty-four percent of the members indicated that they attended annual meetings of their local association. The most frequent reason given for not attending these meetings was "no interest."

The products sold through the local associations are ranked as follows: grain, seed, poultry, dairy products and livestock. Farm supplies purchased through the local were feed, fertilizer, seed, machinery, and fuel, listed in order given.

Of those farmers interviewed who were not members of a cooperative, only 6 percent indicated that they opposed the cooperative type of business. Twenty-two percent of the non-members had previously belonged to a local association at some time. Reasons most frequently given for not presently being a member were (1) particular service no longer required, (2) dissatisfied with buying policy, (3) service cost increase, and (4) disagreement with state or national policy.

Work on objective "C" has included making contacts with various organizations for preliminary survey of materials availability and methods of obtaining such materials as seem useable in this analysis. (*Project 254*)

## Adjustment in Farm Organization in Dairy Farming Areas

B. H. FRAME, O. E. MILLER

### Objectives—to determine:

A. The comparative profitableness of producing grade A and grade C milk.

B. The comparative profitableness of various management practices.

C. *The amount, source and cost of obtaining the financial requirements.*

D. *The personal history of the operator.*

A final sifting of the survey records obtained in 1956 reduced the usable A records to 23 and the C records to 26. The average labor income for the grade A farms was \$2848 and for the grade C farms was \$892.

A total of 146 survey records were taken in Christian, Polk, McDonald, and Barry counties. These records were taken from 22 grade C-DHIA farms, 35 grade C non-DHIA farms, 46 grade A-DHIA farms and 43 grade A non-DHIA farms. (Project 256)

### Marketing Missouri Vegetables

O. R. JOHNSON, B. H. FRAME, J. C. GRADY

An analysis of over 100 schedules has shown that the vegetable industry in Missouri has definite weaknesses. The two most serious weaknesses appear to be the lack of standardization of quality and the standardization of the containers. Another definite weakness of the industry at the present time from the standpoint of producers is the individuality of individual growers, which places them in a highly vulnerable position in relation to selling operations.

There seem to be indications of a lack of knowledge on the part of the producers concerning marketing programs and the need for improvement in the marketing of the products. Few of them understand what standardization can mean in terms of their selling operations. Many produce such small amounts that they can not possibly operate as individuals and separate their small quantities of each product into the quantities required for the various grades.

There is a lack of concern regarding use of irrigation and various cultural techniques which would give better product quality. The producers are unable to place a quality equivalent to that coming from distant areas on their local markets.

The industry is in a state of change. There are two major causes. Locations of some producers in relation to housing developments in the St. Louis area are responsible for land being priced considerably above its alternative use in vegetable production, thus encouraging the producers to sell.

Land prices vary from \$350.00 to \$7500.00 per acre in the St. Louis area. Many of the producers are retiring after sale. Labor has been the other major factor causing changes in the vegetable industry. The industry requires a considerable amount of hand labor and much of the labor required is seasonal in nature. Alternative opportunities to labor in wages and continuous employment have made the supply of labor for the vegetable industry extremely tight.

The vegetable industry of Missouri can make pro-

gress and move out of its relatively weak position in relation to competitors from out of state when these factors are better known. (Project 262)

### How Young Families Get Started in Farming

FRANK MILLER, T. L. JONES

*Objectives:*

A. *To determine types of farm businesses, amounts of investment and procedures that have been used in establishing successful farm businesses in selected areas of Missouri.*

B. *To trace the development of successful operating units for the purpose of determining types of training and extent of family or other financial assistance operators have had.*

C. *To develop procedures for enlarging inadequate farm businesses and for financing young families who want to get started in farming.*

Installment contracts for the purchase of farm land are used extensively in several of the Midwestern states. They are not used much in Missouri, where the deed of trust with strict forfeiture clause is recommended.

The following major disadvantages are associated with this type of conveyance: (1) The seller who forfeits a buyer out after several installments have been paid is likely to have a suit in equity to determine whether or not the amount forfeited is excessive. This situation leaves a cloud on the title to the property that may influence its salability. (2) Removal of this cloud may require court action which is expensive. Under Missouri law, this eventuality can be avoided by using a deed of trust with power of non-judicial sale which allows the holder to remove a defaulting purchaser and extinguish all of his rights in the property in a maximum of 30 days at a cost of \$25 to \$50.

Installment purchase contracts have the following advantages: (1) Use of them permits a buyer to gain possession of a farm with a very small initial payment. (2) The seller can reduce the total amount of income tax and spread the payments over a period of years by declaring only the amount of capital gain associated with the annual payment. (3) The buyer can make the improvements he needs on the farm without fear of losing the unexhausted portion of them because of termination of the lease. (4) The seller can get a larger income than he would receive from rent and not have the responsibility of supervising a tenant.

Analysis of farm records shows that financing well balanced farm businesses by selling common stocks to investors would have the following major advantages:

1. It would provide for more effective use of resources.
2. It would bring in enough net income to pay interest on capital, rent on land, wages to labor and profits to management more nearly according to their contributions to earnings than is possible on a high percentage

- of farms at the present time.
3. It would decrease the economic losses resulting from closing out farm businesses and reestablishing them each generation.
  4. It would strengthen rather than jeopardize the family farm.
  5. It would build strong equities in efficient farm businesses for existing credit agencies to finance.
  6. It would help beginning farmers to get started in a profitable business without paying the penalty of high interest rates to take care of risk.

Three major obstacles lie in the pathway of organizing this type of financing agency: (1) Legal restrictions on corporate ownership of farm land in many of the states. (2) The problem of selling enough stock to finance fifty or more well organized farms at a cost of \$50,000 or more per farm. (3) The expense of operating such a corporation until it becomes established and income begins to flow through it.

If these obstacles can be overcome, a financing corporation appears to be the solution to many of the problems of farm finance.

Analysis of farm records shows that families who do not inherit substantial equities in good farm businesses have difficulty in getting credit needed to finance adjustments and take advantage of the technological developments of the last half-century.

Another problem that confronts young farm operators is lack of skill in managing good farm businesses. A financing corporation designed to bring risk capital to agriculture could overcome this difficulty by providing managerial aid to young operators during their early years in farming. (Project 279)

#### Effects of Fires on Insurance and Other Ginning Costs

J. W. MCKINSEY, B. H. FRAME, O. R. JOHNSON,  
D. N. HARRINGTON AND W. R. SUMMITT

Forty-five fires were reported by the 58 gins from August 1957 to January 1958. The estimated total cost of damages by fires was: \$265 in machinery, \$50 in buildings, \$1,073 in cotton, and \$310 in the value of ginning time lost.

Because of the extremely small cotton crop in 1957, and the adverse weather conditions during the harvesting and ginning season, the results this year are less helpful to the objectives of the study.

Interviews were completed with 54 of the 59 gins in the 1956 sample and information was tabulated. The following summary is reported:

1. Total volume of cotton ginned in 1956 by the sample gins was 155,066 bales.
2. The value of cotton involved in fires in these 54 Missouri gins was \$14,268.00.

3. The value of salvage cotton belonging to:
  - a. the ginners was \$2,211.
  - b. the insurance company was \$4,950.
4. The total cost of fire extinguishing materials (mechanical extinguishers) used in 1956 was \$1,202.
5. Premiums paid for insurance:

Type of Coverage	Premium (\$)	No. of Gins
Building and Machinery	86,458	54
Cotton in Transit	38,127	52
Processing	232	1

6. Payments received from insurance company from the above listed averages:

Type of Coverage	Total Payments Received (dollars)	Number of Gins Reporting Received
Building and Machinery	9,991	10
In Transit	11,272	10

7. Ginners in this sample paid \$5,933 for fire loss to producers where ginner assumed responsibility, without insurance coverage.

#### An Analysis of the Changing Patterns of Livestock Markets in Missouri

E. R. KIEHL, DURWARD BREWER

An intensive analysis has been completed for one of two localized areas to determine the importance of various livestock marketing channels, and motivating factors which influence farmers in their choice of markets. Tabulation of information and a tentative analysis are under way on the second marketing area. (Project 289)

#### Economic Analysis of Grain Marketing

J. W. MCKINSEY, D. N. HARRINGTON,  
DORUIAN WILLIAMS

Preliminary results of this survey include:

- A. In establishing the price they paid farmers for grain, country elevators used the following sources of information in 1956: terminal quotations for two-thirds of the grain they purchased; information received directly from carlot dealers or brokers for one-fifth of the grain purchased. Other sources of information used were grain processors, truckers, local feeders, and home offices of multiple unit elevators.
- B. Terminal grain markets such as Kansas City, St. Louis, Chicago and others, are the most important type of sales outlets for Missouri country grain elevators in terms of volume of grain moving to such markets. Almost three-fourths (72.4 percent) of the grain merchandised by Missouri country elevators was sold in such terminal markets.
- C. The spread between the average Missouri farm price and the average price quoted in terminal markets was widest for soybeans, and narrowest for oats. For the 11-year period (1946-56), this spread averaged 34½¢ per bushel for soybeans and 23.6¢ per bushel for wheat, 10.7¢ per bushel for corn, 5.8¢ per bushel for

oats.

- D. The average gross margin on grains sold locally was higher than the margin on grain shipped by 1¢ to 4¢ per bushel. The range in average margins by type of sale and by grain was as follows.

Type of Sale	Range in Gross Margins per Bushel
Local Sales	8¢, barley to 11.6¢, sorghum grain
Truck Sales	7¢, oats to 7.7¢, corn
Rail Shipments	6.7¢, oats to 8.2¢, soybeans

- E. The average gross margins varied markedly between crop reporting districts. Of the grain shipped by truck, the margin for corn varied from 4.8¢ per bushel in crop reporting district 1 to 15¢ per bushel in crop reporting district 8. For soybeans this margin ranged from 4.5¢ per bushel in crop reporting district 4 to 8.7¢ per bushel in crop reporting district 6. The margin for wheat ranged from 5¢ per bushel in crop reporting district 4 to 8.5¢ per bushel in crop reporting district 6.
- F. Wheat and soybeans were the only grains for which any operator reported an increase in margin during the past ten years. Forty of the 59 elevators indicated no change in gross margin in this period. All operators reporting a decrease in margin gave increased competition as a principal reason.
- G. Of the total grain sold by the Missouri country elevators in 1956, 24 percent was sold locally, 33.8 percent was shipped by railroad, 16.5 percent was shipped by truck, and 16.5 percent by barge.
- H. Of the 46.8 percent of corn that was shipped by rail, 57.3 percent was consigned to terminals, 19.8 percent sold to terminal merchandisers, 14.6 percent sold to carlot dealers, and 4.5 percent sold to processors. Of the 15.6 percent that was shipped by truck, 11.7 percent was sold to truckers at the elevator, 2 percent sold direct to terminal or subterminal elevators, 0.5 percent was sold direct to processors, and 1.4 percent through dealers to terminal or subterminal elevators. All of the corn shipped by barge was sold to terminal merchandisers.
- I. Of the total amount of wheat sold by Missouri country elevators in 1956, 85.3 percent was shipped by rail, 10.5 percent was shipped by truck and 4.2 percent was shipped barge.
- J. Of the total amount of corn, wheat, soybeans, oats, barley and milo sold by Missouri country elevators in 1956, 10.9 percent was sold locally, 62.5 percent was shipped by rail, 15.2 percent was shipped by truck and 11.4 percent was shipped by barge.
- K. Of the total volume of grain handled by Missouri country elevators in 1956, corn accounted for 31.2 percent, wheat 38.3 percent, soybeans 24.1 percent, oats 3.4 percent, milo 2.4 percent, and barley .6 percent.
- L. Of the total amount of grain shipped by truck by Mis-

souri country elevators in 1956, 37.6 percent was financed by cash, or check, 7.7 percent was paid for within five days, 21 percent was paid for in 5 days or more, and 33.7 percent was settled for by advances for or drafts on buyers or dealers pending settlement. (Project 299)

### Flavor Preferences Affecting Consumer Choice of Poultry Meats

LEONARD VOSS, LLOYD BENDER, H. R. FRANKLIN

#### Objective:

A. To test consumer acceptance and preference for existing poultry meats products.

The effect of a new cooling technique for poultry on flavor and tenderness was tested by a taste panel. The new technique which cools dressed broilers to 34°F. in 30 minutes was developed by a Missouri processing equipment manufacturer.

There appeared to be no difference in flavor or tenderness between the birds cooled by the new rapid cooling technique and the broilers cooled in the conventional manner under the conditions of the experiment. This indicated the new technique did not change the flavor or tenderness of dressed, ice packed broilers. (Project 315)

### Economic Aspects of Egg Breaking and Drying In Missouri

LLOYD BENDER

#### Objectives:

A. To determine the importance of egg processing plants as buyers of eggs and their effect on farm prices.

B. To determine the methods and cost of procuring, processing, and merchandising eggs by commercial plants.

C. To determine the significance of physical characteristics of eggs on the procurement policies of firms.

This is a regional cooperating project of NCM-14. Kansas is the leader of the project. A regional representative conducted all field surveys. Results are now being compiled and analyzed at Kansas State College. (Project 316)

### Floricultural Standards and Grades

J. C. GRADY

Work done to date has included making contacts with retailers, wholesalers, and wholesale growers. These contacts have made it possible to design a questionnaire, which is being mailed to the groups.

Work sheets have been prepared for data from all the marketing agencies mentioned and will include such data as number of stems per bunch, number of flowers per stem, length of stem, diameter of stem, amount of foliage, color, maturity and freedom from insect and disease. Objective physical measurements will be needed on some of the factors. (Project 328)

## Milk Supply Responses to Changes In Economic Factors

S. F. WHITTED, J. N. SMITH, RAYMOND HOOKER,  
R. F. FALLERT, R. L. BECK

Of 20 farmers who quit producing milk for the Kansas City milk shed last year, 35 percent stated they quit because they could not make an acceptable level of living by dairying. Forty percent of these shifted to a non-farm occupation; the others changed enterprises on their farm. These were all young men.

Other important reasons given were: old age and illness, handler quit taking milk, hauling charges greater to Kansas City than to another market, and availability of Social Security payments. The average size of these herds was 22 cows, 5 less than the average for all producers. Fifteen percent are still selling Grade A milk to another market, 10 percent are selling manufacturing milk and 75 percent are out of dairying completely.

Thirteen percent of the group that is out of dairying completely said they would return to the market if their sons would come back to the farm and help them. The remainder said they would not return to dairying because of the high investment and low returns.

Herd size has increased 18 percent in the last 3 years.

The most common reason given was to increase income; the next most common, to utilize more fully existing facilities. (*Project 330*)

## Time and Temperature Tolerances of Meat And Meat Products

V. J. RHODES, PHILIP BAUCHAERT

Initial contacts have been made with frozen meat brokers, wholesalers and retailers in Kansas City and with two major packers. Samples of various frozen meat items have been purchased and are being evaluated by a panel. These evaluations will be related to the time period since the products were packed. (*Project 334*)

## The Import of Poultry and Poultry Products Price and Income Policy Upon Producers

E. R. KIEHL, J. G. WEST, LLOYD BENDER,  
GORDON NANCE, LEONARD VOSS, Q. D. BANKS

Preliminary work has been done in the assembling of information on federal price and income support programs which have directly affected the poultry industry. This work was necessary prior to making a detailed study and evaluation of these programs. (*Project 339*)

# Publications

E. B. Winner, Editor

G. I. BANK, CARLTON BOWYER, CLYDE DUNCAN,  
PAUL GWIN, D. E. HATESOHL, MARGARET HOWARD,  
A. A. JEFFREY, R. D. LEE AND DONALD COLLINS

Radio: Thirty-eight stations used the tape recorder programs. Two-page daily farm news script service was provided all stations in the state. In addition, special recordings on experimental field days and state conferences were made for many stations. Some 161 Extension Agents participated regularly in radio programs one or more times per week during the year.

Publications: All manuscripts submitted by the Experiment Station staff and approved for station publications were edited and processed. News releases, periodicals, special publications: Research data were processed and furnished to weeklies, dailies, farm magazines, and trade papers. Stories were provided to these papers and magazines through weekly issue of the Farm News Service, specials, and tips to staff writers of the various publications. In addition, periodicals such as the monthly An-

nouncer were edited and published.

Television: Two 30-minute television shows were presented weekly over KOMU-TV. A 15-minute weekly kinescope was sent to seven stations. KTVI at St. Louis used Missouri College of Agriculture kinescopes for a daily 15-minute farm show through 18 weeks.

Pictures and slides on news events were furnished to stations as available.

Agents in eight counties telecast on a regular basis. The same is true of the consumer information personnel in our six largest cities. In addition, 55 agents used this media occasionally.

Programs on KOMU-TV were determined by the division of agricultural sciences television committee, which includes a representative from each of the departments of the College of Agriculture and the School of Veterinary Medicine.

Motion Picture: Two movies were completed. (*Project 174*)

# Agricultural Engineering

M. M. Jones, Chairman

## Corn Production Involving Rotations and Irrigation

R. P. BEASLEY, R. B. CURRY

### Objectives:

A. To determine the effect of irrigation on such factors as crop yield, quality, germination, early growth rate, maturity date, and decomposition of crop residue in intensive one-year rotations.

B. To determine irrigation practices and procedures best adapted to the production of crops in intensive rotations.

C. To develop a more satisfactory method of irrigation for small plots.

Three different gypsum-type resistance units were used to determine soil moisture. Little correlation was found in the resistance of any of these units. Two different methods of estimating the potential evapotranspiration were compared with evapotranspiration as measured by change in soil moisture as means of determining time to irrigate.

These methods were Thornthwaite's method and a method using a black and white atmometer. The evapotranspiration as estimated by these methods has a fair degree of correlation with soil moisture change if sufficient lengths of time are used (monthly or weekly instead of daily).

A sprinkler which approaches a square distribution pattern was found and tested prior to growing season. These sprinklers gave better water distribution patterns over the plots than had been obtained. Adequate control of this variable would require much more elaborate equipment. (Project 2)

## Soil and Water Conservation Management

M. M. JONES, R. P. BEASLEY, J. F. THORNTON

### Objectives:

A. To improve terrace construction techniques.

B. To determine the effect of terraces on crop yield.

C. To design a canopy inlet tube overfall structure.

D. To study methods of stabilizing grass outlets.

### Objective A—

Work has been continued on improving a method of terracing which will result in terraces with less curvature and fewer point rows between terraces. Three additional terraces, 1300 lineal feet, were constructed on the Agricultural Engineering Research Farm in the spring of 1957. They were laid out and constructed so that there will be no point rows between them.

Seven terraces, 6250 lineal feet, were constructed on a privately owned farm near Versailles. Conventional terrace lines were first staked out and mapped. Improved terraces were then planned and constructed with a bulldozer and motorgrader. The point row area was reduced from 25 percent to 5½ percent. Also the terraces were much straighter and easier to farm. After one crop season, the farmer made the statement that he was able to do the work in producing a corn crop on this field one-third faster than on other fields with conventional terraces.

### Objective B—

Experiments have been set up and terraces constructed with different spacings and grades at the Midway Agricultural Engineering Research Farm.

There was no scouring in any of the channels which could be considered excessive in 1957.

A rain of 3.24 inches on October 15 and 16, 1957, caused excessive erosion where the terrace spacings were more than 1¼ times that usually recommended. The maximum intensity of this rain was 0.69 inches in 18 minutes or a rate of 2.3 inches per hour. This maximum intensity occurred after 1.75 inches of rain had fallen in the previous 24 hours. A rainfall of this intensity can be expected at least once each year. This field had been seeded to wheat.

In 1951 terraces were constructed about two-thirds the distance across a field at McCredie, leaving the remainder of the field unterraced. There have been no significant differences in yields of crops grown to date.

### Objective C—

A canopy-inlet tube structure was installed in the spillway of the pond at the Midway Agricultural Engineering Research Farm. The tube was a 5-inch diameter, smooth galvanized pipe. The length of tube is 63 feet and the overfall is 3 feet. An entrance consisting of a square end on the tube was also tested. The canopy structure starts to flow full at an entrance head of 0.4 feet. For entrance heads greater than this the capacity of the canopy tube is approximately 75 percent greater than the square end tube.

A structure of this type, consisting of 100 feet of 1-foot diameter corrugated pipe has been installed in a spillway from a lake at Bell's Orchard near Boonville.

An overfall structure consisting of two 40-foot lengths of plastic tubing was constructed to protect the overfall from a diversion channel into the northeast pond

on the Midway Farm.

*Objective D—*

The outlets on the Agricultural Engineering Research Farm at Midway were constructed in 1953. These outlets were seeded in the fall of 1953 using the following mixtures on different sections of the outlets: timothy-redtop-bluegrass, timothy-redtop, timothy-redtop-fescue, timothy-fescue, and redtop-fescue.

The maximum depth of flow in the terrace channels at Midway occurred as the result of 1.18 inches of rain falling in 30 minutes on July 27. This was preceded by 1.37 inches of rain on the same date. This intensity of rainfall could be expected at least once a year. The maximum depth of flow was 6 inches in terrace 4 on field C. This terrace is 1350 feet long. The area above the terrace, was in corn.

The outlets were seeded in the fall of 1955 (third time). The following tabulation gives the condition of the outlets in March, 1958.

Timothy-Redtop-Bluegrass: Only a fair vegetative cover, some washing in the outlets where water enters from the terraces.

Timothy-Redtop: Fair to poor vegetative cover with some washing.

Timothy-Redtop-Fescue: Good cover on most areas. In certain sections the fescue is in large clumps with a fair cover between clumps. No washing.

Timothy-Fescue: Fair to good cover on most areas but more and larger clumps of fescue than in the T-RT-F mixture. No washing.

Redtop-Fescue: Fair cover on most areas but even larger clumps of fescue. No washing.

Under the conditions present when these outlets were established the timothy-redtop-fescue mixture has given the best cover.

With the weather conditions that have prevailed since 1953 it has been difficult to establish and maintain a suitable stand of vegetation in the outlets. This points up the need for additional research on stabilization of terrace outlets. (*Project 43*)

### **Influence of Climate on Shelter Requirements For Dairy Cattle**

R. E. STEWART, J. C. WOOLEY, R. G. YECK

*Objectives:*

A. Determine effect of infrared radiation on heat regulation of various animals.

B. Determine housing requirements of young cattle as indicated by effect of high environmental temperature on growth and other criteria.

Three calves each of the Jersey, Brown Swiss, and Holstein breeds were placed in a test room of the psychroenergetic laboratory September 26, 1956, and were held in constant exposure to 50°F temperature and about

65 percent relative humidity until September 16, 1957. A similar group of calves was held in another test room at 80°F and 55 percent relative humidity.

Bedding requirements and litter production were determined. It was found that after 35 weeks of age the pens in the 80°F room required 50 percent more bedding than the pens in the 50° room. At that time the litter production was about 100 pounds per calf per week more in the 80° room than in the 50° room. Litter production increased with increasing age in a near-linear fashion from slightly less than 100 pounds per calf per week at 5 weeks of age to a near maximum of about 450 pounds per day at 39 weeks of age in the 50° room and to a near maximum of about 550 pounds per day at 36 weeks of age in the 80° room. Thereafter, both rooms retained a constant litter production.

Calves drank much more water at 80° than at 50°F. Holstein calves drank 100 percent more, Brown Swiss 30 percent more, and Jersey calves 15 percent more at 80° than at 50°. These results with water consumption did not coincide with changes in stable vaporization rate.

TDN consumption was nearly parallel to water consumption. Over the entire experiment at 80°F the TDN rates were greater than the consumption at 50° by 20 percent among Holsteins and 15 percent among Jersey and Brown Swiss calves.

Daily weight gains were good for all animals, but among the Holsteins and Jerseys the daily weight gains at 50° were slightly better than those at 80°. There was no significant temperature effect on the weight gains of the Brown Swiss calves.

Heart girth and height-at-wither measurements also showed that Holstein and Jersey calves grew better at 50° than at 80°F. Brown Swiss did equally well or perhaps slightly better at 80°, compared to 50°.

A definite change in surface temperature was noted with advancing weight. The main body skin temperatures were higher at 80° than at 50°, with differences of 5°F and greater. The difference between main body hair temperatures at the two air temperatures was 15°F and more.

A decline in skin temperature with respect to body weight, age, or a combination of both, would be expected as rectal temperatures decline with age. However, in this experiment rectal temperatures declined only about 1°F during the initial 11-month period while the skin temperatures declined about 2°F at 80° and about 5° at 50° during the same period. (*Project 66*)

### **Requirements for Farm Animal Shelters**

R. E. STEWART, B. F. CARGILL, M. D. SHANKLIN,  
C. N. HINKLE

#### *Moisture Production of Dairy Stables*

The results of 12 months experimentation with growing dairy calves have provided basic data for design

of ventilation and air-conditioning systems in dairy calf stables.

Heat and moisture dissipation in the experimental chambers was greatest per unit body weight at about 10 weeks of age. Heat loads prior to this age are less per unit body weight. After 10 weeks of age the heat loads per unit body weight decline until about 45 weeks of age when both total heat and latent heat loads per unit weight appear to become level.

As in previous studies with beef calves, the total stable heat dissipation from penned dairy calves was roughly the same at both 50° and 80°F temperatures. However, the latent heat dissipation component was about 70 percent higher at 80°F compared to 50°F.

#### *Young Calf Housing.*

From October, 1956, to September, 1957, three breeds of dairy calves, Brown Swiss, Jersey, and Holstein, were exposed in the Climatic Laboratory to a temperature of 50°F. Similar groups were kept in an 80°F environment.

Casual observations, rectal temperatures, and feed consumption indicated that calves raised at 50°F could withstand constant temperatures as high as 90°F as well as those that were raised at 80°F. Conversely, the calves that were raised at 80°F appeared to withstand the 32° environment as well as those that were raised at 50°F.

#### *Partitional Calorimeter and Radiant Cooling*

The partitional calorimeter, constructed as outlined in previous reports, was completed during 1957 and used for determination of heat dissipation of chickens.

The tests were in the nature of preliminary tests only and designed to determine the operational characteristics of the machine by comparison with similar data obtained under different methods, such as indirect calorimetry. These comparisons indicate that the results check closely with data obtained by other investigators. This implies that the calibration and general heat-transfer-measurement calorimeter are suitably accurate for future work.

#### *Factors Affecting Absorption of Infrared Radiation by Cold Surfaces.*

One method of obtaining relief from summer heat conditions is to provide a cold surface for the absorption of radiant energy from the body. Several factors which will affect this heat picked up by a cold plate were investigated in this study: (1) size of the cold plate; (2) covering of the cold plate; (3) temperature of the cold plate; (4) temperature and moisture content of the surrounding air; and (5) reflectivity of the surrounding surfaces.

The effect of the variation in chamber and plate temperatures was as expected from the theoretical analysis. The moisture content of the air appeared to have no

effect upon radiation transfer; however, high moisture content decidedly increased the heat picked up by the bare cold plates, due to increased condensation.

Any of the experimental results involving radiation exchanges are applicable only to the test conditions because of the shape factors. The following two statements, however, may be applicable to research of a similar nature: (1) changing the emissivity of the surround appears to have no great effect on the amount of total heat picked up by the cold plate; and (2) doubling the plate size in an enclosure of *low* emissivity will neither double the heat picked up by the plate nor double the plate's effectiveness for the removal of radiant energy from an object within the enclosure.

Tests with the covered plates indicated that: (1) the effective radiant temperature was the temperature of the inner polyethylene film; (2) total heat pick-up was reduced from 50 to 75 percent of the bare plate value depending upon the humidity; and (3) the effective transmission for the 100°F radiant energy spectrum was 67 percent. (*Project 136*)

### **Design of Farm Buildings and Equipment To Meet Missouri Conditions**

T. O. HODGES, J. C. WOOLEY

#### *Objective:*

*The design and development of plans for farm buildings and equipment to meet the needs of the state.*

Work during the past year has centered around improving the cooperative plan service of the North-Central States so farmers within each state can have a wider choice of building plans which incorporate the latest research findings and technological advances. (*Project 71*)

### **Forage Harvesting, Storage and Feeding**

M. M. JONES, D. B. BROOKER, C. L. DAY,  
J. S. MCKIBBEN

#### *Objectives:*

- A. To study harvesting, processing, and feeding of hay.*
- B. To study equipment and methods of handling silage crops, with emphasis on reducing storage losses.*
- C. To study stresses imposed on the walls of horizontal silos.*

The hay on the Agricultural Engineering Farm was harvested and processed in the following manner.

1. The hay was cut and windrowed with a conventional mower and side delivery rake.
2. The partially cured hay was picked up from the windrow with a flail type forage harvester, chopped and blown into self-unloading wagons.
3. The wagon was pulled to the barn and the hay was discharged into a flight type elevator.
4. The elevator carried the hay to the barn mow and discharged it onto a distributing conveyor.

5. The distributor spread the hay evenly over the barn area.
6. A forced air drying system dried the hay to a moisture content safe for storage.
7. The hay was fed directly from storage with a minimum of feeding labor.

This "system engineering" approach to hay mechanization gave a continuous flow of hay from field to barn with a 3 man crew. The hay was picked up from the windrow, hauled, and placed in storage at a rate of about 1 ton per hour. The rate that the flight elevator would handle the hay was the limiting factor. The cross feeder that received the hay from the wagon had a narrow cross section at the discharge end which reduced the capacity of the elevator.

The horizontal silo on the Agricultural Engineering Research Farm was filled with corn silage harvested with the flail type forage harvester equipped with a special row crop attachment. Approximately 135 tons of silage with an average moisture content of 60.2 percent was placed in the silo.

The silage operation was carried out with three men. One man operated the forage harvester, one man hauled the silage to the silo and spread it with self-unloading wagons, and one man operated the packing tractor. This crew placed silage in the silo at the rate of 4.8 tons per hour.

The fact that the silage moisture content was relatively low makes it imperative that the data on silo wall stresses be checked before they are published. (*Project 138*)

### Equipment and Procedures for Control of Weeds and Brush

C. L. DAY, MAURICE GEBBARDT

#### *Objectives:*

*A. Develop systems and equipment for the control of weeds in field crops.*

*B. Design, develop and test equipment for weed control in pastures.*

*C. Develop more accurate and efficient methods of applying chemical herbicides.*

#### *Weed Control in Soybeans*

Clark soybeans were drilled in 40-inch rows, 30 feet long on Mexico Silt Loam soil at the University South Farm, Columbia. The following weed control treatments were used.

1. Three cultivations (timely, i.e., when needed to control the weeds).
2. One cultivation early, skip the next cultivation, then apply the post-emergence chemicals with and without shields.
3. Post-emergence treatment only.
4. Omit first and possibly second cultivation, then cultivate and apply the post-emergence chemicals with and

without shields.

5. No cultivations, chemical pre-emergence, and then post-emergence at the time of last cultivation with and without shields.

Weed infestations were heavy at the time of the first cultivation and, therefore, the soybean yields on plots not receiving "first" cultivations were adversely affected. Pre-emergence applications of PCP(Na) at a rate of 20 pounds per acre reduced stands and retarded early growth. The best weed control was achieved on plots with pre-emergence herbicide treatments and the best yields from plots treated with pre-emergence herbicide and one cultivation.

Results from treatments 2, 4, and 5 were analyzed statistically. There was a significant difference between post-emergence chemical treatments as determined both by soybean yields and by weed yields. Among those plots given post-emergence herbicide treatment, soybean yields were highest on plots treated with DNBP and lowest on plots treated with 2,4-D.

The weed yields were also highest on plots treated with DNBP and lowest on plots treated with 2,4-D. Those herbicides which effectively killed the weeds also damaged the soybean plants to the extent that yields were reduced.

The shields used were not effective in reducing plant damage because the plants were not completely shielded from the sprayed material.

#### *Weed Control in Corn and Control of Weedy Brome in Bluegrass Pastures*

These studies are just getting under way so no reliable results can be published at this time.

#### *Calibration of Farm Sprayers*

Four methods of calibrating sprayers were compared:

1. Fill tank, operate sprayer at field pressure and speed of 330 feet, measure amount of water required to fill tank, and calculate the rate of application using the following formula:

$$\text{G.P.A.} = 132 \text{ g/w}$$

where:

$$\text{G.P.A.} = \text{Gallons applied per acre}$$

$$\text{g} = \text{Amount required to fill tank (Gal.)}$$

$$\text{w} = \text{Boom width (feet) or number of nozzle X nozzle spacing (feet)}$$

2. Operate sprayer at field pressure and speed for 330 feet, measure the amount of time required to drive the 330 feet, operate sprayer in a stationary position for the same time interval required to drive the 330 feet, and calculate the rate of application from the same formula used in method one.
3. Essentially the same as method No. 2, except operate the sprayer for two times the amount of time required

- to drive the 330 feet. Calculate the rate of application using: G.P.A. = 66g/w
4. Essentially the same as method No. 2, except operate the sprayer for four times the amount of time required to drive the 330 feet. Calculate the rate of application using: G.P.A. = 33g/w

The first method was patterned after recommended practices now in use and the other three methods were developed to increase the accuracy of the first method. The last three methods were also developed to eliminate any errors caused by spilling and from failure to get the sprayer in the same position when refilling. By operating the sprayer for a greater time interval, a larger amount of material could be sprayed from the tank, thus reducing the error in percent. (*Project 153*)

### Farm Water Supplies

T. O. HODGES, M. D. SHANKLIN

#### *Objective:*

*To develop or to improve methods of securing adequate supplies of good water for farm household use, particularly the collection, filtering, and treatment of farm pond water.*

A slow-sand filter has been constructed for use by a farm family. The unit is designed for a maximum flow of 1200 gallons per 24 hours. Details of the system are similar to those shown in Missouri Experiment Bulletin 691.

Although the filtering sand was washed before it was placed in the filter, the turbidity of the water increased as it passed through the filter for about 21 days, at which time approximately 850 gallons of water per square foot of filter surface had passed through the unit. This showed that the sand did contain some fine silt.

The "curing" period in forming the filtering film might have been shorter if the system had been placed in operation at a time when the turbidity of the raw pond water was higher. After the initial "curing" period, the reduction in turbidity of the water consistently increased until at the end of nine weeks, the turbidity of the pond water was 10 to 12.

At the end of 15 weeks the surface of the filter sand was scraped to remove the accumulated silt. This caused a short-term decrease in filtering efficiency. Even when turbidity of the pond water rose to about 22 parts per million at 21 weeks, the turbidity of the filtered water remained below 5 parts per million, which is a very clear water.

The chlorinator was a hydraulically powered positive displacement pump and some difficulty in fine adjustment was encountered as shown by the week to week variation in chlorine residual. In spite of this difficulty, a very high quality water has been obtained. Data confirmed that the filter alone cannot be depended on to

produce bacteria-free water and that chlorination is needed.

When chlorine is added to water for sterilization, the chloride content increases, depending upon the chlorine demand of the water and the amount of chlorine residual present. The chloride content of the chlorinated water is well under the allowable limits for drinking water but could possibly become exceedingly high under super-chlorination procedures.

#### *Quality of Pond Water*

Water samples from 48 randomly selected ponds have been collected and analyzed monthly to determine the quality of pond water and its seasonal variation. The factors studied are total hardness, turbidity, conductivity, pH, alkalinity, chlorides, sulfates, and iron.

Conductivity varied from a low of 120 in January, 1958, to a high of 205 mhos per cubic centimeter in January, 1957. Turbidity varied from a low of 18 in January, 1957, to a high of 143 turbidity units in May, 1957.

No significant variation in pH occurred on the average, the range being 7.0 to 7.95. Total hardness appeared to increase during times of low water reserve in the ponds, ranging from a low of 54 in June 1957 to a high of 85 in January 1957.

Tests for alkalinity, chlorides, and sulfates were started on a schedule basis in April 1957 and no seasonal trends are yet apparent. Ranges for these factors are: (1) 58 to 68 parts per million alkalinity, (2) 4.6 to 5.1 parts per million chlorides, and (3) 15 to 30 parts per million sulfates. Apparently, only traces of iron are present; however, the test is quite unreliable because of influence by turbidity. (*Project 155*)

### Grain Drying

D. B. BROOKER

#### *Objective:*

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

Approximately 750 bushels of wheat and 825 bushels of ear corn were dried with natural air.

The wheat was dried in a 1000 bushel round metal bin with air introduced through a duct system. Air was supplied by a 3 horsepower directly connected propeller fan.

The wheat that was placed in the bottom of the bin (approximately 200 bushels) had a moisture content of between 25 and 30 percent. The moisture from this wheat had to move up through the entire bin, a process that prolonged the drying somewhat, and added to the drying cost.

TABLE 1--SUMMARY OF CROP DRYING ON THE AGRICULTURAL ENGINEERING FARM IN 1957

Grain	Bushels	Original Moisture Content	Final Moisture Content	Ventilation Rate (cfm per bu.)	Days Drying Time	Electrical Costs (cents per bu.)*
Wheat	750	20.0	11.7	3.7	22	6.0
Ear Corn	825**	30.7**	19.2	5.0	18	1.6

\* Electrical energy figured at 3.0 cents per KWH.

\*\* Two pickings - First (400 bushels) at 30.7 percent moisture and second (425 bushels) at 19.7 percent moisture.

The ear corn was dried in a round crib with open mesh side walls made of welded wire. Air is exhausted from a vertical duct in the center of the crib by means of a fan mounted in the upper end of the duct. The fan is powered by a ½ horsepower motor.

A study of air flow from lateral ducts was made in a laboratory bin. The bin had a floor area of 4 feet by 8 feet and a height of 8 feet. The bin was filled with wheat. The lateral ducts were placed across the short dimension of the bin. They received air from a main duct extending along the outside of the bin. Sliding doors at the end of each lateral made it possible to adjust air flow so that the static pressure was the same in the various laterals during each test.

An increase in the "minimum cfm per bushel" or a decrease in drying time can be brought about by one or a combination of the following methods.

1. Increasing the pressure in the duct by increasing the air delivery (increasing fan output at any given static pressure).
2. Placing the ducts closer together.
3. Using an air escape area that will give the optimum "cfm per bushel"

There are physical limitations on any of these methods. More horsepower is required to increase the pressure by increasing total air delivery. A 5 horsepower fan unit will be required to increase the duct pressure enough so that the ducts will have approximately the same "minimum cfm per bushel" as that obtained with a false floor when a 3 horsepower fan is used. (Project 225)

### Storage and Use of Surface Runoff for Irrigation

R. P. BEASLEY, R. B. CURRY, J. F. THORNTON

Objectives:

A. Determine amount of runoff into and evaporation and seepage from farm reservoirs.

B. Develop methods of reducing evaporation and seepage losses from farm reservoirs.

C. Determine the effect of irrigation on rate and amount of runoff and soil loss.

During the past six years the runoff into the 16-acre reservoir at McCredie has averaged 3.12 inches from the 154-acre watershed. The evaporation and seepage losses from the reservoir have averaged 49.78 inches for

the same period. This is the first year of record for the Midway reservoir.

A basic study of the flow of colloidal suspensions in porous media has been initiated in a search for methods of reducing seepage and evaporation losses.

Literature on prior work in this area has been studied. The design and construction of equipment has been completed, and Carborundum of various particle sizes has been selected for the porous media. Bentonite, a naturally occurring montmorillonitic type clay has been selected for the colloidal suspension.

### Effect of Irrigation on Amount of Runoff.

Runoff was measured from four 2-acre pastures at McCredie. The runoff resulting from rainfall on the two irrigated pastures was 6.66 inches. The runoff from the two pastures not irrigated was 3.68 inches. (Project 227)

### Distribution and Application of Irrigation Water

R. B. CURRY, J. F. THORNTON, V. C. JAMISON

Objectives:

A. To determine adaptability and efficiency of surface and overhead method of applying water on Mississippi River bottom soil.

B. To develop design criteria for furrow irrigation.

This experiment is being conducted on river bottom soil near Elsberry. Corn and alfalfa are the crops used. The corn is irrigated using sprinkler and furrow irrigation methods. The alfalfa is irrigated using sprinkler and border irrigation methods.

Ninety percent of the moisture lost by evapotranspiration on Sharon silt loam was withdrawn from the upper 2 feet when irrigated and 75 percent when not irrigated. Irrigating increased evapotranspiration.

Yield increases, over no irrigation, for surface and sprinkler methods were not significantly different. Choice between the two methods would seem to hinge mostly on equipment and operational costs, at least on soils similar to the river bottom soil used.

The contribution of the soil by layers to evapotranspiration losses for corn was studied. Even in the deep alluvial soil it was evident that most of the water lost by evapotranspiration comes from the upper 2 feet.

Ninety-three percent of the moisture used by corn came from the top two feet of the soil. Irrigating at a

2-inch deficit kept the available moisture above 75 percent at all times.

The infiltration rate was higher after cultivation than when the soil had a crust on it. The rate decreased as the season passed. Irrigating at a 2-inch deficit could cause a lower intake rate.

The effect of furrow shape on infiltration was small. There was no significant difference in intake rates for furrow shape. The roughness coefficient for both furrow shapes was 0.027.

The yield of corn ranged from 151.5 bushels per acre on S<sub>3</sub> to 130 bushels per acre on S<sub>1</sub>. S<sub>1</sub> was sandwiched between the other two treatments. Some of the yield differences could be attributed to the location of S<sub>1</sub> in the center of three plots. (Project 265)

### Water Management in Cotton Production

R. P. BEASLEY, C. F. CROMWELL

#### Objectives:

A. To study problem of water supply for irrigation.

B. To study different methods and improve the technique for applying irrigation water to cotton.

Irrigation wells were drilled on fields leased for research work near Sikeston, Bell City, and Bragg City.

The well at Sikeston was drilled by a combination sand pump-sand bucket method. The sand bucket with bottom flapper valve was equipped with a sliding piston to allow surging and suction loading as well as the impact digging normally done with a sand pump.

The 16-inch hole was kept full of water while digging the well. The lower 30 feet of the 110 foot casing was slotted with a cutting torch to make the screen. Slots were approximately 1/8 inch by 12 inches on 13 inch centers with 1 inch vertical spacing. Adjacent slots were offset 1/2 inch vertically to produce a spiral pattern to the slots.

A 10 inch six-stage turbine pump was installed at a depth of 65 feet. The well, casing, screen, and gravel pack cost \$9.00 per foot and has been pumped at over 900 gpm for a 4-hour period.

The well at Bell City was dug by the sand-bucket method. A heavy piece of 16-inch well casing was used first to dig through the gumbo layer which is about 10 feet thick. Below the gumbo layer the 5-inch sand bucket was operated inside the 6-inch casing and screen, which were forced down by a heavy concrete weight hung on the outside as the sand bucket removed material below the open end of the well screen.

Plans were made to run experiments using both sprinkler and furrow irrigation at several locations in Southeast Missouri. Due to excessive rainfall, these experiments could not be carried to conclusive results. (Project 271)

### Corn Production in Rotations with Small Grain

M. M. JONES, C. L. DAY, J. S. MCKIBBEN

#### Objectives:

A. To investigate the use of corn and to compare corn with other crops for use in intensive two-crop, one-year rotations.

B. To study different methods and improve techniques of quickly preparing seedbeds and planting corn and comparison crops immediately following the harvest of small grain.

C. To determine the earliest stages of maturity practical for harvesting crops which are to be succeeded immediately by other crops in intensive rotations.

D. To study different methods and to improve techniques of early harvest of corn and comparison crops which are to be succeeded immediately by small grain crops.

#### Objective A—

Work toward this objective was carried out to a large extent on the north plot area at Midway Farm. In determining these comparative costs, labor was figured at \$1.10 per hour.

The best returns came from the rotations in which the wheat was removed for silage. The wheat silage was removed in time for a June 5 planting date for the corn. With irrigation the corn made a good start and grew rapidly.

The medium levels of irrigation gave the best returns and in most cases with no irrigation the corn crop showed a loss. Corn as a crop to follow wheat did much better than our comparison crop which was combine grain sorghum following wheat for grain.

#### Objective B—

The strip-till method that was used during the 1956 growing season seemed to hold possibilities for both quick seeding and minimum tillage. The greater need for information in the study appeared to be in ways to improve strip-till methods and a more complete evaluation of strip-tillage as compared to other tillage and planting methods. The work during the 1957 season was directed toward gaining this information.

#### Objective C—

The 1957 season was so unusually dry that no new information regarding objective C could be obtained.

#### Objective D—

Corn was harvested for silage with a Lundell flail-type harvester equipped with a row crop attachment. The machine performed well in the field. The field was left clean except for a very few scattered ears, that were of little consequence. The silage was shredded in good shape except for the stalks which were often left in sections from 2 to 4 inches long. Such sections are refused by animals and tend to collect in the feeding area. The ears were shred into shelled corn and bits of cob. The per-

formance of the machine would be greatly improved by better shredding of the stalk section of the corn plant. (Project 272)

### Use of Electricity on Missouri Farms

K. L. MCFATE, M. M. JONES

#### *Objectives:*

A. To study the costs and benefits of the use of electricity on Missouri farms.

B. To develop new uses of electricity in agriculture and adapt electrical equipment.

#### *Livestock Waterers*

Data obtained on 27 electrically heated livestock waterers showed water warming costs varied from 0.7 to 9.7 cents per day. The number and units of livestock watered, unit construction, waterer location and water temperature all had an effect on operating costs.

#### *Hay Drying Studies*

Results of hay drying investigations indicated that management of the haying system is as important as the drying equipment itself. In one case, a chemical analysis of field cured alfalfa hay showed a protein content slightly higher than that of alfalfa hay that was mow dried on an adjacent farm.

Alfalfa hay dried in bales with heated air at approximately 130° F had highest protein content. Again management of the system affected drying costs. On the same farm, the 1957 drying costs were twice as high as 1956 drying costs. More humid weather and less attention to the stacking of bales were major factors affecting operating costs.

With increased milk production and reduced calving problems, one dairyman evaluated mow dried hay at \$10 more per ton than good field cured hay. Another dairyman's records show a 6 percent drop in milk production when his herd was fed field-cured baled hay as compared to mow-cured chopped hay.

A great advantage of using hay drying equipment is to insure against losses attributed to weather. Without drying equipment, one farmer estimated that 80 percent (50 tons) of his first two cuttings would have been rain damaged and of low quality. Another estimated enough hay saved to pay for one-half of the original cost of the drying equipment.

All of the mow dried hay samples analyzed by the agricultural chemistry laboratory contained more vitamin A units than the field cured hay.

#### *Bulk Milk Cooling*

Electric metering of some 30 bulk milk coolers of different types and makes was completed in February, 1958. Some data need to be obtained from field co-operators before this study will be ready for publication.

#### *Milk House Heating*

Three of the five farm cooperators who used electric space heaters in their milk houses felt that operating costs were too high and thus discontinued use of this heat source before the 1956-57 heating season was complete. Two major reasons can be cited for their decisions; (1) insufficient insulation in walls and ceilings and (2) heat extracted from the milk was dissipated outside through the direct expansion type of milk cooler.

The two farmers who used electric heat throughout the winter period had ice-bank type coolers. The cost of keeping one milkhouse warm (approximately 40° F) was \$6.02; for the other, \$11.14.

#### *Grain Drying*

Four farmers with supplemental heat driers and five with heated air batch driers cooperated in this study. Field data were collected with assistance from power supplier personnel.

Annual fixed costs for supplemental heat driers were figured at 10 percent of new cost. To determine this factor, the average cost of component parts of a typical 3 hp and 5 hp supplemental heat drying system was evaluated.

For straight line depreciation the following values were used: wiring, 6 $\frac{2}{3}$  percent; heater and control, 10 percent; fan and motor, 5 percent; perforated floors, 5 percent. The total of these costs was found to be equal to 10 percent of original investment.

Annual fixed costs for heated air batch driers, determined in a similar manner, were approximately 13 percent of the first cost. If cost alone were considered, an amount in excess of 15,000 bushels would need to be dried annually to justify the large batch driers.

#### *Feed and Materials Handling*

Time has allowed work on only two case studies, a dairy operation in St. Charles county and a poultry operation in Cape Girardeau county. A 2 hp mixer-grinder and screw conveyors were used in each operation.

In the dairy operation, oats, shelled corn and a supplement were mixed and ground simultaneously. Samples of the ground ration were collected periodically and analyzed to determine the consistency of proportions. Results of seven such analyses by the agricultural chemistry laboratory shows the protein content to range from 13.45 to 14.31 percent, giving a maximum variation of 0.55 percent from the desired 14 percent.

In the broiler operation where a similar mill was used the cost (operating) of mixing and grinding the ration and moving the feed into and out of storage was 10¢ per ton. When fixed costs were added to variable costs, home grinding and mixing costs were \$0.63 per ton while grinding and mixing at the local elevator was \$4.60 per ton, seven times greater.

### *Electric Brooding Equipment*

Limited testing of a 200-watt pig brooder indicates that this 15" x 30" x 1½" metal tank (filled with an alcohol-water mixture) will operate for about one-half the cost of heat lamps when a tank surface temperature of 80 to 85° F was maintained. The first cost was \$20.00, compared with \$5.00 for an approved heat lamp brooding unit. Other problems encountered make the widespread use of this particular brooder questionable, in view of the fact that the complete unit has not yet been

approved by the Underwriter's Laboratories.

Investigations regarding the use of plastic covered heating cable embedded in concrete floors under pig brooding areas has begun. A 5-watt-per-foot cable with a density of from 25 to 30 watts per square foot will provide adequate heat when proper insulation and floor construction are provided. While farmers appear satisfied with a floor temperature of from 70 to 75° F, measured temperatures have been found to be as high as 96° F. This study will continue. (*Project 282-1*)

# Animal Husbandry

Albert J. Dyer, Chairman

## Methods of Selection and Breeding for Hog Improvement

L. F. TRIBBLE, R. V. BALAKRISHNA, CLARENCE BRADLEY  
AND C. W. FOLEY

One phase of this study included performance testing of boars as an aid in selection. Pigs from 21 litters were tested to obtain data on the performance of different lines of breeding and to obtain information that might be helpful in setting up a swine evaluation station for swine breeders in Missouri.

Boars gained faster than barrows. The average daily gain for all boars was 1.66 pounds per head per day and the average daily gain for all barrows was 1.52 pounds per head per day. There was a greater difference between the Poland boars and barrows in rate of gain than between boars and barrows of the other breeds. There was no difference in rate of gain between the Landrace boars and barrows.

The variation in rate of gain of the boars was from a maximum of 2.04 pounds per head per day to a minimum of 1.37 pounds per head per day. Backfat probes on the boars at approximately 200 pounds ranged from an average of 0.8 to 1.73 inches. Average daily gains for the barrows ranged from 1.27 to 1.81 pounds. Two barrows made slower gains than 1.27 pounds but these pigs didn't complete the trial as the pens were needed before they reached 200 pounds. Feed efficiency was fairly good in all lots by expected feedlot standards, but ranged from 289 to 348 pounds of feed per 100 pounds gain.

The carcass data on the barrows show a great deal of variation. Carcass backfat ranged from 1.19 to 1.92 inches. Carcass length varied from 27.4 to 30.4 inches. Loin eye area varied from 2.67 to 4.5 sq. ins. The percent

of lean cuts (ham, loin, butt and picnic) in the carcass varied from 42.8 to 50.3 percent.

These variations give an idea of the range that exists in the various characteristics of hogs. The value of these data in aiding in the selection of breeding stock is apparent.

One of the big problems encountered was feed wastage. (*Project 3*)

## Acceptability of Meat and Meat Products

L. A. WEAVER, D. E. BRADY, H. D. NAUMANN,  
EUGENE BIRMINGHAM, D. C. BUBOCK, N. B. WEBB

The eating acceptance of loin steaks from 126 carcasses of various shear strengths and federal grades was tested by a sample of 266 St. Louis white households.

Both the federal grade of a carcass and its shear measurement were fairly useful in predicting the consumer acceptability of loin steaks. While somewhat related, grade and shear were sufficiently independent that acceptance prediction was materially improved by the use of both as explanatory variables.

The leaner the grade the poorer its overall acceptability and the more heterogeneous the acceptability of carcasses within the grade. The acceptability ratings of Prime and Choice were so overlapping that they might have been combined with little loss in eating homogeneity.

On the other hand, Good and, especially, Standard carcasses were so heterogeneous that a redefinition into two or more groups appears desirable.

Evidence from these experiments is largely based upon means of carcasses which were tested by 12 to 14 households. There is evidence that the variation between

carcass means was largely a result of variation in product rather than in consumer likes or preferences.

Over-all ratings were slightly but significantly related to method of cooking and to income. However, there was no relation of particular grade means to either of those variables.

Studies of visual preferences have shown a very considerable popularity of leaner beef. Consumer preferences were found to be definitely related to grade and also to some extent to shear. The fatter loins were generally preferred to the leaner loins or were considered just as good. Invariably, there were a few people who preferred the fatter grade loin in one test and the leaner grade loin in the replicate test. Inconsistent preferences were so frequent that 4 Choice<sub>0</sub> and 7 Prime loins were not preferred by as many as 5 men.

The large number of inconsistent preferences suggests that the acceptance differences between many of the fatter and leaner loins were very small. There is little doubt that a "grade" of leaner carcasses just as acceptable as Choice could be secured if an accurate sorting method was available. Perhaps improved methods of tenderization will some day greatly enlarge the proportion of leaner loins and other cuts which are that acceptable. This would almost certainly reduce the amount of fattening of cattle presently done. (Project 5)

#### Production of Young Beeves

J. E. COMFORT, M. R. BALLARD, WM. DONALDSON,  
J. SINGLETON, M. BASKET, D. HADEN, D. WORSTELL  
*Objectives:*

A. To determine the advantages and disadvantages of September-October dropped calves compared with December-January dropped calves when fattened past weaning, to the same degree of finish.

B. To discover their production needs including winter feeding of dams, "improved pastures", concentrates, and management.

C. To study carcass quality, grades and acceptability.

These studies are just starting with 24 grade Short-horn cows that will be divided into two groups. They will be bred to a registered Shorthorn bull, 12 to have September-October calves and 12 December-January-February calves. The work will be conducted at the University's South Farms and at the Long Cattle Feeding Shed.

The following records will be obtained: 1. Birth weights of calves. 2. Individual weights of calves at 28 day intervals. 3. Feed consumed by cows and calves. 4. Feed Analysis. 5. Breeding records. 6. Diary of pasture conditions. 7. Pasture records indicating carrying capacity and gains. This will necessitate weighing cattle when changes are made from one pasture to another. 8. Marketing data. 9. Carcass data. 10. Photographs. (Project 78)

#### Development of Improved Methods of Pork Carcass Evaluation

H. D. NAUMANN, D. E. BRADY, L. A. WEAVER,  
S. E. ZOBRISKY

The progressive increase of fat, lean and bone and the associated changes in carcass measurements of hogs slaughtered at 50, 100, 200, 250, and 300 pounds live weight was investigated.

Each of the six weight groups contained 12 hogs. The yield of wholesale cuts and the separable fat, lean and bone tissues of the ham were used for expressing the physical composition of the pork carcasses. Appropriate data from 80 additional hogs were obtained from various publications to supplement the data and results of this study.

Among other things, this study supported the following conclusions:

1. As hogs grow and fatten from 125 to 200 pounds live weight, the weight gained is comprised of a greater weight of fat than muscle.

2. During the weight interval, 125 to 200 pounds, the weights of all cuts increase; however, the increase of the fat cuts is considerably larger than that of the lean cuts. These cuts expressed as a percent indicate that the percentage yield of fat increased and the yield of lean decreased.

3. The increase in loin eye area directly parallels the increase in the weight of lean cuts.

4. Backfat thickness increased with the observed weight and/or percentage increase in fat cuts.

An investigation of the quantity of urine creatine excreted in relation to muscle development in swine has been initiated. The data and results will be reported when conclusions have been reached. (Project 88)

#### Stability in Cured Meats Using Ascorbic Acid And Other Stabilizers

L. A. WEAVER, D. E. BRADY, H. D. NAUMANN,  
R. B. SLEETH, A. M. MULLINS, E. H. RANGEY

*Objectives:*

A. To develop a technique of adding sodium ascorbate into ham which would be economical and practical.

B. To study the effect of combining sodium ascorbate, polyphosphates and calcium lactate into hams.

The method used for calculating ham weight was very satisfactory since the calculated ham weight was 14.26 pounds, compared with an actual 14.28 pounds.

Sodium ascorbate and/or sodium hexametaphosphate or calcium lactate-lactic acid mixture, in the quantities used, did not result in marked improvement in cure penetration or uniformity of color. The outer periphery of the semimembranosus and semitendinosus muscles were generally lighter in color than the remaining portion of the center ham slice.

Hams injected while hot were slightly more uniform in color than paired hams which were injected after being chilled.

Sodium ascorbate and/or sodium hexametaphosphate were not beneficial in preventing discoloration when these ingredients were incorporated into the curing mixture. No residual ascorbate was present in the treated hams at the end of the curing and heating process.

Discoloration was delayed considerably when ham slices were sprayed with a 5 percent solution of sodium ascorbate or when dipped in a solution of sodium ascorbate-nitrite mixture.

There was no appreciable difference in palatability factors, i.e., saltiness, flavor, juiciness or tenderness in the treated hams as compared to the commercially cured or control hams as judged by the panel. The commercially cured hams and the control hams ranked slightly lower on all the palatability factors except tenderness but there was not enough difference between any of the treatments to be significant when treated statistically. (*Project 100*)

### Nutrients Required by Hogs

L. A. WEAVER, L. F. TRIBBLE, CLARENCE BRADLEY  
D. E. BAINKER, R. F. RAYER

Among the various studies in this series the value of various compounds to prevent anemia in suckling pigs is of great economic importance.

During the fall of 1957, eleven litters of new-born pigs were selected from the Hampshire, Duroc and cross-bred Landrace-Poland-Duroc breeds. Six similar pigs in each litter were then allotted at random to one of six treatments: Control; 1 ml. of Ar; 1 ml. of Al; 1 ml. of Iron; 2 ml. of Ar; 2 ml. of Al.

Within five days following birth the pigs were bled from the ear vein and hemoglobin values determined by the direct Photometric method using 0.02 ml. of blood in 5 ml. of dilute ammonium hydroxide. Readings were at 540 and on Spec 20. Pigs were then given their respective treatments and returned to their dams and kept on concrete floored pens until they were four weeks of age, at which time hemoglobin determinations were repeated and body weights were recorded.

#### Summary:

Results fall into three groups, the addition of 1 ml. of Al did not increase hemoglobin significantly over that in the control pigs. The addition of 1 ml. of iron, 1 ml. of Ar, and 2 ml. of Al resulted in a significant increase over the controls and these three groups were not different from each other. The addition of 2 ml. of Ar resulted in a highly significant increase in hemoglobin over the controls; however, this was not significantly superior to a dose of 1 ml. of Ar, or 2 ml. of Al. It appears that the product labeled Ar resulted in superior performance in this test when used at the 2 ml. level. (*Project 141*)

### Roughage and Pasture in the Production Of Late Lambs

A. J. DYER, C. V. ROSS, CLARENCE BRADLEY  
L. A. WEAVER, E. W. GERBER

Twenty-eight wether lambs were separated into groups and randomly assigned to four lots. They were hand fed until well on feed, then self fed complete pelleted rations until they would grade choice or were approaching undesirable weights. One lot served as a control and hexestrol implants were made in one ear of each lamb of the other three lots. Levels of implants were: 6 mgm., 9 mgm. and 12 mgm.

The experiment was duplicated with 24 ewe lambs of similar breeding divided into four lots of six lambs.

All lambs were vaccinated for enterotoxemia and were fed Aureomycin at the level of 10 mgm. per pound of feed.

Observations were made on side effects throughout the test. Part of the lambs were slaughtered at the University meats laboratory and the others at a commercial packing plant.

All lambs did exceptionally well on feed. Daily gains were considerable above average for controls as well as lambs implanted with hexestrol. There appeared to be some stimulation of gains in all lots implanted with hexestrol. All lots except the ewe lambs implanted with 12 mgm. hexestrol made gains on less feed than the control lots. Carcasses grades on the 6 mgm. and 9 mgm. implants appeared to be as satisfactory as controls. Lambs implanted with 12 mgm. hexestrol did not appear as fat alive and they graded lower than the other two levels and controls.

There was little difference in carcass yields among the lots. With the exception of ewe lambs implanted with 12 mgm. hexestrol, it required fewer days on feed to finish lambs on hexestrol.

At the end of the first 9 days on feed, ewe lambs implanted with hexestrol had marked udder development and external sex organs were swollen and reddened as though in heat. This tended to diminish as the test progressed; however, one ewe lamb had milk in her udder when slaughtered. All wether lambs in implanted lots had larger mammary glands than controls. Wether lambs in the 9 and 12 mgm. lots had enlarged sex organs and a few had some difficulty urinating. At the end of 47 days, 10 lambs were slaughtered out of implanted lots. Although all but two had sufficient finish to grade choice, the carcasses were somewhat soft and bronze in color. Later groups of lambs had satisfactory color and were firm.

Gains of ewe lambs in the 6 mgm. lot were probably retarded somewhat due to a muddy lot caused by a break in the water line in their pen.

From these results, it would appear that ewe lambs

require somewhat higher levels of hexestrol than wether lambs. Twelve mgm. appeared too high for maximum gains, feed efficiency or carcass grades. (*Project 142*)

### Pasture Improvement

L. A. WEAVER, A. J. DYER, J. E. COMFORT

Mixtures of timothy-bluegrass and trefoil produced a total gain of 252 pounds per acre or 1.92 pounds per day on yearling steers at Columbia. Steers on bluegrass and lespedeza gained a total of 218 pounds per acre or 1.47 pounds per day. Orchard grass with very little ladino provided some grazing from April 19 to August 29 but the gain was less than in other pasture combinations.

Pastures at Pierce City in southwest Missouri were again handicapped by dry weather. Yearling heifers gained 2.10 pounds per day on orchard grass-lespedeza, 0.99 pounds per day on tall fescue-trefoil, and 1.04 pounds per day on orchard grass-ladino, but the larger gains were made in May-June and pastures were depleted by August 10.

A study was made on the relationship between types of animal and rate of gain with yearling heifers previously wintered on corn silage with winter gains varying from 1 to 2 pounds per day. The majority of the heifers making large summer gains were intermediate in type. The youngest heifers making small winter gains made the largest summer gains. The relationship between winter and summer gain had more influence on summer gains than other details on conformation. (*Project 154*)

### Factors Affecting Rumen Digestion

W. H. PFANDER, A. L. DUNGAN, W. C. ELLIS,  
D. T. LYONS, R. L. PRESTON, G. B. THOMPSON,  
L. A. WEAVER, T. W. WHITE AND R. F. ROYER

Digestion trials using the total collection method were made with mature wethers to determine the digestibility of the organic matter, cellulose, and nitrogen of wheat, sudan grass and drouth corn silages. The respective coefficients were: wheat, 61.8, 50.9, 46.3; sudan grass, 56.2, 61.1, 49.1; drouth corn 75.2, 74.9, 70.9.

The chromic oxide reference method, using a single "grab sample" was found to give values considerably lower than those obtained with the total collection method.

The average coefficient of digestibility of organic matter, cellulose, and nitrogen in steer-calf wintering rations, based largely on the same silages, was lower than corresponding values determined in sheep. The greatest depression occurred on the cellulose portions.

Studies using the artificial rumen technique indicated that digestion of cellulose was improved by the addition of diethylstilbestrol (2-20 ppm.), cholesterol (20 ppm.), estrone (20 ppm.), testosterone (10 ppm.), and cortisone (25 ppm.). Hexestrol (1.5 ppm.) depressed cellulose di-

gestion slightly.

When 10 or 20 ppm. of stilbestrol were added to a cottonseed hull-casein ration, the digestibility of cellulose and protein was increased, but sheep could not tolerate these dosages.

When 10 mg. testosterone, 1.5 gm. hexestrol or 20 mg. of cortisone per sheep were added to a ration of 800 gm. alfalfa hay and 400 gm. corn, the T. D. N. of the ration increased from 64.7 to 67 percent; the increases were about equally distributed among the fat, fiber and N. F. E. fractions. There was no change in digestible protein.

Seven and one-half mg. hexestrol had no effect on the digestibility of silage rations by steer calves.

Lambs were fed semi-purified rations containing one of three levels of cellulose (21.4 percent, 31.4 percent and 41.6 percent) and one of three nitrogen levels (1.65 percent, 2.05 percent or 2.45 percent). Cellulose and nitrogen levels were varied by substituting a purified source of cellulose and protein for corn starch.

Increasing the cellulose levels caused a significant linear increase in cellulose and ether extract digestibility; decreased the digestibility of organic matter and, nitrogen-free-extract; reduced the percent of total digestible nutrients; and did not have a significant effect upon the apparent nitrogen digestibility.

Increasing nitrogen levels had a significant quadratical influence on the digestibility of organic matter, cellulose, nitrogen-free-extract, nitrogen and the percent total digestible nutrients. Except for nitrogen, whose digestibility was not further increased by increasing ration nitrogen from 2.05 to 2.45 percent, the digestibility of these nutrients in rations containing 2 percent nitrogen was significantly higher than in rations containing either 1.65 percent or 2.45 percent nitrogen.

The influence of cellulose upon organic matter digestibility in semi-purified rations was shown to be due both to its diluting effect (upon easily digestible components) and to its depressive effect upon non-cellulose organic matter digestibility.

The depressive effect of cellulose upon organic matter reported here is approximately one-fourth that reported for natural type rations. This is interpreted as supporting the "envelopment" concept of depressed nutrient digestibilities with increasing cellulose concentration.

Increased cellulose levels significantly increased daily urinary nitrogen and decreased daily nitrogen balances. (*Project 168*)

### Improvement of Beef Cattle Through Breeding

J. E. COMFORT, CLARENCE BRADLEY, C. W. FOLEY,  
L. L. KRAMER, J. F. LASLEY, L. A. WEAVER,  
C. E. WEBSTER, ARTHUR JOHNSON,  
J. O. BUTCHER, V. B. REDDY

*Objectives:*

A. To develop more effective methods of selection for improvement of performance in beef cattle.

B. To develop more accurate and useful measurements of performance in beef cattle.

C. To test further techniques of identifying "dwarf-free" and "dwarf-carrier" beef cattle.

D. To compare performance of "carrier" and non-carrier beef cattle.

An out-break of Leptospirosis occurred in the experiment breeding herd at Weldon Spring in March 1957. Fortunately, three-fourths of the cows in this herd had calved but 12 abortions and stillbirths occurred and two cows and 5 calves died. Many of the calves were still unthrifty in May and June and did not shed off their winter coat until after July.

All the cattle are being vaccinated at 6 month intervals until no new cases of infection occur.

Leptospirosis affected the percentage calf crop and weaning weights most in one sire group in the "open herd" and one sire group in the "closed" herd.

A study was made of data on 323 calves produced in the registered herd of the San Carlos Apache Tribe at San Carlos, Arizona. The calves were sired by eight different bulls by means of artificial insemination. Data on the length of the gestation period, birth weights and weaning weights were analyzed.

The average length of the gestation period was 286.9 days with a standard deviation of 5.8 days. Bull calves were carried an average of 0.8 days longer than heifer calves and older cows tended to carry their calves longer in utero than younger cows. Neither of these influences on gestation length were significant, however, when tested statistically. The length of the gestation period decreased ( $P < .01$ ) in calves born later in the calving season. This relationship was found to be curvilinear.

*Results with the insulin test for dwarfism:* Approximately 1800 animals have been tested to date and the data are being studied. Under some conditions, the test seems to be quite accurate in picking out carriers of the dwarf gene whereas under other conditions the results are much less satisfactory. The chief disadvantage of the test is the great skill and patience required in making the total cell counts.

The age of the animal and pre-test stress conditions are known to affect the response of the animals to insulin; these factors are being studied further. Other possible methods of improving the accuracy of the insulin test are being investigated.

The insulin tests and blood sugar determinations on the entire experiment herd have not been completed. Detailed observations have been made on all bulls fed in 1956 and 1957 as well as on a sizeable number of cows and heifers. The final analysis will be made when the

tests are completed. (Project 198)

### Economic and Technical Feasibility of Retail Distribution of Frozen Meats

D. E. BRADY, O. J. KAHLBERG, EUGENE BIRMINGHAM  
H. D. NAUMANN, P. D. MCBEE, JR., S. E. ZOBRISKY

*Objectives:*

A. To determine the technical feasibility of frozen meat distribution.

B. To determine consumer acceptance and preference for the frozen product.

A method of fabricating boneless cuts of beef was developed to maximize merchandising versatility. This fabrication method yielded the following cuts: (1) thick steaks, (2) thin steaks, (3) minute steaks, (4) swiss steaks, (5) oven roasts, (6) pot roasts, and (7) ground beef.

Results of a trial of these cuts by a consumer panel indicate: (1) Beef fabricated into boneless cuts has desirable eating acceptability by the consumer. (2) There is potentially more versatility in meat cutting practices than is currently exhibited in retail meat marketing. (3) Steaks may be fabricated from carcass parts normally used as roasting cuts only. (4) Housewives find the identification of cuts solely by name of cooking method to be acceptable. (Project 217)

### Economic Significance of Pork Grades

D. E. BRADY, O. J. KAHLBERG, H. D. NAUMANN,  
EUGENE BIRMINGHAM, S. E. ZOBRISKY

*Objectives:*

A. To determine by sampling what proportion of the consumer population detects a noticeable difference in eating satisfaction between two or more grades of pork for several important cuts.

B. To determine the grade preferred by those consumers expressing a preference.

C. To determine the effect of various processing techniques of pork cuts in relation to consumer acceptability and preferences.

The principal effort this year was expended in conducting a 40 family consumer panel in Columbia which evaluated conventional cuts from hogs of various live weights. Hogs weighing 125, 150, 175, and 200 pounds were used in this study.

Preliminary results indicated that the cuts from the intermediate weight hogs were equally acceptable as cuts from the 200 pound hogs. There were complaints about excess fat in cuts from hogs of all weights but noticeably less from the light weight hogs.

The evidence in the data collected would suggest that there is an imperfect relationship between the fat-lean ratio of different pork cuts. The relationship between the size of the loin eye (*longissimus dorsi*) at different

locations on the loin is lower than previously thought.  
(Project 218)

### Estrus, Ovulation, Nidation, Embryonic Deaths and Related Phenomena in the Female

J. F. LASLEY, L. KRAMER, JOHN MASSEY, MIKE MILICEVIC  
AND V. B. REDDY

#### Objectives:

A. To study the fundamental anatomy and physiology of the reproductive organs during the puberal age and gestational periods.

B. To determine the genetic and environmental factors which influence ovulation rate, fertilization, intra-uterine capacity, embryonic mortality and ultimately litter size in swine.

C. To estimate the portion of the variability in prolificacy that could be accounted for in terms of measurable phenotypic traits.

D. To associate the reproductive performance with the blood picture and thus study the possibilities of selecting the breeding stock on the basis of blood analysis.

E. To study carbohydrate metabolism in swine as related to growth and reproduction.

All the gilts employed in this study were weighed at weekly intervals. As soon as they reached 200 pounds live body weight, some of the phenotypic traits like body length, heart girth, flank girth and subcutaneous deposition of fat on the shoulder, hip and ham were measured and recorded. The mature gilts were then checked with boars at least twice each day and sometimes thrice a day for the detection of estrus. All the gilts were bred to non-related boars to avoid inbreeding of the embryos.

In these studies, injections of insulin caused a rapid hypoglycemic condition in all the sows. Higher dosages of insulin prolonged the duration of hypoglycemia, which is considered to be a measure of the insulin sensitivity of an animal. Durocs were found to be more insulin sensitive than Landrace X Polands. Blood analysis revealed that glucose varied throughout the period of pregnancy reaching its lowest level just prior to parturition. The blood sugar increased again during lactation. A similar trend was observed in the total leucocyte count.  
(Project 222)

### Rations for Fattening Cattle

CLARENCE BRADLEY, J. E. COMFORT, L. A. WEAVER,  
A. J. DYER, BENJAMIN DEAN, MYRON BENNETT

#### Objectives:

A. To determine the effect of additives in some rations fed to cattle being fattened.

B. To determine differences in rate and efficiency of gain and quality of finished carcass in cattle fattened in dry lot and on pasture.

The experiment was divided into wintering, early summer and fattening phases.

Implants of 12 milligrams and 24 milligrams of hexestrol to 500 pound steer calves fed liberally on corn silage plus 2 pounds of soybean meal increased the gain slightly, 2.0 and 2.15 pounds per day compared with a gain of 1.82 for the control lot. The economy of gain was improved by the 24 milligram implant.

In the 77 day early summer period, 700 pound yearlings continued in dry lot on silage and soybean meal gained 1.52 pounds or 19 percent more than steers on orchard grass-lespedeza pasture and 38 percent more than steers on pasture that were implanted with 24 milligrams hexestrol.

During the 114 day fattening phase, cattle with 36 milligrams hexestrol implant and fed grain on pasture gained 14 percent faster, ate 9 percent more corn but required 4 percent less corn to produce a unit of gain, than steers fed on pasture without implants.

Cattle continued in dry lot, implanted with 36 milligrams of hexestrol, made gains comparable to the pasture lot with implants. They required 6 percent less grain per unit gain than the pasture fed implanted steers and 10 percent less grain than steers fattened on pasture without implants.

Dressing percentages were about equal in all lots but the two implant lots produced carcasses averaging high good compared with average good from the pasture lot without implants. Total gain for winter, summer and fattening: dry lot—603 pounds, pasture with implant—572, and pasture without implant—549 pounds. The dry lot cattle with larger gain and \$1.00 per cwt. higher selling price gave the largest net return. (Project 237)

### Effect of Antemortem Handling During Marketing On Subsequent Carcass Quality of Beef

D. E. BRADY, J. E. COMFORT, H. D. HEDRICK,  
H. D. NAUMANN, L. A. WEAVER, D. W. ZINN

#### Objectives, to determine:

A. The cause of dark cutting beef;

B. The physiological mechanisms involved.

C. The preventive measures which can be taken to alleviate this condition.

From this study it was concluded that dark cutting beef is produced as a result of cattle being subjected to prolonged stress before they are slaughtered. Approximately 24 hours of stress were required to deplete the muscle glycogen of a normal animal enough to produce this condition; short periods of stress had no marked effects on carcass characteristics. When stress such as excitement or the administration of adrenalin was prolonged, the homeostatic mechanism for maintaining normal glycogen stores was exhausted and dark cutting carcasses resulted.

There is general agreement in the literature relating to the cause and effect of physiological stress and the results of this study concerning the following principles:

1. Stress arouses the sympathetic nervous system which in turn stimulates the adrenals to secrete adrenalin. Among the physiological processes affected by adrenalin is the activation of phosphorylase in muscle and liver which causes hyperglycemia and glycosuria.

2. Many conditions prevail during the marketing and transportation of cattle that would cause dark cutting beef. Such factors as excitement, trauma, fatigue, and exposure to adverse weather arouse the sympathetic-adrenal mechanism and lead to depletion of glycogen stores of the body. The intensity and duration of such conditions as well as the susceptibility of individual cattle to stress will determine the prevalence of dark cutting carcasses. Cattle previously exposed to adverse conditions possibly build up a resistance against future exposure and therefore may be able to withstand adverse conditions encountered during transportation and marketing.

3. When an animal's glycogen stores are diminished due to the increased secretion of adrenalin, corrective physiological mechanisms are stimulated. Glucocorticoid secretion is increased subsequent to the release of adrenalin. This physiological process enables an animal to withstand and recuperate from stress under normal conditions. (Project 238)

### Returns from the Use of Sheep on Small, Fertile, Irrigated Acres

A. J. DYER, CLARENCE BRADLEY, C. V. ROSS

No results available this year. (Project 235)

### Mineral Nutrition of Ruminants

W. H. PFANDER, R. L. PRESTON, W. C. ELLIS

G. B. THOMPSON, L. A. WEAVER, T. W. WHITE

#### *Molybdenum and Copper:*

Molybdenum and copper additions to rumen microorganisms from alfalfa-fed sheep promoted increased *in vitro* cellulose degradation to the same degree as alfalfa ash additions.

Washed rumen organisms from alfalfa-fed sheep contained about 1 p.p.m. (part per million) molybdenum on a dry fat basis. A semi-purified ration containing 0.36 p.p.m. molybdenum was formulated. A similar ration was supplemented with sodium molybdate to raise its molybdenum content to 2.36 p.p.m.

In two feeding trials, lambs receiving the ration with added molybdenum made significantly faster gains than their controls. The addition of molybdenum significantly increased the digestibility of cellulose but did not significantly alter the digestibility of the other proximate ration constituents.

This work demonstrates a nutritional role for molybdenum in the growing lamb in that it is required for optimum cellulose digestion by the rumen flora. It further suggests that part of the beneficial effect of alfalfa ash for ruminants fed poor quality, high roughage rations resides in its molybdenum content.

#### *Calcium Requirement:*

Eleven ewes fed a low calcium (0.13 percent) ration appeared to settle readily and carried their lambs a full term. The ewes lambed in March and April. Two ewes developed Ketosis and three ewes developed severe vaginal prolapse at parturition. Their lambs were taken by caesarean section. Ewes with single lambs lactated normally; however, ewes with twins did not produce enough milk for their lambs to make normal growth. The ewes produced heavy fleeces of excellent quality (11.23 pounds).

Apparently 0.13 percent calcium was adequate for growth and development of fetus. It may not have been sufficient for normal uterine contraction or lactation.

#### *Potassium Requirements:*

A pilot trial was conducted with lambs produced from the ewes on the low calcium ration to determine potassium requirements. The 8 lambs were divided into three lots on equal lot average weight basis.

#### *Ration (pelleted)*

30 percent beet pulp

23.5 percent corn starch

15 percent casein

10 percent solka flock

15 percent cerelese

2.5 percent lard

4 percent minerals and vitamins

The basal ration was estimated to contain 0.05 percent K. The potassium levels of two lots were increased to 0.2 percent and 0.4 percent by the addition of KCl.

Lambs were fed individually twice daily all they would eat. They were started at 300 grams twice daily and gradually raised to 1000 grams twice daily.

Feed intakes were varied on all lots during August and September. Lambs rarely consumed more than 1,000 grams per day. The small number of lambs per treatment made these results inconclusive. However, it did seem that the basal level (.05 percent K) did not restrict growth in this trial. The ration was inadequate to support normal lamb growth. (Project 248)

### Changes in the Physical Structure of Roughages During Growth and Digestion

W. H. PFANDER, L. A. WEAVER

The samples of wheat and lespedeza harvested in 1956 were stored in the dark. One gram samples were weighed into silk bags and suspended in the posterior dorsal sacks of the rumen of a sheep or steer. Both ani-

COMPOSITION OF WHEAT HARVESTED  
ON VARIOUS DATES

Date	Dry Weight 100 Plants	Composition (Dry Basis) Physical			Chemical	
		Leaf	Stem	Head	Protein	Fiber
May 4	---	68.1	31.9	None	20.7	17.5
May 18	74	57.6	29.4	13.0	---	---
May 24	92	43.2	36.5	20.3	10.1	22.6
May 31	140	33.6	43.6	22.9	10.8	30.7
June 6	218	26.6	45.9	27.5	---	---
June 16	332	23.5	35.2	41.3	8.1	35.3

There was little change in the composition of lespepeza between August 11 and October 6 as shown below.

COMPOSITION OF LESPEDEZA HARVESTED  
ON VARIOUS DATES

Date	Percent Protein	Percent Fiber
Aug. 11	13.4	28.9
Sept. 22	13.3	28.9
Oct. 6	12.5	31.6

imals were eating number 2 alfalfa hay during these trials. Bags were removed after 2½, 5 and 10 hours of digestion. All samples considered, there was little difference in losses from the 2½ and the 5 hour samples. Largest losses were apparent after 10 hours.

It appears that more of the dry matter was digested by the ovine rumen. Part of this difference may be associated with season. (*Project 250*)

The Effect of Nitrate in Feedstuffs on The  
Performance of Cattle and Sheep

W. H. PFANDER, R. L. PRESTON, L. A. WEAVER,  
AND J. L. KETCHUM

"Nitrate poisoning" was produced experimentally by infusing 73.5 mg. of potassium nitrite per kilogram of body weight into the external jugular vein of sheep. Two and one-half gm. potassium nitrate per kilogram of body weight caused transient diuresis, dehydration and high urinary excretion of nitrate but no symptoms of "nitrate poisoning."

Experiments were designed to determine if sheep can utilize nitrate nitrogen. Experimental variables studied were nitrate level, source, and the presence of either butylated hydroxy anisole, or sodium meta bisulfite.

The basal ration contained 67.5 percent ground grass hay, 10.2 percent blackstrap molasses, 20.3 percent ground yellow corn, 1.0 percent salt, and 1.0 percent dicalcium phosphate. Three Shropshire wethers weighing 57.5 pounds received either 0.50 and 1.50; 0.75 and 1.75; or 1.0 and 2.0 percent potassium nitrate in two successive trials.

During one trial a fourth sheep was used which received a 0.25 percent level. The three animals later received ammonium and sodium nitrate at 1.5-2.0 percent levels. Butylated hydroxy anisole was added to one trial of 1.50-2.0 percent potassium nitrate.

Four crossbred wethers (mean weight 100.0 pounds) were fed 1224 grams of the basal ration per day. Later, additions of potassium nitrate at the 1.5, 1.75, and 2.0 percent levels were made in the presence or absence of sodium meta bisulfite.

Eighty-seven samples of feed, feces, and urine were analyzed for nitrogen, and 30 nitrogen balances were calculated. The nitrate and Vitamin A contents of 32 blood samples were determined.

1. Potassium nitrate was utilized as a source of non-protein nitrogen by sheep in rations containing 10 percent blackstrap molasses.

2. Butylated hydroxy anisole improved nitrogen digestibility and retention and markedly reduced the average nitrate content of the blood when added to 1.5-2.0 percent potassium nitrate.

3. The best digestibility of ration nitrogen was in the following order: ammonium nitrate, potassium nitrate plus BHA, sodium nitrate, and potassium nitrate. (*Project 251*)

The Control of Microbial Development  
During Meat Processing

D. E. BRADY, H. D. NAUMANN, R. B. SLEETH  
AND L. A. WEAVER

The tail, as a site of the antibiotic injection into the live animal, offers greater possibilities than any other injection site previously utilized; i.e., intraperitoneally. This is due to (a) ease of injection, (b) economic considerations from the standpoint of tissue destruction, and (c) adequate dissipation of the antibiotic into the tissues for protection against microbial contamination.

In another experiment, adequate protection from sliming and spoilage for quarters aged under elevated temperatures and ultraviolet radiation was provided by the intermuscular injection of 3 or 4 mg. per pound of body weight of oxytetracycline (Biostat) prior to slaughter. Control quarters not treated with oxytetracycline spoiled at the end of 24 hours aging under high temperatures and ultraviolet radiation.

Product protection was not a function of time the oxytetracycline was injected into the animal prior to slaughter. There is a gradual rise in antibiotic residue in the tissues with increasing length of time oxytetracycline is injected before slaughter.

From the standpoint of possible future approval of antibiotics by the Federal Food and Drug Administration for the preservation of red meats, it is significant to note the protection received when animals were injected only 30 minutes prior to slaughter.

The amount of antibiotic residue present appeared to be greatest in the liver, followed by heart, muscle (6 hrs. down to 30 minutes antemortem) and spleen. The absence of antibiotic residue in the spleen from all ani-

mals cannot be explained at this time.

Aging temperature did not influence the dissipation rate of the antibiotic in the tissue.

The total bacteriological count of synovial fluid increased with an increase in the length of the aging period and with an increase in time of injection of oxytetracycline prior to slaughter. Total bacteriological count of internal muscle and popliteal lymph nodes generally increased with an increase in time of injection of antibiotic. (Project 257)

### Endocrine Secretions as Related To Growth, Reproduction, and Gene Action

J. F. LASLEY, L. A. WEAVER, L. L. KRAMER,  
JOHN MASSEY

#### Objectives:

*To study the influence of castration, and oral administration of diethyl stilbestrol on weight gains, feed efficiency, carcass characteristics and certain blood constituents of swine.*

From the start of the experiment when the pigs averaged 44 pounds to the end of the experiment when they weighed an average of 209 pounds, the four lots of male pigs made slightly faster daily gains than the four lots of females. Boars and barrows receiving stilbestrol made faster daily gains than pigs in the control lots, but the normal and spayed gilts made slower daily gains than those on the control ration. Thus, the response of the pigs to stilbestrol depended upon their sex condition.

No significant difference was found in the daily feed consumption per head by pigs in any of the lots. The four lots of males, however, made more efficient use of their feed, requiring only 327 pounds per 100 pounds of gain whereas the treated, spayed gilts required the most or 400 pounds of feed per 100 pounds of gain.

Stilbestrol had no effect upon carcass characteristics and measurements, except in length of carcass and length of carcass leg. Those animals receiving this hormone in their feed had slightly longer legs and longer bodies. Boars had the lowest dressing percentage of all sexes, a smaller amount of backfat than barrows, and also less total fat. Ham fat area was greatest in the spayed gilts and barrows as compared to normal gilts and boars. No difference was found between sexes in the amount of ham lean area or loin eye area.

Stilbestrol had no significant influence on backfat, heart girth, or length of the live hog at 200 pounds. Backfat probes between sexes, however, were significant. Boars had less backfat than barrows and spayed gilts and smaller amounts of backfat than normal gilts. No differences were observed between barrows and spayed gilts, although normal gilts had less backfat than barrows.

The feeding of stilbestrol caused no changes in the reproductive organs that could be determined by outward appearances. Upon closer examination of the reproductive

organs after castration or slaughter, however, it was found that the testes of the non-treated boars were about 33 percent heavier in weight than those from boars fed stilbestrol. This difference was highly significant. No significant differences were found in the number of spermatozoa, or in the weights of the vas deferens and epididymis that could be attributed to stilbestrol.

Gilts fed stilbestrol had ovaries that were reduced in size by 58.5 percent as compared to ovaries of normal non-treated gilts. Treated, spayed gilts had uterine growth similar to that seen in normal gilts, but in the non-treated spayed gilts no uterine growth was observed and their reproductive tracts were infantile.

In the studies of the blood, the only significant influence of stilbestrol that was observed was on the response characterized by a change in the number of eosinophils one hour after mechanical stress. In all classes, or sexes, except the spayed gilts, an eosinophilia or increase in number of eosinophils occurred as a result of this stimulus.

With stilbestrol ruled out as a causative factor influencing the leucocytes other than the eosinophils, the eight classes were then combined into four classes of 16 pigs each. It was found that the boars had a higher number of leucocytes in the blood than the normal gilts, spayed gilts or the barrows. A difference due to sex was also found between the pigs in their ability to show a leucocytic response one hour after stress. This difference was significant between the gilts and boars, with the gilts exhibiting the more extreme degree of leucocytosis.

Results obtained from the differential blood cell counts of the four groups of pigs were significant only in respect to the number of lymphocytes, with boars having a significantly greater number than either gilts or spayed gilts.

In a comparison of the intact animals with the castrates, a difference in eosinophil response was noted, indicating that an eosinopenia (decrease in number of eosinophils) occurred in the intact pigs and an eosinophilia (increase in number of eosinophils) in the castrates. This difference existed only when the 16 intact pigs, boars and gilts, of the group not fed stilbestrol were compared with the 16 castrates of the same group. It did not occur in comparisons within sex.

An attempt to find a genetic influence as evidenced by leucocyte differences between litters failed; no significant differences were found.

The possible existence of significant relationships between body weight and backfat measurements of the pigs and the number of white blood cells per cubic milliliter of blood and/or the degree of leucocyte response to physical stress exhibited by the pigs was investigated. By calculating coefficients of correlation between these factors, a reasonably significant correlation was found

between the weight of the pigs at 154 days of age and the number of white blood cells found per cubic milliliter of blood in the pre-stress sample. Correlations between the 154 day weights and the number of white cells of the second sample taken 1 hour following stress and between changes in cell numbers that occurred during that time were found insignificant, as were those coefficients between the same white blood cell enumerations and the adjusted backfat measurements. (*Project 276*)

#### The Tenderness of Meat as Related To Tissue Components, Genetic Factors, and Ante-Mortem and Post-Mortem Treatment

O. J. KAHLENBERG, H. D. NAUMANN, N. B. WEBB

##### *Objectives:*

A. To determine the tissue components responsible for variations in tenderness of meat.

B. To determine the influence of genetic factors, stress and post-mortem environment on muscle composition and tenderness.

Fifteen steers of different degrees of maturity were subjected to ante-mortem and post-mortem treatments to obtain maximum differences in degree of tenderness between carcasses and between carcass halves.

Twelve and 24 month old animals of the same grade were stressed with adrenalin ante-mortem. After the steers were slaughtered, half of each carcass was placed in an (86° F) environmental aging room, and the other half in a (38° F) cooler. The high temperature carcass was first aged for 48 hours and then transferred to a 38° F cooler for 24 hours. The low temperature carcass was aged for 15 days in the 38° F cooler.

Tissue samples for analyses were taken at intervals

following slaughter to compare the effect of ante- and post-mortem treatments. The samples are being analyzed for moisture, fat, nitrogen, water-holding capacity in order to determine the components which may be responsible for variations in tenderness.

Evaluation of tenderness will be made with a taste panel, shear values, and the amount of connective tissue (hydroxyproline) in the muscle. (*Project 327*)

#### Time and Temperature Tolerances of Meats and Meat Products

H. D. NAUMANN, JAMES L. MCBEE

##### *Objectives:*

A. To determine how frozen meats behave under various conditions of time and temperatures, in-so-far as acceptability, storage, deterioration, etc., are concerned.

B. To attempt to establish a simple chemical analysis for the detection of deterioration in frozen meat.

A design has been established for this project, including the use of beef and pork of different degrees of finish and quality, stored for various periods of time up to one year. The samples will be exposed to a variety of temperature patterns including temperatures fluctuating regularly over several different ranges and temperatures maintained steadily at 10°, 0°, 10° and 20° F.

Subjective evaluation will be conducted to measure organoleptic changes. Chemical analyses have been chosen and adapted to work with this type of product. Objective tests include pH, titratable acidity, amino nitrogen, soluble nitrogen, coagulable nitrogen, sulfhydryl groups, water holding capacity, weight loss, and rancidity measurements. (*Project 335*)

# Dairy Husbandry

A. C. Ragsdale, Chairman

#### Enzymes of the Mammary Gland

C. W. TURNER, C. E. GROSVENOR, H. G. DAMM,  
D. R. GRIFFITH, T. M. A. EL-ATTAR

To evaluate reduction or augmentation of milk "let-down" it was necessary to ascertain normal milk "let-down" under standardized conditions. This was done as follows: On the 14th day postpartum Sprague-Dawley lactating rats were isolated from their litters of 6 young each for 10 hours. During this time milk is secreted to the point where engorgement of the mammary glands of the mothers occurs. Also, milk previously obtained by the young is digested during this period, so after 10 hours

isolation from their mothers, their stomachs are devoid of milk. The young are then united with their mother, allowed to nurse 30 minutes, then removed and killed. After death of each litter, the milk is removed from their stomachs and weighed. Amount of milk thus obtained, expressed as percent litter body weight, is an indirect measure of milk secretion and a direct measure of efficiency of the milk "let-down" response.

By means of pharmacological blockade with Nembutal, Dibenamine, ergot alkaloids and atropine it was possible, by the above procedure, to evaluate which components of the nervous system were involved.

Since Nembutal anaesthesia totally blocked the milk "let-down" reflex, it was possible to determine the amount of oxytocin required for normal milk "let-down." This was done by injecting various doses of oxytocin intravenously into anaesthetized mothers while the young were actively sucking and comparing amounts of milk obtained by the young with the control value of 3.8 percent. It was concluded that normal 14 day postpartum lactating rats vary in amount of oxytocin released, following application of nursing stimuli, from less than .02 to .1 USP/kg. Maximum amounts of milk were obtained with .1 USP/kg.

This latter procedure also constituted a method of assay for milk "let-down." Subsequently, a synthetic oxytocin (Syntocinon) was compared with the natural product and was found to possess equivalent milk "let-down" activity. Relaxin also was assayed and was found to be void of milk "let-down" activity.

The effects of nursing stimuli upon release and subsequent restoration of lactogenic hormone from the hypophysis was studied in two strains of lactating rats. Wistar strain lactating rats produced litters which, when 14 days old, were almost as heavy as those of the much larger Sprague-Dawley mothers.

This suggested more milk was produced in relation to maternal body size in the Wistar animals. There was 15 percent more pituitary gland/100 gm. in Wistar rats which, after 10 hours isolation of mothers and litters, assayed 30 percent more lactogen than pituitaries of Sprague-Dawley mothers. Following 30 minutes nursing there was a greater discharge of lactogen in Wistar than in Sprague-Dawley rats.

About one-half pre-nursing level was restored in both strains within 2½ hours postnursing but in the Sprague-Dawley strain, restoration to the pre-nursing level did not occur even 9½ hours post-nursing. These results suggested the greater relative weight of the pituitary along with higher relative lactogen content of the Wistar lactating rats may have been factors in their ability to produce more milk in relation to body size than the larger Sprague-Dawley rats.

Atropine, Dibenzamine and Nembutal effectively blocked pituitary lactogen discharge in Sprague-Dawley lactating rats since nursing evoked no decline from the control pre-nursing level. These results were interpreted as indicating cholinergic and adrenergic components, along with the central nervous system, were involved somewhere in the neural pathway from mammary gland to pituitary gland. A similar interpretation previously was applied to the release of oxytocin so it was suggested a common sensory pathway existing between mammary gland and hypothalamus is simultaneous discharge of oxytocin and lactogen in response to nursing stimuli.

The role of oxytocin acting as a humoral mediator for lactogen release was postulated by a group of English

workers. Utilizing the technique of Nembutal blockade of oxytocin and lactogen release, oxytocin was administered intravenously in physiological doses into 14 day post-partum lactating rats in which the young were actively sucking. Although normal amounts of milk were obtained by the young, assay of pituitary lactogen failed to show any decline from the normal pre-nursing level. Amounts of oxytocin 30 and 60 times the physiological dose produced but slight discharge. These results suggested oxytocin is not a humoral link involved in pituitary lactogen release.

Although nursing or milking stimuli are applied with regularity, the lactogen content of the pituitary gland of species tested gradually declines as lactation advances. Since lactogen plays a vital role in the initiation and maintenance of milk secretion, it seemed of interest to evaluate amounts of lactogen released due to nursing stimuli in the lactating rat, a species in which milk production increases steadily up to a normal weaning time (21 days).

The absolute pituitary level of lactogen was found to increase up to 6 days postpartum, then gradually decline until the 21st day. The amount of lactogen discharged from the pituitary due to nursing was 50-95 percent on all days except the 21st day.

At this time only 4 percent was released though milk secretion was maximal. It is suggested a conditioning of the mammary-pituitary reflex for lactogen discharge has occurred by this time with the result that total lactogen released per day might be equivalent to, or in excess of, that released within the same interval due to nursing stimuli during the earlier stages of lactation.

During the course of these studies a highly sensitive and repeatable pigeon crop-sac method of lactogen assay was devised. A log dose-response relationship was found to exist. This method of assay was found to have a high index of precision (.11) and is now routinely employed in the Missouri laboratories.

The study of the influence of estrogen upon calcium metabolism has been published. (*Project 28*)

#### **A Study of Marketing Systems and Related Factors As They Influence Production, Reproduction, and Physical Characteristics in Dairy Cattle**

A. C. RAGSDALE, C. P. MERILAN, K. W. BOWER,  
J. D. SIKES, H. S. PEET, H. A. BALL, L. R. RAINEY

##### *Objectives:*

*To determine the relative merits of various breeding plans and practices, as measured by production, reproduction, and related physical functions, for developing improved strains of dairy cattle.*

##### *Results:*

Reproductive records of the Holstein, Jersey, and Guernsey cows in University herds during the period

from 1934 to 1955 were studied. They indicated that the average first service calving rate was highest for cows bred during the first heat (62.4%) and lowest when the first service occurred during the third heat. (56.9%). First service during second heat was intermediate at 59.7% calving rate.

The 515 cows included in the study dropped 1233 calves from 1895 services, an average of 1.54 services per calf.

A study on the relationship between inorganic phosphorus levels in blood and dairy cattle performance was initiated in 1954. The results of 140 blood phosphorus determinations on Holsteins indicate that the blood phosphorus level reaches a peak value in calves approximately 6 to 8 months old. The phosphorus level then declines to about 65 percent of the peak value by the time the animals are 3 years of age. Thereafter, the decline in phosphorus continues at a reduced rate reaching 55 percent of the average peak value when the animals are 6 years old.

Comparison of both absolute phosphorus levels and deviations from the average age-phosphorus curve with preceding, current (time of phosphorus test), and subsequent lactation records (both actual and 305 2x ME) for 60 individual cows indicates the blood phosphorus level in cows will be of little predictive value until, and if, additional data can provide correction for environmental conditions, lactation stress, etc.

An additional 224 blood phosphorus determinations have been completed this year on Holstein, Jersey, and Brown Swiss animals of all ages. Analysis of this new data is in progress.

To date, 20 animals, which were tested for blood phosphorus levels as heifers (13-28 months of age), have completed their first lactation. When the animals are compared on the basis of deviation from the average blood phosphorus level for their age, the animals appear to fall into two groups which have the following general characteristics:

	Group I	Group II
Av. Milk (305 day-2x actual)	7865 lbs.	9907 lbs.
Av. Fat (305 day-2x actual)	308 lbs.	376 lbs.
Av. Blood Phosphorus Values	.80 mg.% above average for age.	.77 mg.% below average for age.

However, the comparison is complicated by the fact that within each group an increase in blood phosphorus is associated with increased production.

Neither age nor reproductive status at time of phosphorus test seems to account for the apparent grouping of production and phosphorus levels. If the difference between groups proves to be real, the general trend of increased production associated with increased blood phosphorus (within each group) could be utilized as one part of a multi-test sequence for evaluating the production potential of young dairy animals. (Project 35)

## Ice Cream Quality as Influenced By Emulsifiers, Sweeteners and Dehydrated Mixes

W. H. E. REID, D. S. SHELLY, R. E. HENSLEY,  
R. L. BINNING

### Objectives:

- A. New types of sweeteners such as liquid sugars and syrups.
- B. Study relation of super store environment to physical properties of respective ice creams.
- C. Spray processed dehydrated ice cream mixes and resultant ice cream.

Study was made on ice creams of 18 different series of two ice cream mixes per series to observe relation of variable amounts of liquid sugar and high and low conversion liquid corn solids to methods of compounding, processing, freezing and flavor, body texture and meltdown of the ice creams subsequent to their exposure for 2, 4, 5, and 7 days respectively to environment of commercial refrigerated dispensing cabinets used in super market stores.

One mix of each series contained vanilla extract. Temperature of ice creams observed at time of removal from cabinet varied from -4°F. to 2°F. Extreme temperatures of the ice cream observed were -15°F. to 17°F. Data indicate that use of sugar and syrups in liquid form is more sanitary and efficient.

Ice cream containing from 15 to 17 percent liquid sucrose was satisfactory as to flavor, body, texture and meltdown. Ice creams containing 12 percent liquid sugar plus 5 percent of either low or high conversion liquid corn solids were satisfactory as to flavor, body, texture and meltdown. Addition of vanilla extract tended to submerge sweetening flavor. Variation in temperature of cabinets had no apparent effect upon flavor and meltdown; however, in some instances it did impair the body of the ice cream.

Addition of corn solids definitely improved body and meltdown, giving a smoother, more chewy and resistant ice cream. Mixes had no apparent effect upon the pH or titratable acidity. Managers of all super stores invited continuation of the project.

The study of spray processes dehydrated ice cream mixes has not been undertaken as the dehydrated mixes are not available at this time. (Project 37)

## A Study of Dairy Bull Semen; Viability and Fertility as Related to Storage Techniques; Physical and Chemical Characteristics

A. C. RAGSDALE, K. W. BOWER, C. P. MERILAN,  
F. M. ORSINI, LEONARD SLYTER, MARION ANDERSON,  
J. D. SIKES

### Objectives:

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

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

*Results:*

The results of autoradiographic studies of bovine spermatozoa suspended in a diluent containing radioactive glycerol indicated that glycerol apparently does enter bovine spermatozoa. Of the total number of beta-tracks observed in the photographic emulsions as the result of beta-tracks observed in the photographic emulsions as the result of  $C^{14}$  decay, 14.9 percent were associated with the spermatozoan head, 13.1 percent with the mid-piece, and 8.9 percent with the tail. Liquid nuclear track emulsions were found to be more effective than either stripping films or dental X-ray plates for studying glycerol- $C^{14}$  localization at the cellular level.

Preliminary results, from studies to determine the optimum methods for glycerating bovine semen, indicate that continuous agitation (70-80  $\cdot \frac{3}{4}$ " strokes per minute), with gradual addition of the glycerolated extender, decreases the time required for equilibration and results in a better post-freezing motility rating. This suggests that larger numbers of spermatozoa survive the freezing process. The addition of fructose to the extender also helps protect the spermatozoa during the freezing process.

Four general methods of dehydration of semen for storage are under study.

Results, to date, show that solubility, as well as rate of water uptake by the dried material, is related to the process used in dehydrating the semen. Thus, the dehydration and rehydration methods are interdependent and equally critical. (Project 54)

### **The Influence of Diet on the Growth and Development of Calves and Older Dairy Animals**

C. P. MERILAN, GORDON STEWART, LEONARD SLYTER,  
A. C. RAGSDALE, H. S. PEET, H. A. BALL

*Objectives:*

*A. To determine the influence of diet with special reference to milk replacers and starter rations and the specific mode of action of antibiotics.*

*B. To compare the later growth and development of the animals on the experimental rations with similar animals reared under normal feeding and management conditions.*

*Results:*

Studies on the effect of potassium nitrate intake on dairy calves indicate that the minimum lethal dose for initial intake is in excess of 30 gm. per 100 pounds body weight. Toxic response to the compound is variable, but not materially affected by experimental method of intake (milk vs. gelatin capsules). Level of  $KNO_3$  ingestion has little, if any, influence on time required for maximum blood levels of methemoglobin to be reached.

Up to 1.3 percent nitrate (W/V), but no nitrite, was

detected in the urine of two calves receiving 25 gm.  $KNO_3$  per 100 pounds body weight, and showing low levels of methemoglobin. Both the heart rate and the amount of methemoglobin formed in the blood were increased by potassium nitrate intake.

Effects of level of feed intake on the response of lactating dairy cows to a daily intake of 15 gm. of potassium nitrate suggest that high producing cows are more sensitive to the effects of  $KNO_3$  administration. However, previous history of the animal was important, since animals which had not received potassium nitrate in earlier experiments were more sensitive. Nutritional level in these experiments showed little, if any, effect on response to the potassium nitrate intake.

Four trials, one to three days each, were conducted with a herd of 32 Jersey cows to determine if a sudden transition from feeding green chopped forage to a hay feeding program would have any appreciable effect on eating habits or milk production. There was no apparent effect on feed consumption. The effect on the production of individual cows was varied, but average production for the herd increased slightly during three of the trials and decreased slightly during the fourth trial. (Project 55)

### **Dairy Herd and Farm Improvement Practices Contributing to an Efficient Farm Enterprise**

H. S. PEET, A. C. RAGSDALE

*Objectives:*

*A. Breed strain of Jersey cattle with high milk production, superior type, good size, and long life.*

*B. Determine the effect upon production and eating habits when hay is substituted for green chopped forage.*

*C. Compare silage preservatives—cane molasses and metabisulfite.*

*D. Study health management and sanitation practices related to Brucellosis, tuberculosis, mastitis, milk fever and calf ailments.*

Twenty-six years of Herd Improvement Registry testing and Official Type Classification have provided a background for a constructive Jersey breeding program. Herd Improvement Registry records show an average production of 7105 pounds of milk and 391 pounds of fat over the 26 year period. The herd average for the 5-year period ending December 31, 1957, was 7421 pounds of milk and 407 pounds of fat. The Hatch Farm herd was officially classified April 26, 1957, at which time 12 animals classified "Very Good", 18 "Good Plus", and one "Good", making an average classification score of 84.27 for the herd.

The study to determine the value of pasture grasses, sudan and legumes as soiling crops for dairy cows as compared with normal pasturing of these crops was continued during 1957.

The yield of alfalfa and alfalfa-brome varied from

4 to 6.5 tons of green chopped forage per acre, depending upon the cutting and weather conditions prior to and during harvesting. The yield of sudan grass was considerably higher. In 1957, eight acres of sudan grass yielded more feed than was required for the 32 Jersey cows.

The average time required for one man to chop the forage and feed both night and morning was approximately 40 minutes. Only one tractor was used; therefore, the time included changing the tractor from the wagon to the chopper and back to the wagon. Also all harvesting was done on terraced land with considerable slope, thus requiring more time than on large, level fields. Other devices such as self-unloading wagons and fence-line feed bunks would reduce the time required.

Savings on rental of silo filling equipment in previous years, surplus forage harvested as hay and increased milk production more than equalled the yearly cost of machinery investment.

The normal decline in milk production through advanced lactation was retarded by the feeding of green chopped forage in comparison to normal pasturing. This has been especially true during drouth periods because the amount and kind of pasture grasses consumed can be more accurately determined. Our results show that the average production per cow for the late summer months was as much as 70 pounds of milk per month over previous years when normal pasturing was practiced.

Although the work at this Station has not been sufficient to be conclusive, our experience indicates that good quality hay may be substituted for green chopped forage for a period of one to three days in emergencies without any significant change in production or eating habits.

We conclude that there are three conditions which particularly warrant consideration of feeding green chopped forage as a soiling crop to cows on dry lot: (1) on farms with insufficient pasture acreage, (2) on farms where it is desired to increase the number of animals without increasing the pasture acreage, and (3) on farms which have field choppers available which previously were used only for silo filling.

Dairy men and livestock men in this area continue to show much interest in this practice and several have introduced it into their farming methods. (*Project 64*)

### Endocrine Genetics of Milk Production

A. C. RAGSDALE, C. W. TURNER, GAYLE PIPES,  
JACK SAROFF, H. L. RUPPERT, JR., B. N. PREMACHANDRA,  
AND P. R. STAHL

#### *Objectives:*

*A. Study various factors influencing the thyroxine secretion rate of cattle.*

*B. Mate fowls showing varying thyroxine secretion rates to gain an insight into the mode of inheritance of thyroxine secretion.*

*C. Continue study of the experimental growth of the cow's udder and stimulation of milk secretion.*

#### *Determination of Thyroxine Secretion Rate of Cattle*

Equipment has been developed which facilitates a study of the quantitative changes of thyroidal-I<sup>131</sup> in the bovine during progressive stages of growth and under various environmental conditions and physiological states. Replacement therapy with thyroxine during thiouracil treatment indicated the feasibility of measuring the actual daily secretion rate of individual animals in terms of l-thyroxine.

A total of 114 individual estimations of thyroxine secretion rates were made in dairy cattle. The average thyroxine secretion rate for the cows was 0.56 mg. (range 0.2-1.0) l-thyroxine per 100 pounds body weight in winter and 0.6 mg. (range 0.2-1.0) l-thyroxine per 100 pounds body weight for the calves during the same period. Thyroxine secretion rates were reduced three-fold in the summer, but the extent of depression varied with the individual. There was an average three-fold variation in thyroxine secretion rate between individuals during the same season.

The rate of change in thyroxine secretion was not in direct proportion to the rate of seasonal change under decreasing ambient temperature and it is thought that an increasingly warmer environment may be a greater stimulus to a reduction in thyrotropic hormone secretion than a gradually colder environment for increased thyrotropic activity.

The relationship of thyroxine secretion rates with hormonal release rates was rather poor, which was believed to be due to the variation in the size of the thyroid gland with identical or different release rates. None of the indices of thyroid activity satisfactorily measured the actual amount of thyroxine secretion.

Preliminary investigations on a very limited number of animals with 3:5:3': l-triiodothyronine in cattle revealed that it was 3-5 times more potent than thyroxine when injected subcutaneously. The experimental findings with thyroprotein revealed that the oral effectiveness of thyroxine contained in thyroprotein was about 10 percent as effective as subcutaneous thyroxine administration.

#### *Biological Activity of Goitrogens*

A method has been described for the estimation of the biological activity of goitrogens in intact cattle. This information is believed to be useful in increasing the fattening rate and the carcass quality toward the end of the feeding period.

In mature cattle 1 gm. per 100 pounds body weight produced maximum inhibition of I<sup>131</sup> uptake from re-

utilization, whereas 4 to 8 gm. per 100 pounds body weight produced greater inhibition in younger animals (300-400 pounds).

#### *Effect of Ovarian Hormones on Thyroxine Secretion Rate*

Estrogen (estradiol benzoate) alone at 1.15 mg. per day or in combination with progesterone at 100 mg. per day had no effect on  $I^{131}$  release rate from the thyroid. At the higher levels, 2.5 to 3.0 mg. per day of estrogen, there was an indication of a slight increase in the rate of release of the hormone, but progesterone at 100 mg. per day had no effect on  $I^{131}$  release.

There was circumstantial evidence that continuous injections of estrogen and progesterone at the levels used for growing the mammary gland of the sterile animals did not affect thyroid function as shown by the uptake and release of  $I^{131}$ .

#### *Determination of Thyroxine Secretion Rate in Fowls*

A modified and improved method is described for the measurement of the individual thyroxine secretion rate in fowls which eliminates frequent blood sampling and makes possible the administration of lower doses of  $I^{131}$ . Thiouracil at 0.1 percent in feed has been satisfactory to produce a sufficient deflection in the slope of normal release of  $I^{131}$  from the thyroid gland of the fowl.

Two lines of New Hampshire chickens, selected for three generations on the basis of their response to the feeding of thiouracil by variation in average thyroid weight, differed markedly in thyroxine secretion rate. The line showing a marked response to thiouracil (high line) secreted an average of 1.02 micrograms l-thyroxine per 100 grams body weight of the bird, whereas the low line secreted an average of 2.98 micrograms per 100 grams body weight per day. While there was some overlap of thyroxine secretion rate in the two lines, the degree of separation is quite remarkable.

The hormone release rate constants were not properly correlated with thyroxine secretion rates of the bird. From the results on cattle and poultry, it is inferred that the estimation of thyroxine secretion rate is the best index of thyroid function. (*Project 80*)

### **Effects of Environmental Temperature On Growth and Related Reactions In Heifers**

A. C. RAGSDALE, H. H. KIBLER, CHU S. CHENG,  
H. D. JOHNSON, J. I. KENNEDY, T. H. KOMAL,  
A. BERMON

#### *Objective:*

A. To determine the influence of climatic factors on growth, milk production, and related physiological reactions of various breeds of cattle.

B. To furnish basic data for recommendations on selection of cattle adapted to climate and on shelter construction.

An experiment on the growth responses of Holstein, Brown Swiss, and Jersey calves was begun October, 1956, and ended September, 1957. Exposure of these animals raised at the two conditions to rising environmental temperatures began September, 1957, and ended January, 1958. From January, 1958, to approximately March, 1958, basal metabolic studies were made on these two groups of heifers at 65° F. Age and shelter requirement studies with follow. Reports on some previous growth experiments on Shorthorn, Santa Gertrudis, and Brahman calves are included in the following summary.

1. Physical Growth Responses: The Holstein and Jersey calves made better growth gains at 50° F than at 80° F as indicated by body weight, heart girth, and wither height measurements. The Brown Swiss did as well or better at 80° F than at 50° F temperature.

The conformation measurements suggested a greater ratio of wither height to chest girth at 80° F than at 50° F in all breeds.

2. Feed and Water Consumption: Feed and water consumption of European evolved dairy cattle are sensitive indicators of the depressive effect of higher environmental temperature. Throughout the growth experiment the animals at 80° F had a higher water consumption than those at 50° F. At 80° F the TDN consumption was lower.

Water consumption for the Holstein calves was approximately 100 percent greater at 80° F than at 50° F. It was approximately 30 percent greater for the Brown Swiss, and 15 percent for the Jerseys.

TDN consumption shows that Holstein calves consumed 20 percent more TDN at 50° than at 80° F, and Brown Swiss and Jerseys consumed 15 percent more. Calves were fed hay *ad libitum* and grain according to schedules recommended by H. H. Herman, University of Missouri Agricultural Experiment Station Research Bulletin 377, 1937.

3. Thyroid  $I^{131}$  Activity: The thyroid gland is a link in the neuroendocrine chain which influences all life processes such as milk production, beef production, feed consumption, and growth and related functions. The activity of the thyroid gland is measured by the *in vivo* (live animal)  $I^{131}$  method. It is hoped that as more thyroid data are obtained and correlated with other physiological reactions we may predict the other processes, including the potential agricultural productivity of the young animals.

The thyroid activity has been intensively measured on these growing dairy calves. From the age of one month to approximately 12 months there was a striking increase in the thyroid  $I^{131}$  release rate in the 80° F groups; at the 50° F level the change in all breeds was more gradual.

Throughout the growth experiment the Jersey calves

maintained the highest level of thyroid I<sup>131</sup> activity and the Holsteins had the lowest. The Brown Swiss were intermediate at 80° F and similar to the Holsteins at 50° F. The breed level of thyroid activity at 80° F may rank the animals in an apparent order of decreasing heat tolerance.

Thyroid I<sup>131</sup> activity expressed per unit body weight naturally reduces the differences in thyroid activity between the 50° and 80° F animals due to the depressed growth responses of the animals at 80° F, with the exception of the Brown Swiss.

At both 50° and 80° F the thyroid activity per unit weight decreases with age. The relative rates of decrease are about the same in all three breeds at both temperatures. (Project 125)

### Characterization of Microorganisms Common to the Dairy Industry

J. E. EDMONDSON, K. L. SMITH, ROBERT MARSHALL

One of the first problems to be solved was to increase the solubility of the milk proteins so that large milk samples could be filtered. Addition of non-ionic wetting agents, at the rate of 0.1 percent to the dilution water, enabled filtering milk samples of 10 ml. or less. Work completed indicates that no wetting agent is required for samples of 0.1 ml. or less (wetting agents of the alkylated aryl polyether alcohol type proved to be most effective).

Several media trials were set up using single, double and triple strength MPH broth (9 g. milk protein hydrolysate, 1 g. glucose and 1000 ml. distilled water for single strength) and EHC enrichment broth (AWWA) plus 5 g. of glucose. Of this group the double strength MPH broth has proved to give the best correlation with the Standard Plate Count.

Many studies indicate that difficult counting may be the large source of error because the size of the colonies on the filter. To eliminate this error by making the colonies more distinguishable, triphenol tetrazolium chloride (TTC), an oxidizing agent causing the production of red pigment in the colony, was added to the medium. Concentrations of 0.0010; 0.0025; 0.0050; 0.0075; 0.010; 0.020 and 0.030 percent were checked to see if counting technique could be improved. Concentrations of 0.0025 to 0.0075 have proven satisfactory on a number of raw samples; however, some samples show effects of inhibition due to the TTC.

Because some species of bacteria may be inhibited by TTC, several samples failed to show good correlation between the membrane filter and the Standard Plate Count. The addition of TTC to the medium definitely produces colonies that are easier to count, but the presence of an inhibitory effect on some species of bacteria prevent its use for accurate enumeration of bacteria in

all milk samples.

Based on experimental results to date, the accuracy of the membrane filter technique is within  $\pm 10$  percent of the Standard Plate Counting procedure. Many samples check within 1 percent. (Project 133)

### Official Testing of Dairy Cattle and Milk Goats

JOHN D. SIKES

#### Objectives:

To provide official testing service to purebred dairy cattle and milk goat breeders in Missouri so that Herd Improvement Registry and Advanced Registry records may be made available for use in planning breeding programs.

This project is basically a cooperative enterprise involving the National Dairy Cattle Breeding Associations, American Milk Goat Record Societies, the Purebred Breeders and the College of Agriculture, Department of Dairy Husbandry.

Official testing service was made available to Missouri Breeders as follows:

#### HERD IMPROVEMENT AND ADVANCED REGISTRY TESTS

January 1 - December 31, 1957

Breed	Number of Herds		Number of Cows and Goats	
	Total	Avg. Per Mo.	Avg. Per Mo.	Total Individual Tests for Year
		(5 months only)		(5 months only)
Jersey	21	18	436	5,229
Guernsey	17	11	565	6,785
Holstein	39	37	1,375	16,501
Brown Swiss	10	10	238	2,850
Goats	1	1	2	9

Ninety-one percent of the herds enrolled in the official testing program are enrolled in the Herd Improvement plan.

During 1957 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.

The highest butterfat and milk producing cow for the year in the Herd Improvement Registry program for all breeds was Miss Paganok Gingerbread Betty, a Holstein cow owned by Scott Meyer & Sons, Palmyra, with 29,033 pounds milk, 1,284 pounds fat, 4 years 10 months of age in 365 days 2X.

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

Jersey—Pinn Royal Peggy, owned by School of Ozarks, Pt. Lookout, with a record of 16,800 pounds milk, 982 pounds fat at 6 years 5 months of age in 365 days 3X.

Guernsey—Pre-Eminent Sibyl owned by J. C. Penney Farm, Gallatin, with 15,050 pounds milk, 764 pounds fat at 2 years 1 month of age in 305 days 2X M. E.

Brown Swiss—Churchview Georgia's Katie owned by University of Missouri, Columbia, with 14,478 milk, 656 fat as 3 years 6 months of age in 305 days 2X M. E.

The highest butterfat and milk producing cow for the year in the Advanced Registry program for all breeds was Pinn Royal Peggy, a Jersey cow owned by the School of Ozarks, Pt. Lookout. She produced 16,800 pounds of milk, 982 pounds of fat in 365 days 3X at 6 years 5 months of age. A March 21, 1958, release from The American Jersey Cattle Club states Pinn Royal Polly owned by The School of Ozarks has made a record of 18,237 pounds of milk, 944 pounds of fat in 365 days 3X at 8 years 3 months of age.

The high cow for other breeds enrolled in the Advanced Registry Program was Valiant Boy's Faithful, a Guernsey cow owned by Everett Baker, Butler, with a record of 14,703 pounds of milk, 691 pounds of fat at 3 years 2 months of age in 305 days 2X M. E.; North Repelmar Symvron owned by Repelmar Farms, Versailles, was the high cow on Register of Production test for the Brown Swiss breed with 15,466 milk, 682 fat at 4 years 11 months of age in 305 days 2X M. E.

The above mentioned are only a few of the outstanding records made during 1957. Along with the official testing program, encouragement is being given to breed better cattle, thereby improving the economic status of the Missouri Dairy Cattle Breeders. (Project 134)

#### Foremost Guernsey—Breeding for Herd and Breed Improvement

L. R. RAINEY, A. C. RAGSDALE, J. E. EDMONDSON,  
C. P. MERILAN AND J. D. SIKES

##### Objectives:

A. Develop cattle of good size, large milk production, superior type, and longevity and develop outstanding sires and brood cow families.

B. Study loose housing vs. conventional housing for cows in milk, closed vs. open barns for calves, and aluminum vs. asphalt shingle roofing for heat transmission and for service life.

*Dairy Cattle Breeding:* The herd in 1957 was made up of 147 cows of milk producing age, with an average of 133 cows in milk daily. The 133 milking cows averaged 9565 pounds of milk and 438 pounds of fat. For 147 animals, including dry cows and a number of aged cows retained because of proved breeding value, the production was 8530 pounds of milk and 398 pounds of fat. Three-times-a-day milking was discontinued this year and all records quoted are on twice-a-day milking. Approximately 25 percent of all cows in milk in the present herds are over 10 years of age.

A few achievements in breeding are illustrated by the following animals:

*Foremost Footprint's Quality:* Completed a 9 year old record in 1956 of 15481-768-9yr-HIR-365C-2X. She was classified Excellent in 1957 as a 10 year old and completed another record of 14845-711-HIR-335C-2X. Her last calf, a bull, is an outstanding herd sire prospect. She has a production record in six lactations of 94876 pounds of milk and 4706 pounds fat, with one lactation missed, the year the herd was moved to Missouri.

*Foremost Footprint's C Quantity:* Calved in 1957, classified Very Good, and has just completed 13181-643-Jr2C-HIR-2X. She is a full sister to "Quality" mentioned above. The third full sister has just calved and seems to be cut on the same pattern. Here we have an outstanding demonstration of family strength and of inheritance.

During the calendar year of 1957 a total of 153 calves were dropped—69 females and 84 bulls. The calves dropped included four sets of twins (two sets of bulls and two sets of male and female). Sixty-four of the heifer calves were raised for breeding purposes; 19 of the bulls have been sold for breeding purposes and 11 held for sale. One may be held as a future herd sire. Forty-eight bulls were sold as bob veal and six were lost in 1957.

*Farm Visitors:* Many organized groups and individuals, including FFA, 4-H, college student and women's groups and cattle breeders and foreign visitors, came to the farm throughout the year. An estimated 2500 people were shown the farm. (Project 200)

#### Specific Role and Synergistic Effects of Microorganisms in Dairy Cattle

J. E. EDMONDSON, C. P. MERILAN, K. W. BOWER,  
R. J. WILSON AND V. H. VIEBROCK

##### Objectives:

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

Manometric studies have been made on the *in vitro* utilization of a cellulose substrate (solka-floc) by suspensions of rumen microorganisms from fistulated dairy heifers maintained on a roughage ration. Low levels of  $KNO_3$  in the reaction flasks stimulated gas production by 9.6 percent, 5.8 percent, and 3.3 percent, respectively, for concentrations of 0.125 percent, 0.25 percent, and 0.5 percent  $KNO_3$  on a dry matter basis. However, the change in the portion of total gas production, which could be attributed to cellulose digestion, indicated 27.3 percent, 32.4 percent, and 27.8 percent increase in apparent cellulose digestion at these potassium nitrate concentrations. Higher levels of  $KNO_3$ , 1.0 percent, 2.5 percent, and 5.0 percent, resulted in decreased total gas production, as

well as 26.1 percent, 48.9 percent and 80.0 percent decreases in apparent cellulose digestion.

Potassium nitrite concentrations, ranging, from 0.01 percent to 0.1 percent of dry matter, inhibited apparent cellulose digestion 7.9 percent to 67.0 percent, respectively, while 5.0 percent  $KNO_2$  decreased the cellulolytic activity by 91 percent.

Preliminary studies have been made to determine if bacteriophage exist in the rumen of the dairy cow. Their presence would provide at least a partial explanation for some of the changes which occur in the rumen microorganismal population. A total of 548 bacterial cultures from the rumen of three fistulated cows were used. No evidence of bacteriophage was found in any of the 548 tests completed; thus, it is concluded that bacteriophage probably do not constitute a major factor in rumen microorganismal population control.

However, these findings, to date do not prove the absence of bacteriophage in the rumen since minor variations in environmental or test conditions could prevent the increase in bacteriophage numbers necessary to be detected by either the tube or plaque formation tests. (Project 246)

### The Quality of Milk and Related Products As Influenced by Handling and Marketing

W. H. E. REID, J. E. EDMONDSON, D. S. SHELLY,  
K. L. SMITH AND B. L. BERRY

#### Objective:

*A. To determine the nature, extent and cause of deterioration in fluid milk and related products from the time it leaves the farm until it reaches the consumer.*

A survey revealed that many self-service dairy cabinets were operated at temperatures much too high for proper storage of milk. Educational programs were inaugurated in these markets with the result that the average cabinet temperature for the past several months has been less than 38°F.

Conclusions from a milk temperature study indicate that (a) milk may be stored very successfully for a period of seven to ten days if the temperature is maintained be-

low 41° F.; (b) in all cases more uniform milk flavor was maintained at 36°F than 41°F storage temperature; (c) to retain the highest flavor during the 10 day storage, even at 36°F. temperature, all milk samples must have a very low initial bacterial population; and (d) to insure delivery of high quality milk to the consumer, it is necessary for dairy sales personnel to check continually self-service storage cabinets to maintain 36-38°F. temperatures.

Consumer preference studies on ice cream package size, shape and design have been conducted only four months. Seventy-five families, ranging from two to seven persons (total of 249 persons), were selected by random sampling techniques. These families are geographically located in the city of Columbia and have a wide range of income levels.

To date the first trial of the size of ice cream serving studies has been completed. At least two additional size studies will be made. Samples of 3, 4, 5 and 6 ounce sizes have been used for individual serving preference. In addition to individual preference study cards, each family fills out a general ice cream survey questionnaire.

Based on the first trial data, 64.4 percent of the group preferred the five ounce serving. The two and three member families preferred the five ounce serving, 67 and 69 percent, respectively. Generally a larger number of the five, six and seven member families have a preference for the smaller (four ounce) serving. As would be expected the women prefer the smaller serving (four to five ounce size) while the men have a preference for larger servings (five to six ounce size). In most families the preference difference between women and men is equal to one ounce.

Data on preference according to age is not complete for all divisions, and some groups are too small to be significant. The children's group (age one to nine) preference ranges from the three to five ounce serving, primarily because of weight and size difference. The group ranging in age from 10 to 19 years almost unanimously prefer the five and six ounce servings. In most cases the girls preferred the five ounce while boys, the six ounce servings. (Many would actually prefer larger sizes if available for study.) (Project 284)

# Entomology

Philip C. Stone, Chairman

### Furnishing Missouri Farms with Timely Information on Insects and Their Control

P. C. STONE, C. W. WINGO, P. L. ADKISSON,  
W. R. ENNS, L. HASEMAN, LEE JENKINS, D. C. PETERS

#### Objectives:

*A. The supplying of accurate, timely insect information on the economically important insect pests of the state.*

An ecological survey of *Loxosceles reclusus* was undertaken in the late summer of 1958. The species was found to be common to abundant in the southern half of the

state south of the Missouri River and rather common 50 to 75 miles north of the river.

No specimens were collected in the northeast section of the state. Actual distribution of the species within the state seems to agree closely with reported or known cases of necrotic arachnidism among laymen and physicians. *L. reclusus* appears to be more closely associated with human habitation than it was formerly thought to be.

A study of harboring places of the species indicates a preference for seldom-disturbed storage areas in and around homes. This is a significant finding since such habits tend to make a given venomous species a greater potential hazard.

A large series of specimens of *L. reclusus* from Missouri have been furnished Dr. W. Gertsch of the American Museum of Natural History for his use in a taxonomic revision of the genus *Loxosceles*.

Each member of the Department is assigned to this project. The major financial support is for the travel expenses of the survey entomologist, who is jointly sponsored by the State Department of Agriculture, United States Department of Agriculture, and the Extension Service.

Each week during the growing season the survey entomologist records the abundance or scarcity of insects on the major crops in the state. This information along with that supplied from the research staff is distributed by the extension entomologist to all interested persons by every possible type of communication.

Much of this information is sent directly to the fruit growers, cotton farmers, livestock men, insecticide dealers, and aerial operators in the form of weekly news letters. The research staff and the survey entomologist work directly with any group in the state interested in insect control. The principal work of this project is keeping all individuals and organizations concerned with insect control informed about pests which might be causing them trouble and supplying information on the best ways to control the pests. (Project 30)

### Investigation and Control of the Codling Moth and Other Fruit and Vegetable Insects

W. R. ENNS, L. HASEMAN, R. K. STRANGE,  
F. E. ST. AUBIN

#### *Codling Moth:*

Only one new insecticide for codling moth control was evaluated in 1957. This was a wettable formulation of Alpha-naphthyl N-methyl carbamate which bears the trade name Sevin. It appears to be relatively safe from the spray operator's standpoint.

The control blocks were treated with the most effective program known, utilizing DDT, Parathion, and Di-

azinon. Sevin appeared very promising as an apple insecticide since it also controlled red-banded leaf roller in our blocks. It is not effective against mites, however, and suitable acaricides had to be applied in July.

On February 13, 1958, the USDA granted temporary label registration for use on apples to within 7 days of harvest and the FDA granted a temporary tolerance of 10 parts per million.

#### *Mites:*

In cooperation with H. G. Swartwout of the Horticulture Department, rather extensive counts were made to determine mite suppression by a fungicide known as Karathane. Its principal use is as a preventive of powdery mildew of apples. There may be a fringe benefit from its use as a mite suppressant. The data have not been analyzed.

#### *Mealybugs:*

In 1957, an outbreak of grape mealybugs (either *Pseudococcus maritimus* or *Ferrisiana virgata*) developed in vineyards at Rosati. Although only three vineyards were infested to the point where injury developed and controls had to be applied, by the end of the season every vineyard checked in that area was found to be infested. A great deal of trouble with this insect is anticipated in 1958. No mealybug problem had occurred in the state since 1952 when light to moderate infestations were recorded in most vineyards as far north as Jackson County.

The principal grape varieties involved in 1957 were Concord and Cynthiana. Three vineyards (Cardetti; Welch; and Jonas) were used for evaluation studies of insecticides. Malathion, Parathion, and Diazinon were used as experimental insecticides. No formal blocks were laid out but appropriate controls were available in each vineyard. Sprays were applied by the growers.

All three insecticides gave good control, though difficulty was encountered with Parathion at first due to poor coverage. The grower was using an air blast sprayer moving at about 4 mph. It was found that a fine application was being made to the outer sides of the leaves but that the undersides and the grape clusters received no deposit. A shift to hand guns on a conventional hydraulic sprayer gave control comparable to that obtained by the other two materials.

#### *Scale:*

Two vineyards, one at Florissant (St. Stanislaus Seminary) and one at Sibley (J. H. Allison) which are infested with grape scale (*Aspidiotus uvae*) were used in evaluating insecticides for scale control.

At Florissant, five materials were used in replicated blocks. These included Thimet granules, Thimet emulsion, Phosdrin, Chipman R.6199, and Parathion. Applications were made by the grower on June 10 and 11 and again, in the Phosdrin and Parathion blocks only, on June 19. Thimet emulsion, 1½ pint 47.5 percent per

hundred gallons, gave 97 percent control. Parathion, 1.5 pounds 15 W per 100 gallons, gave 95 percent control. (*Project 31*)

### Entomology Museum

H. E. BROWN, W. R. ENNS, L. HASEMAN,  
P. C. STONE, C. W. WINGO

Additional progress was made in incorporating some of the beetles in the Bock collection into the research collections. In addition, a great many of the species represented in our collection of Coleoptera have been catalogued. This was done, and is being continued, in connection with a sizable trade we are effecting of duplicate material with Dr. G. H. Nelson of Loma Linda, California.

Routine fumigation and maintenance work was performed. The museum was rearranged to make more and better desk space available for taxonomic research. One graduate and one undergraduate student worked on taxonomic problems in the museum during the year. Taxonomic studies on Meloidae are continuing.

A large number of specimens was added to the collections. A large collection of spiders was made preparatory to offering a class in araneology in the winter semester, 1958. A trade of several hundred specimens was made with Dr. G. H. Nelson, College of Medical Evangelists, Loma Linda, California. Additional specimens collected in connection with project work were donated by various staff members.

Some time was spent at the Illinois Natural History Survey studying Meloidae and observing museum techniques as practiced in that institution. (*Project 36*)

### Biological Investigations and Control Of the Stable Fly, Horse Flies, and House Flies as Animal Pests, etc.

C. W. WINGO

#### *House Fly Response to Organic Phosphates.*

The experimental insecticide Dow ET-14 was re-evaluated as a residual spray for house and stable fly control. Twenty-six days of excellent control of house flies were afforded by a single application of this material from June 18 to July 14 under conditions of moderate to heavy infestation.

Control during the second period during August was excellent for only 14 days (as in the 1956 season) from August 16 to August 30 with good, practical control for a period of 27 days. There was no evidence of formulation deterioration during the 1957 season.

These data indicate that recommendations for the use of ET-14 in Missouri should include directions for spraying at least every 30 days with a 1 percent finished spray. This will provide a cheaper alternate material for residual spraying in house fly control.

Incidental to the house fly control experiments, a series of experiments using reduced concentrations of Toxaphene and DDT in oil were run on several lots of cattle for horn fly control. Of three lots of cattle exposed to backrubbers treated with 2.5 percent Toxaphene in oil, two lots showed excellent control during the period—one lot evidently did not accept the rubber and no control was obtained. Of two lots of cattle exposed to rubbers treated with 2.5 percent DDT, neither lot showed control of horn flies.

These results indicate control of horn flies with 2.5 percent Toxaphene may be secured with backrubber application, presumably with some expectation of reduced accumulation of the insecticide in animals tissues. DDT at 2.5 percent in oil may not control horn flies when applied by backrubber.

#### *Area Treatments for Lone Star Tick Control.*

The Lone Star Tick study area located in State forestland 6 miles north of Eminence was again sampled for tick populations in May, June and July of 1958. In addition, Plat II, which had received 2 pounds of DDT per acre in 1955, was retreated in April, 1957, with 1 pound of Dieldrin. A granular formulation was applied by Stearman Aircraft at the rate of 40 pounds of 2.5 percent granular Dieldrin per acre. Coverage was generally good with the exception of the south border where over-correction for drift by the pilot resulted in treatment extension into the South Buffer area for approximately 40 yards.

Rainfall much in excess of normal fell during the spring of 1957 which washed away considerable of the insecticide and in effect penalized the performance in tick control. Twenty-one and fifty-nine hundredths inches of rain were recorded at Eminence from April 10 (application date to May 31).

The data indicate control from the 1955 application to Plat I has practically ceased and populations have almost recovered to approach those of the check area. The reduction of total stages in the S Buffer is undoubtedly due to Dieldrin washed from Plat II during the heavy rains of April and May.

The 1957 Lone Star Tick population in the area was generally higher than in previous years. Plat I continued to show a depression of tick numbers, especially in May and June when over-wintering nymphs and adults would have been most affected by the insecticide remaining in the forest duff and top soil. (*Project 46*)

### The Influence of the Different Elements And Plant Nutrients on the Well-being and Fecundity of the House Cricket, and Other Insects

L. HASEMAN, P. C. STONE

Two experiments were carried out at room temperature to study the possible effects of microorganisms on

crickets reared in jars having unsterilized and sterilized soil floors.

Throughout the year large stock cultures of crickets were maintained having a daily hatch of from 300-3000 nymphs. By practicing strict sanitary measures and feeding the crickets pelleted food, no losses were experienced and day-old crickets as well as crickets of any age were available for entomology projects.

Through the year crickets were used for the rearing of poisonous spiders for toxicity tests and as live laboratory class specimens. A search was begun in 1957 to determine whether the laboratory colonies of the house cricket contained parthenogenetic representatives so that a more uniform cricket would be available for nutritional studies. (Certain Orthoptera such as roaches, phasmids and grasshoppers are known to be parthenogenetic.)

Each day five late instar female nymphs were placed in an oviposition jar for the duration of their lives. The oviposition jars were wide-mouth gallon pickle jars containing 3 inches of moist sand, a vial of drinking water, a metal fruit jar lid containing a pelleted food and a cover consisting of several layers of cheesecloth held in place with rubber bands. The oviposition jars have been held at room temperature for the past three months. The females have laid thousands of eggs but as yet no eggs have developed. (Project 74)

**Biology and Control of Field Crop Insects  
With Special Emphasis on the Corn Ear Worm,  
Hessian Fly, Grasshoppers, European Corn  
Borer, and Primary Soybean Insects**

HARRY E. BROWN, L. HASEMAN, LEE JENKINS,  
P. C. STONE

*Migration of the Potato Leafhopper*

The objective is a cooperative undertaking with NC-29. Collecting was started in southeast Missouri in early April. The first specimens of *Empoasca fabae* were taken this year on April 25. These first arrivals were females as in the past, but this year, for the first time, these female specimens could be positively identified due to new techniques developed at the regional identification center at Urbana, Ill., by Dr. Herbert H. Ross and his co-workers.

It now appears that this insect overwinters in the lower Mississippi delta area and that this is our source of yearly migrations. The reasons behind the migrations are not completely clear as yet, but the major facts behind the mass movements are beginning to emerge.

During May, June and early July, 1957, Missouri experienced the first severely damaging populations of potato leafhoppers on alfalfa and clover crops in the state in many years. Exact information on this point is lacking but nothing comparable to these infestations can be remembered by present workers. We have mass migra-

tions pass over the state toward the north which could produce such infestations provided the right conditions were present.

*Control of Hessian Fly with Insecticides.*

Field experiments at Columbia were designed to test two formulations of Thimet, two new phosphate insecticides, the seed slurry method of application (using Thimet), and the effects of planting date on control and plant growth. Two levels of insecticide rate were used and all applications except seed slurry were made on 12-12-12 fertilizer at 200 pounds per acre. Results:

1. Only Thimet gave complete protection at the 1 pound rate, although all materials greatly reduced the infestation.

2. Seed slurry treatments of Thimet at one-half pound rate (about the maximum amount which can be slurried on satisfactorily) did not hold the infestation to 0 when exposed a full month before the fly free date but did so on wheat planted September 26, 12 days before fly free date.

3. Ponca, a fly resistant variety of wheat, performed very well in these tests, the controls showing very low infestation rates. The plots in this experiment were sampled for forage yield on two dates. (Project 102)

**Insects of Cotton in Missouri**

P. L. ADKISSON

The 1957 Missouri cotton crop had several major insect problems occurring generally over large portions of individual counties but not over the entire cotton growing area.

*Cotton Fleahopper (Including tarnished plant bug and rapid plant bug):*

Activity of the fleahopper complex reached a peak late in July and continued high throughout August. Economic populations occurred in many fields but damage was generally light. Control measures were used in only a few individual fields where square set was delayed by the vegetative condition of plants plus the fleahopper complex.

*Spider Mites (Mainly Tetranychus atlanticus).*

Marginal infestations were present by early July but heavy rainfall prevented a serious build-up. Some increase did occur in late August resulting in about 25 percent of the fields showing scattered small spots of locally heavy mite populations. Control measures used were largely marginal applications.

One interesting observation made during the season was that *T. atlanticus* appeared to survive heavy rainfall much better than other species of mites known to infest cotton in Missouri.

*Cotton Bollworm (Heliothis Zae):*

Bollworm infestations began to increase late in July and reached a peak by mid-August. Heavy infestations continued well into September. At the peak of infestation, up to 50 eggs and 65 to 100 larvae per 100 terminals could be found in Dunklin, Pemiscot, and New Madrid Counties. Bollworm control measures were generally used in these heavily infested counties and good control was obtained with from 1 to 2 applications of recommended materials.

*Cotton Boll Weevil (Anthonomus grandis):*

For the second consecutive year, a very few weevils successfully overwintered in Missouri. Very light marginal infestations were found in Dunklin County late in June and infestations slowly increased in Dunklin, New Madrid, Scott and Stoddard Counties until mid-August.

Adult weevil migration began in mid-August and percentage of field infestations rose sharply and continued to increase until the killing freeze of October 27. Boll damage to mid-season and late planted cotton ranged from light to very heavy along the western and northern margins of the cotton growing area.

Estimates of loss in this heavily infested area ranged from 0 up to as high as half a bale per acre. Weevil damage to the bolls also reduced the quality of the crop in the above-mentioned area.

Some boll weevil control measures were used in Dunklin, New Madrid, and Stoddard Counties early in September. However, as evidenced by the estimate of loss, much more late season control practices would have been advantageous. (Project 214)

### Corn Insect Control

R. JACKSON, H. E. BROWN, L. HASEMAN  
P. C. STONE, D. C. PETERS, P. K. MOORE

*Cutworms:*

Toxaphene bran bait was applied on a farm near Cairo, Mo. in an effort to control cutworms damaging corn about 2 feet tall. Counts were made a week later and indicated excellent control, but these were somewhat inconclusive because of the way in which the material was applied and the sharp decrease in numbers of cutworms in both the checks and the treated area.

*Breeding field corn for resistance to corn earworm.*

Cooperation with the corn breeding program, Field Crops Project 85, continued through the season of 1957 and further progress was made toward developing Missouri adapted, earworm resistant strains.

*Fall Armyworms:*

Fall army worm counts were made on the Depro farm near Matthews in conjunction with third brood European corn borer control studies involving aerial ap-

plications of 10 percent Toxaphene granules at 10, 15, and 20 pounds per acre. The counts were so erratic that no statistically significant difference could be shown. The highest dosage did show a degree of control but not enough to be considered satisfactory.

Counts were also made on the Frank Van Horn farm near Sikeston following the application of 1 pound of Heptachlor and DDT and ½ pound of Endrin granules for European corn borer control. All three insecticides produced about 75 percent reductions in fall army worm populations.

On the James Judah farm, corn varying in height from 24 to 40 inches was treated with several different insecticides and rates. A high clearance sprayer with one nozzle over each row was used. Twenty gallons of solution were applied per acre at a pressure of 40 p.s.i.

Toxaphene was significantly poorer than the other treatments.

In a hand application of granules for fall armyworm control there was apparently a slight amount of chemical burn with Endrin at the rate used in this experiment. (Project 269)

### European Corn Borer Studies

D. C. PETERS, P. C. STONE, K. R. THOMPSON  
R. D. JACKSON, P. K. MOORE, CHESTER ROBINSON

The same two counties were used again this year, Carroll County on the Missouri River, and New Madrid County, in the Mississippi River Delta. Last year's report gave a more detailed account of both counties.

Due to the change in station personnel and the excess rainfall during the planting season, only 31 farms in Carroll County and 12 in New Madrid County were included in the census. In Carroll County the first brood survey began on July 15 and the second on August 26.

In New Madrid County the first brood survey began on June 26 and the second on August 12. The one field available for third brood survey in New Madrid County was checked on October 13, 1957.

Results of the 1957 Annual Census for Missouri show a major corn borer population increase in Carroll County and a slight overall decrease in New Madrid County.

Data from Carroll County did not indicate larger borer populations in bottomland farms than in upland farms, which was true in 1956. This may be explained by the increase in precipitation in 1957 to the extent that soil moisture was not as limiting a factor as in 1956.

A scatter diagram of the data appears to indicate a positive correlation between earliness of planting and first brood borer populations, and almost as distinct a relationship between lateness of planting and second brood populations. Other factors were operative but indiscernible from the data available.

Borer survival in Carroll-County was unusual. Unfortunately, the prescribed spring survey was not conducted, but counts by Missouri's survey entomologist indicated a low potential population. First brood egg laying did reach what is considered economic levels in a few of the fields, but detailed records are not available in order to estimate actual survival for the various fields.

Random second brood egg mass counts never exceeded 50 per 100 plants. In the light of these observations the five-fold increase of second brood larvae over first brood was considered as indicative of an exceptionally high survival rate. The change in ratio of borers to empty tunnels from 1:2 in 1956 to almost 2:1 in 1957 would also appear to substantiate this.

The first brood borer population in New Madrid County was about the same as in 1957. The second brood population was only slightly larger than the first brood population.

The excessive rainfall and subsequent flooding interfered with corn planting and may well have affected borer populations. On the one farm checked for third brood borer populations there were 32 percent as many *Lydella grisescens* puparia as live borers. By possible coincidence the Rogers field again had the highest borer count.

#### *Borer Larvae Parasites:*

Over 1200 corn borer larvae were collected in 22 counties and sent to the USDA European Corn Borer Parasite Laboratory at Ankeny, Iowa where they will be examined for parasites. One collection of hyperparasites has been tentatively identified by George T. York as *Eupteromalus sp.*, family pteromalidae.

The parasite determinations for 1956 have been received during the past year. *Lydella grisescens* was the only species recovered. The 1956 samples were all from Southeast Missouri and an average of 13.2 percent of all borers were parasitized.

Puparia of *Lydella grisescens* were found in all extensive fall dissections. The percentage varied from 3 percent in a test in Atchison County to 25 percent in Scott County. The percentage of *Lydella* was not reduced in any of the insecticide treatments used this year.

#### *Experiments with Insecticides for Corn Borers:*

The increase in corn borer populations made it possible to conduct several different insecticide studies during the past summer.

On the Charles Robertson farm near Boonville, two fields of different planting dates were sprayed with 1½ pounds actual DDT in 10.5 gallons of water per acre. The fields showed from 80 to 90 percent of the plants with some leaf damage.

The field planted on May 1 to Pioneer 332, was treated on June 19. This treatment on June 20 had re-

duced the population a month later by only 10 percent, but the population in the entire field was below economic levels. This again demonstrates the fact that larval survival is very poor on young corn and that plant growth must be considered in recommending insecticidal treatment.

Aerial applications of Aldrin and DDT emulsions were made on the Burr Oak Ranch near Tarkio, the first week in July. Yield data indicated no apparent gain from any of the treatments.

This could probably be explained by the variability of the soil and the heavy second brood borer population. While Aldrin gave very poor control according to the summer counts, the fall population in the Aldrin plots was significantly lower than the populations in either the check or DDT treated plots. (*Project 270*)

### Plant and Animal Tolerance To Soil Insecticides

C. W. WINGO, H. E. BROWN

Two of the McCredie Station rotation plots, treated with varying levels of Dieldrin and Heptachlor in 1955, were cropped during the 1957 season to determine plant response to the insecticides remaining in the soil. No appreciable differences in germination, stand or early growth were found. (*Project 283*)

### Grasshopper Control

ROBERT L. SHOTWELL, C. M. SEWELL

#### *History and Habits of Grasshoppers.*

Because of a greatly reduced grasshopper infestation in southwestern Missouri no large scale control experiments could be conducted there in 1957. The infestations were scattered, small in size, and became noticeable at irregular intervals. Tests of the insecticides were limited to single fields where different dosages of the insecticides, aldrin and heptachlor, were used. One additional chemical, malathion, was tried in limited tests.

On the Ash Grove grasshopper control area where extensive spray operations were conducted in 1955 and 1956 two surveys of grasshopper populations were made, one in June and one in late August. The surveys showed what developed on the area the year following two years of intensive effort to eradicate grasshopper infestations from the area.

Grasshopper infestations in the Ash Grove area in 1957 were down at least 80 percent from what they were in 1956. They were scattered, small in size, and developed irregularly throughout the summer.

The two most important species of grasshoppers present in southwestern Missouri in 1957 were *M. mexicanus* and *M. differentialis*. During the first half of the

summer *M. differentialis* was the dominant species. In the latter half *M. mexicanus* became the dominant species as the second generation hatched out and *M. differentialis* adults gradually disappeared. It was impossible to plan a definite schedule of spray tests at Ash Grove because of the scarcity of infestations. Most of the time was spent in making grasshopper collections and surveys to determine what effect the 1956 spray operations may have had on the 1957 infestations.

A total of 416 acres of pasture, alfalfa and field margins were treated with aldrin between June 6 and August 29, 1957, at dosages of 2 to 4 ounces per acre. Good results were obtained with 2 ounces per acre up through July 13 which seems questionable for this later date. On July 13 the maximum temperature was 97° F. After July 13, 3 and 4 ounces per acre was the dosage needed. (Project 286)

### Taxonomy and Biology of Insects Attacking Acorns

JEROME BREZNER, W. R. ENNS

The rearing of the 1956 collection of larvae proved quite successful in 1957. A total of approximately 325 adults were recovered and are being held for identification and host-species relationships. The following species of *Curculio* are represented to date in the collections derived from acorn hosts: *Curculio rectus*; *C. strictus*; *C. longidens*; *C. confusor*; and *C. orthorhynchus*. Two other species not recovered from acorns were also secured, *Curculio caryae* (from hickory nuts) and *C. auriger* (from chestnuts).

No new forms of insects other than *Curculio*, as outlined from last year's report, were obtained.

The major emphasis of this work has been placed on a taxonomic study of the larval forms of *Curculio*. Larvae were dissected and mounted on microscope slides and carefully examined for morphological variations. To aid further in this effort, a trip was taken to the U. S. National Museum, and under the supervision of a larval taxonomist, Dr. William H. Anderson, an effort was made to separate the species of *Curculio*.

The variations in the external structure, however, were extremely minute, and it was impossible to arrive at certain diagnostic characters. Individual variations also complicated the picture to a great extent. It was decided to attempt a separation on the basis of serum proteins in an effort to substantiate small morphological differences as species criteria.

Since the quantity of serum which could be extracted was exceedingly small, routine analytical procedures could not be followed. A relatively new separation technique was employed. This technique is called electrophoresis. The special equipment for this analysis

was furnished by the University Research Council and the Department of Entomology. This phase is incomplete at the present writing. (Project 294)

### The Spotted Alfalfa Aphid

D. C. PETERS, R. D. JACKSON

The alfalfa webworm was a limiting factor to spotted alfalfa aphid increase in Missouri this year because infestations by the former resulted in early cutting of the crop and reduced plant vigor. These factors are not conducive to build-up of the spotted alfalfa aphid.

Heavy rains have apparently been the major climatic factor in limiting aphid population. In southeast Missouri in a field that had over 300 aphids per sweep before a 5-inch rain, the counts were reduced to less than five aphids per sweep a week later.

No sexual forms of the spotted alfalfa aphid were found in the Entomology Department plots at Rollins Field, Columbia, this fall.

Systematic samplings were started on October 28, to determine the relative populations in the hand sown area of the fall planted plots. A 3 x 5 inch card was placed at the base of the plants and the plants were stroked ten times over the card. The number of aphids falling on the card were counted. Three of these samples were taken in each plot on each date.

The highest counts were taken on October 28, and the population diminished from that time forward. The last date on which aphids could be found was December 26. No aphids could be found on the Vernal plots that had received Thimet seed treatment on that date. No aphids were found on January 6 or 11, 1958. Counts on untreated Buffalo and Vernal were about 8 times higher than counts on the untreated Lahontan and Vernal treated seed plots. These observations were made by shaking the plants over a 3 x 5 inch card and counting the aphids on the card. Each observation is the total of 3 counts of aphids on a 3 x 5 inch card.

The preliminary studies seemed to indicate that both Vernal and Buffalo were susceptible to about the same degree to the spotted alfalfa aphid. Seedling Lahontan is resistant to spotted alfalfa aphid under Missouri conditions.

Populations of the spotted alfalfa aphid in Missouri during 1957 have not warranted chemical control, other than on an experimental basis.

Several plots were planted to Thimet treated seed of Vernal alfalfa. The treatment appeared to be very effective throughout build-up and decline of the fall population.

More study is necessary before any definite conclusions can be drawn. Counts of predators were made incidental to the sampling of aphids but they were not of sufficient number to lend themselves to tabular presentation. Some parasites were collected and will be sent to

the U. S. National Museum for identification. (*Project 309*)

## Nematodes of Missouri

LEE JENKINS, G. E. MOORE

A partial survey in Dunklin County, in cooperation with Glen Antle, indicated that garden crops grown on sandy soil were subjected to injury from root knot nematodes: melons, sweet potatoes, tomatoes, okra, cabbage, squash, and peppers.

Peonies in the Independence area were heavily infested with root knot nematodes. They also were found in nursery stock in Louisiana, Mo. The shrubs infested were red leaf barberry and althea.

Methods of rearing the nematode DD136, which is being studied for use in insect control, were explored. In addition to the wax moth, the yellow meal worm, *Tenebrio molitor*, was found to be a promising host.

Work was started in the laboratory on studies of the life cycle and ecology of nematode DD136. A set of permanent slides is being prepared showing the stages of development in the life cycle of this nematode.

### *Nematodes on Cotton*

In 1954 there were 424,456 acres of cotton grown in Missouri. According to soil maps about one-fourth of the cotton-growing area of Missouri is sandy. That means about 106,114 acres of cotton land are sandy and are subject to possible nematode fusarium damage.

Dr. William Sappenfield, who is in charge of cotton breeding in Missouri, estimates that 75 percent of the cotton fields on sandy soil show some damage from the nematode fusarium complex. This would indicate that close to 75,000 acres of cotton have been damaged to some degree by nematodes.

The problem is most important on sandy soil. In some fields the less sandy portions can be located by the appearance of the cotton plants. In most cases the damage from the nematode fusarium complex occurs in irregular spots in the field.

Nematode infestations may reduce the initial stand of cotton and cause successive dying of the plants which often continues on up to harvest time. The amount of damage to areas of infested fields seems to vary somewhat from year to year.

However, there are entire fields on which cotton growing is unprofitable unless the soil is either fumigated or a resistant variety of cotton is planted. In some areas the nematode fusarium complex is so severe that even the most resistant varieties suffer. Mr. Fritz at Bucoda, Mo., planted Auburn 56 cotton on a field that had a severe nematode problem. Nine rows were left untreated as a check and the remainder of the field was treated with Nemagon row treatment at one-half gallon

per acre. There was a noticeable difference between the treated and untreated areas in early September. The roots of plants from both the treated and untreated areas were examined for the presence of root knot nematodes. The plants from the treated area were practically free from root knots while the plants from the untreated area had numerous knots on the roots.

Another field at Bucoda, which is operated by Robert Matthews, was planted to Fox cotton, a variety which is very susceptible to nematode damage. In 1956 the cotton crop on this field was unprofitable due to fusarium wilt. In 1957 Nemagon at one-half gallon per acre was used as a row fumigant applied in the liquid form by means of soil chisels two weeks before planting. Twenty rows were left untreated in this field.

A good crop of cotton seemed assured on the treated area when examined in early September. The untreated 20 rows were so poor that the crop would be produced at a loss on that area.

The cotton in the test area on the Edwards farm at New Madrid was planted on May 10, 1957. The first picking was made October 31. Heavy rains and continued wet weather prevented picking a second time.

All soil treatments except the Nemagon granules and the Thimet granules were made on April 25 and 26. The Thimet granules and the Nemagon granules were applied on the day of planting using an All Chem machine which put down a strip of granules eight inches wide which was mixed with the soil to a depth of four inches.

There was no evidence of phytotoxicity to the seedling cotton from the Nemagon granules.

### *Soybean Cyst Nematode Work*

In early spring of 1957 a field infested with soybean cyst nematodes was selected for experimental work. With the help of Herbert Morgan of the USDA Plant Pest Control Division and Virgil Owens, Assistant State Entomologist, the field was surveyed to determine the degree and uniformity of the infestation.

A total of 3,000 varieties of soybeans were planted for screening to determine possible resistance to soybean cyst nematodes. The remainder of the six-acre field was planted to soybeans in an effort to build up nematode populations for experimental purposes in later years.

Ratings of the Missouri tests were compared with ratings of North Carolina tests. On the basis of these ratings, four varieties were used in making crosses.

The field was reseeded to soybeans the last week in August. These late seeded plants were examined on November 1 for the presence of soybean cyst nematodes. The average level of infestation was heavier on these plants than was the case on the earlier planted beans when they were examined in late August. The nematodes were distributed uniformly over the upper and lower portions of the roots. The infestations on roots of the

earlier planted beans were mostly on the lower portions of the roots. (Project 312)

## Control of Carpenterworms and Borers in Missouri

A. M. RIVAS, W. R. ENNS

### Objective:

*To study the biology, taxonomy, ecology and control of carpenterworms and associated borers and evaluate their importance as enemies of hardwoods in Missouri.*

Sixteen plots near Salem, Missouri are being used in this study. Five of these are located on the Sinkin Experimental Forest owned by the U. S. Forest Service and eleven plots are located on property owned by Pioneer Forest, a privately-owned forest.

Both areas have been used in previous experiments and it was for this reason that they were chosen. Permission was obtained from managers of both areas to make this study.

On the Sinkin area, approximately 1900 trees were examined for the presence of carpenterworms. These trees had been part of a blazing study conducted in 1955, and of which 600 trees had been wounded with an axe, 600 had been wounded with a geologist's pick, 600 were not wounded, and 100 had been reserved should extra trees be needed.

Forty-six trees were thought to contain larvae and many others evidently had contained larvae as shown by the presence of pupal cases on the ground and, in some instances, still in the tree. A total of 89 screens were placed on these 46 trees to catch emerging adults. Records have been kept of the activity of the larvae within the tree as shown by the frass extruded into the cages.

Carpentermoths show a tendency to infest wounded areas on trees and because of this a blazing study was made to determine the wound height and direction most attractive to them. Blazing was conducted on the Sinkin

Forest on previously undamaged trees that showed no visible signs of infestation.

On three plots a total of 52 trees were blazed in cardinal directions at four 4-foot intervals on the bole. For instance, the first blaze would be made on the north side 4 feet above the ground, the second blaze on the west side at 8 feet, the third on the south side at 12 feet and the fourth on the east side at 16 feet. The blazes were made the second week of July, which apparently was too late since no carpenterworm larvae were recovered from them.

A logging operation at the University Forest near Poplar Bluff was surveyed and it was found that no logs had to be left in the woods because of borer injury. At the University Forest mill eleven logs were sawed into 83 boards. Of these, only 37 boards were free of borer damage. Two boards contained so much rot that borer damage could not be determined; the remaining 44 boards had 25 carpenterworm holes and 55 other large unidentified borer holes.

Three other mills have been visited to determine damage attributable to carpenterworms. These sawmills are located in Boone, Callaway and Shannon Counties. Logs going into the mill were checked for species and external evidence of infestation. Boards coming from the head saw were checked for thickness, width, length, total units, units cut, percent units cut, surface measure, board feet, grade, minimum size-cut and comments. The boards were graded twice, first as they actually are, and second as they would be if the borer damage was not present.

A list of the primary wood products processors currently operating in the state has been compiled. The list includes loggers and sawmill operators. These people will be contacted by letter and questionnaire concerning the borer damage they encounter and some will be visited to check this damage. (Project 321)

# Field Crops

E. L. Pinnell, Chairman

## Improvement of Missouri Farm Seeds

E. L. PINNELL, W. E. ASLIN, L. E. CAVANAH,  
F. E. FORSYTHE, CARL HOWARD, VIOLA STANWAY

### *Certified Seed Production and Distribution*

The production of certified seed declined for the second straight year to 16,357 acres, the lowest since 1947. Many crops were planted two to three times before suitable stands were obtained. And the stands that were obtained on many fields were heavily attacked by diseases.

The unfavorable weather continued well into the harvesting period, resulting in many seed producers can-

celling their requests before inspections were performed. Those seed producers who did not cancel their requests for certification found much of their fall harvested seeds germinated too low to be considered certified seed.

Of the 16,357 acres examined for qualities best seen in actual crop growth, 15,836 acres were approved and accepted for certification subject to later seed inspection and detailed tests for purity and germination.

The inspection summary of certified seed in 1957, the value of seed produced and the estimated acreage this seed will plant is as follows:

Seed Stocks	Production
Inbred corn lines:	
Oh 29	10 bu.
Oh 7B	3 bu.
Mo. 5	15 bu.
Single cross corn:	
B10 x C103	92 bu.
Wf9 x Oh7a	95 bu.
Wf9 Tms x Oh7a	109 bu.
Oh29 x Oh7B	12 bu.
C17 x Oh7B	6 bu.
C121E x Mo. 3	28 lbs.
Double cross corn:	
Mo. Pipe	169 bu.
Small grain:	
Wheat, Ponca	322 bu.
Barley, B-475	40 bu.
Spring oats, Mo. 0-205	367 bu.
Soybeans: Strains and varieties	
S2-7158	556 bu.
D51-4888	271 bu.
L9-5139	72 bu.
D53-526	29 bu.
Chief	122 bu.
Sorghum:	
Hybrid grain, RS-610	1800 lbs.
Sudangrass, Lahoma	234 lbs.
Orchardgrass - Potomac - 15 acres to successful stand.	

Detailed purity tests	1091
Examination for noxious weeds	1745
Varietal identification	2309
<i>Experiment Station and Missouri Farmers</i>	
Total samples received	997
Germination tests	951
Detailed purity tests	306
Examination for noxious weeds	406
Identification of plant specimens	47
<i>Tests of all samples</i>	
Germination tests	3229
Detailed purity tests	1397
Examination for noxious weeds	2151
Identification	2356
Total tests	9133

#### Performance of Grain Sorghum in Missouri

##### State Sorghum Variety Test:

The testing of grain sorghum was expanded considerably in 1957, primarily due to the great increase of interest brought about by the development of hybrid varieties. Twenty-three varieties of open-pollinated and open-

Crop	Acres Inspected	Bu., Lbs., Tons, Certified	Value \$	Sufficient to Plant Acres
Barley	2,664	55,392 bu.	138,480.00	27,500
Wheat	4,972	97,780 bu.	352,008.00	48,900
Oats	707	17,567 bu.	24,593.80	8,500
Grasses	743	141,700 lbs.	19,838.00	10,000
Corn	610	*20,000 bu.	170,000.00	125,000
Sorghum	71	*70,000 lbs.	7,000.00	7,000
Sudangrass	14	none		
Legumes	133	*21,000 lbs.	2,940.00	2,000
Soybeans	4,503	*84,000 bu.	294,000.00	110,000
Cotton	1,706	420 T.	73,000.00	20,000
Rice	234	*18,000 bu.	54,000.00	10,000
Total	16,357		6,536,359.00	368,900

\* Estimated figures.

In addition to the certified seed production, seed stocks were produced on contracted acres for further increase and distribution to certified seed growers located over the state for the ultimate benefit of all farmers of the state.

#### Seed Testing Laboratory

Seeds were tested by the seed testing laboratory in all four of its functional parts, (1) research in the breeding of superior plants carried on by the Experiment Station, (2) multiplication and distribution of the seed of the superior plants carried on by the Missouri Seed Improvement Association, (3) student classes in seed analysis for those who are further interested in seed technology, and (4) testing seeds for farmers, County Extension Agents, Vocational Agriculture teachers, and others who teach or demonstrate the great value of improved seed in progressive farming.

The breakdown of the annual work is as follows:

##### Missouri Seed Improvement Association

Total samples received	2309
Germination tests	2278

pedigreed and closed-pedigreed (commercial) hybrids were included in the state tests at Columbia, Trenton, Pierce City, and Sikeston.

Birds caused heavy damage at Pierce City and complete destruction at Sikeston. Yield data were only obtained from the Columbia and Trenton tests. Yields were good at these two locations with little or no lodging observed. The RS hybrids outyielded the standard varieties by 29 percent. The commercial hybrids outyielded the standard varieties or hybrids by 17 to 27 percent. None of the standard varieties or hybrids were sufficiently dry at harvest for safe storage.

##### Regional Sorghum Variety and Strain Test:

Twenty-six strains of sorghum were tested at Columbia in a cooperative program with the states in the sorghum and corn belts. Of particular interest were the

improvements in the hybrids over the older RS hybrids. One group of hybrid strains outyielded the standard varieties by 43 percent. Plant type was also more desirable, being more uniform in height, more open type head and a drier head similar to the Martin variety.

#### *Regional Observation Sorghum Nursery:*

In addition to state and regional tests, an additional 50 strains were included in an observation nursery. These strains were observed for their plant characteristics and relative yield potential. Of this group, a greater number had drier heads than the earlier developed strains.

#### *Grain Sorghum vs. Corn*

Two varieties of sorghum were compared with two varieties of corn as to their comparative yield when planted later than the normal time for planting corn, May 24. The high yielding RS hybrid sorghum yielded favorably with the two hybrid corn varieties. The standard variety of sorghum yielded 25 percent less.

This preliminary study indicates the hybrid sorghums will yield favorably with hybrid corn when planted during environmental conditions favorable for sorghum.

#### *Dates, Row Widths and Plant Spacing of Grain Sorghum*

Four different dates of planting, three different widths of rows and two different plant spacings within the row was observed in this experiment. Although bird damage prevented accurate results from being taken, some useful preliminary results were obtained.

Yields were increased when row widths were reduced from standard corn row widths, however, the yield difference may not be sufficient to offset the added cost of changing farm machinery. With adequate moisture the results indicated a spacing of six inches within the row yielded slightly more than a twelve inch spacing. The results of the dates of planting could not be accurately evaluated because of the heavier bird damage on the earlier plantings. (*Project 19*)

### **Mechanism of Heredity in Corn**

M. G. NUFFER, E. H. COE, JR., T. YABONO,  
K. S. HSU, G. C. SUD

#### *Objectives:*

A. To study the mechanism by which some genes control the mutation frequency of others and how these genetic mutations can be put to practical use.

B. To analyze further the structure of the gene by studying selected gene loci.

C. To develop techniques for the study of the mechanism by which genes control biochemical processes.

D. To determine whether X-rays can cause desirable heritable changes which are not changes of the gene itself.

E. Study new genes and genetic phenomena.

#### *Genetic control of gene mutation*

Experiments during the last year revealed some new facts that should be useful in determining the mechanism

by which certain mutator factors (*Dt, Ac, M, Id, etc.*) can increase or lower the rate of mutation at certain specific gene loci. It is now clear that the solution is of vital importance, because it is now known that mutator factors of this kind are very important in producing the types of genetic variability that are fundamental to evolutionary change and to selective improvement by plant breeders. A clear demonstration of this latter point has been made by the fact that we were able to produce, through the use of the *Ac-Ds* system, several mutants which show promise of having a high-amylose phenotype, which is highly desired by the plant breeders.

Another aspect of this problem is the study of the mutable loci that respond to these mutator systems in order to obtain information leading to the understanding of the nature of the gene. An extensive trial has been conducted during the last two years to determine the effect of crossing over a three closely linked genes, two of which are subject to the action of these mutator factors. The results of this experiment are not yet complete but they clearly indicate that there are certain limitations as to the size of unit that the mutator factor can affect. In addition a search is being made for the purpose of locating new mutator systems. Experiments were designed and carried out to determine the exact location on the elements of the systems already known. The analysis of these mutator systems will receive the major emphasis during the coming year.

#### *Analysis of gene structure at selected loci.*

A continuation of the detailed analysis of selected loci, that are well-suited for determining the structure of the gene, has been carried out during this year.

The *C* locus on chromosome 9 which has given every indication of being of a compound nature, has been subjected to an exhaustive test for the purpose of separating it, by crossing over, into two possible components. It is now possible to state that if the *C* locus is compound, the distance between the two units must be less than 0.079 units, since no cross-overs were obtained among 308,825 gametes.

More rapid progress in experiments using a cross-over analysis seems to be possible in the future because of the discovery during the last year that the frequency of crossing over can be more than doubled through the use of the chelating compound, ethylene dinitrilo tetracetic acid. This compound called EDTA has been quite successful in increasing crossing over in other organisms, but has given negative results in corn. It was found that through special techniques, positive results could be obtained.

A study of heterozygotes for three closely linked markers (two of which were mutable) shows that induction of mutability at a given locus sometimes affects the frequency of crossing over.

#### *Mechanism of genetic control of biochemical processes.*

Successful culture of intensely pigmented aleurone tissue has been accomplished. The materials and techniques used are the same as those used in other laboratories for the culture of the corn endosperm. The medium used is the standard basal one with tomato juice added. Strong pigment production was obtained by using a purple sugary line recessive for the aleurone color intensifier, *in*, instead of the previously used purple sugary line, Black Mexican sweet corn. Successful cultures were obtained only with endosperm excised at 10 or 11 days post-pollination.

#### *The effects of X-rays and ultraviolet radiation on gene mutation.*

A test of a large progeny from X-ray treatment of a highly uniform (doubled haploid) line was conducted to determine whether desirable types could be produced. In the  $X_1$  grown in the field many types of mutants were observed including chlorophyll, narrow leafed, semi-sterility, and dwarf types, but all proved to be deleterious. Among 5205 plants grown from seed where the pollen had been treated with X-rays, not a single more vigorous or more desirable phenotype was found. It should be mentioned, however, that the choice of a desirable phenotype is purely an arbitrary one. Self progeny from many of these plants were planted in a sand bench in the greenhouse and examined as seedlings for segregation of mutant types. Again many chlorophyll, narrow leaf, dwarf and defective types were found but no more vigorous or more desirable mutants were seen.

#### *Study of new genes and genetic phenomena.*

Nearly 3 percent paternal haploids are induced in certain egg parents by the pollen of a genetic inbred now under study. It is possible that this inbred can be used as a haploid induced when it is converted to a convenient genetic type.

It has been found that gibberellic acid is highly effective in producing normal pollen shedding in otherwise genetically male-sterile plants. Gibberellic acid will probably be a useful tool in overcoming sterility in certain inbred lines.

A new recessive colorless aleurone mutant has been found and tentatively designed  $c_2$ . (Project 48)

### **Improvement of the Missouri Soybean Crop**

CARL HAYWARD, ARNOLD L. MATSON, L. F. WILLIAMS

#### *Objectives:*

A. To secure data for release to growers through the Extension Service on the performance of new strains and varieties of soybeans in various parts of the state.

B. To develop soybean varieties with good economic characteristics and resistance to disease.

C. To secure information on the effects of certain production practices (date of planting, rate of planting, irrigation) on the performance of various soybean varieties.

D. To secure information regarding certain basic problems in soybean breeding such as methods of breeding and selection, inheritance of various character and linkage relations.

Variety tests were planted at 14 locations in Missouri. Five of these were abandoned due to drouth, hail, and flood. The strain L9-5139, which was increased at Columbia from 15 pounds to 75 bushels continued to perform well. It is slightly better than Lincoln in yield and seed quality and much better in resistance to shattering.

In southeastern tests, S2-7158 gave an outstanding performance. S2-7158 is similar to Perry in maturity but yielded as well as the latest varieties. This strain is resistant to bacterial pustule and wildfire diseases. This was increased from 24 to 570 bushels and will be named and released to growers in 1958.

Two other bacterial pustule resistant strains performed well in southeast Missouri. D53-526 is of Dorman maturity and have yielded better than Dorman in all tests. This was increased to 30 bushels and will be released in 1959. D51-4888 is a yellow seeded strain of Ogden maturity and was increased to 270 bushels. With these three new varieties there will be available, yellow seeded soybean varieties with resistance to bacterial pustule and wildfire in the entire maturity range now grown in southeast Missouri.

Uniform regional tests were grown at seven locations in Missouri. Groups II and III were grown at Kirksville, III and IV at Columbia, and IV, V, and VI at four locations in southeast Missouri. Data from these tests are summarized in "Results of Cooperative Uniform Soybean Tests 1957."

Major testing fields for new strains were at Kirksville, Columbia, Sikeston, Malden, Bragg City, Bell City and Vinson. Due to the risk of crop failure, a system has been adopted of testing new strains by planting one replication on each of the five fields in southeast Missouri. (Project 49)

### **Breeding Hybrid Corn for Missouri**

CARL HAYWARD, O. V. SINGLETON, PHIL SMITH  
MARVIN WHITEHEAD, VIRGIL FERGUSON,  
C. O. GROGAN, M. S. ZUBER, W. A. CRANE

#### *Objectives:*

A. Increase efficiency of corn production through breeding better adapted hybrids for Missouri.

B. Study the effect of weather, cultural practices, and nutrition on the growth, development and quality of corn.

C. Control of diseases by breeding resistance to the major organisms attacking corn.

D. Develop and increase seed stock of productive new hybrids.

E. Develop new hybrids for special purposes.

F. Determine performance records for new popcorn hybrids.

G. Measure yield and quality of promising new sweet-corn hybrids suitable for canning purposes.

*Effect of Weather, Cultural Practices, and Nutrition on the Growth, Development, and Quality of Corn:*

Results of the date of planting studies were similar to those of previous years with few exceptions. At Sikeston, where the season is considerably longer than at Columbia and where the moisture was more than adequate in 1957, the average yield of all hybrids was about the same for the April 1 and June 1 dates, and the April 20 and June 20 dates.

Stalk lodging, ear height, corn borer larvae and tunnels, and earworm penetration generally increased as the dates were delayed. The time required from planting to tasseling and silking decreased by nearly 4 weeks between the April 1 planting and the June 20 planting. The test at Columbia showed a decrease in yield of approximately 10 bushels per acre for each month in delay in planting (April 19, May 22, and June 20) with the early hybrids producing a higher yield than the late hybrids for the last date of planting. The pattern of the other data collected was nearly identical with that at Sikeston.

The rate of planting (8,000, 12,000 and 16,000) studies conducted at Huntsdale, Pierce City, and Sikeston gave slightly different results in some respects. The 12,000 plant population gave the highest yield at Huntsdale and Pierce City but it was only slightly below the 16,000 plant population at Sikeston.

Stalk lodging sharply increased at the 16,000 plant population. The number of ears per plant decreased as populations increased with the most noticeable change from the 8,000 to the 12,000 plant population. There was some evidence of barrenness of a few of the single ear hybrids at high planting rates even at Sikeston where rainfall was abundant throughout the growing season.

Prolific hybrids were better able to make adjustments to varying plant populations than single ear hybrids. Dixie 33 was found to be capable of withstanding higher plant populations better than the other prolific hybrids. AES 904W has continued to be the most prolific of all the hybrids tested.

The test of various single, double, and top crosses on 4 levels of nitrogen (0, 60, 120, 240) at McCredie indicated that as the nitrogen levels were increased, stalk lodging increased by approximately 10 percent for each level of increase of nitrogen.

There was not an appreciable difference in yield between the 60 and 120 pound applications but these applications were better than either the none or 240 pound

applications, especially the 240. Moisture, ear height, days from planting to tasseling and silking, and shelling did not vary much with nitrogen levels in 1957.

*Control of Corn Diseases:*

The *Diplodia zeae* organism spreads more rapidly in a susceptible host when introduced 20 days after anthesis than when introduced at the time of anthesis. Corn stalks are essentially immuned to the organism until after tasseling and silking but they lost the resistance at varying rates, differing in the resistance or susceptibility pattern of the host.

*Diplodia zeae* isolate from different geographical localities vary in reaction in a given environment. In Minnesota, the Minnesota isolate was more virulent than either the Oklahoma or Missouri isolate. In Missouri with the same single crosses under test, the Minnesota isolate was the least virulent. Single crosses differ in reaction to isolates.

Stalk lodging has been found to be correlated negatively at the 1 percent level with rind thickness, crushing strength, and weight of a two-inch section from the middle of the second internode of the stalk. The weight of the two-inch section was not as highly correlated as rind thickness and crushing strength.

The combination of insecticides and fungicides in treating seed reduces the harmful effect when using insecticides alone in pre-planting treating of seed. The use of a sticker increases the effectiveness of the seed treatment. (Project 85)

### Testing and Breeding of Winter Barley Varieties and Strains

J. M. POEHLMAN, CARL HAYWARD,  
CHARLES HAYWARD, NORMAN BROWN, D. T. SECHLER  
*Objective:*

*To breed winter barley for higher yield, winterhardiness, stiffer straw, and disease resistance.*

B-475, a new variety of winter barley distributed by the Experiment Station in 1955, continues to gain in favor with Missouri farmers. It is replacing much of the acreage previously planted to Mo. B-400. The advantages of B-475 over B-400 are higher yield, better threshing qualities and higher test weight.

It is estimated that the two Missouri varieties B-400 and B-475 were planted on over 90 percent of the 359,000 acres of barley harvested for grain in Missouri in 1957. In addition a large acreage is grown for pasture and silage.

Progress is being made in improvement of B-400 and B-475 varieties. Several crosses have been made that offer promise and groups of experimental lines from these crosses are being grown.

Yield tests were conducted at Columbia, Bethany,

Pierce City and Sikeston. A total of 136 varieties and strains were tested. The highest yielding strain tested at the four locations was B1043, from the cross B-475 x B700. B1043 yielded 64.7 bushels as compared to 60.3 bushels for B-475, and 57.3 bushels for B-400.

The test weight of B1043 was 45.5 pounds bushels as compared with 43.0 pounds for B-475, and 41.2 pounds for B-400. B1043 is more winter hardy than either B-475 or B-400 and is resistant to loose smut. The second and third highest yielding strains were from the cross Harbine x B-400.

B969, a winter hardy selection from a Korean introduction (C.I. 7407-3) which was reported in 1956 as being outstanding in winterhardiness, ranked 6th in yield in 1957. The superior winterhardiness of this strain may make possible the development of varieties for north Missouri, either by growing the strain directly or by its use as a parent in crosses.

A total of 238 experimental strains were grown in increase rows, and 1862 strains in head rows in 1957. Bulk hybrids of 30 crosses were advanced one generation.

Special nurseries grown in 1956 included: uniform winter barley yield nursery, 28 entries; uniform winterhardiness nursery, 40 entries; and new entries from U.S.D.A. world collection, 250 entries.

Lines from the cross B-475 x C. I. 4966 were advanced one generation and tested for resistance to loose smut. The purpose of this cross is to add the gene for smut (*U. nuda*) resistance from C. I. 4966 to B-475. C. I. 4966 has been resistant to all collections of loose smut to which it has been inoculated. (Project 90)

### A Study of the Diseases of Field Crops of Missouri

MARVIN D. WHITEHEAD

#### Diseases:

<i>Losses From Corn Diseases in 1957:</i>	<i>% yield reduction</i>
Leaf blights—	3.0
Stalk rots—	10.0
Ear rots—	3.0
Seedling rots—	<u>2.0</u>
Disease loss	18.0

An 18 percent loss to disease of an estimated crop of 137,320,000 bushels equals a loss of 30,143,414 bushels or \$34,664,936 at \$1.15 per bushel.

Damage from corn stalk borers was severe during the 1957 season. In a high percentage of the entries into stalks by corn borers an infection on *Diplodia zae* was introduced. This phenomenon made for high incidence of *Diplodia* stalk rot. The dry period as the plants neared maturity prevented heavy losses from lodging on the portion of the crop harvested early in the season but with

late fall rains, lodging became extensive in unharvested fields.

*Diplodia* inoculated and uninoculated check plantings showed yield losses from *Diplodia* stalk rot. Greater reduction is obtained when the organism makes entry 20 days after pollination as compared to 5 and 10 days after pollination. In disease nurseries the common practice has been to inoculate at approximately five days after pollination when that is really about the minimum age that a corn plant is susceptible.

In a cooperative *Diplodia* isolate study with Minnesota and Oklahoma again a direct correlation existed between isolate origin and degrees of pathogenicity. The Missouri isolate was the most virulent in Missouri and the Minnesota isolate was most virulent in Minnesota.

In a stalk rot-ear rot inheritance study it was found that certain lines susceptible to stalk rot showed a greater resistance to ear rot and those resistant to stalk rot were susceptible to ear rot.

In preliminary studies of the reaction of a group of corn single cross progenies to inoculation with charcoal rot, *Botryodiplodia phaseoli*, indications were obtained that if ratings were made one month after inoculation good differences between corn lines could be made.

The wet weather conditions of early spring forced late plantings of a large acreage of corn, especially in the Mississippi Delta area. Helminthosporium leaf blights, *Helminthosporium turcicum* and *H. maydis*, were very severe on this late planted corn inciting yield losses of 10-75 percent.

Transfer of Helminthosporium leaf blight resistance to corn lines is a lengthy process. An excellent epiphytotic of northern and southern corn leaf blights developed in the Huntsdale nursery, spreading from an inoculated series.

Readings indicated that some of the Missouri lines carry high resistance. Material brought back from South Africa by Dr. Clarence Grogan has a high percentage of good resistance. (Project 127)

### Control of Weeds

O. HALE FLETCHALL, CARL HAYWARD, E. J. PETERS  
H. D. KEN, F. S. DAVIS

#### Objectives:

A. Evaluate the selective effects of chemicals on individual weed species and their effects upon desirable forage.

B. To test new and standard herbicides as pre-emergence treatments, post-emergence treatments, and directed sprays under varying conditions of the crops, weather, and soil

C. To compare various combinations of chemical and cultural weed control practices from the standpoint of efficient crop production.

D. To compare new chemicals and possible new techniques for defoliating cotton.

ATA, MH, TBA and dalapon significantly reduced the number of garlic plants. Repeat treatments were about equal to single treatments. TBA was superior to other chemicals for reducing the number of plants in the garlic stand.

Two treatments, a year apart, were effective in reducing the number of ironweed stems to about 15 percent of the original stand. Sodium salt of 2, 3, 6 trichlorobenzoic acid was about as effective an amine and ester formulations of 2,4-D.

CDAAs at 4 pounds and EPTC at 5 and 10 pounds per acre gave good control of early broad-leaved weeds and grasses when applied as pre-emergence sprays to common and sericea lespedeza. Early post-emergence treatments to alfalfa with neburon at 1 and 2 pounds per acre resulted in excellent control of smartweeds.

Weedy grass control was excellent at the 2 pound rate but not quite as good at the 1 pound rate. Both rates of neburon eliminated birdsfoot trefoil seedlings. EPTC at 5, 10 and 15 pounds applied as an early post-emergence spray controlled crabgrass well but failed to control emerged smartweeds.

No injury was noted to lespedeza, trefoil and alfalfa from all rates of EPTC. Alfalfa yields were increased by all applications of neburon and EPTC, but some injury may have occurred from 2 pounds of neburon as this treatment yielded slightly less alfalfa in the first cutting than neburon at 1 pound. Stand points indicate that the alfalfa was not injured by any of the treatments. (*Project 156*)

#### Better Cotton Varieties for Southeast Missouri

WM. SAPPENFIELD, L. E. TRUCE, J. O. FOSTER,  
NORMAN BROWN, AND M. D. WHITEHEAD

Rex, a variety, developed in Arkansas, produced superior yields. Mo. 17-50, a new strain developed at the Southeast Missouri Research Center, was outstanding among new strains tested.

*Effect of some fungicides on seedling diseases of cotton in the irrigated desert valleys of southern California:*

In 1954 PCNB, used as a spray treatment in the row at planting time, increased the percentages of emergence and survival of cotton plants in a field test in which the treated rows had previously been infested with an oat culture of *Rhizoctonia solani*. Nabam increased emergence, but the total survival of plants recorded 1 month after planting was not statistically different from the check. In 1956 soil was infested with both *R. solani* and *Pythium* sp., but only *R. solani* appeared to be pathogenic in this test. Each of the row treatments, PCNB, PCNB plus captan, PCNB plus zineb, PCNB plus Ceresan 200, and zineb (nabam reacted with zinc sulfate), induced a higher percentage of emergence and survival of plants than no treatment.

The results due to treatments did not differ statistically from each other. Several complicating factors involved in field testing in southern California should be considered in evaluating fungicidal row treatments on a practical scale.

These are: erratic incidence of disease, poor physical condition of the seed bed, high salt concentration in some soils, and crusting of soil over seed. Differences due to fungicides in some field tests were obscured because of variation which could be attributed to environmental factors. (*Project 160*)

#### Breeding and Evaluating New Strains of Soft Wheat

CARL HAYWARD, CHARLES HAYWARD, J. M.  
POEHLMAN, D. T. SECHLER, NORMAN BROWN

##### *Objectives:*

*To breed new strains of soft wheat with resistance to loose smut, leaf rust, and Hessian fly.*

Knox and Vermillion have become leading varieties of soft wheat in Missouri. Vermillion was first grown by farmers in quantity in 1957. Both varieties are early, short, leaf-rust resistant, high in yield, and have excellent soft wheat quality.

They tend to be susceptible to certain races of loose smut. Dual was added to the recommended list of varieties in Missouri for use as a pasture or silage variety. Dual is resistant to the Hessian fly but susceptible to certain races of loose smut.

##### *Progress in Breeding*

Progress has been made in combining resistance to loose smut and the Hessian fly into a high yielding, stiff-strawed variety. The most promising strain tested in 1957 came from the cross Pawnee x (Trumbull-W38-Fultz-Hungarian).

An unusually promising group of selections from the cross (Kawvale-Marquillo-Clarkan) x C. I. 12,750 were included in yield tests for the first time in 1957. (C.I. 12750 is a sister selection to Dual.) A selection from this group yielded 50 bushels, the highest yield recorded at Columbia. This selection is also resistant to loose smut, Hessian fly, and leaf rust, but tends to be taller than desirable.

##### *Disease nurseries*

Artificial inoculations were made with leaf rust to establish a leaf rust epiphytotic throughout the nursery at Columbia. Heavy mildew developed from natural infection and observations were made on mildew resistance.

##### *Hessian fly nursery*

A Hessian fly nursery was grown at Columbia, in cooperation with Elmer T. Jones, Entomology Research Branch, Manhattan, Kan. Duplicate plantings were made in this nursery of all strains with potential fly resistance, as well as entries from Kansas and Nebraska Agricul-

tural Experiment Stations. Due to the dry soil conditions at time of planting, the seed did not germinate early enough for seedling plants to emerge in time for heavy fly infestations. The Missouri strains are being tested by Mr. Jones in the greenhouse at Manhattan.

#### *Wheat Quality Studies*

Leading wheat varieties and experimental strains are evaluated for quality by the Department of Home Economics, University of Missouri, and by the Soft Wheat Quality Laboratory, Wooster, Ohio. Seed harvested from drill plots of 10 varieties was saved and milled by the Scott County Milling Company. Baking tests will be run by the Department of Home Economics. Fifty samples from nursery plots were sent to the Soft Wheat Quality Laboratory for preliminary evaluation of quality. (*Project 202*)

### Breeding and Testing New Oat Strains For Missouri

CARL HAYWARD, CHARLES HAYWARD,  
J. M. POEHLMAN, D. T. SECHLER

#### *Objectives:*

*To breed an improved early variety of oats with stiff straw, good seed quality, and resistance to the prevailing races of crown rust, stem rust, and smut.*

#### *Spring Oats*

*Present varieties*—Mo. O-205 and Andrew are currently recommended in Missouri. Mo. O-205 has been the leading variety in Missouri from the standpoint of yield, test weight, and adaptation. In 1957 a new race of crown rust, race 216, was widespread in Missouri for the first time. This race infects varieties with crown rust resistance derived from Victoria.

Although O-205 derived its rust resistance from Victoria it does not carry the V gene for resistance, possessing instead a moderate type of resistance. However, crown rust was more severe on O-205 than had ever been observed and yields of O-205 declined.

Burnett, which produced excellent yields in 1956, was generally unsatisfactory in 1957. Newton produced good yields in both 1956 and 1957, but it is later in maturity than generally desired. Minhafer, a new variety from Minnesota, was the outstanding variety tested in 1957.

Minhafer has the ABC genes for stem rust resistance and the Landhafer gene for crown rust resistance. This variety is now recommended for Missouri and some certified seed will be produced in Missouri in 1958.

A small increase of 04346, Columbia x Marion (CI6625), was made in 1957. It will be increased further in 1958, with distribution to certified growers planned for 1959. Yields of 04346, which has been tested for a ten year period, were slightly below those of O-205 until race

216 of crown rust became prevalent. It appears to be damaged less by this race, a circumstance that makes it desirable now that 04346 has been increased and distributed.

The 04346 has a light colored grain and higher test weight than O-205. It has the A gene for stem rust resistance (the same gene present in O-205 and Andrew), resistance to smut, and is similar to O-205 in maturity and straw stiffness. It is well adapted in Missouri but does not appear to have the wide regional adaptation found in O-205.

An outstanding strain for lodging resistance and seed quality, is 04635, (Columbia-Marion) x { (Victoria x Hajira-Banner) x (victory x Hajira-Ajax) } (CI7272). It compares favorably with O-205 in yield, has moderate resistance to crown rust, the ABC genes for stem rust resistance, and resistance to smut.

It was entered in the uniform red oat nursery and the North Central Nursery in 1957. About one bushel of seed was produced in 1957 and this will be planted in 1958 for possible increase as a new variety.

#### *Winter oats:*

Increased emphasis is being given to winter oats. The uniform winter oats yield nurseries were grown at Pierce City and Sikeston. Elite selections from hardy x hardy oat crosses were harvested and will be grown in a uniform yield test in 1958 in seven states. A new group of 57 crosses were grown at Columbia. (*Project 203*)

### Use of Water in Producing Crops

PHIL SMITH, E. L. PINNELL

#### *Objectives:*

*A. To learn the effect of irrigation on yield and quality of corn and cotton grown under different levels of fertilization.*

*B. To learn the effect of irrigation on yield and quality of pasture for beef cattle.*

*C. To learn the effect of irrigation on yield and quality of forage crops.*

Moisture conditions at McCredie, while quite typical, were somewhat unfavorable. Repeated light rain showers and storms during May and June resulted in such wet soil conditions that it was impossible to plant corn until the middle of June. This rainy period was climaxed with a 5 inch storm on June 29 and 30. July then had subnormal rainfall and August was quite dry.

Grasses generally respond well to nitrogen fertilization under irrigation. Third cutting yields of grasses with irrigation and ample nitrogen were better than for legumes and legume-grass mixtures. The best yields for high nitrogen under irrigation were for canary grass and timothy. Responses to nitrogen on grasses without water were small and inconsistent. (*Project 204*)

## The Improvement of Pastures with Legumes

CARL HAYWARD, E. MARION BROWN

### *Objective:*

*To determine which legumes to use with established stands or new seedings of adapted grasses for profitable pasture production.*

During this, the fifth successive dry year at Columbia (Subsoil dried by previous drouth and rain April 1 to September 30, 6.4 inches below normal), ladino, killed by the 1956 drouth and reseeded during March in the orchardgrass-ladino pastures, came up to a good stand but died during August.

Drouth also killed most of the lespedeza in the bluegrass-lespedeza pastures before it produced seed, but the stand of birdsfoot trefoil increased in the timothy-bluegrass-trefoil pastures.

Steers gained 216 pounds an acre and 1.4 pounds per steer per day on the timothy-bluegrass-birdsfoot trefoil pastures; 165 and 1.2 on the orchardgrass pastures which contained no ladino; and 85 and 2.0 from July 19 to September 12 on the timothy-bluegrass-birdsfoot trefoil pasture from which 1.7 tons hay an acre had been harvested May 27.

At Lathrop, where the subsoil also was dry at the beginning of the growing season and where rain April 1 to September 30 was 2.8 inches below normal, spring-sown ladino was reestablished in the orchardgrass pastures and in two of the three bluegrass pastures reseeded, but not in the bromegrass pastures.

Although the seedling ladino survived dry weather in July and August, it made too little growth to contribute to steer gains made on any of the grass-ladino pastures. Steers gained 246 pounds an acre and 2.0 pounds per steer per day on the orchardgrass-ladino pastures; 226 and 1.6 on the timothy-bluegrass-birdsfoot trefoil pastures; 142 and 1.6 on the bluegrass-ladino pastures; 350 and 1.9 on the bluegrass pasture fertilized annually with 200 pounds ammonium nitrate an acre; 215 and 1.8 on the bluegrass-lespedeza pasture in which lespedeza has volunteered each year since 1945; and 261 and 1.8 on the bromegrass-ladino pasture in which a September reseedling of ladino appeared to have reestablished the clover by October.

At Sikeston, where 43 inches of rain fell from April 1 to September 30, steers gained 246 pounds an acre and 1.7 pounds per steer per day on the bromegrass-birdsfoot trefoil pasture which was grazed continuously from April 10 to September 24; 115 and 2.6 on the bromegrass-birdsfoot trefoil pasture from which 2.4 tons hay an acre was harvested May 27, and which was pastured by steers taken from the orchardgrass-ladino pasture July 10 to 30 and August 27 to September 10; 349 and 2.2 on the

orchardgrass-ladino pasture; and 398 and 2.0 on the orchardgrass-alfalfa pasture.

At Pierce City, where excessive rainfall during April, May, and June was followed by severe drouth during July and August, spring-sown ladino failed to survive in either the tall fescue or the orchardgrass pastures. The 1956 drouth had killed all ladino in both pastures.

Drouth, during which only 0.09 inch rain fell July 3 to August 16, also killed most of the lespedeza in the orchardgrass-lespedeza pasture and in the wheat-lespedeza pasture, and defoliated but did not kill the birdsfoot trefoil in the tall fescue-trefoil pasture.

Purebred Hereford heifers, which had been wintered too well to make high gains on pasture, gained 131 pounds an acre and 0.9 pound per heifer per day on the tall fescue-ladino pasture; 115 and 1.1 on the orchardgrass-lespedeza pasture; 87 and 0.9 on the orchardgrass-ladino pasture; 110 and 0.9 on the wheat-lespedeza pasture; and 82 and 0.9 on the tall fescue-birdsfoot trefoil pasture.

Although ladino clover has been grown successfully on the better soils in the Missouri Ozarks, its use cannot be recommended on soil as rocky as that on which the Pierce City pastures are located. (*Project 213*)

## Testing Species and Varieties of Grasses and Legumes

J. D. BALDRIDGE, E. MARION BROWN

### *Objective:*

*To compare new species and varieties of forage grasses and legumes made available by plant introduction and by plant breeding with species and varieties now in use to determine their value for pasture in different climatic regions and on different soils in Missouri.*

Grass variety tests were harvested only at Sikeston. Of the orchardgrass varieties tested (P-2453, Akaroa, Iowa-1, Iowa-6 Trogdon, Potomac, S-143, Palestine, Pa. Med. Syn., Pa. Late Syn., Utah Syn., and Cornell Syn. 2 F), no variety produced substantially more herbage than commercial ones. Six varieties produced at least one-half ton less dry herbage an acre than commercial orchardgrass.

Varieties of bromegrass tested were Achenbach, Lancaster, Minn. Syn. B., Wis. 55, Wis. 63, Southland, Manchar and Saratoga. Southland outyielded Achenbach, the check, by one-third ton dry herbage an acre. No other variety yielded as much as Achenbach.

The varieties of sudangrass tested were: Stoneville Syn. 1, Stoneville Sel., Sweet, Sweet 372, Sweet 372-S-1, Piper, Georgia 337, Greenleaf, and Lahoma.

Piper and Greenleaf each produced 0.4 and 0.36 ton more dry herbage an acre than commercial. These two varieties also were more disease resistant than commercial, Sweet, and Sweet selections. Stoneville Syn. 1, which equaled commercial sudan in yield, was the most disease

resistant variety. (Project 220)

## Breeding and Developing Superior Strains Of Birdsfoot Trefoil and Annual Lespedeza

J. D. BALDRIDGE

### Objectives:

A. To develop varieties of trefoil superior to present varieties in disease resistance, seed production, and other agronomic qualities.

B. To develop more aggressive and more productive varieties of lespedeza, and to evaluate strains of perennial lespedeza.

### Birdsfoot trefoil:

Variety trials showed little difference in forage yield between strains of European type. A Missouri selection was superior while Viking was inferior to others in seed production. Empire was low in forage yield because of poor stand.

New seedlings of varieties were aided in establishment by the use of dalapon herbicide for weedy grass control. Empire was injured less by the chemical than other varieties.

An Iowa strain bred for seed-holding qualities shattered badly in late July and August.

Foreign introductions were not superior to domestic strains in forage production.

The development of new strains has been hampered greatly by chronic drouth and, recently, by epidemics of disease. Irrigation and new disease-resistant plant stocks are needed to solve these problems.

In a two-year-old clonal test, Empire selections suffered a 74 percent reduction, while European selections suffered a 35 percent reduction in stand. In a two-year-old progeny test, Empire selections suffered 20 to 90 percent reductions, while the European check suffered a 10 percent reduction. Phoma blight and crown-and-root rot appeared to be responsible for much of the loss.

Root diseases have been so serious that pathological studies have been initiated to identify the organisms involved, and to develop techniques for breeding and for resistance. Preliminary work indicated that *Fusarium* and *Leptodiscus* may be important root pathogens.

Healthy survivors were selected in disease infested nurseries to start a new breeding program aimed at building disease resistance in the crop. Until this is accomplished, it will be difficult to breed for other desirable agronomic qualities.

A comparison of young plant behavior with adult plant behavior indicated that the performance of young plants in the first season was of limited value for predicting the performance of those same plants in the succeeding year.

European develops to the blooming stage more rapidly than Empire. The blooming of the two can be

synchronized for cross pollination; e.g. if European is cut back about May 15, the two will bloom together in June.

If both are cut back, Empire should be cut back from 5 to 15 days earlier depending on environmental conditions. Ordinarily European seedlings or cuttings should be transplanted a few days ahead of Empire. If special strains of each are used, then adjustments must be made in accordance with the blooming characteristics of each strain.

The average self-fertility of 40 European clones was 0.06 seeds produced per selfed floret. The most self-fertile clone produced 0.65 seeds per floret (open pollinated checks produced 5.90 seeds per floret). Scratching the stigma with a toothpick produced 0.09 seeds, while rolling the florets between thumb and forefinger produced 0.02 seeds per selfed floret. With cross pollination, Empire produced 11.7 seeds while Viking produced 5.2 seeds per pollinated floret.

In a study of cutting frequency, Empire seedlings withstood severe defoliation better than those of European, and both withstood it better than Vernal or Buffalo alfalfa.

Temperatures of  $-8^{\circ}$  F killed small seedlings of Empire and several strains of European type. Experience has shown that trefoil seedlings must attain considerable size to survive winter heaving and freezing conditions.

A breeding nursery at Sikeston was completely killed by surface flooding for three days or more during heavy spring rains.

### Lespedeza:

Thirteen strains and varieties of annual lespedeza were compared and certain experimental strains, mostly selections from a cross of one early with one late maturing strain, were superior in yield. Tar spot leaf disease was serious and reduced the yield of susceptible strains and varieties.

Previous tests have shown early maturing Iowa 6, medium maturing Rowan, and late maturing Climax to be superior to Standard Korean (in one or more respects) in their given maturity classes. Climax has been recommended for southeastern Missouri, where about 50,000 pounds of seed is being grown for certification.

Breeders' seed of Climax and F.C. 31057-5 was produced to continue the supply of seed for testing. Bacterial wilt has been the most serious disease of Korean over a period of years; but tar spot is increasing in severity.

Continued efforts to improve lespedeza should include breeding for resistance to these diseases as well as wider use of hybridization and other methods of inducing variation.

Many strains and species of perennial lespedeza have been observed over a period of seven years. *L. cuneata* is the most promising forage species but outstanding varie-

ties are not available. Needed are strains with greater palatability, more seedling vigor, better seed holding, and greater persistence and higher yield. *L. tomentosa* and *L. inschanica* (Uruguay 1386) have been vigorous, persistent, and good seeders, but intolerant of close defoliation.

In a test planted June 6, 1956, sericea varieties established in this order of decreasing success: Arlington, Tupelo, Commercial, and Low Tannin. Some strains were well established by fall. All strains winterkilled severely, with little heaving, and were abandoned, thus emphasizing a winter hazard of the crop in Missouri.

Crown vetch has been extremely drouth-hardy in drouthy situations, long lived, disease resistant, and satisfactory in seed set; but all strains were unpalatable. Needed are easier establishment through better seedling vigor or selective herbicides, and more palatable strains for forage. (Project 221)

### Testing Alfalfa Strains

J. D. BALDRIDGE, EMMETT PINNELL, CARL HAYWARD

#### Objectives:

*The improvement of alfalfa in yield, quality, and resistance to disease through the selective testing of varieties and strains.*

#### Varietal Trials

Weather conditions in Missouri in 1957 were conducive to high yields of alfalfa in spite of generally widespread infestations of bacterial stem blight early in the season, rather heavy blackstem attack, and extremely heavy attacks of leaf hoppers.

The Weldon Springs trial gave an average yield of 6.0 tons per acre from four cuttings, the Columbia trial 4.1 tons per acre also from four cuttings, and the Lathrop trial 3.7 tons per acre from three cuttings.

Repeated floods on the Sikeston trial caused heavy mortality and eventual abandonment of the trial in August. Heavy spring rains undoubtedly were the principal cause of plant mortality in the Pierce City trial which was abandoned after two cuttings.

Although not a factor in the varietal trials reported here, bacterial wilt is present in the state and constitutes a real threat to stand longevity. Missouri farmers as a rule like to leave their alfalfa fields in production as long as the stand remains satisfactory. Therefore varietal recommendations by the Experiment Station must be made with wilt resistance as a primary consideration.

The wilt resistant varieties, Vernal, Buffalo, and Ranger gave only slightly lower yields than the wilt susceptible Du Puits and Oklahoma Common in these trials where wilt was not present. They would be expected to give relatively better performance under conditions of heavy wilt infection. Other susceptible varieties such as Atlantic, Williamsburg and Narragansett appear about

equal to Vernal, Buffalo, and Ranger in forage yields.

On the basis of the yield trial results reported here and disease and agronomic information from neighboring state trials the following alfalfa variety recommendations for Missouri appear sound.

*First choice*—Vernal, Buffalo, Ranger

*Second choice*—Du Puits, Williamsburg, Narragansett, Atlantic, Oklahoma Common, Kansas Common, and other common alfalfas of similar type. (Project 241)

### Cytogenetics of Wheat

JOHN H. LONGWELL, JR., MIKIO MARAMATSU

#### Objectives:

*A. To obtain and study additions of single chromosomes of rye to wheat.*

*B. To test the hypothesis that the normal allele of the gene virescent on chromosome III has duplicate loci on the homoeologous chromosomes XII and XVI.*

#### Rye chromosome additions:

Material segregating for various numbers of added chromosomes from the rye variety Imperial was available in the previous year, and three different single-chromosome additions were obtained. One more has now been verified, and at least two, and possibly three, additional ones obtained. The additions already available were (1) hairy neck, (2) red coleoptile, awned, and (3) precocious ripening.

The hairy-neck chromosome was tested for its rate of transmission when present as a monosomic addition. Following self-pollination, the hairy-neck character was transmitted to 27 percent of 167 offspring. Approximate correction for the occurrence of undetected plants carrying a telocentric for the short arm of the rye chromosome brings the figure for transmission to 31 percent.

Male transmission of the hairy-neck character was 11.4 percent of 140 plants. Again, it may be assumed that there was some transmission of the short arm of the chromosome, but the amount would depend on the competitive ability of pollen grains carrying the short-arm telocentric or isochromosomes.

Long-arm telocentrics accounted for 75 percent of the transmission of hairy-neck, and long-arm isochromosomes accounted for another 12.5 percent of the transmission. One plant in the population from self-pollination had a translocation involving the hairy-neck chromosome. Most of the long-arm had been translocated to a wheat chromosome.

Irradiation experiments to induce transfer of the hairy-neck character to wheat chromosomes have resulted in 466 seeds from X-rayed addition-monosomic plants pollinated on normal, non-irradiated material.

The genes for redness of coleoptile and promotion

of awn development have been found to lie on the same arm of one rye chromosome. The red-coleoptile character was somewhat unreliable as a basis for detecting the presence of the rye chromosome, not all plants showing the character under the ordinary greenhouse conditions which prevailed.

The awn-promoting effect, while very slight at one dose, is easily detectable at the two-dose level. In its effect on awns and in causing narrowness of the leaves and slenderness of culms, this rye chromosome is similar to wheat chromosomes II, XIII, and XX. Male transmission of the chromosome appears to be at least as high as that of the hairy-neck chromosome.

The chromosome for precocious ripening causes most of the seeds produced to be small and underdeveloped, with apparently no relation between the degree of development reached by particular seeds and their chromosome constitution. This chromosome also results in redness of coleoptile.

A fourth chromosome has now been identified which carries resistance to race 15B (and presumably to other races as well) of black stem rust. It has no pronounced effect on the plant, but apparently does cause some delay in maturity.

Four other monosomic additions have been obtained, all of which apparently differ from the four just described. Two of the chromosomes concerned have approximately median centromeres, while the other two have an arm ratio of about 2:1. The latter two are believed to be the same chromosome—the satellited chromosome. The two chromosomes with median centromere may be two different chromosomes.

#### *The virescent gene and its normal allele.*

Previous work had shown that plants homozygous for *vv* on chromosome III were green rather than virescent if four doses instead of two of the homoeologous chromosome XVI were present. This suggested that chromosome XVI may carry a gene more or less identical with *V*, the normal allele of *v*, and that *V* and *v* compete with each other. Subsequent results have confirmed the interaction between *vv* and chromosome XVI, and have shown a similar interaction between *vv* and the other homoeologous chromosome, XII.

Following pollination of monosomic XVI by *vv*, plants were obtained which were mono-XVI *Vv*. In  $F_2$  it would be expected that approximately 75 percent of the virescent offspring would be nonosomic. In fact, however, no virescent plants were monosomic—all were disomic. This indicates that mono-XVI *vv* is a zygotic or embryonic lethal. Confirmation was found in the fact that the  $F_1$  plants bore 15-20 percent of shriveled seeds.

A similar experiment with monosomic XII showed that only about half the mono-XII *vv* seeds were shriveled, the other half producing seedlings under favorable

circumstances. The plants obtained, however, were strikingly less vigorous than their disomic-XII *vv* sibs. Evidently chromosome XII is less effective than XVI in opposing the action of *vv*. (Project 261)

### Hybrid Corn Testing Service

O. V. SINGLETON, C. O. GROGAN, M. S. ZUBER

A report of this work is in Station Bulletin 697 of the Missouri Experiment Station, "1957 Missouri Hybrid Corn Yield Trials." (Project 310)

### The Diseases of Cotton in Missouri

M. D. WHITEHEAD, NORMAN BROWN,  
W. P. SAPPENFIELD

#### *Objectives:*

- A. To determine the diseases of economic importance to cotton and make estimates of cotton loss due to diseases.
- B. To seek means of control and varieties with resistance.

There was a good basis for accurate determination of the Missouri cotton yield loss due to disease during 1957. The cotton breeder had lines planted in heavy disease infested plots that differed primarily in susceptibility to the different diseases.

Sufficient data have been obtained to delineate the disease infested areas. The Fusarium wilt-nematode complex infests the lighter soils of over 25 percent of the total acreage. Verticillium wilt is confined to the heavier soils adjacent to the Mississippi River from Charleston, Missouri to the Arkansas line.

In 1957 nearly 40 percent of the fields in this area showed evidence of wilt. In some fields yields were reduced in excess of 50 percent. The heavy rains incited heavy loss through bacterial blight and boll rots. The losses were estimated as:

<i>Disease</i>	<i>% reduction</i>
Fusarium wilt, <i>F. vasinfectum</i> and root-knot nematode	8.0
Verticillium wilt, <i>V. albo-artrum</i> . . . . .	2.5
Bacterial blight, <i>Xanthomonas malvacearum</i> . . . . .	7.0
Anthracnose boll rot (exclusive of seedling disease losses) <i>Glomerella gossypii</i> . . . . .	10.0
Seedling damping-off . . . . .	1.0
Nub-root (mature plant symptoms of seedling disease)	0.1
Ascochyta blight, <i>Ascochyta gossypii</i> . . . . .	1.0
Root-knot nematodes <i>Meloidogyne spp.</i> and other parasitic nematodes . . . . .	2.0
Boll rots (except Anthracnose and bacterial blight) various organisms . . . . .	1.0

Disease Loss 32.6

32.6 percent loss to disease of a 250,000 bale crop equals a loss of 61,567,000 pounds or \$20,932,780 (@ 0.34¢ per pound). (Project 322)

## Mutation Studies in *Arabidopsis Thaliana*

GYORGY REDII

### *Objectives:*

A. To study the cytology and culture techniques for *Arabidopsis Thaliana*.

B. To analyze the causes of inviability of induced mutants.

C. To analyze genes affecting metabolic steps using mutants that are unable to carry out the synthesis of essential substances.

D. Range and nature of progressive mutation.

### *Cytology.*

*Arabidopsis thaliana* (L.) Heynh. (most common English name: Mouseear-cress) may be found under at least five synonyms in the botanical literature. Data about the chromosome number are very confusing.

A recent paper admits the failure of accurate counting (Roebbelen, 1957)—During the years, cytological preparations with various techniques resulted in convincing evidence that the gametic chromosome number was five. The extremely small size (about 1  $\mu$  in length) requires very laborious microtechnique and therefore this material is not suitable for detailed cytogenetic work. The number of dark staining bodies in certain nuclei is the same as that of the chromosomes.

### *Culture technique.*

The modified medium, used for *in vitro* culture, proved to be efficient in obtaining uniform growth under constant conditions. Only 10-20 individuals are needed to establish relatively small quantitative differences at a highly significant level. The technique is simpler than that recommended in the literature (c.f. Langridge, 1957)—The improved complete medium by this laboratory seems more satisfactory for selecting and analyzing biochemically blocked mutants.

It should be mentioned in connection with the preceding that a very different toxicity of the D- and L-optical forms of alanin was observed, which is generally not taken into consideration in the plant physiological literature (c.f. Am. F. Bot. 1957: 44: 252 Science 1958: 127: 82).

### *Analysis of the causes of inviability of induced mutants.*

About 56 inviable recessive mutants are found but only a few showed monofactorial segregation in the  $X_2$  generation. The deviate ratios in the  $X_2$  are mainly due to the sectorial nature of the plant arising from the irradiated seeds, but even in the  $X_3$  progenies, there was a consistent deficiency of the mutant class most probably as a result of chromosome aberrations. Further analysis is underway.

*Analysis of genes affecting metabolic steps using mutants that are unable to carry out the synthesis of essential substances.*

A few of the inviable mutants grew to a certain stage, but only three of them developed to the flowering stage even under heterotrophic conditions. One albina type developed almost the same number of leaves as the normal and formed up to 2-3 three flowers on the slightly elongated stalk, but died without seed yield.

At present, it can be maintained only as heterozygote—an xantha type yielded some seeds as did virescens. As soon as a sufficient quantity of seeds is available, further genetic-physiological analysis will be carried out.

Some further information was obtained about genetic control of the physiology of flowering. In some mutants the flowering can be promoted considerably with sugar feeding, even under constant illumination. Another mutant which is very sensitive to day length is quite indifferent to sugar.

### *Range and nature of progressive mutation.*

Eleven fully viable mutants are obtained. Most of them differ from the standard, physiologically. A series of later types were found that are considerably more vigorous than the earlier. The size of the plants is generally strongly influenced by environmental conditions. (Project 331)

## Weed Control and Crop Defoliation In Cotton Production

O. HALE FLETCHALL, RAYMOND HICKS,  
NORMAN BROWN

### *Objectives:*

A. To discover more effective and more efficient chemical and cultural methods of weed control in relation to cotton production.

B. To discover more effective and more efficient methods of defoliating cotton.

### *Weed Control in Cotton.*

CDAA, sodium PCP, FW-450, simazin at 2 pounds per acre and G-30028 at 4 pounds per acre reduced the stand of cotton. There was evidence of stunting and chlorosis of seedling cotton plants by all Geigy materials, except chlorazin. CDAA, sodium PCP, and FW-450 also stunted cotton seedlings.

Weeds were mostly crabgrass, pigweed, smartweed, morning glory, and common purslane. Treatments which reduced hoeing time to equal to or less than that following 1 pound per acre of diuron were simazin at 1 and 2 pounds per acre, chlorazin at 8 pounds per acre, G-27901 at 1 and 4 pounds per acre, G-30031 at 4 pounds per acre, and G-30028 at 2 and 4 pounds per acre. CDAA, sodium PCP and FW-450 did not give satisfactory control of common purslane.

G-30028 and FW-450 at the 4 lb rate reduced the cotton yield. Diuron, chlorazin at 8 pounds per acre, and

G-27901 resulted in higher yields than the check.

There is indirect evidence that diuron, chlorazin, and G-27901 hastened maturity.

#### *Cotton Defoliation.*

Good defoliation was obtained with B-1776, Penco, V-C 1-443, Magron and Shed-A-Leaf. Fair defoliation

was obtained with 0-2300.

Substituting  $\frac{3}{4}$  pound per acre of amino triazole for one-half the normal rate of other defoliants resulted in a reduction in defoliation in every case.

Amino triazole alone at up to 1.5 pounds per acre gave no leaf injury. (*Project 332*)

# Forestry

R. H. Westveld, Director

## Christmas Tree Culture

R. H. WESTVELD, J. M. NICHOLS, R. B. POLK

Work involved mostly a continuation of records and treatments as outlined in previous reports. Observations of special interest follow.

#### *Tip Moth:*

An upsurge of the pine tip moth population over all of Missouri resulted in an intensification of studies in control of that insect. The insect suddenly reached epidemic proportions in plantations that previously had been subjected to only light attacks. Even in natural stands of shortleaf pine in the Missouri Ozarks, where the tip moth is commonly held in check by natural parasites, severe and unprecedented damage was reported by foresters.

Studies in chemical control included some new insecticides. For the first time, promising results were obtained with a systemic called *Thimet*, known chemically as O, O. diethyl S-(ethylthiomethyl) phosphorodithioate. Records of residual effects of the various insecticides provided some significant and heretofore unreported information.

It appears that certain of these chemical (endrin and malathion, for example) while at first appearing very effective on the tip moth may actually have an end effect of being harmful. A possible explanation would seem to be that certain insect parasites, normally very active in the pest population, have a greater sensitivity to these insecticides than the tip moth.

#### *Simazin Tests:*

Heavy and prolonged rains during spring interfered with establishment of the Simazin tests at rates of 1, 2, and 4 pounds per acre. The Simazin was very effective, however, in reducing herbaceous cover and warrants further testing.

#### *Genetics:*

Genetical work during the year involved two phases: (1) control pollination of selected jack pine (*Pinus*

*banksiana* Lamb.) and (2) a racial study of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco.) and other species.

On August 23, 1957, a collection was made of cones that resulted from the controlled pollination of selected jack pine at the Weldon Spring Experimental Farm (this work was detailed in reports of the previous two years).

Following collection of cones in August (a bit earlier than desired, but the collection date was forced by a suddenly heavy cutting of cones by squirrels) the cones were cured during the fall, followed by seed extraction in December and January.

Although numerous testae appear to have developed normally, no sound seed have resulted from the attempted interspecific-cross (*Pinus glabra* Walt to *P. banksiana* Lamb.)

There are several possible causes of this. One would be incompatibility. Evidence is such as to suggest the unlikelihood of this. Another possibility comes from the fact that pollen grains remain separate entities from time of pollination until one year later when fertilization occurs. It may be that pollen of *Pinus glabra* is not winter hardy at this latitude. This question needs further study.

Further controlled pollination of jack pine, involving both interspecific and interspecific crosses, was attempted during the April 28—May 2 period, 1957. This work was made difficult by almost continuous rain.

A disturbance resulting from the bagging process greatly impeded a normal cone yield. To a less extent this was true of the 1956 pollination work, at which time weather conditions were more normal.

These results, as well as results obtained elsewhere, indicate need for some basic research on improved bagging techniques for controlled pollination in tree breeding work. An improvement of this kind in field technique would result in both quantitative and qualitative increases in seed yield.

Rains delayed seeding of nursery beds at the Licking State Tree Nursery. As a result, when seeds were finally sown (about 6 weeks later than usual), conditions were both too warm and too wet.

Damping-off claimed most of the young seedlings from 14 sources of Douglas-fir plus provenience collections of certain other miscellaneous western conifers (*Cupressus arizonica* Greene, Arizona cypress; *Picea pungens* Engelm; blue spruce; *Abies concolor* (Gord. and Glen.) Hoopes, white fir; *Pinus edulis* Engelm., pinyon pine; and *Pinus flexilis* var. *reflexa* Engelm, Southwestern limber pine). Details of these collections were presented in last year's report.

Only a few seedlings survived from each of the seed lots representing the various species and sources, the one exception being Arizona cypress. Numbers of this species from each of the six seed sources ranged from 39 to 83, enough for the establishment of small plots on several soils. This, of course, hinges on winter hardiness of the seedlings in nursery bed. Actually, the overwintering of these seedlings will lend much insight into prospects for successful use of Arizona cypress in Missouri.

Seed collections of Douglas-fir have been replenished and increased, making possible a new effort at nursery production of this species, beginning in the spring of 1958. (Project 9)

## Investigations on Oak Wilt

T. W. BRETZ

### *Host-parasite relations.*

Trees of the black oak group invariably die as a result of oak wilt infection. Trees of the white oak species group are known to be less severely affected. No quantitative indication of mortality rate has been available. During 1957, 462 oaks were examined which were known to have been wilt infected sometime during the period 1952 through 1956.

Results supported the accepted concept of the susceptibility of trees in the black oak group to oak wilt, with 99 percent dead and one diseased out of the 365 diseased trees examined. They were less conclusive for the white oak group, since the disease could again become active in some of the 55 symptomless trees and some of the 26 trees which still displayed disease symptoms may recover. Only 19 percent out of 97 white oaks had died.

The results do suggest that the mortality rate in infected white oaks is relatively low but it should be recognized that if the oak wilt fungus persists in white oaks in the absence of disease symptoms, such trees might constitute an important and obscure reservoir for the pathogen.

Some plant pathogenic fungi become less virulent, or completely non-virulent, when grown for varying lengths of time on artificial culture media without periodic passage through a susceptible host. In 1957, five isolates of the oak wilt fungus were tested for pathogeni-

city by inoculation into vigorously growing, six to eight-year-old nursery trees. The cultures, originally obtained from naturally infected trees in 1947, 1949, 1950, 1951, and 1952, had grown continuously on standard laboratory culture media since they were isolated.

The results, particularly in the case of inoculated red oaks, indicate little difference in the pathogenicity of the different ages of isolates used. Oak wilt fungus isolates can, apparently, retain a very high degree of virulence while growing strictly as saprophytes for periods of at least 10 years.

### *Local spread of the disease.*

The relative frequency and importance of oak wilt spread through root-grafts as opposed to above ground spread of the disease is unknown. Study of the frequency and pattern of root grafting in oaks under various conditions in Missouri has been undertaken.

An exploratory study of the use of cooper sulfate for tracing root-grafts has been completed. Twenty-five white oaks and 25 black oaks were severed and the stumps treated with a solution of the chemical. Ensuing symptoms of copper injury in adjacent untreated trees were evidence of root-graft connections between the treated and symptomatic trees.

As indicated by this study, 16 percent of the black oaks and 20 percent of the white oaks in the test location were root connected. In one instance, the treated tree was connected to three other trees in a series. No other cases of more than two trees being interconnected by root-grafts were located. No grafts were found between trees of different species.

### *Long-distance spread of the disease.*

The small oak barkbeetle (*Pseudopityophthorus minutissimus*) has transmitted the oak wilt fungus in tests under nursery conditions. These tests involved the caging of more than 150,000 beetles on 241 red, pin, and black oak seedlings 3 to 8 feet tall. Bolts, containing about 120,000 beetles, from naturally infected trees, were placed in cages on 117 seedlings. Oak wilt developed in one seedling.

Approximately 20,000 beetles reared in the laboratory from similar bolts were placed in cages on 87 seedlings and oak wilt developed in one seedling. Approximately 1700 beetles reared from bolts artificially impregnated with the oak wilt fungus were placed in cages on 13 seedlings and although oak wilt symptoms developed in one seedling, infection was not confirmed by isolation of the fungus.

Similar tests were run with beetles from non-diseased trees and in all cases, the results obtained were negative. In all tests the beetles fed extensively in twig crotches, bases of leaf petioles and in rough spots on the stems and larger branches. The successful transmission of oak

wilt by *P. minutissimus* in these tests indicates that this beetle may be involved in the overland spread of oak wilt.

A statistical analysis of the data collected on an oak wounding study in southern Missouri shows that a significant correlation exists between date of wounding (April) and the type of wound (blaze). (*Project 52*)

#### Improvement of Low Quality Understocked Hardwood Stands

R. H. WESTVELD, R. A. MUSBACH, J. M. NICHOLS,  
L. K. PAULSELL

##### *Fire Studies*

Two sets of fire plots received burning treatments. Tagged trees (1.6" d.b.h. and larger) were examined for mortality and scarring. Heights were measured as a basis for growth analysis. All mil-acre reproduction plots were examined and plot maps maintained. Research Bulletin 640 gives the analysis.

Studies also are under way on pruning of oak, decay and defects, and conversion of low-value hardwood stands to conifers. (*Project 75*)

#### A Working Guide to Important Native and Introduced Range Plants of the Missouri Ozarks

C. L. KUCERA, JOHN EHRENREICH

Diagnostic drawings to the key are nearly completed. The key has been enlarged to include a number of poisonous species. (*Project 79*)

#### Marketing the Timber Crop

LAWRENCE LENEY, J. M. NICHOLS, W. J. O'NEIL

##### *Objectives:*

A. Preservation of fence posts and farm timbers.

B. Determine the effect of grading on the sale value of lumber.

On March 9, 1957, the posts in the Columbia plot were tested again by having a loop of ½ inch manila rope placed around the post 3 feet from the ground and a horizontal pull of 40 pounds exerted with a spring balance. If the post did not fail it was considered serviceable.

Three posts failed. Post 29, a catalpa post which was not treated, failed at 24 pounds pull. Post 39, a chinkapin oak post treated with a creosote 2¼ hour hot bath and 1 hour cold bath, was missing. Vandals evidently removed it. Post 84, a black oak post treated with creosote ¾ hour hot and 1 hour cold bath, failed at 20 pounds.

September 10, 1957, the posts set out at Weldon Springs were tested in the same manner. Twenty-two of the 783 posts failed. Eleven of those that failed were untreated cottonwood.

The remaining failures included two hickory posts treated with 5 percent penta, two black oak and two

shortleaf pine treated by the double diffusion method, one untreated elm post, one ash post treated with Osmose Salts and three cottonwood posts treated with Osmose Salts.

The posts will be tested annually hereafter. (*Project 120*)

#### Reproduction and Forest Stand Improvement Cuttings

R. H. WESTVELD, R. A. MUSBACH, A. J. NASH,  
J. M. NICHOLS, L. K. PAULSELL

##### *Stand Improvement Cutting*

Phase 1.—Stand Improvement of Immature Oak (University Forest): Plots were examined for crop tree mortality; all tags were checked and replaced if missing. Initial data were transferred to IBM cards for future analysis.

Phase 2.—Cottonwood Thinning (Weldon Spring and Dupont): Annual routine remeasurements were made according to the plan. Analysis necessary for the preparation of a manuscript on cotton wood thinning was begun.

Phase 3.—Timber Stand Improvement (Weldon Spring): Nine 2-acre plots were established in a stand in need of a light stand improvement treatment. Preliminary measurements and observations were made to insure uniformity between plots.

##### *Regeneration Cutting.*

Phase 1.—Regeneration Cutting at University Forest: Work on the second block of plots was completed. The third and final set at University Forest was established and all work completed. Parts of this study are located on U. S Forest Service lands of the Shawnee National Forest. Data was transferred to IBM cards to facilitate computations.

Phase 2.—Regeneration Cutting at Weldon Spring: The second block of plots was completed. This involved measurements, tagging, cutting, log scaling and collection of appropriate data.

Cutting of the plots and isolation strips yielded 54,840 bd. ft. of sawtimber and 756 chord feet of stone blots with a total sale price of \$1115.40. A location was selected for the third replication of this study.

Phase 3.—Growth in Partially Cut Stands (Weldon Spring): The 30 one-fifth acre growth plots in partially cut stands were re-examined. Tree diameters were remeasured to calculate basal area growth. The mil-acre reproduction plots will be re-examined in the summer of 1958.

Phase 4.—Weldon Spring Timber Management: A total of 280 white oak trees was advertised for bids but not sold due to a drop in the market. Smaller sawtimber sales incidental to land clearing and excavation of a lake totalled 21,245 board feet and brought a sale price of \$212.45.

A new timber sale agreement was prepared to provide for sale of successive small tracts of marked timber to the successful bidder of the first small tract offered. This will insure against the possibility of having to keep an inefficient operator through a large sale. (Project 122)

### Ecological Studies in Forestry

R. E. McDERMOTT, J. M. NICHOLS

#### Acorn Production

From limited samples, it appears that the mast crop in the southeastern Missouri bottomlands was heavy. The upland mast crop continued spotty. In general, the upland black oaks crop was fairly good, while the white oak crop was light.

#### Effects of Forest Grazing

Optical differences were apparent in the open range areas of the Pioneer Forest. Plans for recording the herbaceous differences were discarded due to just slight amount of the changes. (Project 123)

### Economics of Timber Production

P. C. SMITH, A. J. NASH, A. B. COLE

#### Case Studies of Income:

Under 124-1, Comparative Timber Income Possibilities from Farm Forests in Dent County, collection of field data was completed by November. Sorting and tabulating of data, using punched cards, has been completed. The balance of analysis and preparation of a manuscript is to be done during the first half of 1958.

#### Growth and Yield Studies:

Some field work was done to collect additional information. It consisted of obtaining more data on individual tree diameter-height relations, total age in relation to total height and more information on site index. A total of 65 plots were visited in various parts of the state. This and the data obtained in the previous year were combined to provide trends of growth and yield in Missouri's forests which will be reported next year.

#### Taxation of Forest Land:

Missouri Agricultural Experiment Station Research Bulletin 624 was issued during the year, providing the most recent information on taxation of forest land. (Project 124)

### Techniques for Improving The Results of Forestation

R. B. POLK, J. M. NICHOLS, R. A. MUSBACH

Adaptability-study plantings involved approximately 7200 seedlings with nine species represented on 4 blocks of 3 plots each (one plot fully plowed, one row plowed, and one unplowed). The two blocks scheduled for post-planting mowing or cultivation as needed received two

between-the-rows mowings, once in June and again in August.

In the 1955 adaptability study, involving a total of 4896 hardwood seedlings with eight species represented on 22 plots (some pure and some mixed with regards to species composition), survival has been unexpectedly good, considering that severe drouth plagued the area during the first two growing seasons following planting. A 1957 inventory of trees by species showed percentages of trees still living to be as follows:

Species	Percent living
<i>Maclura pomifera</i> (Raf.) Schneid.	80
<i>Liriodendron tulipifera</i> L.	69
<i>Juglans nigra</i> L.	51
<i>Quercus alba</i> L. (Missouri origin)	73
<i>Quercus alba</i> L. (Ohio origin)	84
<i>Robinia pseudoacacia</i> L.	88
<i>Catalpa speciosa</i> Ward	84
<i>Liquidambar styraciflua</i> L.	66
<i>Fraxinus pennsylvanica</i> Marsh	94

Early growth in these plots is considered poor, attributable in part to extend drouth (1952-57) preceding and following the time of establishment. A growth summary at this time would be premature.

Four plots of a *Populus* hybrid (*P. alba* L. X *P. grandidentata* Michx.) were established at the Weldon Spring Experimental Farm, using rooted cuttings. Two of these plots were placed on a typical bottomland cottonwood site, the soil being of alluvial origin.

The other two were placed on an old-field upland site, the soil being a moderately eroded phase of the loessial Weldon series. The seedlings succumbed to an extended inundation of several weeks on the bottomland site, possibly attributable to a complete submersion of the crowns rather than root systems alone.

It was noted in the case of adjacent plots of *Populus deltoides* Bartr., a species whose root system can take extended flooding, the seedlings of that species too died where the water was sufficiently deep to cover the crowns. A replanting of the hybrid on the bottomland plots, using taller plants, would seem worthwhile. Survival and growth of the hybrids on the upland site was good, the average height development being 2.3 feet.

A direct seeding vs. 1-0 seedling planting of *Quercus rubra* L. was established in the E ½, NE ¼, Sec. 6, T45N, R3R, 5th P.M., on the Weldon Spring Experimental Farm in St. Charles County. Experimental layout was as follows:

Four plots, two fully plowed and two unplowed, each plot containing two subplots. A subplot, 24 x 150 feet, contains three rows, planted at random with either acorns or seedlings, the rows being 8 feet apart with a 6 foot spacing in rows. The study includes a total of 300 seedlings and an equal number of carefully graded acorns:

Unfortunately, heavy and continuous spring rains delayed planting until May 11 (1957). This is about six weeks later than desired. Seedlings had leafed out heavily at this late planting date; and the acorns had germinated, with radicles extending out to lengths exceeding 2 inches.

Even with very careful handling, considerable damage was done to the new root growth of the seedlings and many of the acorns had radicles broken. Thus, the conditions of establishment left much to be desired. Even at the late date of planting, the farm tractor (wheel type) used to pull the planting machine became buried several times in the wet soil. For a suitable scheduling of planting operation with planting machine, a crawler tractor becomes an essential piece of equipment.

Early survival figures, made June 27, showed 98 percent of the seedlings to be alive as compared to only 52 percent emergence of seedlings from the acorns. Foliage of the stock from acorns appeared more vigorous, however. No difference at this early date could be attributed to plot treatment (plowed vs. unplowed). Heavy rains following sowing, however, appeared to have prevented emergence of the young seedlings on some parts of the fully plowed acorn subplots.

Survival of the cottonwood plots has been high during the first growing season, averaging 95 percent and better on three blocks. On the fourth block, one of the two located on bottomland, complete inundation of some seedlings for a period of several weeks reduced survival to about 60 percent. Plans are to replant spots that fail during the spring of 1958 in an effort to bring these spacing study plots to full stocking. (*Project 157*)

### Effect of Forest Cover on Soil and Water Resources

P. W. FLETCHER, R. A. MUSBACH, R. H. WESTVELD  
R. Z. WHIPKEY

#### *Hydrologic Orientation*

Made first trial rainless period depletion curves from mean daily records for Current, Black, and St. Francis Rivers.

Basic precipitation and runoff data were assembled for three small basins near Rolla.

Developed, presented, and convinced the U. S. Forest Service and the Department of Agricultural Economics on the concept that a watershed area in the Ozarks should be selected and developed as a demonstration of integrated land use centering on intensive cultural practices on valley land through irrigation.

Installed and operated weather station at Weldon Spring Experimental Farm.

#### *Soil Moisture Studies*

Made first trial soil moisture rainless period depletion curves for both shallow wells and resistance units, and published paper.

Continued cooperative weather station and trough interception records at University Forest.

Continued analysis of cooperative records from the Sinkin Experimental Forest.

#### *Small Watershed Studies*

Planned, in cooperation with the U. S. Forest Service, further studies.

Constructed one-half mile of access road to the first installation at University Forest. (*Project 158*)

### Utilization of Native Timber and Residues

LAWRENCE LENEY

#### *Objectives:*

A. Seek improvements in the conditioning or treatment of wood.

B. Improve techniques for fabricating products from wood.

Thirty-three cross sections of oak trees were collected in connection with logging operations in the vicinity of Moberly. The species represented were: 26 *Quercus alba*, 3 *Q. macrocarpa* and 4 *Q. rubra*. The sections cut from the top of the butt log were sealed in polyethylene bags within a few minutes after the tree was felled. Specimen blocks cut from these sections the same day were used to determine specific gravity, moisture content, and shrinkage. The data are not yet analyzed for the several relationships involved.

The sapwood of *Q. alba* is consistently wetter than the heartwood by a difference of 10 to 20 percent. The samples of *Q. macrocarpa* and *Q. rubra* were too small for any conclusions. The sapwood of all samples of *Q. rubra* was lower in moisture content than the heartwood.

The study of sycamore "in use" was completed. Fifty boards which had either not warped during drying or were not seriously warped, were chosen at random.

By suspending them by one end so they were free to warp without restraint of any type and subjecting them to outdoor conditions of changing relative humidity, any tendency to change shape could be noted. About 20 percent of the boards tested in this manner showed noticeable change of shape.

Of the nine boards showing a change, six had been classified as slightly warped before the test but showed increase or change in warp during this "in use" test. None of the tendency to change shape was serious enough to prevent use of the boards as rough construction. For more exacting uses, as in furniture, the lumber would have to be chosen with care.

This study of drying sycamore emphasized the need for additional research to relate the tendency of the lumber to warp with the growth conditions of the tree. There are indications that warpage may be due to irregular grain but it would take additional study of a

more basic nature to determine the cause with any degree of confidence.

From observations of this 2000 board feet of sycamore there is reason to believe a relationship exists between warpage and the tendency to have shake. The original logs and lumber showed very little evidence of separation of the annual rings; however, considerable showed up during drying.

Matched blocks of white oak were dried from the green condition at several elevated temperatures to determine the effect of heat on darkening of the wood.

Blocks dried at temperatures up to 200° F for three days showed no significant discoloration. Blocks heated for six days at high humidity and 170° F showed some darkening. Those heated at 200° F at low humidity showed even greater discoloration. There was the greatest amount of darkening in blocks heated for six days at 200° F and high humidity.

Apparently, heat, humidity and time all affect the darkening of white oak. A more detailed test is needed to determine better the degree of effect of these factors.

It was not possible to run test kiln schedules this year.

Over 1500 one-inch square sheets of veneer have been sliced from small cottonwood blocks. By measuring the forces on the knife and observing or photographing the deformation of the cellular structure it is anticipated a more basic knowledge of cutting action will result. Six hundred feet of motion pictures have been taken through a microscope to record the action of the forces at the edge of the knife.

Tests on knives sharpened on different grades of sharpening stones showed little effect on the forces during cutting. However, the smoothness of the cut surface was affected.

With a simplification of procedure it is expected less time will be required to obtain data on three other species representing types of wood structure so some general conclusions can be reached concerning the mechanics of the cutting action. (*Project 159*)

### Control of Undesirable Trees In Timber Stand Improvement

J. M. NICHOLS

Research Bulletin 638 is a compilation of research results under this project from 1949 to 1955. Included are results using 2,4,5-T, ammate, CMU, and sodium arsenite on several hardwood species with emphasis on seasonal aspects of application of chemicals.

Tests will continue to check effectiveness of different chemical applications at yearly intervals following treatment.

Plots of old field persimmon treated in March 1955,

on which second season results were reported in 1957, were re-examined. The only treatments which appeared effective after three growing seasons included 2,4,5-T at a rate of 16 pounds acid equivalent per 100 gallons diesel fuel applied to stumps and to a height of 1 foot on bases of standing stems.

Plots of old field sassafras treated in 1956 were re-examined for second season results. All treatments were effective in top-killing. However, none suppressed sprouting and on all plots as many new sprouts appeared as there were original stems. (*Project 166*)

### Marketing Christmas Trees

R. H. WESTVELD, J. M. NICHOLS, L. K. PAULSELL  
R. B. POLK

#### *Objectives:*

*A. To determine the size of the Missouri market for Christmas trees.*

*B. To determine (1) consumer preferences with respect to species, size and grade of Christmas tree and (2) consumer habits in the use of Christmas trees and evergreen boughs.*

*C. To determine at the retail level of industry (1) the present sources of supply and their reliability in terms of quantity and quality; (2) the calendar period, size and nature of individual operations; and (3) basis for pricing.*

*D. To determine methods of operation, sources of supply and problems encountered by wholesalers of Christmas trees and evergreen boughs.*

*E. To determine marketing methods employed and problems encountered by growers of Christmas trees.*

*F. To develop improved methods of Christmas tree and evergreen bough marketing.*

Data from two years' work have been partially analyzed and upon completion will provide dependable information on consumers' buying habits. It will also provide a good estimate of the number of trees used each year.

A new consumer preference study also was completed in December, 1957. This involved a display of six species of trees commonly used for Christmas trees. Within each species, three grades were exhibited.

The study was performed in Columbia, St. Charles, and Kirkwood. Consumers were asked to choose the species of their choice and their grade preference within that species. Missouri grown Scotch pine received over 50 percent of the preference votes. Balsam fir ranked next with about 25 percent of the preference votes.

Except for a number of observational visits to retail lots, work on the retail situation was limited to a continued analysis of data obtained in December, 1946. The same was true for the wholesale study.

An attempt has been made to contact by mail every person in the state who has planted trees for Christmas tree production. Names were obtained from country

agents, farm foresters and the shipping lists (planting stock) of the Missouri Conservation Commission. A letter and questionnaire were sent to each person thought to be a grower. The analysis of data is underway.

Few Missouri trees have been marketed because, generally speaking, plantings have not been established long enough to yield merchantable trees. A high percentage of the people planting trees have made inquiries on species, methods and marketing as they became aware of the research underway. Many people have planted species unsuited for Christmas tree use either through ignorance or incorrect advice from other people.

Information obtained on this objective has been limited. A great deal has been learned about processing, handling and marketing trees from the annual marketing at Ashland and Weldon Springs. Visits to Christmas tree lots have pointed out changes which can improve marketing techniques. (*Project 245*)

### Marketing and Processing of Hardwood Paneling

R. C. SMITH, LAWRENCE LENEY, W. J. O'NEIL,  
R. A. MUSBACH, L. K. PAULSELL.

#### *Consumer Preferences:*

A questionnaire was devised after consultation with a psychologist and market analysts. Typical pieces of paneling representing grades, patterns, and widths were selected, erected into mock-up walls and photographed.

Wood samples to go with the consumer questionnaire were prepared and assembled in carrying racks. A questionnaire for interviewing lumber retailers concerning paneling was also prepared.

A set of stereo pairs of photos, wood samples consumer questionnaires, and retailer questionnaires were sent to the agricultural experiment stations at Ohio, Indiana, and Illinois so these stations could assist with the collection of consumer acceptance data.

A sampling plan was devised and an interviewer was hired to contact about 250 home owners and about 50 lumber retailers in four towns during the spring of 1958.

#### *Fasteners and their Use:*

No. 3 and No. 4 finishing nails, the most promising sizes from preliminary study were tested in a series of 3,488 tests. It was found that almost all nails cause a small split at the back surface of oak paneling. No. 3 nails cause more splitting than No. 4 nails because they are not sufficiently stiff. They bend slightly and exert a side thrust. In red oak,  $\frac{1}{4}$  inch thick nails should be driven  $\frac{3}{8}$  inch or more from the edge of the stock. In  $\frac{3}{8}$  inch thick stock, nails may be set  $\frac{1}{4}$  inch from the edge. For post oak,  $\frac{1}{4}$  inch in thickness, neither No. 3 nor No. 4 finishing nails are satisfactory. In  $\frac{3}{8}$  inch stock, nails

should be set  $\frac{1}{4}$  inch or more from the edge.

Paneling specimens were furnished to the agricultural experiment station of Indiana to study dimensional stability and to develop recommendations for installing paneling.

#### *Methods of Manufacturing:*

Over 12,000 board feet of lumber, 88 percent red oaks and 12 percent post oak, were kiln dried, sized, rough plane machined to the improved pattern developed last year. After trimming, amount of lumber available for use was 11,400 feet and the yield of paneling was 9,000 board feet. Expressed in percent, the grades of lumber used and the yield of paneling by grade were:

<i>Rough lumber</i>		<i>Paneling</i>	
FAS	2.5	Wapello	1.9
No. 1 Com.	7.5	Osage	6.9
No. 2 Com.	22.0	Montauk	69.7
No. 3A Com.	33.4	Shawnee	21.5
No. 3B Com.	34.6		

Waste in all grades of lumber combined was 23.5 percent of the volume.

#### *Costs of Processing and Pricing of Products:*

Efforts to enlist the help of wood manufacturing firms in developing a cost analysis for processing were only partially successful. However, cost figures from a number of sources were assembled and a price structure based on costs of rough lumber and processing costs was developed, with a break-down by grade and size of piece. We are not entirely satisfied with results to date because the prices appear to be rather high. In summary, the retail prices for enough paneling to cover a wall 8 by 12 feet are:

<i>Panel grade</i>	<i>Price</i>
Wapello	\$45
Osage	35
Montauk	24
Shawnee	22

(*Project 259*)

### Effect of Soil and Parent Material on Distribution of Native Ozark Timber Species

P. W. FLETCHER, R. E. MCDERMOTT

The greenhouse studies described in the 1956 and 1957 reports have been set up. As a result of one growing season, height growth and foliar coloration differences were apparent last fall. Fall soil saturation conditions were applied to a replication of seedlings, and the spring as well as spring and fall conditions will be applied this spring.

By late spring of 1958, it will be possible to as-

certain the survival and growth relationships of pin oak, white oak, sycamore, shortleaf pine, and eastern redcedar, as related to full, one-third, and one-tenth sunlight. These light responses may be correlated with the interactions of fall, spring, and spring and fall soil saturation. (Project 260)

#### Effect of Stand Treatment on Growth, Seed Production, and Regeneration Of Bottomland Hardwoods

R. H. WESTVELD, R. E. McDERMOTT,  
DONALD JOE JONES

Trees eliminated by 2,4,5-T in an axe frill to reduce stand stocking and structure in the winter of 1956, continued to break up, causing considerable damage to acorn traps.

The 900 acorn traps were modified to eliminate leaves blocking the tops. The mast crops for pin oak and willow oak appear moderately heavy. The data are being analyzed for possible correlations of basal area and tree sizes to mast production. (Project 287)

#### Use of Forced Air in Forest Fire Control

J. M. NICHOLS, L. K. PAULSELL

##### Objectives:

*To continue tests and make improvements in two types of forced air fire control equipment.*

With assistance from personnel of Buffalo Turbine Company, Gowanda, N. Y., an axial flow blower, previously tested on a jeep, was adapted to a John Deere 420 crawler tractor. Preliminary tests were made.

A small hand-propelled blower from Atwater-Strong Company, Atwater, Ohio, was tested. The company made changes in the equipment to adapt it to fire-fighting purposes and the first pilot model was tested on going fires by personnel of the Missouri Conservation Commission. Additional modification of the equipment is now in progress. (Project 290)

#### Trees of Missouri

R. E. McDERMOTT

Preliminary work has been started to develop winter photography techniques for uniformity of tonal contrast and scale. (Project 341)

## Home Economics

Margaret Mangel, Chairman

#### Investigation of the Changes in Meat Pigments Under Various Treatments

MARGARET MANGEL, MINA GLIDDEN,  
MURIEL CALDWELL

Data from previous work have been analyzed and several additional experiments studying the interaction of sulfur containing compounds with oxidizing and reducing agents have been done. A manuscript dealing with these findings is now near completion.

The collection of data on the effect of various anti-oxidants on meat color and palatability has been completed. The data are now being analyzed and a manuscript is being prepared. (Project 87)

#### Nutritive Status of Older Women

HELEN GORDON, CECELIA PUDELKEWICZ,  
LINDA WHITWORTH

##### Objectives:

*Work on summarization and preparation for publication of results toward all objectives has been done this year.*

*Report of Progress including detailed Results:*

Two manuscripts are being prepared for publication as station bulletins:

- A. Creatinine Excretions in Healthy Women on Self Selected Diets.
- B. Dietary Patterns and Nutritive Intake of Missouri Women.

Two manuscripts now in thesis form are being rewritten for publication in journals:

- A. Comparison of Methods of Calorie Determination in Diets.
- B. Metabolism Study on one Subject with Varying Levels of Nitrogen Intake before and after Weight Reduction. (Project 95)

#### Studies on the Utilization of Processed Food and Food Improvement

GEORGIA AMICK, BERTHA A. BISBY, LETA G. MAHARG,  
CLETA RODGERS, CAROL SECHLER, NANCY WEBB,  
GERALDINE MIER, AND HELEN CALDWELL

Family sized recipes for yeast breads and rolls have been developed and standardized using large amounts of nonfat milk solids for high nutritive value.

Studies are in progress on methods of incorporating dried eggs in food products, effects of freezer storage on

baked goods and effects of salt on whipping quality and stability of foam from dried eggs.

Work on tenderizers has not been completed. The proteolytic activity of some enzymes with a low pH value showed greatest activity and as temperature was increased, the activity increased, especially the pure papains.

A formula was developed and standardized for a quick bread mix. (*Project 130*)

### Consumption, Characteristics and Serviceability Of Textile Products in Childrens' Clothing

CECILIA ALEGORLUS, ADELLA E. GINTER,  
DAISY MARIE JONES

Summarizations were made for (1) The home laundering practices used by the homemakers in Kansas, Minnesota, and South Dakota; (2) color changes as measured by the continental gray scale, laboratory-made reflectance meter and the Gardner color difference meter; and (3) the serviceability of the two qualities of control flannel shirts in size 8.

Statistical treatment is nearing completion for the laboratory measures of breaking strength, elongation, test strength, abrasion, and color change that were made on the gingham and flannel shirts in size 12. (*Project 162*)

### Studies to Improve Food Utilization And Selection, Preparation and Storage Practices

LETA G. MAHARG, ISABELLE DELANEY, CLETA RODGERS,  
HELEN CALDWELL, CAROL SECHLER

*Objectives:*

A. To develop new uses of wheat.

B. To investigate edible coverings for foods.

C. To make a pilot study on the time required to cook meats and baked products in the electronic range.

Since wheat is one of the surplus commodities, work on the use of wheat and wheat flours in such products as cookies, quick breads, dumplings and casserole dishes is being continued. Procedures for preserving wheat for emergencies are being developed.

A study on the use of methoxyl pectins showed that these products could be used satisfactorily for making jellies, jams, puddings, gelatin desserts, low calorie diets and as a protective covering in freezing fruits such as strawberries.

Plans are being made to study time and temperature necessary for preparation of meats, vegetables and baked products. (*Project 163*)

### Testing Flours

LETA G. MAHARG, CLETA RODGERS, NANCY WEBB

*Objectives:*

A. To test and evaluate experimentally milled flours from the most promising wheat selected by wheat breeding program.

B. To study the best methods of incorporating dried egg albumen in cake formulas.

Ten experimentally milled flours were evaluated this year. Not all tests have been completed, so results are not available.

Methods used for incorporating dried egg whites into cake formula are under study. (*Project 205*)

### Factors Affecting Palability And Nutritive Value of Poultry

NANCY WEBB, CECELIA PUDELKEWICZ,  
LETA G. MAHARG, AND HELEN GORDON

*Objectives:*

A. To determine the effect of processing and cooking on thiamine, riboflavin, methionine and lysine content of poultry.

B. To study, develop and standardize methods and equipment for preparation of poultry.

One hundred twelve birds were prepared for panel testing. Methods used were roasting and stewing (for broth). Panel results showed that more flavor differences were distinguishable in broth than in roast meat.

Records are available for weight changes in thawing and roasting, drip losses, roasting times and temperatures.

A short study was made with a commercial firm testing palatability of poultry processed by a new method versus standard processing methods. The panel results showed no significant palatability differences in the two methods.

A pilot study was done on 24 fowl to determine the effect of processing and cooking on light and dark meat. Procedures for preparation of samples and for assaying thiamine, riboflavin, methionine and lysine have been standardized. Moisture, fat and total nitrogen determinations were made by the experiment station laboratories. (*Project 314*)

### Factors Affecting Metabolic Expenditure Of Animals and Man

HELEN GORDON, CECELIA PUDELKEWICZ

A gradient calorimeter constructed by Dr. R. E. Stewart, Department of Agricultural Engineering, is now being rebuilt and will be available for use in May.

At that time a small pilot study using rats will be undertaken to give the staff an opportunity to become familiar with operation of the gradient calorimeter. Methods for determination of body composition of rats will be developed at the same time. (*Project 317*)

### Protein Requirements of Animals And Man

HELEN GORDON, CECELIA PUDELKEWICZ,  
LINDA WHITWORTH

This is part of regional project NCT-42, entitled: Factors Affecting Requirements of Adult Human Subjects for Protein and Amino Acids.

This is part of regional project NCT-42, entitled: Factors Affecting Requirements of Adult Human Subjects for Protein and Amino Acids.

New Laboratory workers have been oriented to the field and trained in microbiological assay techniques.

At present computations are being made preliminary to the establishment of a good basal diet. These computations include carbohydrate, protein, fat, calories, the usual minerals, and vitamins, as well as the eight essential amino acids. (*Project 318*)

### Serviceability of Fabrics Made From Cotton of Selected Fiber Properties

ADELLA E. GINTER

Time has been spent on planning the laboratory work to be done on the sheets and working out a satisfactory cutting plan for the serviceability measures in cooperation with Oklahoma.

Plans are being developed for interlaboratory testing between the Missouri and Louisiana stations in which the tear strength of shirting will be measured. (*Project 319*)

### Physical Properties of Cotton Fabrics Containing Crease Resistant Finishes

JUDY CARR, ADELLA E. GINTER, MARTHA EDEN,  
MARIE JONES

#### Objectives:

A. To compare some physical properties of cotton fabrics of similar construction but varying in finish.

B. To determine the variability among the physical properties of cotton fabrics treated with crease resistant finishes.

Six varieties of cotton shirts with crease resistant finishes are now being laundered according to definite procedures. Laboratory evaluations will be made after three periods of wear.

The Wisconsin station is cooperating in this project. (*Project 320*)

### Time and Temperature Tolerance of Meat and Meat Products

ISABELLE DELANEY, MAHLA INEY

A questionnaire has been developed and a pilot study on 10 families is in progress. (*Project 336*)

# Horticulture

R. A. Schroeder, Chairman

### Use of Water in Horticultural Crop Production

A. D. HIBBARD, V. N. LAMBETH, R. A. SCHROEDER,  
AND JOE CORGAN

#### Objectives:

A. To study the utilization of soil moisture by fruit plants in irrigated and non-irrigated plantings.

B. Investigations in the moisture relationships and supplemental irrigation by vegetable crops.

C. To study the build-up of moisture reserves (naturally or by off-season irrigation) and their utilization during the growing season.

Moisture blocks were installed in new irrigated orchards to follow utilization under irrigated conditions. The rainfall pattern during 1958 was excessive at most locations so that data on utilization were difficult to obtain.

The records from cooperative orchards have little value because of the excessively heavy precipitation dur-

ing most of the growing season. Some of the orchards did develop a deficiency during the month of August, but this was restored by general rains during September.

At the horticulture farm near New Franklin the rainfall was not as well distributed or as abundant as in the other orchards where soil moisture block installations were made. Here a block of young peaches showed serious moisture depletion by June 20th, at which time these were given a 4-inch irrigation and one month later another similar application.

The irrigated peach trees yielded 10.5 percent more peaches by weight and the peaches were 9.2 percent bigger.

Soil moisture blocks were installed throughout the root zone to study rate of soil moisture depletion and replenishment in the young orchard at the Horticulture Research Farm. So far there is nothing to report from these installations but root extraction of soil moisture and root extension will be followed for several seasons or until the entire root zone becomes occupied.

Variable irrigation was applied to tomatoes grown on a Menfro silt loam soil in a greenhouse ground bed during the spring of 1957. Bouyoucos moisture blocks were buried at the 12-inch and 24-inch depths in each plot and irrigation water was applied according to the following treatments:

- a. Applied 1 inch when the average block reading dropped below 75 percent.
- b. Applied 1 inch when the average block reading dropped below 50 percent.
- c. Applied 1½ inches when the average block reading dropped below 50 percent.
- d. Applied 1 inch when the average block reading dropped below 25 percent.

Moisture block readings were taken twice weekly.

Although there was no significant difference in response between treatments a and c, the number of fruit per plant was increased 48 percent and fruit weight per plant increased 42 percent over treatment D, where the poorest response was shown. Treatment B gave an intermediate effect. Blossom-end rot and fruit cracking were more prevalent in the low-moisture treatment (D).

Prior to the harvest season approximately 1 inch of water per week was required to maintain the moisture level above 75 percent. During the harvest period, June 13 to August 13, this requirement increased to 1.7 inches per week.

Potted apple seedlings were grown under controlled moisture conditions during the summer of 1957. These were allowed to deplete the moisture supply during the fall and enter the dormant season with varying degrees of moisture. The responses will be evaluated during the next growing season. (*Project 1*)

### Nutrition of Fruit Crops

H. G. SWARTWOUT, A. D. HIBBARD, D. D. HEMPHILL  
AND JOE CORGAN

Leaf samples were taken from about 30 commercial apple orchards from all parts of the state and analyzed for phosphorus, potassium, calcium, magnesium, manganese and boron. The phosphorus level, which had been steadily declining during the past several years, was back up to optimum level in practically all orchards. In 1956 the average tested was 0.120 percent while in 1957 it was 0.175 percent. A few orchards were low in potassium. Comparisons were made between the levels of these elements in Jonathan, Red Delicious and Golden Delicious varieties. The three varieties did not differ significantly with respect to any of the above elements.

Some trees in a manganese deficient orchard were sprayed with manganese sulfate at 4 pounds per 100 gallon and some with maneb, a fungicide, at 2 pounds per

100 gallons. The sprays were applied May 15 and again three weeks later. The soil under some trees was treated with ¼ pound per tree of manganese chelate on May 15. The manganese sulfate and maneb both were effective in correcting the deficiency. The chelate was not effective the first year. The leaf manganese content for samples taken in late July was with no Mn applied 17 ppm, Chelate 22 ppm, maneb spray 58 ppm and manganese sulphate spray 181 ppm.

Increasing N from 25 to 50 pounds per acre did increase yields and there was a trend toward reduction of yields.

Increasing phosphorus from 80 to 150 and 300 pounds per acre gave significant yield increases when soil moisture was maintained at a high level (75 percent field capacity). At lower soil moisture levels increasing phosphorus had no effect.

Increasing potassium from 212 to 379 pounds per acre consistently reduced yields.

Foliar analysis from vines in three vineyards in the Rosati area of the Ozark region showed potassium levels that indicated potash deficiency in areas where vine behavior was abnormal. Similar symptoms have been observed in many of the vineyards of this area.

Glyodin sprays for the purpose of increasing the solids in grape juice (favorably reported upon elsewhere) were replicated 20 times on 10 to 20 vine plots through two vineyards. At harvest, Brix and refractometer readings of expressed juice from composite samples showed fruit from ferbam-sprayed vines to be higher in total solids in 17 of the 20 replications. In only three of the 20 plots was the total solids higher with ferbam-glyodin sprays. (*Project 4*)

### Use of Antibiotics and Antibacterial Substances in the Control of Horticultural Crop Diseases

R. N. GOODMAN, R. F. BECKER, W. M. DOWLER

*Objectives:*

- A. Fireblight control.
- B. Control of horticultural crop disease with antibiotics.
- C. To study absorption, translocation and residues of antibiotics in plants and plant tissue.

The experimental plots set out to evaluate certain antibiotic formulations for the control of this disease were abandoned since the disease failed to develop in significant proportions.

Two field plots were established to evaluate further the efficacy of streptomycin applied at 50 ppm as a control measure for bacterial shot hole of peach *X. pruni*. A six-spray schedule was extremely successful for the second year and reduced the incidence of the disease on fruit three fold.

Streptomycin, terramycin and aureomycin suppressed the development of bacterial soft-rot *E. caratovora* in artificially inoculated prepackaged spinach. The antibiotics were applied as dips at 25 ppm for one minute. At the end of a 4-day period the antibiotics had 1/20 to 1/100 of the microbial population present in the refrigerated controls.

Naphthylacetamide and gibberellic acid at 20 and 30 ppm, respectively, increased streptomycin absorption by bean plants 2½ times.

Similar increases in streptomycin absorption were obtained with the addition of 1 percent tri-ethylene glycol, di-ethylene glycol and glycerine.

Bioassays of cabbage, spinach and potato tissue revealed the following facts.

a. Streptomycin remains biologically active in spinach after a 3-minute exposure to live steam.

b. Terramycin, aureomycin and streptomycin remain biologically active for at least 3 months in potato tissue.

c. The tetracycline antibiotics are inactivated by brief exposures to heat and neutral pH.

d. Terramycin applied to cabbage prepackaged as slaw retards oxidation at concentrations of 5 and 25 ppm. (Project 27)

#### Virus Diseases of Stone Fruits

D. F. MILLIKAN, R. E. BROWN, R. E. HENDERSON

##### *Objectives:*

A. To develop means of identification and eradication of virus infection in our commercial and nursery stocks.

B. To study virus spread in nursery and orchard trees.

No new viruses have been found among our stone fruit plantings during the past season. Suspicion of K & S infection in our flowering cherry has been confirmed and a single clone apparently free from this infection was found in the tests.

The presence of a stem pitting disorder in cherry was noted last year. This had been tentatively designated as leaf roll, described in England but unreported for the U. S. Inoculation tests will be made to determine if this disorder is the same as that found in England.

Phony peach and peach mosaic surveys indicated that no infection had occurred during the past season. The low incidence of phony infection indicates excellent control of this potentially serious disease for Missouri growers. If this situation repeats itself for two additional years, Missouri can be removed from quarantine.

Information on virus spread in nursery and orchard trees has been limited primarily to indexing nursery and scion block trees this year.

In addition to stem pitting and the scar skin disorder, we appear to have infection resembling chat fruit,

flat apple, rubbery wood and rough skin in apple and vein yellows, red mottle and stony pit in our pears. The incidence of infection does not seem to be very high but more work needs to be done on these disorders. (Project 68)

#### Horticulture Farm Staff

##### DEPARTMENT OF HORTICULTURE

##### Report of Progress:

Completed residence for farm worker. Cleared additional land on banks of the stream draining into the 30-acre lake. Continued fence construction around farm. It is now approximately two-thirds completed. (Project 116)

#### Commercial Culture of Truck Crops and Greenhouse Vegetables

V. N. LAMBETH

##### *Improvement of Commercial Sweetpotato Production:*

Ten varieties and advanced breeding lines were tested in a replicated field planting at the Horticulture Research Farm near Franklin, following testing procedures of the Cooperator's Field Test Committee. An additional 10 lines were observed in a separate planting. Good evaluations were obtained for type and performance of characters.

The most promising new entries in the Missouri tests were: Clemson 607, L-3-77, 1-364 and HM-288. Performance and/or quality of Md-29-10, B6455, L-1-80 and HM-122 were so poor it was suggested they be dropped from further trials. A detailed report of the Missouri tests was forwarded to Dr. C. E. Steinbauer of the U.S.D.A.

Several new techniques were tested and proposed for maintaining seed rootstock with minimum levels of internal cork infection. Seed was increased to four new varieties to provide foundation stock within the state.

##### *Cultural Practices for the Processing Tomato Crop:*

Ten STEP entries and 30 breeding lines and hybrids of processing types were tested at Franklin. Under good fertilization and irrigation practices, yields ranged to 28.5 tons per acre and large varietal differences were apparent.

Again as in previous years most entries far exceeded Rutgers, the "standard" processing variety, in yields. Of the STEP entries, 275 and F<sub>1</sub> from North Carolina were outstanding at this location. As in 1956, Mo. 13-S-28 and 13-S-15 were the best genetically stable lines.

An F<sub>1</sub> hybrid of Mo. S-15 X Early Red (Sioux) possessed an unusually good combination of desirable type and performance characteristics. Several additional good hybrid combinations were noted. All varieties, hybrids and breeding lines were screened for resistance

to Fusarium wilt (race 1) and evaluated for resistance to fruit cracking and for fruit shape and color.

#### *Cultural Practices to Improve Irish Potato Yields and Storage Keeping Quality.*

As a participant in the North Central Regional Irish Potato Trials, the Missouri station evaluated 22 varieties and advanced breeding lines, including the standard varieties Triumph, Cobbler and Pontiac.

Cool, rainy weather in March delayed sprouting and reduced yields, however, significant yield differences were found. The most promising entries included Michigan RI39-9, B926-9, ND2906-1, I-801-10 and B605-10.

A high percentage of vascular discoloration was apparent in B595-76, Wisc. 143.52. Nebr. 82-49-1X was very high in specific gravity, 1.082 compared to 1.064 for Red Pontiac. (*Project 121*)

### Culture of Stone Fruits

A. D. HIBBARD

#### *Peach Varieties*

New varieties were added to bring the total number of varieties of 55. Most of these have completed two years of growth and have set a crop for fruit buds for 1958.

#### *Fruit Thinning:*

Thinning sprays of naphthalamic acid (A. C. P. Peach Thin) were applied during the late bloom period to determine the most favorable time of application. The trees used were three years old and of the Redhaven variety.

The sprays were applied at the rate of 200 ppm when 75 percent of petals were off April 23; when 95 percent of the petals were off, April 25, and eight days after full bloom at 300 ppm, April 30.

This last treatment produced severe foliage modification, as evidenced by many sickle-shaped leaves folded along the midrib. The trees had evidently recovered fully by May 24.

Set count on May 25 indicated that the sprays applied before the petals had completely fallen were effective in thinning whereas the higher concentration one week later resulted in an increased set. Fruit count and yield data at harvest indicated that the spray applied at 95 percent petal fall produced the most desirable type of thinning without materially reducing yield but causing an increase in fruit size.

The earlier application produced a more severe thinning and accompanying yield reduction. The spray one week after full bloom increased fruit set and total yield, but fruit size was reduced drastically. No general inference can be made from these trials since the trees were very young and represent only one variety in a particular

season.

A block of the Loring variety, which is to be used for soil management studies, made satisfactory growth during the second season. These studies will be initiated at the close of the 1958 growing season.

Differential pruning treatments were applied to trees for a thinning experiment on a split block design. Four intensities of pruning were given as follows: (1) no pruning, (2) light, a corrective type with one-half pounds of wood being removed, (3) moderate, with one pound of wood removed, and (4) heavy, in which two pounds of wood were removed.

The light pruning treatment apparently stimulated a slight increase in yield while the moderate and heavy treatments caused a slight loss in total production and size of fruit. The effect on total yield was much greater than that on individual fruit size. (*Project 126*)

### The Breeding, Improvement and Testing Of Vegetable Varieties

V. N. LAMBETH, J. L. PEARSON, A. D. HIBBARD

#### *Objectives:*

A. To breed disease resistant watermelons for commercial production in Missouri.

B. Evaluate wilt resistant hybrids of *L. pimpinellifolium* X *L. esculentum* and breed for improved horticultural characteristics.

C. To study adaptability of varieties of sprouting broccoli.

Trials of varieties and strains were conducted in cooperation with the Southern Region. Of the newer varieties Blackstone is the most promising and is suggested for those localities where a Black Diamond type is desired and wilt is serious.

The lines, Miss 17-17, Louisiana I (Summit), and Ark. 56-21, were also quite promising for this type of melon. Georgia 4 was a very good icebox type. The Bush Dessert King was outstanding in resistance to leaf disease. The bush (short internode) habit may be of value in breeding.

The Missouri line, BD 33, was grown in a seed increase plot. Sufficient seed was secured for extensive field trials. This line appears to have excellent commercial possibilities as well as resistance to fusarium wilt. Progress was made in developing watermelon of the icebox type. The golden rind color was introduced into several lines of this type. Also, crosses were made to secure the bush growth habit.

Trials were run on a number of green-fleshed cantaloupe varieties to determine their adaptation to Missouri conditions. The varieties Rocky Ford and Gold Line Rocky Ford appear to be most promising for our conditions and are recommended to growers who wish to grow melons of this type for a specialty market.

Variety 40-50, a selection out of mildew resistant 45

appeared to be best of the yellow-fleshed types for commercial production. With this type the market requirement should be carefully considered. (*Project 128*)

### Physiological Mechanisms of Reproduction In Horticultural Plants

R. B. NEVINS, D. D. HEMPHILL

#### Objectives:

A. To learn effects of growth-regulating substances and cold treatment on flower bud differentiation in tomato.

B. To study effects of growth-regulating substances on fruit set.

C. Investigate physiological relations in the rest period of fruit buds.

D. Study the influence of Gibberellins and Kinetin on reproductive and vegetative processes in certain horticultural plants.

Plots of tomato seedlings were subjected to night temperatures of 50° F and 65° F, for three weeks beginning with the first appearance of the true leaves.

Cold treatment (50° F) gave no appreciable increase in flower initiation.

Gibberellins and N-m-tolylphthalamic acid treatments gave a marked increase in the number of flowers in the first and subsequent clusters. Marketable yield of fruit was not increased by these treatments due to a failure of many of the fruit to reach a marketable size (3 oz.). Gibberellins did not increase flower bud formation.

Similar results were obtained in both fall and spring crops.

p-Chlorophenoxyacetic acid and 2,4-dichlorophenoxyacetyl methionine increased set of tomato fruit in fall, but not in spring crops. The presence of several growth-regulating substances in dormant peach buds has been confirmed. Preliminary work has been done on enzymatic studies of apple buds through their dormant period to determine their terminal oxidase and phosphatase activities and protein and non-protein nitrogen contents at periodical intervals during the dormancy period.

Gibberellins and Kinetin had no effect on flowering of bulb crops. Gibberellins increased length of flower stem in african violets, chrysanthemums, gloxinias, tomatoes and strawberries. Quality and number of flowers were not improved.

Gibberellins increased growth of several species of ornamental shrubs, but growth was undesirable—"leggy" and chlorotic. (*Project 129*)

### Control of Weeds in Horticultural Crops

D. D. HEMPHILL

#### Objectives:

- A. To evaluate chemicals for use in grape vineyards.
- B. To evaluate chemicals for use in strawberry plantings.
- C. To evaluate chemicals for use in vegetable and flower crops.
- D. To evaluate chemicals for the control of lawn weeds.
- E. To evaluate chemicals for the use in weeds around apple trees.

Simazin (2-chloro-4,6 bis (ethylamino)-S-triazone) gave effective weed control in vineyards without evidence of injury. Diuron (3,4-dichlorophenyl)-1-1, dimethyl urea) and CIPC (isopropyl-N-(3 chlorophenyl) carbamate continue to give favorable results and are presently recommended.

EPTC (ethyl N, N-di-n-propylthiolcarbamate), CDAA (2-chloro-N,N-diallylacetamide), and 3Y9 (tris 2,4-dichlorophenoxyethyl phosphite) compared favorably with 2,4-DES (sodium 2,4-dichlorophenoxyethyl sulfate) for weed control in strawberry plantings.

Sixteen chemicals were evaluated as herbicides in vegetable crops. New promising results: NPA 20G in sweet potatoes; CDEC and G-27901 (2-chloro-4 diethylamino-6 ethylamino-S-triazine) in transplanted tomatoes; CDEC in snapbeans.

Alanap IF gave most satisfactory preemergence control of crabgrass while Methar (disodium methyl arsonate pentahydrate) gave most satisfactory post-emergence control.

Diuron and Simazin gave excellent control of weeds around young apple trees. Aminotriazole gave excellent kill of poison ivy, horse nettle as well as most other plant species beneath bearing apple trees. (*Project 146*)

### Promotion of Horticulture

R. A. SCHROEDER

Report of research findings and recommendations were given to the horticultural crop producers in the state through the following department publications: Horticultural News, Floricultural News, Vegetable News, and Weekly Spray Letter.

Apple merchandising work, bringing producer and buyer in touch with each other is accomplished with an up-to-date availability-of-apples letter.

Staff members also attend many horticultural meetings and present information of interest to producers and other research workers and assisted with short courses in the fields of floriculture, landscape gardening, vegetable growing and fruit production. (*Project 169*)

### Downy Mildew and Black Rot Control on Grapes

H. G. SWARTWOUT

Ferbam with and without glyodin, zineb, maneb, phaltan and cyprex; and bordeaux, 2-2-100, in the summer sprays following early applications of ferbam, were

evaluated for the control of black rot and downy mildew. The season was unusually favorable for the development of both diseases.

In general, ferbam and cyprex reduced the incidence of black rot to less than  $\frac{1}{3}$  of 1 percent as compared to about 50 percent infection on unsprayed controls. Zineb and maneb plots ran about 2 percent black rot. With ferbam early and bordeaux in the summer the incidence of black rot was about 3 percent.

Ferbam gave poor control of downy mildew, zineb and maneb almost complete control, phaltan and cyprex good control, while bordeaux during the summer held the disease from time of application. The addition of glyodin to ferbam had no effect on the control of either disease.

Cyprex at  $1\frac{1}{4}$  pounds caused light foliage injury and moderate to heavy fruit injury, bordeaux foliage injury was light to moderate; leaf injury from maneb was trace; phaltan leaf injury was moderate to rather severe. (*Project 194*)

### Hormone Sprays for Fruit Thinning and Control of Preharvest Drops

D. D. HEMPHILL

#### Objectives:

A. To determine effectiveness of naphthylacetamide and naphthaleneacetic acid in thinning apples.

B. To determine effectiveness of N-1 naphthylphthalamic acid in thinning peaches.

Temperatures below 32°F. during bloom resulted in poor fruit set and in most cases effects of naphthylacetamide were accentuated to the extent of overthinning. Due to low temperature late applications of naphthaleneacetic acid were not made.

In experiments with three year old Red Haven peaches N-1 naphthylphthalamic acid 200 ppm applied 2 days after full bloom gave satisfactory thinning, while a higher concentration, 300 ppm, applied eight (8) days after full bloom caused leaf modification and increased fruit set. (*Project 195*)

### Response of Vegetables to Established Cationic Saturation Levels on Low Exchange Soils

V. N. LAMBETH, A. W. PURDY, E. R. GRAHAM

#### Objectives:

To evaluate cation exchange capacity of vegetable roots.

Preliminary investigations were made of the cation exchange capacity of two vegetables in an attempt to explain in part the differential responses by different plant species to identical nutrient concentrations. Seminole snapbeans (a legume) and Golden Bantam sweet corn (non-legume) were compared, using plants of comparable age.

Seedlings were grown in granite gravel periodically flooded with modified Hoagland's nutrient solution. After 14 days, the plants were removed and the roots carefully washed in distilled water.

Groups of 25 uniform seedlings were selected, bathed successively in 0.01 N HCl for 10 seconds, saturated Ca (OH)<sub>2</sub> for 30 sec., and 0.01 N HCl 10 seconds. A distilled water bath followed each bath. Cations were quantitatively determined by spectrographic methods and expressed as m.e./100 gm. dry weight of root tissues.

By this procedure, the cation exchange capacity (C.E.C.) of the bean was found to be 22.9 m.e./100 gm. and that of sweet corn 19.7 m.e. These values are of the same order as those found by other workers using electro-dialysis methods. (*Project 196*)

### Pesticides for Disease Control and their Effect on Fruit Finish in Apples

H. G. SWARTWOUT

#### Objectives:

To evaluate from standpoint of disease control and phytotoxicity, several experimental fungicides which screening tests have indicated may be useful in spraying apples.

Cyprex gave excellent control of apple scab, but was only moderately effective against cedar rust on Jonathan leaves. Finish was excellent on Delicious (also Starking) and Jonathan, but the material appreciably increased the severity of russet induced by frost on Golden Delicious.

Necrotic spotting of Delicious leaves ranged from light to moderately heavy from Captan-sulfur combinations early in the season. A similar spotting in light intensity appeared with Captan-Karathane ( $\frac{3}{4}$  lb.) combinations, but was absent in captan-zineb combinations. Intensity varied in the direction of greater tree vigor. This is the first time necrotic spotting of leaves from captan alone or in combination has been noted in Missouri.

Karathane at  $\frac{1}{4}$  pound with and without 2 ounces Triton B1956; at  $\frac{1}{2}$  pound with Triton and at  $\frac{3}{4}$  pound with Triton caused no noticeable injury to fruit or foliage of Jonathan, Delicious and Golden Delicious. Temperatures, however, were low for a good evaluation of Karathane injury. Karathane effectively suppressed sooty blotch, but with indications of short residual protection. Glyodin as a wetting agent for Karathane materially increased russetting of Golden Delicious. No powdery mildew was present. (*Project 232*)

### Technology of Apple Products

M. R. JOHNSTON, J. D. EDWARDS, NEIL FINLEY

#### Objectives:

A. To develop a technique for making frozen concentrated apple cider.

*B. To develop a continuous mechanical device for apple juice extraction.*

The varieties Jonathan, Ben Davis, Staymen Winesap, York Imperial, Winesap, Golden Delicious and Rome Beauty were characterized for acidity, sugar, flavor and aroma. The order of varieties listed was found to be the descending order for tartness by Paired-Comparison Method with a balanced incomplete block design.

Flavor (aroma) ranking of the varieties from the same design was Jonathan, Ben Davis, Golden Delicious, Winesap, York Imperial, Rome Beauty and Staymen Winesap. Further studies of yeast fermentation of apple juice with strains Y-1081, Y-1683, Y-1485 (*E. vernalia*) and Y-1062 (*E. vernalia*) have not indicated any way of increasing the flavor and aroma production by these organisms.

A vacuum single-effect evaporator was designed and fabricated of pyrex glass. Test runs to determine its operating characteristics have been completed and they are as follows:

1.8 liters water per hour evaporating capacity from apple juice; 54 mm Hg. pressure; 38°C product temperature; 150° F water temperature for heat source; condensing temperatures 65, 34 and 10°F and apple juice circulated at 65° Brix by heat pump effect.

B. Visited with Mr. A. H. Brown, Western Utilization Research and Development Division, A. R. S., U. S. D. A. concerning his group's approach to the apple juice extracting problem. (*Project 233*)

### Technology of Irish Potato Products

M. R. JOHNSTON, NEIL FINLEY, J. D. EDWARDS

*Objectives:*

*A. To determine the relative storing qualities of irish potato varieties and the effect of several treatments on these varieties.*

*B. To study the factors affecting the texture and color of mashed potatoes during preparation, freezing and frozen storage.*

Irish potatoes, variety Red Warba of size 2¼ to 2½ inches were stored at 45° F and 65 percent R. H. in 5 pound sample replicates. Package types used were 15 mil perforated, 15 mil sealed (low density) and 15 mil sealed (high density) polyethylene bags.

Antimicrobial agents used were: sorbic acid; tetrachloroethylene griseofulvin; terramycin; aureomycin; two and three way combinations of first three with terramycin and aureomycin; streptomycin-ilotycin; oligomycin; terrachlor; citric acid and control (distilled water). Bacteriological examination using four differential media were made during a 7-week storage period and two quality (usable wt.) examinations were made during 4 months storage.

The bacteriological data strongly indicated that in addition to the direct effect of an agent on a group there is found an indirect stimulation of another segment of the microflora. Aureomycin and terramycin gave good control of coliform and related micro-organisms, but they stimulated the yeast population.

Streptomycin-ilotycin combinations had the lowest anaerobic bacteria; coliform bacteria and total population by nutrient medium but its yeast population was high though not as high as aureomycin and terramycin. Bacterial "soft-rot" was not found to be the cause of loss during storage, but a yellow and black mold did cause soft and dry rot, respectively. Total samples prepared and examined were 540. (*Project 234*)

### Bacterial Spot, Brown Rot and Peach Scab Control and the Effect of Newer Pesticides Upon Fruit Finish of Peaches

H. G. SWARTWOUT

*Objectives:*

*A. To evaluate some of the newer fungicides in the control of peach leaf curl, peach scab and brown rot and their effects upon fruit finish.*

Captan gave fruit of better finish than wettable sulfur. Wettable sulfur of 5 micron particle size at 6-100 in early sprays and at 4-100 in summer sprays gave a dulling of the fruit on the sun exposed side and in some cases a brownish discoloration of the skin. Very little peach leaf curl developed on trees that had received captan 2-100 and wettable sulfur (with parathion) the previous year.

Sulfur was a little more efficient than captan. On check trees and nearby trees not sprayed the year before almost 100 percent of the early leaves eventually became affected with curl. (Secondary infection was extensive the spring of the current year).

Both sulfur and captan on a two-week schedule gave complete control of peach scab while Omadine (zinc salt) gave poor control. No brown rot developed in any of the plots. (*Project 243*)

### Horticultural Pathogens

M. N. ROGERS, D. F. MILLIKAN

*Objectives:*

*A. Identify and recommend control measures for any epiphytotic that would seriously threaten a horticultural crop.*

*B. Study the etiology, symptomatology and control of new diseases of ornamental plants.*

Approximately 75 letters were answered concerning diseases affecting horticultural crops. In addition several trips were made to examine conditions that could not be covered by mail. Three disorders were recognized and are listed below.

*Crown Rot of Forsythia:* The exact organism associated

with this disease has not been positively identified. One imperfect fungus has been isolated but pathogenicity trials are incomplete. Crop rotation appears to offer the best solution for this trouble.

*Crown Rot of apple:* This trouble has reappeared during the past season on newly planted trees. Although a fungus could be isolated from the diseased trees, this proved to be secondary rather than the primary cause for the disease. The use of a weak Bordeaux (4-4-50) drench around the trees prior to irrigating arrested the disease. Cankers on mature trees in the same orchard proved to be incited by *Botryosphaeria ribis*.

*Limb Canker on Peach:* The description in writing of this disease proved to be quite misleading. An examination indicated that the trouble was horticultural rather than pathological. Lesions noted on the upper surfaces of the scaffold branches were diseased; but occurred primarily because of poor pruning practices.

His habit of opening the centers invited sun-burn, which in turn killed tissue. This invited entry of fungus pathogens that would girdle the entire scaffold branch. An improvement in his pruning techniques will control this disorder.

Experiments were carried out to determine the effects of certain bulb treatment chemicals, soil fungicides, removal of basal roots and growing temperatures upon the growth of the plants and severity of root rot symptoms on potted Croft lilies.

The soil was not artificially infested with the pathogen and since there was a very low incidence of severe root rot in the untreated bulbs grown under normal conditions, no statistically significant differences were found in root rot development.

Plant growth and bud count, however, were reduced by both soak chemicals, formalin and mercuric chloride, and by root removal. One soil fungicide, zinc omadine, caused a reduction in plant weight, but no decrease in height or flower count. Growing temperatures other than 60° F resulted in differences in flowering time and plant growth. (Project 258)

### Chemical Inhibition of Plant Virus Diseases

R. E. BROWN, D. F. MILLIKAN, R. E. HENDERSON

#### *Physiology of virus reproduction:*

Our approach to this study has been restricted to a correlation of virus infection with nucleic acid synthesis. This is a logical approach inasmuch as recent work indicates that the nucleic acid residue of the virus molecule may be the essential part for infection.

Unfortunately, the difficulties encountered in this work have been extremely vexing and workable methods to extract the nucleic acids from plant tissues have been difficult.

During this past year a modification of perchloric acid extraction (J. Histochem, Cytochem. 4:1) has given good quantitative results. Improvements have now been made so that the method appears to be reproducible but we are still experiencing difficulties in separating DNA and RNA. We are hopeful that these difficulties may be overcome so that we can direct our efforts from quantitative studies to qualitative ones.

#### *Antimetabolite studies:*

This work has been hindered due to the difficulties mentioned above. We feel that our most promising leads lie in the use of certain structural analogs of folic acid, amino acids, purines and pyrimidines. Since these compounds seem to be effective in blocking nucleic acid synthesis, we feel that it is essential that our methods to determine nucleic acids be perfected first. (Project 285)

### Problems in Small Fruit Culture

D. D. HEMPHILL

#### *Objectives:*

A. Evaluate new strawberry varieties.

B. Improve strawberries through breeding.

C. Evaluate blackberry and raspberry varieties.

D. Determine causes of sterility in blackberries and develop methods of control.

Thirty-four varieties and numbered selections were set in 1956 and fruited in 1957. Earlidawn and Redglow, new U. S. D. A. introductions appeared promising.

Approximately 3,000 seedlings fruited in 1957 from crosses made in 1955. Thirteen selections were made from this group. Thirty-nine selections are presently under test.

C. Early Harvest and Jersey Black continue to be the most promising blackberry varieties. Marion was the outstanding raspberry variety in 1957 yields.

D. Early Harvest blackberries united to a wild sterile selection continued to exhibit sterility conditions of the wild strain. Grafts were made involving a number of varieties. (Project 291)

### Greenhouse Flower Crop Production

J. E. SMITH, M. N. ROGERS, GERALD COORTS

#### *Objectives:*

A. Determine relation of soil analysis to flower production and quality.

B. Study greenhouse cooling and its effects on flower production.

C. Determine factors affecting the keeping quality of cut flowers.

Visual toxicity symptoms were studied and recorded for calendulas, carnations, chrysanthemums, poinsettias, roses, snapdragons and stocks in various levels of manganese; weights and spectrographic analyses were made. A condition similar to iron deficiency is typical for man-

ganese excess and at higher levels is manifested by discoloration and necrosis of the midribs and scattered necrotic spots.

Suppression of terminal growth is also noted at the extremely high levels. Optimum growth in all plants was attained at 1 to 5 ppm. Mn in solution, with about 200 to 300 ppm. Mn accumulating in the tissue.

Six varieties of snapdragons were grown during the summer in houses equipped with fans alone, fans plus wet pads and fans plus low-pressure mist. The treatments resulted in no significant differences in flowering time, but plants cooled by fans plus wet pads were shorter and lighter in weight than those grown under the other two treatments.

Other plants of the same varieties grown in pots in the house cooled by fans plus wet pads were subjected to short day treatment, supplementary illumination all night at 200 to 300 f.c. using mercury vapor lights and normal day lengths.

Those plants receiving short day treatment were significantly taller and heavier but required longer to flower than plants in the other two treatments.

Plantings of the six entries in the National Snapdragon Society Nationwide Summer Trials were grown in the air cooled greenhouse in comparison with other commonly grown varieties. Three of the entries exhibited exceptional merit under our conditions by producing flowers of almost winter quality at a season of the year hitherto considered quite unfavorable for snapdragon production.

During the fall, further study was made of the effects of additional lighting and short day treatment on timing and quality of snapdragons. Lighting plants in the seedling stage within the first month after potting results in earlier flowering, but reduced grade of product. Short day treatment has the opposite effects. Continuing experimental work is underway to determine plant reaction to these treatments at all seasons of the year.

Five varieties of snapdragons were grown in three greenhouse environments: (1) fan exhaust, (2) low pressure mist and (3) air-cooled by wet pad. Those grown in

environments (1) and (3) (145 hours average). (Project 293)

## Market Quality of Processed Missouri Vegetable Products

M. R. JOHNSTON, J. D. EDWARDS, NEIL FINLEY

*Objectives:*

A. *Correlate the factors of raw produce quality as to their resulting influence on market quality of processed vegetables.*

B. *Ascertain the time interval at which vegetable crops will remain at optimum maturity for a given processed quality grade.*

Raw and market quality factors were evaluated during the year for canned tomato pulp; canned and frozen sweet potatoes and frozen broccoli, kale, okra and spinach.

Tomato pulp samples from breeding lines and harvest dates (32 variables) were analyzed for total solids, titrable acidity, color by reflectance, citrates, iron, sodium, potassium, calcium, magnesium and manganese as to their association with pH and tartness by taste test.

Sweetpotatoes, two varieties and ten breeding selections, were evaluated organoleptically for color, texture, flavor in the canned and frozen form.

Preliminary evaluation of maturity and quality of frozen broccoli (5 varieties) and kale (3 varieties) was made by size measurements, ascorbic acid content, total solids, color and shear press values. Approximately 180 broccoli and 100 kale samples were prepared and examined. Field records of air and soil temperature and soil moisture are being associated with maturity and quality changes. With advancing maturity in kale, a decline in ascorbic acid content was found.

The association of maturity to quality in frozen okra and spinach was made by the methods indicated for broccoli and kale. In addition the determination of iron, sodium, potassium, calcium, magnesium and manganese content was completed. A total of 12 okra and 30 spinach samples were prepared and examined. (Project 295)

# Poultry Husbandry

E. M. Funk, Chairman

## Nutritional Requirements of the Chick

J. E. SAVAGE, E. M. FUNK

*Objectives:*

A. *To determine the amino acid requirements of the chick for maximum growth.*

B. *To determine the requirement of the chick for unrecognized growth factors.*

A fast growing strain of White Rocks was used to study the requirements of heavy breed chicks for arginine. In studies done several years ago fast feathering breeds

such as White Leghorns had a higher requirement for this amino acid than the slower feathering heavy breeds. Many of the broiler feeds in use at the present time are calculated to be on the borderline with respect to arginine content as measured by the requirement of White Leghorns. More information is needed on the requirement of fast growing, fast feathering meat strain birds for arginine and the related compounds, glycine and creatine.

When the broiler strain chicks were fed a practical type diet that was calculated to contain sub-optimal levels of 1.25 percent of arginine and 1.0 percent of glycine, additional supplements of these amino acids did not improve growth.

When the basal ration was further modified to contain only 0.95 percent of arginine and 0.65 percent of glycine then both arginine and glycine supplements improved growth. Creatine was not as effective as either of the amino acids as a growth stimulant.

Further studies are necessary with the practical type diet calculated to have sub-optimal arginine content. It is not known whether the lack of response to arginine in this diet is due to an ingredient which spares arginine or whether it is simply a case of more of the amino acid being present in the corn and soybean meal than published analytical values would indicate.

#### *Unidentified Growth Factor Studies*

A limited number of observations indicated that the zinc content of practical broiler rations may be on the border line with respect to the amount of zinc required by the chick. In three out of four battery trials zinc supplements slightly improved the growth of broiler strain chicks. This observation is of considerable significance in view of the reports that much of the unrecognized growth factor activity of certain crude supplements is found in their mineral or ash fraction. (*Project 277*)

#### **Rations for Laying Hens**

J. E. SAVAGE, E. M. FUNK, R. M. O'NEAL

*Objectives, to study the:*

*A. Effect of changing the energy level of the ration on the productive performance of laying hens.*

*B. Effect of unidentified nutritional factors on hatchability.*

*C. Effect of maternal diet on performance of progeny.*

Leghorn and Leghorn x Red Crossbred pullets in their first year of production were fed rations that differed by approximately 100 calories of productive energy per pound.

The average egg production of hens that received the 800 calorie ration for the October-June period was 62.7 percent with 5.53 pounds of feed required per dozen eggs. The egg production of similar hens that received the 900 calorie ration during this period was 61.1 percent and 5.33 pounds of feed were required per dozen eggs.

The increase in energy content improved the feed efficiency but did not improve egg production.

It appears that the laying hen has a rather wide tolerance for feed energy levels and can maintain equal production rates on diets that differ by as much as 100 calories per pound or more. Feed required per dozen eggs is a function of energy level and decreases as the energy level increases.

In studies with the free choice system of concentrate and grain feeding it was found that egg production on a 32 percent protein concentrate with corn and oats fed free choice was equal to the production of hens that received a 20 percent mash and limited amounts of hand fed grains.

The addition of trace minerals, "unidentified factors" and vitamins E and K to the rations of broiler strain hens did not improve either egg production or hatchability. An antibiotic supplement improved both egg production and hatchability.

No maternal transfer of either "unidentified growth factors" or improved chick growth due to the presence of an antibiotic in the hens diet could be demonstrated. (*Project 255*)

#### **Factors Affecting Growth and Feed Efficiency in Broilers**

J. E. SAVAGE, E. M. FUNK

*Objectives:*

*A. To study the effect that crystalline amino acids, agricultural by-products, and sources of unidentified growth factors have on growth, feed efficiency and cost of production of broilers.*

It was found this last year (O'Dell and Savage, Poultry Science 36: 459-460, 1957) that in purified diets zinc was responsible for most of the effect of zinc in a practical broiler ration were carried out. Texas workers also reported this last year that molybdenum was also of importance in chick rations and this element was added as a supplement in one series.

The basal diets used for the trace mineral and unidentified growth factor studies were corn-soy diets fortified with the necessary vitamins, minerals, methionine and a coccidiostat. It is apparent that molybdenum did not improve either growth or feed efficiency. The zinc supplement improved growth and feed efficiency slightly but this difference was not significant. The mixture of unidentified growth factors produced a significant increase in chick growth rate.

Since molybdenum appeared to be ineffective a second trial was conducted to study the effect of the zinc and unidentified factor supplements in more detail. In this second trial the basal ration used in trial I was modified to include 3 percent of animal fat as a source of additional energy.

Duplicate lots of 50 sexed White Cornish x White Rock cross male chicks were started on each ration. The test period was for 8 weeks.

It is apparent that the results of this second trial are in agreement with the first. The zinc supplements again produced a slight but insignificant increase in growth and the unidentified supplements significantly improved growth over the basal. The improvement in growth caused by the unidentified factor supplement is particularly striking, in view of the performance of the birds on the basal diet. The average weight of the basal fed birds was over three pounds and their feed efficiency 2.14 at eight weeks of age. Further studies with these supplements are necessary. (*Project 24*)

### Relationship of Egg Composition to the Preservation and Utilization of Shell Eggs and Egg Products

O. J. COTTERILL, E. M. FUNK, F. A. GARDNER,  
F. CUNNINGHAM

*Objectives, to study:*

A. Influence of season and age of bird on shell egg composition.

B. Importance of various handling methods and treatments toward retaining quality.

C. Role of chemical additives in altering the functional properties of egg white.

The chemical composition of egg white produced by three age groups of birds having similar genetic history is being observed through a one year production cycle.

Age of the bird has an influence on egg white quality, white and yolk volume and possibly phosphorus concentration. The total ash chlorine, sodium, potassium and calcium contents appear to be unaffected by age of the bird (preliminary data).

The effect of "sealed bucket egg gathering" and wire basket gathering on interior quality has been compared under conditions comparable to some commercial practices.

Eggs held in a bucket for one to four days had about 10 percent higher interior quality than eggs held in a basket. This difference was still present after the eggs were removed from the bucket, cartoned and moved through the market channel.

Preliminary taste panel observations (Triangle Taste Test) indicated that flavor differences could not be detected in scrambled eggs and custards made from eggs held in sealed containers for as long as one week at 80° F.

The effect of temperature on CO<sub>2</sub> loss from infertile shell eggs was illustrated by noting the accumulation of CO<sub>2</sub> in the air surrounding eggs in glass desiccators held at 33, 40, 50, 69, 77 and 100° F. At higher temperatures more CO<sub>2</sub> was evolved. Subsequent cooling of eggs caused

a partial reabsorption of the gas.

The effect of different chemical substances on the surface tension, pH, and viscosity has been observed. This information should be useful in future studies in determining the manner whereby different ingredients alter the function of egg white in food products.

Certain limitations connected with "sealed bucket egg gathering" render the technique impractical as a generalized recommendation. However, where instructions will be followed, for example by large producers or with organized market egg programs, a 10 percent improvement in quality may be expected. (*Project 17*)

### Testing the Performance of Different Strains And Crosses of Poultry

Q. B. KINDER, A. B. STEPHENSON, E. M. FUNK

Performance testing of purebreds, strain and breed crosses, and hybrids for egg production. Ten pure lines of White Leghorns, R. I. Reds and New Hampshires were mated in 48 combinations and performance tested using four commercial crosses and hybrids as controls.

Hybrids continued to show uniformly good performance. Selected crosses between heavy breeds and White Leghorns appeared to offer more possibility in improved performance than strain cross Leghorns or crossing of two heavy breeds. (*Project 26*)

### Care of Hatching Eggs

E. M. FUNK AND JAMES FORWARD

This year's tests were designed to determine the value of adding CO<sub>2</sub> to the atmosphere surrounding hatching eggs after laying and before incubating. In other tests the eggs were held in Cry-O-Vac bags either in cases or baskets.

Increasing CO<sub>2</sub> in the air surrounding hatching eggs before incubation may be beneficial but in one test where apparently an excess of CO<sub>2</sub> was used, hatchability was depressed significantly. It is doubtful if a practical application of adding CO<sub>2</sub> to the atmosphere surrounding hatching eggs can be made.

An attempt was made to contain the CO<sub>2</sub> released by the eggs by holding them in Cry-O-Vac bags, both in baskets and cases. Hatchability was increased slightly in eggs held 1-7 days and 8-14 days when they were held in bags in cases. Apparently there was a greater CO<sub>2</sub> concentration surrounding eggs held in baskets than in cases.

Comparisons of hatching results were also made between holding eggs in cases with small end down and in baskets without regard to position. Though the eggs held in baskets hatched a slightly higher percentage of chicks the difference was not significant. (*Project 40*).

## Determination of Thyroxine Secretion Rate of Growing Turkeys

H. V. BIELLIER, E. M. FUNK

### *Objectives:*

A. Determine effects of hormones on growth and fattening of turkeys.

B. Study the value of the grain sorghum, milo, consumed on range by growing turkeys.

An experimental trial designed to test the effects of feeding thyroprotein to growing turkey poults from six to sixteen weeks of age was completed. Five hundred Thompson Large Broad White day-old poults were purchased August 21 and brooded in batteries for five weeks. The poults were transferred to the range shelter and at seven weeks of age, were weighed, debeaked and randomized into ten equal lots. A regular 28 percent turkey starter ration was fed during the brooding period.

The experimental treatments were designed in duplicate and consisted of 6, 8, 10, and 12 grams of "protamone" included in 100 pounds of basal feed. All lots were placed on treatment at the age of seven weeks.

The feeding of "protamone" at the levels used in this trial showed no benefit in growth rate of poults from seven to sixteen weeks of age. All birds were placed on a finishing ration from sixteen to twenty weeks of age to promote fat finish and marketed at the end of the period.

Sixteen hundred B. B. Bronze day-old poults consisting of four different strains were purchased May 30, 1957. All were brooded to eight weeks of age in a pole-frame brooder house. At eight weeks of age all poults except 600 were transferred to range growing area.

Seventy-five poults of each sex from each strain were grown from 8 weeks of age to market maturity under confinement conditions.

Four hundred poults of equal sexes were placed on milo range and 470 poults on grass sod range at 18 weeks of age. Birds on Milo range were restricted as to mash and grain consumption in order to increase Milo consumption from the standing plants. (*Project 72*)

## Breeding Chickens for Egg Production by Recurrent Selection and Intraflock Selection Methods

A. B. STEPHENSON, Q. B. KINDER, E. M. FUNK,  
BOBBY JONES, MAYNARD YOES

### *Objective:*

To test the conventional systems of poultry breeding by family and individual selection against the newer method of recurrent selection.

Recurrent selection is basically a top cross. An inbred male line is mated to a non-inbred or segregating female line. These parental lines may be of the same or different breeds and their progeny are referred to as test

crosses.

Selection among females of a segregating line to reproduce the parental strain is based on the test cross progeny. Since some individuals of the segregating line combine better than others with a given tester line, the recurrent selection breeding system provides a means of improving the segregating line each generation for specific combining ability.

### *Performance from 1951 through 1955.*

Over this six-year period a comparison of the test crosses with the intraflock Leghorns as a control has shown about 10 percent lower fertility. This condition is probably partially due to the use of inbreds as the male parent. Inbred birds are not usually very vigorous. Hatchability of fertile eggs has been the same for both groups although there has been considerable yearly variation.

Viability for the crosses has averaged 1 percent less during the brooding and rearing period and three percent less in the laying house. Considering the large yearly variation no significance is attached to these small differences in livability. Weight at eight weeks was only one percent greater for the crosses. Since one parent in all crosses is of the American class a greater difference would have been expected.

One recurrent selection combination consistently gave pullets smaller (about 6 percent) at eight weeks. This slow growth rate up to eight weeks was later overcome so that at 22 weeks this particular cross has averaged nine percent above the Leghorns. The means of all crosses was 11 percent above the Leghorns. Body weights in January were 14 percent greater for the crosses than for the Leghorns.

Over this same six-year period egg weights have been consistently heavier for the crosses by about three percent. Age at first egg has shown considerable variation and averaged two percent later for the crosses.

An earlier age at first egg has usually been observed in crosses where the Leghorn was the male parent. The crosses with the Leghorn as the male parent usually result in higher laying house mortality than the reciprocal cross. Production from first egg over the last three-year period has averaged 4 percent more for the crosses.

This value was relative to the intraflock Leghorn as 100. The percent increase in actual rate of production was about 2.5 percent ( $.04 \times 64\%$ ). The difference in production between the crosses and control was increased by the superiority of all crosses in 1956.

Production from 22 weeks of age has averaged two percent less for the crosses in general. The fact that the crosses showed an advantage when production was calculated from first egg and a disadvantage when calculated from housing was influenced by slightly later sexual maturity for the crosses. These two rates are not exactly

comparable since in some instances different birds and years were involved.

Recurrent selection as a breeding method, with the stock hatched from 1950-55, has given some improvement, if one assumes no environmental change. However the rate of improvement with recurrent selection has been less than with family and individual selection in the Leghorn line which was considered as a control.

In this control line production has had an average increase of about one percent per year. The improvement by recurrent selection was in addition to the heterosis of the first generation top cross.

#### *Performance in 1956.*

The data on chicks hatched in 1956 agreed with those of previous years in that the crosses had lower fertility, heavier body size, lower viability on range, greater egg weight, and approximately the same age at first egg. This year's data differed in that crosses, when compared to the intraflock Leghorns, had better hatchability and about the same viability during brooding and laying.

The most outstanding difference this year is that crosses equaled or exceeded the control Leghorns in egg production with a range of 0 to 18 percent from first egg. This year is the first time the test crosses as a group have laid at a higher rate from housing.

A respiratory infection during the test year seemed to be more serious among the Leghorns. It is probable that a difference in exposure and/or resistance to this disease is partially responsible for this difference in egg production. (*Project 164*)

### Systems of Flock Replacement

Q. B. KINDER, E. M. FUNK

#### *Comparison of confined and range reared pullets for egg production:*

The second year's work on this project was in agreement with the first year study which indicated faster growth rate, earlier sexual maturity and higher feed efficiency in confinement reared pullets. There was no difference in the percentage of pullets suitable for housing. Subsequent egg production favored the range reared birds by +1.9 percent from housing and +3.5 percent from sexual maturity. There was no difference in adult mortality, body weight or egg weight.

#### *Development of an "all in one" poultry unit:*

The use of three hatches per year with brooding, growing and laying facilities in the same building did not adversely affect livability of the birds or egg production. Seasonal effects of date of hatch appeared to influence egg production and culling rate with the February hatch showing the best performance. Date of hatch had a marked influence on egg size pattern in relation to age

of bird. The use of three broods per year tended to smooth out yearly production and produce a more uniform flow of various size grades of eggs; however, production was below average from August through November.

#### *Keeping yearling hens in laying shelters an additional 3-4 months:*

Moving 76.5 percent of the original number of hens to laying shelters after 11 months of production in regular laying houses resulted in an average of 55.1 percent hen day production for the additional 140 day period when accompanied by once per month culling.

Average number of birds for test period was 79.1 percent of number moved to shelters. Eggs graded 84.8 percent large and extra large. Feed per dozen eggs was 6.0 pounds. Income over feed cost was estimated at \$1.25 per bird moved to shelters for 140 day period. (*Project 244*)

### Photoperiodicity and Age on Chicken Reproduction

H. V. BIELLIER, E. M. FUNK

Forty-eight S. C. White Leghorn hens were maintained in cages within a "light-tight" basement room. An automatic oviposition recorder recorded the time of lay every 15 minutes throughout the laying year. The experimental trial was begun September 16, 1956, and was terminated July, 1957. The day periods made up of one-half artificial light and one-half total darkness for two-week intervals were as follows: 24, 23, 22, 21, 24, 25, 26, 27, 28, 29, 30, 32, 34, 36, 38, 40, and 42 hours.

The duration of the total amount of light and darkness making up a test day had a direct effect upon time of oviposition. Days of less than 24 hours had the effect of shortening the egg clutch and increasing the number of days skipped in egg production between clutches.

Day lengths from 26 to 32 hours caused the oviposition to occur in the period of darkness. All day lengths of 25 hours duration or greater increased the clutch length and maintained a higher percentage of hens in egg production.

These results show that the optimum day length to maintain maximum egg production is somewhere between 24 and 27 hours for the breeding and ability to lay of the hens used in this trial.

A second trial is under way.

During the year of 1957 a trial was made of 1500 S. C. White Leghorns and Leghorn x heavy breed cross hens during their second year of egg production. The hens were transferred from their regular laying quarters and randomized into five pens of a summer laying shelter from June 17 to June 24, 1957.

A 20 percent laying mash was kept before the birds at all times. Grain was hand-fed daily. All pens were

culled periodically to remove non-layers. All pens were subjected to regular daylight in addition to the various artificial light treatments. Artificial light was begun June 27 and continued to December 1, 1957. Two pens received a constant total of 14 hours of natural and artificial light and two others received a constant total of 16 hours of natural and artificial light. A fifth pen received no artificial light and served as the control lot.

The unlighted control pen laid well during the months of June, July, August, and September, but began to decline rapidly about the first of October. The other two groups declined more slowly and were still laying at a 47 percent rate in December, compared with 34 percent for the controls. (*Project 292*)

### **Thyroid Activity of Chicken Laying Hens as Affected by Age, Season Level of Production, Ambient Temperature and Light**

H. V. BIELLIER AND E. M. FUNK

#### *Objective:*

*To determine the level of thyroid gland activity of laying hens as related to age, season, and rate of egg production.*

This project was submitted in June of 1957. Work was begun in preparation of housing facilities, equipment, and experimental birds. Thyroid rate determinations are to be collected during the spring laying season (1958). (*Project 296*)

### **Factors Affecting the Flavor of Poultry**

O. J. KAHLBERG, E. M. FUNK, AND W. C. HURLEY

#### *Objective:*

*Improve quality and retain flavor in poultry products.*

As a part of the general plan of studying the factors affecting flavor, inorganic constituents were analyzed in the chill water from both eviscerated fowl and broilers when chilled in distilled water at 34° F for periods varying from 1 to 24 hours.

The inorganic constituents for the fowl, in terms of milligrams per gram of eviscerated bird, increased from 1 to 24 hours as follows: sodium, 0.0805 to 0.1508, and chlorine 0.1118 to 0.2689. For the broilers, sodium 0.0365 to 0.2307; potassium 0.1569 to 0.7483; calcium 0.0087 to

0.0234; phosphorus 0.0379 to 0.1978, and chlorine 0.1205 to 0.5942.

Further studies were made with 144 eviscerated birds consisting of 72 fowl and 72 broilers divided into four equal groups of 18 each and chilled in air, distilled water, and distilled water plus "high" and "low" levels of inorganic ions for 3, 8 and 18 hours.

The meat taste panel found only a small difference in the fowl samples and no difference in the broiler meat due to the various chilling methods. Organoleptic evaluation of broth made from the fowl showed detectable differences between carcasses cooled for various lengths of time in various mediums. Differences were noted in the broth from broiler carcasses cooled in various mediums but not from the carcasses cooled for various lengths of time.

The absorption and loss of water of both broilers and fowl carcasses were similar for time periods but not when treatments were compared. The carcasses in the 18 hour chilling period absorbed the highest amount of water, those in the 8 hour period next and those in the 3 hour period the least amount of water.

The fowl pattern of water absorption for treatment was: "high salt" treatment the most water, cold distilled water treatment second, and "low level salt" treatment the least. The broiler pattern of absorption for treatment was: cold distilled water; "high level salt," second; and "low level salt" treatment, third. Both the fowl and broiler air-chilled carcasses lost water.

Results of this study lend support to other basic research work which is being conducted on the properties and identity of chemical compounds which are responsible for chicken flavor. (*Project 313*)

### **Methods of Processing Poultry and Commercial Precooked Frozen and Canned Products**

O. J. KAHLBERG AND E. M. FUNK

Preliminary results on a limited number of birds indicate that the most tender meat was obtained when birds were cooked by "boiling" in tap water alone, and when cooked by either "simmering" or "pressure cooking" in 0.75 percent potassium chloride solutions.

Meat samples for fat and water retention studies have been taken but the analyses are not complete. (*Project 323*)

# Rural Sociology

C. E. Lively, Chairman

## Social and Cultural Factors Affecting the Dissemination and Use of Scientific Farm Information by Missouri Farmers

J. S. HOLIK, H. F. LIONBERGER, C. E. LIVELY

Interpersonal patterns of communication regarding farming operations were found to be structured by such socio-economic status factors as income, years schooling, and community prestige, but no serious barriers were imposed by them in the community studied. The general tendency was for information seekers to choose persons higher on the status scale than themselves as sources. Nevertheless, choices decreased as status differences increased.

Choice patterns were relatively free from class oriented manifestations. T-coefficients of association indicated that technological competence as a farmer was the most important of 10 factors considered in the choice of persons as sources of farm information. Participation in organizations which took a farmer outside the immediate locality rated second in all three of the information seeking relations considered. Gross farm income generally rated a close third. Schooling, participation in local organizations, age, and size of operations were of much less importance and, in fact, little associated with choice.

Analysis showed high relationship of gross farm income and total social participation with improved farm practice ratings (technological competence) farm income and total social participation. Age and years schooling completed did not show a relationship. Nevertheless, other evidence indicates that kind of schooling is associated with technological competence as a farmer even though amount of schooling is not (with the other three factors held constant). Only one of the six possible joint effects was significant, age and income. For persons with incomes under \$3000, age was negatively associated with improved farm practice adoption rates while for those with gross farm incomes over \$3000 the relationship was positive.

Findings from the Boone County television survey are reported in Station Bulletin 702, Television Viewing in Boone County. (Project 29)

## The Rural Church in Missouri

L. F. HEPPLER

### Objectives:

A. To prepare for publication the eight parts of the

study planned to appear as six Experiment Station research bulletins.

### Report of Progress and Results:

Work this year has consisted of checking and editing manuscripts in the eight-part series. Part I and II have been published as Research Bulletin 633 A and B. (Project 143)

## Cultural Factors Affecting Illness in Rural Social Areas of Missouri

E. W. HASSINGER, J. S. HOLIK, C. E. LIVELY  
AND R. L. MCNAMARA

### Objectives:

A. To determine the magnitude of general morbidity in rural areas.

B. To determine the cultural factors influencing family and individual behavior with respect to the maintenance of personal and community health.

C. To determine variation in patterns of health maintenance in different social areas.

As reported last year, field work has been completed in two counties representing different cultural situations. Schedules and other field materials are now available for over 300 open-country households. Work this year has concentrated in the preparation of reports: two research bulletins have been completed, a third is underway.

These relate to the field study undertaken in Laclede County. Little field work was necessary this year since the accumulation of materials from the last two years of field study has provided a solid basis on which to prepare a series of significant reports. (Project 201)

## Human Factors Affecting Food Selection and Consumption Patterns

C. E. LIVELY, C. L. GREGORY, MARY BOWMAN

### Objectives:

To evaluate motives affecting food selection in the markets.

About 200 interviews have been conducted with women in Columbia concerning the factors affecting a selection of food at the markets.

A number of scaling plans have been designed and tested for their sensitivity in distinguishing levels of motivation and for the ease in which they can be administered to women of varying educational levels.

It is thought that satisfactory scaling techniques are now available for the measurement of the following defined motives:

1. *Economic motive.* A consciousness of cost in the purchase of a food commodity, tending toward the selection of less expensive foods at a sacrifice of other desirable qualities.
2. *Nutrition.* The selection of food with a conscious effort toward securing balanced diets and healthful individual foods.
3. *Time and ease in preparation.* A tendency toward the selection of foods for their quality of being quick and easy to prepare.
4. *Variety.* A tendency toward the selection of foods because they represent a change in the general menu pattern.
5. *Taste.* A tendency toward the selection of foods because they are pleasing to the taste and the avoidance of foods that are not liked by the family members.
6. *Prestige.* A tendency toward the selection of foods characteristic of the class to which a person aspires or to which he makes reference. This may also include the avoidance of foods because they are characteristic of a class below him.

In addition, tabulation plans have been developed for the analysis of interviews from a sample designed to show differences in food buying patterns and motives with respect to income, occupation and educational levels. Preliminary figures show that the buying motives may differ widely from one occupational and educational level to another. (*Project 266*)

#### Small Community Development

J. S. HOLIK, C. E. LIVELY, GERTRUDE MCMILLON

During the year the 65 community reports on improvements made in 1956 were analyzed by size of town. A tabulation of the projects, frequency, and types of projects which were successfully completed was made. The tabulation of types of projects undertaken, completed, and not completed by the 114 communities submitting reports for 1957 will be made prior to June 30, 1958.

The most popular type of project in 1956 was the improvement of recreation facilities. The 65 towns had 155 projects for improvement of local recreation facilities; they completed 80 percent, or 124.

Clean-up and beautification were the next two most popular projects, with 83 and 61 projects, respectively. The completion percentage was approximately the same for the latter two projects as it was for improvement of recreation facilities. These projects were of equal popularity regardless of the size of the town.

Improvements in water system facilities—fire protection, sewage disposal and elimination of safety hazards (such as removal of old dilapidated buildings, etc.,) were undertaken by numerous towns. Again, size of town did not seem to influence the choice of these projects.

The tabulation and analysis of the frequency and kinds of projects undertaken in 1957 by the 154 towns participating in planned progress is not, as yet, complete due to the fact that their written reports have just been received.

These communities were all visited and a progress conference was held with the planned progress committee in each town. During the conference a five-page questionnaire on the way improvement projects were initiated and carried to completion in the community, was completed. At the end of the calendar year uniform reports of the year's work were submitted by 114 of the 154 communities. These reports were scored, and on the basis of the scores, 22 communities were selected for encouragement awards provided by the Union Electric Company. Twenty-three others received honorable mention. (*Project 306*)

#### Population Resources of Southwest Missouri

R. L. MCNAMARA

*Objective:*

*Interpretation of U. S. Census and other reports concerning population and agriculture to provide a benchmark on human resources for the Southwest Missouri area.*

Only preliminary work has been done on this project pending the full scale effort of the Missouri Agricultural Experiment Station in an interdisciplinary and integrated research program in Southwest Missouri. Indexes of urbanization and mechanization have been prepared for state economic areas and are being computed on a county basis. (*Project 325*)

## Soils

W. A. Albrecht, Chairman

#### The Characteristics and Development Of Heavy Clays in Missouri Soils

C. E. MARSHALL, C. M. WOODRUFF

Data on electrochemical properties (conductivity,

pH and metallic cation activity) of Putnam clay, Arizona bentonite and Wyoming bentonite as affected by electro dialysis or by exchange resin treatment (results obtained in 1956-57 by W. T. Higdon) have been assembled.

A comparison of a strictly thermodynamic method (Ag-Ag Cl electrode) with the membrane electrode KCl bridge combination and with conductivity measurements is under way. In these experiments small amounts of chlorides are added to the clay systems under investigation.

Measurements of cation's transport number and of clay particle cataphoresis are planned. Three sets of electrodes are being used for the thermo-dynamic methods; silver-silver chloride, silver-silver bromide, and silver-silver iodide. Work to date has been the preparation of clay systems and preparation and calibration of electrodes. (Deshpande)

The experimental investigation of the Hagerstown soil has been completed and reported in a research bulletin.

The combination of X-ray methods and electrochemical techniques used enabled important conclusions to be drawn as regards the pedogenic processes involved in the formation of this limestone soil.

The main clay constituent was a hydrous mica, intermediate in composition between glauconite and illite; this has an unusually high bonding energy for divalent cations. (Brydon)

A number of micas have been ground and fractionated for experiment, in which their exchange reactions against various solutions of salts and acids are studied. Various methods for the determination of small amounts of magnesium have been tried. (Project 6)

### **The Effect of Deep Fertilization On Runoff and on Yield of Corn, Wheat and Alfalfa**

PHIL M. SMITH

An area on the McCredie field that was subsoiled and deep treated in 1947 and 1954, 16 inches deep on 18 inch centers showed little effect of these treatments on alfalfa in 1957.

Significant differences for alfalfa yields had occurred through 1956, but there were no differences due to these treatments in 1957. The residual effects of shattering a traffic pan on Sharon silt loam (Elsberry) was not measurable by crop yields, bulk density, or moisture measurements.

Observations were made on subsoiling and deep fertilizer placement treatments of previous seasons in southeast Missouri. The extremely wet season prevented any new work. Only observations were made at all locations except the Malden field. On most locations stands were too erratic to obtain dependable results.

In one experiment on Dexter sand at Malden field, there was little effect of subsoiling on cotton yields. The largest increase was from an adequate application of plant nutrients in the surface soil.

In another experiment on the same type of soil, but with a traffic pan, subsoiling alone had no effect, but when combined with the liberal application of nutrients, the deeper tillage increased cotton yields. (Project 70)

### **The Effect of High Fertility on Runoff and Erosion From a Claypan Soil**

PHIL M. SMITH

Continuous corn on seedbeds prepared by the sub-till mulch method had about one-half inch less runoff and 1.2 tons per acre less soil loss than on comparable plots with plowed seed beds.

Corn yields of 79.5 bushels per acre in a corn-wheat-meadow rotation receiving full fertility treatments were nearly 50 bushels per acre less than in 1956, when the highest yields were obtained for the 17 year period the station has been in operation.

This compares with 99.8 bushels for the 1948-1953 period and 92.2 bushels per acre average for 1955-1956. Yields in 1954 were less than a half-bushel per acre, because of hot and dry weather during the month of July.

Yields from continuous corn on plots with seedbeds prepared by the subtilled mulch method were practically the same as corn in rotation and continuous corn on plowed seedbeds, all receiving full fertility treatments.

Lower yields obtained this year were probably caused by late planting and drouth although considerable fertility loss could have occurred with the large runoff from the rain of June 29 and 30. Corn on the high fertility plots was side dressed with 203 pounds per acre of 33.5-0-0 on June 26, three days before the large runoff occurred.

Total rainfall (15.22 inches) received during the corn growing period would have been adequate had it been more evenly distributed. A rain of 1.63 inches occurred on July 27 and only 1.11 inches, occurring as small showers, was received until September 27 when 0.70 inches was received.

Corn yields per inch of water used on the high fertility plots were 3.66 bushels, or more than double the 1.75 bushels per inch from corn receiving no treatment and about one bushel more than from corn receiving only starter fertilizer. (Project 77)

### **Minor Soil Elements**

W. A. ALBRECHT, C. E. MARSHALL, GEORGE E. SMITH  
G. H. WAGNER, T. R. FISHER

The paper on Trace Elements and the Production of Proteins was published and reprints made available.

Another paper was prepared and published showing (a) the attack by fungi was prevented when the fertility was raised by increased calcium; (b) the attacks by thrips were lessened as the plant protein was increased by higher nitrogen in the soil and also when that was

balanced by more calcium; and (c) the attack by the lesser grain borer was reduced when nitrogen fertilizer was coupled with phosphorus additions.

This presents for consideration the belief that our insect problems represent a case of imbalance in plant nutrition because of imbalance in fertilizer treatments on the soil growing the crops.

Data have been assembled for publication on the research of growing *Lemna minor* with Boron in relation to calcium using different saturations of colloidal clay and different total amounts of calcium. This is in process of publication as Research Bulletin 663. (*Project 92*)

### The Permanence of Grass-Legume Sod

W. A. ALBRECHT, T. M. DEAN

#### *Report of Progress:*

Yield records were obtained of field plots of various grass-legume mixtures receiving different soil treatments at the Weldon Spring, McCredie, and Pierce City fields.

New seedlings were made at Columbia and at the Thompson Farm. Measurements of the effect of soil treatments on bluegrass were made at Weldon Spring, and the Thompson Farm. Records of bluegrass yields were obtained from cooperative experiments from five fields in northwest Missouri.

The quality (percent grass and weeds) of bluegrass pastures has been influenced by past treatments. Total harvested weight of forage frequently means little since the untreated land may contain a higher percentage of weeds that will increase the total weight.

The influence of soil treatments on the production of different species in an old bluegrass pasture was studied at the T. T. Lamme farm near Laclede.

At most locations nitrogen treatments with minerals, when soils were deficient, increased the percentage of bluegrass in the mixture and reduced the percentage of undesirable species.

Yields of bluegrass seed were secured on a portion of the plots. The effects of nitrogen were striking. In most cases highest yields were obtained with from 30 to 60 pounds of nitrogen per acre, when the mineral supply was adequate. There was little difference in response to fall and spring applications of nitrogen.

There appears to be much land now in poor quality bluegrass pasture where the cost of liberal soil treatments could be more than recovered in one season from the increase in seed yields alone. Increased yield and quality of pasture would then be secondary benefit at no cost. (*Project 99*)

### Crop Sequences and Continuous Cropping As Affected by Legumes

W. A. ALBRECHT, CARL HAYWARD, GEORGE E. SMITH,  
AND M. H. BROWN

Results in 1957 continue to indicate that the level of nutrient supplies are more important factors in plant growth than are crop sequences. Responses to chemical nitrogen were smaller than in some past seasons.

It would appear that following the past dry seasons there has been an above average release of nitrogen and deeper rooting, particularly on soils with a high percentage of clay in the subsoil. Where nitrogen has been applied to small grains there has been difficulty in establishing legumes in the past dry summers. Applications of nitrogen for corn have been more effective in increasing corn yields than have green manure crops where the growth has been sparse.

The spring of 1957 was wet in most sections of the state. Planting of corn was delayed and weed control was a problem. Small grains were difficult to harvest and yields were lower than in the past three years. A shortage of moisture in July and August reduced corn yields.

Sanborn Field: Sanborn field continued to show, through the revisions made in 1950, that a deficiency of nutrients can account for most differences in yield between various crop sequences. It is evident that continuous cropping with full treatment is producing yields as high as rotation systems with the same nutrient additions.

Of particular interest are the results from plots 6 and 7 where full treatment was applied to old plots that were abandoned because of nutrient exhaustion from previous cropping. The yield was limited to 66 bushels per acre, because of a shortage of moisture in July and August. (A portion was irrigated and yields were increased over 25 bushels). In contrast in a rotation (Plots 1-3-4) which has received similar treatment, the yield in 1957 was only 55.4 bushels per acre.

In the eight years that these treatments have been made the average yield of continuous corn with full treatment has been 75.8 bu. and for corn in a three year rotation with wheat and red clover 74.2 bushels. There has been no noticeable difference in lodging or loss from insects and diseases. (*Project 117*)

### Soil Analysis—Rapid Routine Methods

T. R. FISHER

#### *Objectives:*

A. *The development and improvement of accurate, suitable methods to be used by county soil testing laboratories.*

B. *Preparation and supplying of soil testing reagents and equipment to Missouri County Soil Testing Laboratories.*

Activities were continued in soil testing as in the past. Chemicals, reagents, standard solutions, and check samples were prepared to make available to soil testing laboratories.

Packaging of the phosphorus extracting reagent was changed to plastic bottles to avoid contamination from

soft glass containers. Investigations of the sodium tetrophenylboron test for potassium were successfully completed.

This test has now replaced the old sodium cobaltinitrite test in most instances. Work was continued on simplifications of the magnesium test; however, to date no specific changes have been made. Improved procedure in the method of determining soil pH was investigated. A method referred to as "salt pH" was installed in a number of the county laboratories. (*Project 178*)

### Fertilizer Applications On Farm Crops

W. A. ALBRECHT, M. H. BROWN, T. M. DEAN, J. A. ROTH, GEORGE E. SMITH, FRANK STANLEY

Work on the project is conducted at the South farms at Columbia and on the outlying fields at McCredie, Weldon Spring, Pierce City, Thompson Farm, Malden, Bragg City and Bell City.

Excessive moisture prevented planting at Bell City, and small grain at Bell City was not harvested because of the excessive rainfall. Yields of small grain were obtained at the other locations. Differences resulting from various fertility treatments were obtained but total yields were lower than in some previous seasons.

*Denitrification Losses from Chemical Nitrogen Applications to Soil:*

Soils previously reported to show difference in loss of N as  $N_2$  or  $N_2O$  were incubated for four months in quart cans with different fertilizer materials. Soil moisture, temperature, and organic matter were additional variables.

The fertilizer salts were either applied as surface applications or mixed in the soils. Soil reaction (either loss or fixation) was measured by growing sudan grass until the available nitrogen was exhausted. The soil was thoroughly washed from the roots and the amount recovered by the plants determined by a total nitrogen analysis.

*Water Solubility of Phosphorus in Mixed Fertilizers:*

Mixed fertilizers containing different percentages of water soluble phosphate have been compared as starter fertilizers on small grains, cotton, sorghum, and corn.

Under the wet conditions experienced on Sharkey clay soils, liquid mixed fertilizers or those supplying phosphorous in water-soluble forms gave more rapid early growth. With other crops and on other soils the difference in crop response to these various materials was small.

*Soil Treatments for Small Grains:*

Various fertilizer materials were applied at different rates at most of the outlying fields. The results were influenced by weather conditions, but all pointed to the necessity for adequate levels to produce high yields and quality.

At the Pierce City field a freeze on April 13 seriously damaged small grains. Where liberal treatments had stimulated growth the injury was much greater than where there was less spring growth. Yields were greatly reduced and the influence of soil treatments on wheat, barley, winter oats, and spring oats were not great. A response to sulfur, which has been noted in some previous years, was not obtained in 1957. There was little difference in response to a number of sources of nitrogen when top dressed either in late fall or early spring.

Small grain plots at the Thompson farm produced wheat yields in excess of 40 bushels per acre. Yields of both Barley and Oats were good. However, with the exception of a response to phosphate, fertilizers had little influence on yield. This soil is an old sod and apparently sufficient nitrogen and potassium are being released to take care of nutrients from the soil.

Responses of small grains to fertilizer additions at the University south farm were lower than in some seasons. There is the indication that soil cracking and deeper rooting as a result of past dry seasons is resulting in an increased rate of release of nutrients from the soil.

An experiment to compare different potash carriers (chloride, sulfate, and carbanate) did not indicate significant difference in response when measured by small grains, cotton, and corn. (*Project 178*)

### Missouri Soil Survey and Classification

C. L. SCRIVNER, H. H. KRUSEKOPF, RICHARD FENWICK

*Objective:*

*The detailed classification and characterization of Missouri soils.*

The detailed soil survey of Howard County was completed. This county, containing 468 square miles, is covered by 130 aerial photo maps. The cartographic work on the maps is nearly completed in preparation for reproduction and publication.

The maps will show the distribution of 60 soil types. The loess is mainly Peorian in age and varies in thickness of deposit from more than 30 feet near Glasgow to approximately 5 feet in northeastern Howard County. The glacial till varies from relatively unweathered Kansas till to the highly weathered gumbo till of Yarmouth times (350,000 to 650,000 years ago). The variations in parent materials plus differences in natural vegetation and drainage account for most of the differences in soils.

The detailed soil survey of Henry County was initiated and 72 square miles are now recorded on aerial photomaps.

Soils of Henry County, in contrast with northern Missouri counties, are not influenced by glacial till and have only small amounts of loess as parent materials. Soil parent materials are mainly limestones, shales and

sandstones of Pennsylvanian age plus some Mississippian limestone. Major soil differences are noted between soils formed from acid, micaceous shales and other soils from interbedded limestone and shales.

The soil survey participated in three conversion inspections in S. C. S. soil districts. The purpose of these inspections is to convert all mapping legends in soil districts to standard types such as used in Howard and Henry Counties. The aim is to prevent future duplication of efforts in the field of soil mapping.

Information was compiled on soils for the National Soil and Water Conservation Needs Survey. Unpublished photo-maps and legends were furnished for Boone, Christian, Moniteau, Livingston, Daviess, Holt, Jasper, and St. Charles counties to supplement S. C. S. mapping of trial areas. (Project 206)

### The Fertility Level of Missouri Soils

W. A. ALBRECHT, VERNON RENNER, M. H. BROWN

The work in the relation of calcium to potassium as these modify the proteins in crops is continuing with the refined clay techniques.

A new flame photometer of larger possibilities has been developed during the year to make the measurements more accurate.

The matter of ratios of the major elements in proper balance as offerings by the soil to the plant is becoming more and more significant in understanding the plant's activities in moving the ions from the soil into the plants. Imbalance of some suggests "Exclusion" of others.

Due to the leave of absence of Dr. E. R. Graham, some phases of the study are being held in abeyance. (Project 207)

### The Protein Role of Nitrogen in Organic Matter

W. A. ALBRECHT, G. H. WAGNER, T. R. FISHER,  
ROBERT GAST

*Objectives:*

A. To determine the Role of Trace Elements in the production of proteins.

B. To study the role of organic compounds in the growth of plants.

Higher concentrations of protein in legume plants resulting from bacterial inoculations have previously been shown to effect more ionic exchange from a standardized soil colloid into the plants.

Since copper seems necessary for the plant's synthesis of its own protection against fungus attack, and since balanced suites of major nutrient elements grew scab-free potatoes while the unbalanced suites failed, the theory is ventured that the balance of the major nutrients may mean plant protein in quantity and quality is neces-

sary for the root hairs to move trace elements effectively from the soil into itself and the plant.

Accumulated evidence continues to support the theory that the production of proteins involves having soils fertile in (a) the major nutrient elements, (b) in organic matter, and also (c) in the trace elements required for the synthesis by the microbes and by the plants of all the essential amino acids in truly complete proteins. Trace elements apparently contribute more to quality than to quantity of nutrition in what we grow, especially the proteins.

A technique was developed whereby seedlings could be germinated under aseptic conditions and the embryo separated from the endosperm and then planted and grown in a sterile environment. This permits testing of the effect of organic nutrition on plant growth and quality in an environment void of microbial life.

Preliminary studies were initiated to test the effects of various organic compounds in sterile nutrient media on the growth of sudan grass seedlings. Root development was restricted in these sterile sand cultures. Some differences in growth have been attributed to treatments with different sugars. The investigation is being continued. (Project 208)

### Reclamation of Eroded Soils

C. M. WOODRUFF, GEORGE S. CARTER

*Objectives:*

A. To determine the relative yields of alfalfa and grass on fertilized subsoil.

B. To determine the effect of rate of planting of corn upon yields from fertilized subsoil.

C. To determine the effects of rates and kinds of phosphate fertilizers upon the growth of red clover and alfalfa upon subsoil.

Alfalfa seeded in 1957 and fertilized, lespedeza unfertilized, and a mixture of fertilized hay grasses were grown on three of the seven plots of subsoil that comprise this study. The yields of hay obtained were:

fertilized alfalfa 3.15 tons per acre

unfertilized lespedeza 0.62 tons per acre

fertilized grass 2.82 tons per acre

Five facts have emerged from the results of this study:

1. Without fertilization, the productive capacity of the subsoil of the glacial till soils of Missouri is exceedingly low, too low to be of any value to a farm.
2. The rate of recuperation of glacial subsoils with a cover of lespedeza left unharvested has been so slow as to not be detectable 18 years after the inception of the study.
3. Both alfalfa and grass meadow grow well on subsoil which has been fertilized.

4. The yields of alfalfa and grass meadow from fertilized subsoil although good are limited by the water holding capacity of the soil which is substantially less than that of the uneroded soil.
5. The second cutting of alfalfa of the second year crop exhibited severe nutrient deficiency symptoms suggestive of a boron deficiency.

Corn planted at rates of 4356, 8712, 13,068 and 17,424 stalks per acre on fertilized subsoil yielded 41.6, 38.2, 31.9 and 13.4 bushels per acre respectively. The percentages of the harvested corn that consisted of ears weighing one half pound or more were 85, 60, 31, and 27 for the respective rates of planting.

Red clover grown in pots of subsoil with different amounts of phosphorus fertilizer over a period of eight years established the facts that (a) 400 to 600 pounds per acre of  $P_2O_5$  as super phosphate were required to attain good levels of production; (b) on limed soils no loss of phosphorus by fixation in the soil occurred; and (c) that rock phosphate was very ineffective as a source of phosphorus for red clover on soils near neutrality.

Since the results with rock phosphate were unfavorable, and since alfalfa generally is considered to be able to use phosphorus from rock phosphate it was deemed desirable to determine whether or not alfalfa would obtain phosphorus from rock phosphate in neutral soils.

The pots of soil were remixed and seeded to alfalfa in January of 1958. At this time, March 20, 1958, the new seeding of alfalfa is showing excellent response to the treatments of rock phosphate that were applied in the spring of 1950. (*Project 209*)

#### Meteorological and Climatological Variations On Agricultural Production in Missouri

W. L. DECKER, J. F. GERBER

##### *Objectives:*

*A. To measure water used by economic crops and to relate this to weather conditions.*

*B. To establish and maintain weather observing sites which provide information important to Missouri's agriculture.*

During the past summer season attempts were made to measure evapotranspiration under grass and corn covers. Many difficulties were encountered which resulted in a failure of obtaining worth-while data.

There appeared to be a disparity in the runoff measurements and in the distribution and amount of irrigation water supplied. These difficulties produced data in which there was a low confidence of its validity. (*Project 210*)

#### Infiltration Rates and Available Water Capacity for Major Soils of Missouri

P. M. SMITH, FRANK STANLEY, V. C. JAMISON,  
GEORGE E. SMITH

##### *Objectives:*

*A. To obtain relationships between water intake rates obtained by direct irrigation methods of sprinkling or surface and more rapid ring infiltrometer results for several representative Missouri soils and soil conditions.*

*B. Determine the optimum water application rate for various soils of the state.*

*C. To determine the moisture tension relationships of major soils of the state of Missouri.*

*D. To estimate available moisture storage capacities for the various soil horizons of the profiles of the major soils of the state.*

The ring method usually gave a higher value than direct application methods of measurements.

When the soil was loose, before the first irrigation, there was some fringe wetting observed around the rings. The later ring measurements compared very well with the direct sprinkling method. The intake (per total area) is less for furrow than sprinkling. The direct furrow measurements show a significant combined effect for furrow shape and alternate furrow application in comparison with conventional shape and application in every furrow.

It is evident that the ring method gives only an approximate estimate of the intake rate to be expected by direct application. Variations from spot to spot as well as from plot to plot on the soil are wide. Any method will improve in accuracy as the area measured or tested is extended to include more of the area to be represented.

The survey of major soils for available storage capacity begun in 1956 was continued. Additional profile samples were taken from the SCS Nursery plots at Elsberry, the Fertility plots at the South Farm at Columbia and at Weldon Springs.

In addition to this, samples were taken from the location of the former erosion plots at Bethany as well as various locations in northwest, southwest and southeast Missouri.

For each horizon the soil plus stones were taken to the laboratory, separated with a 2 mm screen and the separates (stones and soil material) dried and weighed. Moisture release curves were determined for screened soil and stones. The volume of the soil and stones in the undisturbed condition was estimated by measuring the volume of fine sand needed to fill the hole.

The available storage capacity of the stone portion often exceeded 5 percent, especially with those samples containing considerable sandstone fragments. Dense cherty stones contributed little to available storage capacity. (*Project 211*)

#### Soil Tests and Fertilizer Response

GEORGE E. SMITH, CARL HAYWARD, T. R. FISHER,  
FRANK STANLEY

Different levels of nitrogen, phosphorus and potas-

sium were provided and correlated with soil test procedures now in regular use. It is becoming more evident that the season, the soil type and origin as it influences unweathered mineral content, and organic matter content all contribute to the complexity of determining the proper amount of nutrients for most efficient crop production.

In the 1957 season a late freeze in southwest Missouri seriously damaged the small grain plots with the more liberal soil treatments and most vigorous growth. In some cases, the plants that received little or no treatment made little early growth. They were covered by snow when the low temperature occurred, and received little damage and produced some of the highest yields.

In southeast Missouri tests where high levels of nitrogen were provided, responses to both phosphorus and potassium were secured on cotton on some soils even though soil tests indicated an adequate level. Apparently the excessive rainfall reduced the availability of soil nutrients and that applied in fertilizers gave a response. At most locations there was a depressing effect of the heavier applications of phosphate.

At the Thompson Farm corn and oats in a rotation experiment have given a response to phosphate, but apparently the level of potassium has been adequate for the amount of moisture available. The hay crop (a mixture of grasses and legumes) has shown little response to any element.

This experiment field is located on an old sod that had not been plowed for many years. Apparently the decomposition of the organic matter reserves is supplying nutrients beyond the amounts indicated by the soil tests in present use.

At Weldon Springs, on a Weldon silt loam, extreme phosphorus deficiency developed on young corn where phosphate additions were low. However, the plants recovered late in the season in 1955 and the treatment had little effect on yields.

In both 1956 and 1957 there has been little response to phosphates. Soil tests indicate a higher phosphate test in the surface soil in the last two seasons. No explanations are available at present but it appears that phosphorus may be moved from the subsoil to the surface by tillage operations and plant growth. (*Project 229*)

### Soil Treatments for Maximum Crop Yields

GEORGE E. SMITH, JAMES A. ROTH

On the McCredie Farm, corn received nutrients in amounts removed by a 200 bushel crop has produced maximum yields in some years of about 140 bushels per acre.

Soil treatment variables have been dropped in this experiment since past results show there is no value in applying water when nutrients are deficient. In 1957, planting was delayed because of the wet spring. With

only 0.44 inch of rain in August, yields were limited and supplemental irrigation was most helpful. The effects of population and irrigation on corn are shown in the following table. Nutrients needed for a 200 bushel crop were applied.

	<i>Population</i>	<i>Yield, Grain</i>	<i>Yield, Silage</i>
Not Irrigated	12,000	62 bu.	10.9 tons
Not Irrigated	17,000	51 bu.	12.7 tons
Irrigated	17,000	103 bu.	16.7 tons

(8 in. in Aug.)

These results show the limitations of increasing yields from added nutrients if such factors as shortage of water or an incorrect stand limit yields.

In a second experiment on the McCredie field (no irrigation) there was no benefit from nitrogen; an application of 240 pounds per acre reduced yields.

Apparently this soil (corn for four consecutive years) released sufficient nitrogen for a yield of 75 bushels and the yield was limited by a deficiency of moisture.

Similar results were obtained at the Thompson Farm and the South Farms at Columbia. (*Project 230*)

### The Improvement of Soil Fertility Through Heavy Applications of Nitrogen And Carbonaceous Organic Matter

GEORGE E. SMITH

Measurements have been made of the effects of large quantities of carbonaceous residues on Mexico silt loam. Yields have not been depressed by the addition of these materials, provided adequate supplies of nutrient were added.

The amount of nitrogen necessary at one time does not need to be sufficient to provide a nitrogen-carbon ratio of 1:10 at the time of the residue addition. When such amounts of nitrogen were applied, some lodging of small grains resulted which indicated an excess.

There is also evidence that when this large amount of chemical nitrogen is added at one time there may be a loss by denitrification process, when the soil type would be of a nature to make leaching losses negligible.

Relatively small increases in soil organic matter have been noted from soil tests. Apparently much of the carbon has escaped to the atmosphere instead of forming soil humus.

#### *Handling Straw After Combine:*

The depressing effect of large amounts of straw turned under for wheat is correlated with shortages of nitrogen. Thirty pounds of nitrogen plowed down with wheat straw residues on Mexico silt loam have not been sufficient to produce optimum yields.

Higher yields are obtained when nitrogen is increased to 60 pounds per acre, and further increased where the straw is removed. There has been little difference in the source of nitrogen applied, although the

greatest increase in grain yield has been on plots receiving calcium cyanamid. This would suggest that the active calcium supplied by this material has been a factor in biological processes.

The effect of burning has been noticeable in the surface condition of the soils in the spring and after heavy rains. Laboratory measurements have shown a slight decline in organic matter, an increased bulk density and poorer granulation. (Project 231)

### Soil Treatments for Alfalfa

T. M. DEAN

Records were obtained from stands of alfalfa 2-years old or older at Sikeston, Columbia, and Pierce City. New stands have been established at the Thompson farm and Weldon Springs and the first harvests were made in 1957. A new stand at McCredie was not sufficiently uniform for experimental measurements. The land was plowed and reseeded in the fall of 1957.

Birdsfoot trefoil seedlings were made at Weldon Springs, McCredie and the Thompson farm. The McCredie stand failed. That at Weldon Springs made excellent growth and yields are reported.

On most fields yields were good and did not show as wide contrasts as have been obtained from soil treatments in some previous years. It is suggested that the drying and cracking to greater soil depths in the past dry seasons may have increased the rate of nutrient release from the soil so that the fertilizer nutrients have had less effect on plant growth.

This work shows that with an adequate supply of nutrients, alfalfa can produce high yields on many soils where it has not been considered adaptable. Two plots on Sanborn Field were seeded in 1950. These areas had received small treatments in the past and were low in productivity. Plot 24 had lost considerable top soil from erosion. Both received liberal treatments to a depth of 12 inches.

They have received annual applications of phosphorus and potassium each season. Plot 21 still has a good stand of alfalfa, but little brome grass. The stand on plot 24 is now disappearing. During the seven year period, plot 24 has averaged over four tons of hay per year, and plot 21 has reproduced slightly less than 5 tons. (Project 242)

### Energetics of Ionic Relationships In Soils and Plants

C. M. WOODRUFF, D. E. BAKER

Objectives:

A. To determine the effect upon the growth and yield of oats of different energy balances between magnesium and calcium in soil.

B. To determine the effect upon the growth and yield of oats of different phosphate potentials at different lime potentials in soil.

C. To determine the effects of chlorides and sulfates upon the phosphate potential of soils and upon the growth of plants.

D. To investigate phosphate equilibrium in soils.

Two crops of oats were grown to maturity on pots of soil containing different amounts of magnesium.

Deficiency symptoms associated with magnesium generally known as oat speck disease appeared in plants when magnesium constituted 1 percent and less of the total exchange capacity of the soil. Yields of grain were depressed by levels of magnesium of 1 percent and less in the soil.

Yields of grain were depressed by high levels of magnesium, 16 percent and 32 percent, when the potassium levels of the soils were marginal. No such depression occurred with normal amounts of potassium in the soil.

Energies of replacement of magnesium by calcium, as determined in saturation extracts of the field moist soil using 0.01 NHCl which has passed through the soil four times, suggested the following scale of energy values in calories per chemical equivalent:

3500 calories	Magnesium deficient soils
3000 calories	Marginal conditions for magnesium
2500 to 1000 calories	Desirable range for the growth of plants.
500 calories	Marginal conditions with respect to excessive amounts of magnesium.

Oats were grown to maturity in a series of 48 pots with treatments of lime and phosphorus as variables to determine the phosphate potentials of the soil required for the best development of the plants.

The results suggest the following scale of values for the concentrations of phosphorus in saturation extracts of the soil at high levels of nitrogen.

P moles per liter x 10 <sup>6</sup>	Growth of Oats
0.5	Very Poor (very deficient in phosphorus)
1.0	Poor (phosphorus deficient)
2.5	Good
5.0	Very Good
10.0	Excellent
20.0	Very Good (excess phosphorus)

The results with oats were essentially the same as those for corn obtained in a similar experiment the preceding year. However, the growth of corn was very poor at phosphorus concentrations of 1.0 x 10<sup>6</sup> m/l whereas the growth of oats at this same level was somewhat superior to the growth at lower levels.

Corn was grown in a series of 80 pots with soil treatments of lime, phosphorus and chlorides as variables to determine the extent to which ion combinations and ion competition affected the growth and composition of the plants.

Results of the study suggested that the first order effect governing the phosphorus nutrition of plants was the amount of phosphorus required to establish adequate phosphate potentials in the soil. Second order effects were produced by (a) free lime which depressed the phosphate potential at high levels of phosphorus in the soil and (b) chlorides which served to depress the phosphate potentials of the soil slightly and which competed with phosphorus and with nitrogen so as to reduce their concentrations in the plants.

Some evidence has accumulated which suggests that the phosphate potentials of soils that are necessary for proper development of plants are affected by the nitrate potentials of soils more than by any other factors. There is evidence that suggests that excellent nutrition of corn plants may be achieved with phosphate potentials expressed in terms of activities that range from  $0.5 \times 10^{-6}$  m/1 of P provided that the balances of these phosphorus potentials with the potentials of other anions is correct.

Corn was grown to maturity on a series of 20 field plots with high basic levels of lime, phosphorus, and nitrogen but with variable levels of potassium. Each plot was subdivided to give five different treatments of fertilizers drilled with the seed at planting time. Each treatment was replicated four times. The concentrations of phosphorus and potassium in the plant sap at the silking stage were determined and yields were determined at the end of the season.

Results for both the composition of the sap and the final yields indicated the following:

(a) When the basic level of phosphorus in the soil was high as reflected by phosphate concentrations in saturation extracts of the soil of  $2.5 \times 10^{-6}$  m/1, phosphate fertilizer applied as a starter gave no increase in the concentration of phosphorus in the plant sap nor in the final yield.

(b) That 50 pounds per acre of  $K_2O$  drilled with the seed provided higher concentrations of potassium in the plant sap than did high levels of potassium in the soil. Final yields were equally good for both the placement application of potassium and the high levels of potassium in the soil.

Phosphate equilibrium in soils was investigated in the laboratory at different pH levels of soils and in the presence of different ratios of cations in the exchange complex of the soils. The results of several weeks of work revealed that rates of reaction of the phosphorus with soils in moist systems were very slow and that no conclusions could be drawn from such an approach to

the problem.

By drying the soils prior to equilibration, it was discovered finally that the reactions could be driven to completion so as to give satisfactory equilibrations. The original experiments have not yet been repeated using the knowledge gained from the effects of drying. (*Project 263*)

### Soil Fertility and Cotton Production

G. E. SMITH, J. A. ROTH, FRANK STANLEY

Soil fertility studies with cotton were hampered by excessive moisture. The annual rainfall exceeded 70 inches over most of the area. No cotton was planted at the Bell City field and planting was delayed until June at Bragg City. Most experiments on the Malden Field (sandy soil) were completed. Cooperative work was done at three additional locations; the Mills Farm on Dunklin ridge, the Watkins Farm near Rives, and the Maddox and French Farms near Gideon.

#### *Soil treatment effects on cotton production:*

Total yields were lower than in more favorable seasons. However, the percentage increase from soil treatments was greater. At Bragg City the June planted cotton, which received no fertilizer, failed to develop any open bolls.

Where soil treatments were applied some yields were as high as 170 pounds of lint per acre. In some past years yields of about 500 pounds of lint have been secured with little effect of added treatment. On the sandy soils, yields without treatment ranged from 100 to 200 pounds per acre, while the addition of a balanced supply of nutrients produced over 400 pounds of lint.

Apparently on the soils with a higher clay or organic matter content the excessive moisture prevented a breakdown of organic matter and the release of nutrients. The fertilizer additions had significant effects. On the sandy soils leaching was apparently increased and the addition of nutrients at the proper stage of plant growth was striking.

#### *Effect of Soil Treatments on Boll Set.*

Work on this objective was limited to calculations on boll count data collected in the field in 1956, and the preparation of a technical paper.

This work indicates that seldom do more than 50 percent of the flowers produced develop into mature cotton bolls. When yields are improved, most of the increase comes from a greater number of flowers produced rather than an increase in percentage set.

There are limitations to the size of plant that can be harvested by mechanical pickers. There is need for fundamental information on the factors influencing boll drop as a means of increasing the percentage of fruiting forms that will develop into harvested bolls.

### *Seed Bed Preparation.*

Limited data were obtained on the Sharkey clay soil at Bragg City because of the delay in planting resulting from excessive moisture. However, trends agreed with those obtained in 1956 which indicated the need for deeper seed bed preparation than is secured with "middle breakers." On both this clay soil and on the Dexter sand, yields of cotton were improved by placing the bulk of the fertilizer in bands below the seed row before rebedding, than from methods of application where the fertilizer was mixed with the soil. (*Project 267*)

### **Soil Fertility and Corn Production**

GEORGE E. SMITH, CARL HAYWARD, L. E. BARNES,  
PHIL M. SMITH

#### *Effect of Limestone on Corn Yields.*

In one experiment at Columbia where corn has been grown continuously since 1950 with heavy applications of nitrogen, the crop showed less vigorous growth where nitrogen that leaves an acid residue had been applied. Soil tests showed pH readings from 4.2 to 4.5 on some of the plots.

The plots were split for the 1957 season to provide three levels. The highest average yields were obtained with calcium nitrate and sodium nitrate, materials that would leave an alkaline residue. An average of all sources of nitrogen at each lime level showed little difference in yield. The area receiving no lime last year produced an average yield of 63.8 bushels while the yields following 4 and 8 tons of limestone per acre were 63.9 and 60.1 bushels respectively.

#### *Wheel Track Planting*

Corn was planted on an old orchard grass sod on Mexico silt loam at Columbia with different amounts of seedbed preparation. Higher yields were obtained when land was plowed and immediately planted in tractor tracks than where the land was plowed early and a smooth seedbed prepared by discing and harrowing.

This difference can be partially explained by a heavy rain that came in late June. Where the land was smooth and compact there was considerable runoff. Where it was rough most of the moisture was held. This was of much benefit during July and August when there was little rainfall.

#### *Time of Planting*

Dry summer periods in recent years have raised questions regarding planting dates and yields. In 1954 late corn produced some grain where early plantings were destroyed by the hot dry weather. In 1955 and 1956 best production was secured from early plantings.

One experiment at Columbia has been established where an early and a late variety of corn have been

planted at three dates and at two nitrogen levels. On this land, which has been in corn since 1950, nitrogen was beneficial at all dates of planting.

At the earliest planting (May 5), the early 90 day corn produced a higher yield than a 120 day corn. However, when the same varieties were planted June 10 and July 5, the longer season corn produced the most grain. Highest yields were obtained at the June 10 planting which is normally very late for mid-Missouri.

The time of occurrence of summer drouths, particularly if they occur at time of tasseling, is the most important factor in determining the effect of time of planting.

#### *Chemical Nitrogen vs. Legumes in Corn Production*

Continuous corn, on soil where erosion is not a problem, when well supplied with chemical nitrogen, continues to give yields equal to or better than corn following legumes.

#### *Rate and Source of Nitrogen Application for Corn— Weldon Springs*

The Weldon Springs area had good moisture distribution and yields were some of the best secured in the state. There was an increase in yield from a 120 pound application over 60 pounds plowed down before planting. All sources of nitrogen gave good response.

Different rates of phosphorus and potassium and sources of potassium had little effect on yields.

Where chemical nitrogen was compared with legume nitrogen for corn, legumes supplemented with chemical nitrogen produced no higher yield than where the same amount of nitrogen was applied with contour cropping to corn. Continuous corn without nitrogen (on eroded soil) produced only 15 bushels per acre, but with some treatments yields were over 70 bushels.

Finer grinding of rock phosphate gave slightly higher corn yields than where certain coarser material was applied.

Phosphoric Acid was inferior to superphosphate in increasing corn yields.

Ammonium sulfate produced higher yields than ammonium nitrate when rock phosphate was the source of phosphorus.

#### *Thompson Farm*

Deep applications of lime in the subsoil to a depth of 12 inches increased corn yields.

Corn following corn produced as much grain as where corn followed a legume and the same amount of nitrogen was applied.

There was little difference in yield resulting from ammonium or nitrate nitrogen applied in either the fall or the spring.

### *Malden*

Nitrogen applied as a side dressing was most effective in increasing corn yields.

Fall applied nitrogen was inferior to spring applications.

Ammonium nitrogen was superior to nitrate nitrogen.

### *Bragg City*

Excessive rainfall prevented any significant response to soil treatments.

### *Holt County—William E. Lawing Farm*

Soil treatments and irrigation were applied to a Wabash loam in an effort to obtain increased yields. Yields of only about 100 bushels per acre were produced. Irrigation did not have consistent effects on yield. Trace elements were applied and there was an indication of a response to Zinc. Starter fertilizers had no effect on yield. Phosphate fertilizers with different contents of water soluble phosphate gave similar response.

These results indicated that some factors other than deficiencies of soil nutrients may have been responsible for the failure to obtain higher yields when nutrients and supplemental irrigation were provided.

Fertilizer applications were made on sorghum on the Lawing farm, but unfavorable fall weather prevented satisfactory yield records. Irrigation increased stalk heights. Phosphate fertilizers depressed total growth and yield. At early stages of growth the new leaves were chlorotic. The cause is not known.

### *McCredie*

A shortage of moisture in July and August reduced yields. There was little response to any of the soil treatments applied. Yields were mostly in the range of 70-80 bushels per acre. Irrigated corn with full soil treatment produced over 100 bushels per acre.

In an experiment where different single and double cross corn seed was planted at different nitrogen levels, there was a variation in response by the different varieties. When averages are considered there was little increase from nitrogen. The highest rate of application (240 lbs/A) depressed yields.

Little response was obtained from nitrogen applied to sorghum. Apparently moisture shortage limited yields and the soil supplied sufficient nutrients for the available water. (*Project 268*)

## **Effects of Climatological Variations On Agricultural Production In Missouri**

W. L. DECKER, J. MCQUIGG

### *Objective:*

*To analyze climatological data important to Missouri's Agriculture.*

A study of the energy received from the sun dur-

ing the past 13 years has been completed. Of particular interest are the oscillations which occur in these 13 year averages. It will be important to determine which of these oscillations are significant features of Missouri's climate.

Cloud cover has the most effect on the amount of solar energy when it occurs at noon. The largest reduction induced by cloud cover in the amount of energy occurs when the sky becomes overcast.

Cloud cover determines the amount of energy reaching the earth's surface. By a practical solution to the relationship between cloud cover and solar energy, an estimate of the energy received in other years and locations in the state could be obtained.

Other regression lines have been determined for the other months and the year, and an attempt is being made to apply these relationships to the problem of estimating the solar energy received at other locations in the state.

### *Temperature Summaries Important to Agriculture:*

The maximum and minimum temperatures for the past 49 years at Hannibal, Missouri have been investigated. About 75 percent of the frequency distributions did not test significantly different from the normal distribution. The frequency distributions associated with minimum temperatures showed the greatest tendency to divert from the normal distribution.

In winter one-third of the daily frequency distributions associated with minimum temperatures showed the greatest tendency to divert from the normal distribution. In winter one third of the daily frequency distributions were negatively skewed. A current effort is being made to study the effect which non-normality has on the estimates of the probability of temperatures. (*Project 281*)

## **Efficient Utilization of Soil And Fertilizer Nitrogen**

J. A. ROTH, L. E. BARNES, PHIL M. SMITH  
AND GEORGE E. SMITH

This study was initiated at four locations according to the project plan.

Malden Field—Dexter sand

Bragg City—Sharkey clay

McCredie—Mexico silt loam

Thompson Farm—Edina silt loam

In southeast Missouri excessive rainfall before planting and through out the growing season resulted in low yield and inefficient use of nitrogen. At McCredie and at the Thompson Farm a shortage of moisture in July limited yields.

Yields at the Thompson Farm varied from a low of 77.0 bushels to 80.1 bushels and at McCredie from 66.2 to 75.1, with no correlation for the nitrogen treatments.

Apparently in this dry season these soils released sufficient nitrogen from soil organic matter and moisture supplies limited yields. On the McCredie Station irrigated corn on the same soil type produced 140 bushels per acre.

At Bragg City, on the Sharkey clay, there was so much moisture that the maximum yield was 23.6 bushels. There was no significant difference between sources, rates or time of nitrogen application. It is suggested that under these conditions a considerable portion of the nitrogen may have been lost by denitrification.

On the Dexter sand, at the Malden field, fall applications apparently were leached and lost. Ammonium sulfate applied in the spring increased yields, but there was no effect of the spring-applied nitrate. (Project 304)

## The Determination of Geographic Distribution of Precipitation Clouds By Use of Radar

JONUS MCQUIGG, AND WAYNE L. DECKER

### Objective:

*To develop a method for determining the climatological distribution of rain clouds by use of radar.*

Little Progress was made during the past year. The radar installation was completed by the Weather Bureau, but the camera to be used for the collection of data has not been installed. Preliminary plans for the analysis of these photographs have been made. (Project 324)

# Veterinary Medicine

A. H. Groth, Dean

## Blood Titer Studies in Brucellosis

CECIL ELDER, A. H. GROTH AND D. E. RODABAUGH

### Objectives:

*A. Attempt to develop a technique and differentiate between vaccinal and field infection titers.*

*B. To study the application of this as it applies to the interpretation of blood titers encountered in the state plan for the control of Brucellosis.*

*C. To study the possibilities of finding a specific antigen that will be suitable for differentiation purposes.*

Since work from other Stations has indicated there is some cross reaction between *Pasteurella* and *Brucella* agglutinins, it was decided to carry this work a little further and try to obtain more information regarding this phenomenon.

In the first series of tests, 11 cows carrying *Brucella* titers from adult vaccination and four cows carrying natural infection titers were used. All animals were injected with 5 mls. of bovine mixed bacterin No. 1 subcutaneously. Following the injection, blood samples were collected daily for one week, twice weekly for the second and third week and once weekly for the next three weeks.

The blood samples were tested with *Brucella* antigen by the tube agglutination method.

The results of these tests showed no significant change in titer following injection of the bacterin. However, all *Brucella* titers were relatively high and *Pasteurella* agglutinins may have been present in low concentrations. *Pasteurella* antigens were not used on these samples.

In the second series of tests, ten cows carrying *Brucella* titers from adult vaccination, four cows carrying

natural infection titers and four negative control animals were used. One half of the animals in each group was injected with 5 ml. of a bacterin, prepared by us from *Pasteurella multocida*, serotype C, and the other half was injected with 5 mls. of *Pasteurella multocida*, serotype D bacterin. Blood samples were collected daily for seven days following injection. On the seventh day all animals received a second injection of 10 mls. each of the same serotype bacterin they had received previously. Following the second injection blood samples will be collected twice weekly for two weeks and thereafter each week for four weeks. Agglutination tests with *Brucella* antigen are being made on these samples.

In so far as we have progressed, at time of this writing (12 days after injection of bacterins) no appreciable change in blood titers has been observed. Tests will be made later with antigens prepared with each serotype of *Pasteurella*. (Project 8)

## Internal Parasites of Ruminants

A. H. GROTH, D. E. RODABAUGH, G. C. SHELTON

### Objectives:

*A. To evaluate present methods of control of internal parasites of ruminants.*

*B. To determine the relative disease producing powers and histo-pathology of gastro-intestinal parasites of ruminants.*

The main emphasis of the work during 1957 was directed toward objective A. An effort was made to compare a radically new approach to the control of internal parasites of sheep with the standard recognized methods.

The results of these studies were as follows: (1) The chemical larvicide failed to prevent the development of

clinical parasitism under the conditions of this experiment. However, the basic information and experience gained from this study may prove extremely helpful in future work utilizing this relatively new approach to control of parasitism.

(2) The Phenothiazine regimen controlled and prevented the development of gross or clinical parasitism. However, the lambs on the phenothiazine program made slightly inferior gains to the lambs on pastures where clinical parasitism developed.

(3) The importance of the parasite carrier ewe in relation to the subsequent development of parasitism in the lambs was clearly demonstrated. (Project 108)

### Hog Cholera Immunization

CECIL ELDER, A. H. GROTH, D. E. RODABAUGH  
AND H. B. WRIGHT

#### Objectives:

A. To study and if possible determine the factor or factors influencing antibody production in the hog cholera immunization.

B. To study the immunity produced by the injection of hog cholera vaccine (Swivax) with and without hog cholera serum.

Work was continued this year with a study of the effect of low protein diet on the immunity established in swine against hog cholera.

C. To challenge the immunity produced under different methods of management.

The results would seem to indicate less immunity in pigs being given antiserum with the vaccine and that there was some loss of immunity when the time of challenge was delayed. Also it appears that low protein diets may be a factor influencing the production of immunity to hog cholera. (Project 140)

### Pregnancy Disease in Sheep

A. H. GROTH, CECIL ELDER, H. H. BERRIER

#### Objectives:

A. To determine the efficacy of drugs and chemicals now being used for treatment.

B. To test out new drugs as they are developed and appear on the market.

C. To test various combinations of new drugs and new chemicals.

D. To develop methods of prevention by use of various drugs, chemicals, and antibiotics or other products.

As we must depend for our experimental material upon field cases brought to the clinic for treatment, we have been handicapped the past year because there have been so few cases. Our efforts to produce experimental cases have been largely negative and results unsatisfactory.

The scarcity of field cases may in a large part be due to the fact that preventive measures outlined by us in the past are producing the desired results and thus preventing the occurrence of this disease.

Some work has been done with the drug sodium propionate with fairly satisfactory results. The dose of drug recommended was ½ ounce per ewe daily, with this amount being sprinkled upon the feed.

This drug apparently was not distasteful to the sheep and seemed to be well liked by the animal. Sodium propionate was recommended on the feed during the last 6 to 8 weeks of the gestation period. Unfortunately not enough cases have been available to draw definite conclusions. (Project 144)

### Pullorum Testing and the Production Of Pullorum Antigen

A. H. GROTH, H. C. MCDUGLE, E. L. MCCUNE,  
D. C. BLENDER

#### Objective:

The production of *S. pullorum* antigen to be used in the tube agglutination test for the detection of pullorum disease reactors.

- a. 58,060 samples were tested to detect pullorum disease reactors.  
Of these 119 were positive. (0.20).
- b. *S. pullorum* antigen on hand at beginning of year to test 347,875 samples.  
*S. pullorum* antigen on hand sufficient for 502,500 tests.  
*S. pullorum* antigen diluted used during the year 129,008 ml.  
*S. pullorum* antigen distributed to hatcheries to test 132,000 samples.
- c. Salmonellas from birds of different ages are grouped as:  
Chicks under 4 weeks of age—14 isolations.  
Chickens over 4 weeks of age—27 isolations.  
Poults under 4 weeks of age—18 isolations.  
Turkeys over 4 weeks of age—8 isolations.  
34 isolations were *S. pullorum*.  
5 isolations were *S. gallinarum*.  
7 isolations were *S. typhimurium*.  
7 isolations were *S. san diego*.  
3 isolations were *S. montevideo*.  
2 each of *S. infantis*, *S. bredeny*, *S. meleagridis*, *S. anatum*, and *S. californica*.  
4 Salmonellas could not be classified.
- d. Typhimurium "O" antigen (concentrated) on hand 100 ml. (to test 20,000 samples).  
Typhimurium plate antigen (concentrated) on hand 25 ml. (not standardized)

(Project 145)

## Studies on the Prevention of Disease Transmission from Carrier Sows to Baby Pigs

A. H. GROTH, A. A. CASE, AND H. B. WRIGHT

### Objectives:

A. Prevention and control of hog cholera by means of a modified virus and serum.

B. Prevention and control of swine erysipelas by use and comparison of two methods.

C. Prevention, control and elimination of leptospirosis in the swine owned by the University of Missouri Animal Husbandry Department.

Hog cholera control has been so effective that there has not been a single instance of this disease since the program was first put into use. Each piglet was vaccinated at weaning age by subcutaneous inoculation with 2 cc of reconstituted modified virus of swine origin (MLV in 1953, 'X3, DLV since 1955 plus two methods of simultaneous serum administration:

10 to 15 cc of anti-hog cholera serum administered either subcutaneously in the opposite flank from the one into which the virus was given, or intraperitoneally.

Both appear to be equally effective, but the serum subcutaneous method is preferred as less serum shock was seen where subcutaneous serum administration was used.

Swine erysipelas had been troublesome in the University swine herds. It caused complications of the hog cholera immunization program, especially before the modified hog cholera virus became available. Much arthritis and occasional dermatitis of older swine also was caused by the swine erysipelas organism.

Two products have been used with favorable results during the past 5 years. A bacterin (DUOVAX, Lederle) was first used and gave good control of swine erysipelas, but it was characterized by very severe local reactions where the bacterin was administered. Some of the abscesses required surgical after-care.

When it became available, an attenuated or rather avirulent live vaccine was put into use. EVA (Norden) proved, under our conditions, to be as effective as the bacterin had been. The severe local reactions were not seen with this product.

Leptospirosis, *L. pomona* strain, made a sudden and explosive appearance in the Landrace at the South Farm in the spring of 1955. How this condition gained entrance to the swine drove has not been determined for sure but it may have been introduced by means of a borrowed boar. One human case developed (the herdsman) and all of the landrace were infected with leptospirosis during this outbreak. Prompt vaccination of all cattle and unexposed swine, both on the South Farm and the campus helped to halt this outbreak.

The reacting sows aborted during the spring, but

nearly all of them carried excellent litters to full term, and raised the pigs to weaning age during the following fall. The swine at the south farm were placed on high antibiotic rations for 4 weeks, and the boars were individually treated with heavy doses of penicillin and streptomycin to eliminate carrier animals. In 1956 and 1957, serological survey and lack of any evidence of the presence of "lepto" support the effectiveness of the method used. (Project 175)

## Salmonellosis in Turkeys

A. H. GROTH, H. C. MCDUGLE

### Objective:

A. To determine the ability of Terramycin or its vehicle to raise titres.

June 10, 1957, 250 mg. of Terramycin was injected I. V. to 25 adult turkeys (4 W. Hollands, 21 Bronze). 250 mg. of water soluble Terramycin was injected I. M. in 4 W. Holland adults. At the time of injection 4 of the 29 birds reacted to a standard *S. pullorum* antigen (17, 19, 20); the highest reaction 2+ in a 1 to 25 dilution. June 13, six birds reacted, the highest reaction 3+ in a dilution of 1 to 50.

June 20 twelve birds reacted to standard *S. pullorum* antigen, the highest reaction 4+ in a dilution of 1 to 100. August 23 *seventy-four days* after administering Terramycin, I. V. and I. M., 12 birds reacted to standard antigen (the highest was 2+ at a 1-100 dilution). August 23, 1957, each of the 26 remaining birds was injected subcutaneously with 2 ml. of peanut oil used for cooking purposes. The titre to standard (17, 19, 20) *S. pullorum* antigen began to rise. Seven days after injecting the birds with peanut oil, 16 reacted (the highest was 1+ in a dilution of 1-100).

Most of the titres remained for 21 days. However, pen 6 at the end of 21 days had the highest titres recorded against the standard pullorum test of any time they were tested; however, the other 24 birds showed a much lower titre. 250 mg. of Terramycin (poultry formula) in a capsule was given by way of mouth to each bird September 23, 1957.

Four days later 17 birds had increased titres. Eight days after the poultry formula was given 20 of the 24 birds reacted. The highest reaction was 1+ in a dilution of 1-200. Nineteen birds remained reactors for 15 days. Thirteen birds remained reactors at the end of 28 days. The birds in pen of 6 reacted for 36 days.

Several antigens (intermediate *S. pullorum* No. 9611, and 6926; *S. chester*; and Gwatkins' proteus) were found to be unsatisfactory for testing agents for the above group of turkeys. Strains of *S. pullorum* (17, 19, 20) either properly combined or used singly showed approximately the same degree of reaction. Two irregular Gram staining *Streptococcus* sp. made into antigens were unsatisfactory.

*S. typhimurium* testing was done on the above group of birds. Two were reactors to "O" antigen, 4 were weak to the "H" antigen. The same 2 "O" positive birds were positive to *S. pullorum* antigen.

Throughout 1957 a total of 1,611 tests of 4 dilutions were run on the above birds.

Tests were made using 3 drops of a 10 percent potassium ethylenediamine tetraacetate to 5-10 ml. of blood as an anticoagulant. It gave excellent results and was used through the greater part of 1957. Other anticoagulants failed. Heparin was not used because of cost. For several years we have been using the shaft of a 3 inch, 15 gauge, hypodermic needle inserted through the stopper of a regular Bangs' testing tube and stopper with excellent results—bleeding the birds from the large wing vein directly into the anticoagulant.

The 12 turkeys that have died or that have been killed were all cultured. Salmonellas were not isolated. However, a *Proteus* sp. was isolated from hen number 166. From hen 303 two types of *Streptococci* were isolated, and antigen was made. It was used with the sera from 16 birds.

One designated as 303-7 indicated all sera to be positive whereas 303-15 showed 9 to be positive; but on the same date, January 23, 1958, only 2 birds were weakly positive to *S. pullorum* standard antigen. On the same date all 16 birds were negative to the "O" type of *S. typhimurium* antigen. Serums from all birds were negative to PPLO antigen. (Project 176)

### Drug Studies

C. J. BIERSCHWAL, A. D. ALLEN, G. C. SHELTON  
A. H. GROTH, AND E. F. EBERT

#### *Attempts to induce estrus in lactating sows.*

One of 20 sows not treated with pregnant mare serum exhibited estrus during lactation. Three of 18 sows treated about 20 days post-partum with 1,000 I. U. of the hormone came into estrus in 4 to 5 days. Ten of 11 sows given 2,000 I. U. of hormone at 20 days post-partum exhibited estrus 4 to 6 days following treatment. All 10 sows were bred and 5 were slaughtered at 50 days of gestation. The 5 sows carried litters of from 5 to 17 pigs, an average of 10.2.

Indications are that the appropriate level may be between 1,000 and 2,000 I.U. of the gonadotropic hormone.

#### *The effect of oxytetracycline hydrochloride on the endometrium of the bovine uterus.*

Biopsy samples of the endometrium from three treated animals gave extremely variable results. No additional animals were treated because it was found that additional equipment was needed before reasonably accurate results could be expected.

#### *The efficiency of larvicides and ovicides for destruction of worm*

#### *eggs in the soil.*

*Against ascarids and cecal worms of poultry:* Sodium pentachlorophenate used as one spray application at the rate of 4 ounces or more per 100 square feet of soil reduced ascarid populations in susceptible chickens from 50 to 60 percent and cecal worm populations from 55 to 70 percent. Increasing the rate of application of the chemical above the 4 ounce level did not appreciably increase the efficiency in this experiment.

*Against ascarids of swine:* Liver scars were reduced 50 to 70 percent by one application to the soil of contaminated pens. Pigs on treated pens made about 20 percent greater gains over a period to 10 and one half weeks.

Against gastro-intestinal parasites of sheep reported under Project 108.

#### *To determine the efficiency of Otrhomin in the treatment of porcine and bovine enteritis.*

The drug has been administered to 4 horses, 2 dogs, 18 cattle, and swine from six different herds. Both the oral and parenteral routes have been used for administration. The true efficacy of the drug has not yet been determined. (Project 177)

### Experimental Surgery on the Ruminant Stomach

A. H. GROTH, H. E. DALE, AND A. D. ALLEN

#### *Objective:*

*A. To devise surgical methods of removing the three forestomachs of immature ruminants and the supportive therapy necessary to maintain these animals in a normal physiologic state. Also to devise other surgical techniques useful in investigations of ruminant physiology as duodenal fistula and different types of ruminant fistula. These techniques would be important to researchers in the ruminant fields as they could select the techniques most applicable to the method of study desired.*

No conclusions were drawn from this work; however, two young bovines were operated on with the rumen being removed. These animals did not recover from the operational techniques, but sufficient information was obtained from this attempt to indicate that an approach which embodied an intestinal transposition would perhaps be of practical significance in this technique. Several ovine and bovine subjects were equipped successfully with rumen fistulae. (Project 252)

### Infectious Synovitis Complex

H. C. McDOUGLE, A. H. GROTH, E. L. McCUNE

By using embryonating chicken eggs, several isolations of the causative agent of synovitis have been accomplished. Attempts to grow the agent on artificial media have failed. After egg passage its virulence was not affected; however, after repeated serial passages in

birds, the agent produced only mild symptoms in susceptible young birds.

The agent is common to chickens and turkeys as alternate transfers from turkeys to chickens and back to turkeys has been accomplished.

An opportunity to study the action of chemotherapeutic agents has not occurred.

The extent of gross and microscopic damage caused by the agent or agents has been investigated. Evidence of a generalized organic disturbance has been found but further observations must be made before these findings can be used to aid in identification of the disease. The symptoms and gross pathology of a number of cases have been observed and recorded.

The causative agent or agents have been identified in so far as growth occurs only in the embryonating egg. Several strains of the agent have been isolated, and one of them was capable of infecting and remaining viable after its isolation and passage from the turkey to a chicken and back to a turkey.

This passage indicates chickens and turkeys to be infected by a common agent. However, most strains of the agent became nonpathogenic after several serial egg passages. (Project 308)

### Swine Enteritis

CECIL ELDER, H. B. WRIGHT, D. E. RODABAUGH

#### Objectives:

A. To study the cause or causes of enteritis occurring in swine under Missouri conditions.

B. To study enteritis in swine due to *Salmonella choleraesuis*.

C. To determine the efficacy of Furazolidone in treating swine enteritis due to *Salmonella choleraesuis*.

D. To determine the value of Furazolidone as a preventive agent in the control of swine enteritis due to *Salmonella choleraesuis*.

Furazolidone either at time of exposure or two days later failed to protect the pigs in the amounts used on this experiment. All pigs on treatment plus the controls developed the disease (swine enteritis), as evidenced by temperature rises and scouring.

Pigs that were exposed by pen contact only, developed the disease the same as pigs that were exposed directly by dosing them with the culture. Six pigs died of *Salmonella choleraesuis* enteritis. The drug failed to prevent the disease in pigs that were exposed by contact. The low level of the drug, 0.0055 percent, failed as a therapeutic or prophylactic agent in eight pigs held at this level for a nine week period. It should be pointed out however, that the 0.0055 percent level showed better prophylaxis than the .011 percent level given for a 14 day period.

The results are disappointing from the standpoint of using the drug as a therapeutic agent or as a prophylactic agent, but might have been much more favorable had the Furazolidone been given at a higher level.

The pigs on the drug treatment for the most part made better gains and also made a pound of gain on a less amount of feed, than did the untreated controls kept under the same conditions and handled in the same manner. (Project 326)

# Fertilizer Control

W. L. Baker, Chairman

### Fertilizer Control

W. L. BAKER, W. R. BERNHARDT, R. H. WEHRMANN,  
C. B. ROBERTS, W. F. MCNEALL, R. C. PREWITT,  
DORIS A. STONE

#### Objectives:

Efficient administration and enforcement of the Missouri Fertilizer law.

During the calendar year 1957 three full time inspectors calling on farmers, dealers, and manufacturers secured approximately 2500 official samples of bagged and bulk fertilizers representing lots from every county in the state.

A schedule of approximately ten days from collection of samples to reporting of analyses was consistently achieved, thereby permitting a return in time to issue a

stop sale order before most of the fertilizer in lots found to be misbranded had been sold.

The percent of lots found misbranded declined in 1957 and the percent meeting guarantee in all respects increased significantly as compared to 1956.

Maintenance of accurate and current tonnage records made possible checking of fees collected against tonnage reported as soon as received. It was generally possible to account for discrepancies by correspondence, except where manufacturers failed to file all invoice copies as required by law.

Fees collected on fertilizers sold for use in Missouri during the year ending December 31, 1957, amounted to \$241,742.30. Most companies reported, as required, within 30 days after July 1 and January 1. (Project 186)

## Outlying Experimental Farms Thompson Farm Improvement

SAM ROWE, CHARLES CROMWELL

Work during the past year has consisted primarily of cropping the land, working toward getting the areas into research projects. The research itself has been reported by the respective departments.

Crops produced during the year included 3,838 bushels of soybeans for sale and 595 bushels for seed. Cash sales amounted to \$7,892.75 and the value of seed was \$1,243.55. A total of 2,432 bushels of oats was produced and sold for \$1,264.36.

Rye production amounted to 275 bushels, selling for \$12,219.50. Heavy field losses were experienced running as high as 15 bushels per acre because of delay in harvesting from bad weather conditions. Popcorn production amounted to 475 bushels and sold for \$563.50.

Grain sorghum totaled 6,260 bushels and sold for \$4,365.84. What sales totaled \$2,534.82 for 1,300 bushels and an additional 100 bushels valued at \$200.00 was used for seed. Barley production amounted to 409 bushels and sold for \$409.29.

Bluegrass seed harvested under a cooperative contract amounted to 208 bushels and we received \$121.49 for our share. Total value of crop sales and seed amounted to \$31,089.64. About 650 tons of corn silage was put in trench silo and about 50 tons of wheat silage was harvested.

### *Major improvements and additions:*

Lake construction was started and about 30,000 yards of dirt were put in the dam. Two 30" road culverts were installed at the west end of a grass waterway to take water under the country road. Two 30" road culverts were installed in the creek crossing on the east side of the west section.

A 1600-bu. grain drying bin and equipment were purchased and installed. The total cost was \$975.00. Nine steel rod corn cribs were purchased for \$1,890. A set of truck scales costing 1,250 dollars was purchased. A 6,000 gallon anhydrous ammonia tank and equipment was purchased and installed for \$3,750. The furnace in the house was repaired and improved at a cost of \$375.

A new water heater also had to be purchased for \$122. The septic tank for the house had to be replaced at a total cost of \$250. Sheet steel was used to line the ear corn cribs to permit storage of shelled grain. A number of test wells for irrigation water were drilled. (*Project 273*)

## Improvement of Land And Buildings At Weldon Springs

GERALD V. WRIGHT

The work on this project was devoted primarily to

the production of feed and pasture for the Hereford herd located at Weldon Springs and used on Animal Husbandry research projects.

Along with the production of feed is the responsibility of feeding and caring for the herd and furnishing facilities for handling them. As a secondary purpose, the project helps in providing facilities for research projects of Soils and Forestry Departments.

On January 1, 1958, the herd at Weldon Springs consisted of the following:

### PUREBREDS

- 127 mature cows
- 21 bred heifers (1955)
- 36 yearling heifers (1956)
- 43 heifer calves (1957)
- 41 steer calves (1957)
- 11 bull calves (1957)
- 7 herd bulls

### GRADES

- 178 mature cows
- 15 bred heifers (1955)
- 58 yearling heifers (1956)
- 85 heifer calves (1957)
- 84 steer calves (1957)
- 4 undersized heifer calves
- 1 undersized steer calf
- 30 yearling steers (1956)
- 3 Angus bulls

This listing does not include this year's calf crop which is not yet complete. The first calf came on December 18 and up to and including March 11, a total of 143 calves have been born.

Of these 135 have been saved. One (1) was killed by dogs, 2 were injured and froze, 1 died of pneumonia, 1 was a very small calf and died, 1 was stillborn, and 2 cows had calving trouble and calves were lost.

Since July 1, the following have been sold: 103 head of steers (30 grade yearling steers were from above listed inventory); 3 bull calves; 1 calf produced by nurse cow; 23 cows and 12 heifers. The latter 35 head were herd culls. Total sales for these cattle amounted to \$17,811.29.

Physical improvements during the year include: Construction of a 40 acre lake involving the movement of about 125,000 cubic yards of dirt; a low-water crossing over Femme Osage Creek; a new 175 feet x 36 feet x 10 feet trench silo was dug; the old trench silo was enlarged by 175 feet x 15 feet x 10 feet; approximately 15 acres were cleared of brush; 1.2 miles of temporary fence and 0.8 mile of permanent fence were constructed; A corral with covered weighing area was constructed in Hidden Valley; basic lime and fertilizer applications included 34 acres limed at rate of 2½ tons per acre, and these 34 acres received a total of 20 tons of rock phosphate. 105 acres of new pasture were seeded, 170 acres were re-

seeded and 510 acres of temporary pasture were seeded.

Five (5) surplus government buildings were secured and torn down. Approximately 120,000 board feet of lumber was salvaged at a cost of about \$4,000. Part of this lumber was used for constructing the corral in Hidden Valley.

Crop production included 1,200 tons of grass silage, 1800 tons of corn silage, 900 tons of sorgo silage, 150 tons hay, 500 pounds of fescue seed, 700 pounds of orchard grass seed, 2,500 pounds brome grass seed, 1800 pounds of timothy seed, 150 bushels wheat, 750 bushels oats and 600 bushels of rye. (*Project 297*)

### **Poultry Husbandry Turkey Farm**

CHARLES CROMWELL, GROVER PERKINS

The work on this project the past year consisted primarily of improvements on the Rocheford Turkey Farm. Improvements included construction of 19-acre lake, clearing lake and adjacent areas of trees and brush, clearing out fence rows, construction of diversion channel to catch additional water and direct it to lake. (*Project 298*)

### **Operation of Southeast Missouri Fields**

NORMAN BROWN, CHARLES CROMWELL

This project has provided operational service to 29 different research projects in Southeast Missouri located on six leased fields and 24 cooperating farms.

Irrigation wells have been provided on three of the leased fields and irrigation equipment has been leased to provide these facilities where needed.

A car port attached to the administration building has been converted into a laboratory for nematode control work. Material was secured from Weldon Springs surplus buildings for this construction.

Sales this past year from salvaged crops (after research harvestings were made) were low because of extremely wet conditions which prevailed over the entire Southeast Missouri area. Crop sales amounted to less than \$5,000 for the year. (*Project 307*)

## **SPECIAL SERVICES**

### **Spectrographic Services**

E. E. PICKETT, S. R. KOIRTYOHANN, H. E. FIEHLER,  
B. E. HANKINS, R. L. SMITH

The Spectrographic Laboratory performs analyses by spectrographic and other means as a service to projects sponsored and approved by the Experiment Station, and to other departments of the University and, as time allows, to organizations and individuals outside the University. The laboratory also develops methods and tech-

niques to aid in these analyses.

The preliminary chemical concentration of the biologically important trace elements copper, cobalt, zinc, and molybdenum, by the carrier precipitation method (cf. 5, Publications, above) and the chelation-extraction method employing dithizone, were developed further and evaluated carefully by means of radioisotopes. This was done with the result that either method is now very effective and versatile and may be used interchangeably as a rule, or one or the other may be preferred in certain instances.

The acquisition of the direct-reading spectrograph made necessary a very detailed study of excitation conditions, sample form and chemical preparation, exposure conditions, sensitive lines, and other variables. The aim was to permit the determination of as many as possible of the elements calcium, magnesium, iron, manganese, boron, copper, and zinc in the plants and soil extracts, with the minimum of sample preparation, and with the precision and accuracy of 2 percent or better readily attained in the direct reader analysis of alloys. This effort, which has not been reported before, has been reasonably successful, resulting in a very rapid method in current use for the first four. There are good prospects for extending it to the others, with even greater speed and ease of sample preparation. (*Project 76*)

### **Analytical Services**

C. W. GEHRKE, L. D. HAIGH, E. W. COWAN,  
FRANK JOHNSON, B. R. SMITH, W. G. GODBEY,  
W. M. LAMKIN, JOANNE YAEGER, JOHN McMILLAN,  
AND D. W. LIERLE

Analytical research work on the various research projects submitted by divisions of the College of Agriculture and related agencies is carried out in this project.

Basic research is also conducted in agricultural chemistry and related fields. (*Project 132*)

### **Statistical Service**

C. L. GREGORY, GLADYS D. SLINGER

The project was organized to service the electronic computing needs growing out of research activities at the University. Since its installation, the machine has been operated nearly 100 percent of the rental time, exclusive of those occasions when the equipment was out-of-order.

During the first months a considerable amount of time was lost due to breakdowns which now appear to be a factory fault requiring some time to eliminate. More recently practically no time has been lost due to breakdowns, and headway is being made in utilizing the accumulated time lost during the early months. (*Project 302*)

## STATION PUBLICATIONS

JULY 1957 TO JUNE 1958

### Research Bulletins

- 636—Economic Survey of Small Slaughtering Plants in Missouri by Robert J. Reid, V. J. Rhodes, and E. R. Kiehl. July, 1957, 40 pages, 1500 copies.
- 637—The Etiology of "Nitrate Poisoning" in Sheep. By W. H. Pfander, G. B. Garner, W. C. Ellis, M. E. Muhrer. August, 1957, 12 pages, 1500 copies.
- 638—Control of Woody Vegetation by J. Milford Nichols. August, 1957, 28 pages, 1500 copies.
- 639—Influence of Temperature on Vitamin Levels in Bovine Blood. A Study of B-Vitamins and Vitamin C Levels in the Blood of Brahman, Santa Gertrudis and Shorthorn Heifers, Reared Under Different Environmental Temperature Conditions. By Ranjit Singh and C. P. Merilan, September, 1957, 40 pages, 1540 copies.
- 640—Effects of Burning on Ozark Hardwood Timberlands. By Lee K. Paulsell. September, 1957, 24 pages, 1560 copies.
- 641—Spectrophotofluorometric Determination of Estrogens in the Urine and Feces of Cows During Different Stages of Pregnancy, by Tawfik El-Attar and C. W. Turner, October, 1957, 48 pages, 1500 copies.
- 642—Environmental Physiology and Shelter Engineering XLII. Effects of Constant Environmental Temperatures of 50° F on the Growth Responses of Brahman, Santa Gertrudis, and Shorthorn Calves, by A. C. Ragsdale, Chu Shan Cheng, Harold D. Johnson. October, 1957, 32 pages, 1500 copies.
- 643—Environmental Physiology and Shelter Engineering XLIII. Energy Metabolism and Cardiorespiratory Activities in Shorthorn, Santa Gertrudis, and Brahman Heifers During Growth at 50 and 80° F Temperatures. By Hudson H. Kibler, October, 1957, 32 pages, 1560 copies, Reprint June, 1958, 1000 copies.
- 644—Localization of Glycerol-1-C<sup>14</sup> in Bovine Spermatozoa by an Autoradiographic Technique. By B. W. Pickett and C. P. Merilan, October, 1957, 28 pages, 1560 copies.
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- 646—Environmental Physiology and Shelter Engineering. By Harold D. Johnson, A. C. Ragsdale, and Chu Shan Cheng. November, 1957, 52 pages, 1700 copies.
- 647—Extent of Illness and Use of Health Services in a South Missouri County. By Robert L. McNamara and Edward W. Hassinger, January, 1958, 32 pages and 1700 copies.
- 648—Environmental Physiology and Shelter Engineering XLVI. Comparison of the Effect of Environmental Temperature on Rabbits and Cattle. Part 2. Influence of Rising Environmental Temperature on the Physiological Reactions of Rabbits and Cattle. By Harold D. Johnson, Chu Shan Cheng, and A. C. Ragsdale. January, 1958, 28 pages, 1500 copies.
- 649—Environmental Physiology and Shelter Engineering. By Clifton Blincoe, January, 1958, 28 pages, 1550 copies.
- 650—Effect of Potassium Nitrate Intake on Lactating Dairy Cows. By G. A. Stewart and C. P. Merilan. January, 1958, 12 pages, 1560 copies.
- 651—Predicting Consumer Acceptance of Beef Loin Steaks, By V. James Rhodes, Elmer R. Kiehl, D. E. Brady, and H. D. Naumann. January, 1958, 52 pages, 1600 copies.
- 652—St. Louis Consumers' Eating Preferences for Beef Loin Steaks. By Elmer R. Kiehl, V. James Rhodes, D. E. Brady, and H. D. Naumann. January, 1958, 32 pages, 1600 copies.
- 653—Relationships of the Public to Physicians in a Rural Setting. By Edward W. Hassinger and Robert L. McNamara. January, 1958, 36 pages, 1500 copies.
- 654—Response of Sheep to Irrigation and Fertilization of Pastures. By Armand D. Moles, G. B. Thompson, and A. J. Dyer. February, 1958, 24 pages, 1500 copies.
- 655—Mineralogy and Chemistry of the Hagerstown Soil in Missouri. By J. E. Brydon and C. E. Marshall, February, 1958, 56 pages, 1500 copies.
- 656—Environmental Physiology and Shelter Engineering by R. E. Stewart and M. D. Shanklin. February, 1958, 24 pages, 1500 copies.
- 657—Experimental Oak Wilt Control in Missouri, by T. W. Jones and T. W. Bretz. February, 1958, 12 pages, 1900 copies.
- 658—Quality of Eggs Laid by Caged Layers by E. M. Funk, Glenn Froning, Robert Grotts, James Forward, and Quinton Kinder. March, 1958, 8 pages, 1500 copies.
- 659—Seasonal Variation in Egg Quality, by E. M. Funk, Glenn Froning, Robert Grotts, James Forward, and Owen Cotterill. March, 1958, 1500 copies, 24 pages.
- 660—Design Data for Above-Ground Horizontal Silos, by M. L. Esmay, D. B. Brooker, and J. S. McKibben. March, 1958, 16 pages 1500 copies.

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- 693—Problems in Milk Vending, by Quentin D. Banks and Stephen F. Whitted. October, 1957, 12 pages 3500 copies.
- 694—Above Ground Gasoline Storage, by D. B. Brooker, October, 1957, 8 pages, 3500 copies, Reprint, March, 1958, 2000 copies.
- 695—Missouri's Research Story of 1956-57 (Experiment Sta. Annual Report), by Experiment Station Staff. November, 1957, 140 pages 3500 copies.
- 696—Silage—Feed of Excellence, by Depts. of Animal Husbandry, Field Crops, Agricultural Chemistry, Agricultural Engineering, and Agricultural Economics. January, 1958, 24 pages, 3500 copies.
- 697—1957 Mo. Hybrid Corn Yield Trials, by C. O. Grogan, O. V. Singleton, M. S. Zuber, January, 1958, 40 pages, 3500 copies.
- 698—Talks from the 9th Annual Missouri Farm Forum, October, 1957, by Clyde Duncan, 36 pages, 3525 copies.
- 699—A New Method of Terracing, by R. P. Beasley, April, 1958, 16 pages 3500 copies.
- 700—Southeast Missouri Agricultural Research, by Entomology, Field Crops, Soils and Agricultural Engineer Departments. February, 1958, 48 pages 3545 copies.
- 701—A Century of Missouri Agriculture, by M. F. Miller, Dean and Director Emeritus, May, 1958, 92 pages, 3500 copies.
- 702—Television Viewing in Rural Boone County, by Herbert F. Lionberger, April, 1958, 16 pages 3500 copies.
- 703—Water Livestock the Automatic Way, by K. L. McFate, and C. L. Day, April, 1958, 8 pages, 4000 copies.
- 704—20th Annual Livestock Feeders Day, April 11, 1958

- by J. F. Lasley, F. E. Comfort and J. O. Butcher. April, 1958, 16 pages, 4500 copies.
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- 706—Should I Install a Bulk Milk Tank? by Horace E. Armstrong and Stephen F. Whitted. June, 1958, 16 pages, 3500 copies.
- 707—Chances of Dry Periods in Missouri by Wayne L. Decker, June, 1958, 12 pages, 3500 copies.
- 708—Learn to Live With Nitrates, by George B. Garner June, 1958, 8 pages, 3500 copies.

#### Contributions To Scientific Journals

- 1766—Estrogenic Steroids in the Urine of Swine During Pregnancy, Henry E. Bredeck and Dennis T. Mayer, Department of Agricultural Chemistry, in cooperation with the Animal Husbandry Department, University of Missouri. Submitted July, 1957, for publication in the Proceedings of the Third Symposium on Reproduction and Infertility.
- 1767—Community Prestige as a Structural Element in the Choice of Persons as Sources of Farm Information in a Missouri Farm Community, by Herbert F. Lionberger, Department of Rural Sociology, University of Missouri. Submitted July, 1957, to be read before joint meeting of the Rural Sociological Society and the American Sociological Society. Also will be submitted to Public Opinion Quarterly for possible publication.
- 1768—An Inexpensive Unit for Converting a Vacuum Cleaner to an Insect Aspirator, by Perry L. Adkisson, Department of Entomology, University of Missouri. Submitted July, 1957, for publication in the Journal of Economic Entomology.
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- 1774—The Influence of Plant Growth Regulating Substances and Hydroxy-Compounds on the Absorption of Streptomycin by Plants, by R. N. Goodman and W. M. Dowler, Department of Horticulture, University of Missouri. Submitted August, 1957, for presentation at the Fourth International Plant Protection Congress, Hamburg, Germany, September 9-16.
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- 1782—(Abstract) Fattening Lamb Responses to Rations Fed in Various Physical Forms with Special Emphasis on Rumen Changes, by G. B. Thompson, D. T. Lyons, and W. H. Pfander, Department of Animal Husbandry, University of Missouri. Submitted August, 1957, for publication in the American Society of Animal Production.
- 1783—The TDN of Rations Containing Shelled, Cracked, Ground, and Flaked Corn as Determined with Sheep, by R. Fisher, C. W. Gehrke, M. E. Muhrer, and W. H. Pfander, Departments of Agricultural Chemistry and Animal Husbandry, University of Missouri. Submitted August, 1957, for publication in the American Society of Animal Production.
- 1784—(Abstract) I. Physical Factors that Influence the Response of Sheep to Added Corn Oil, by W. H. Pfander and I. S. Verma, Department of Animal Husbandry, University of Missouri and Lincoln University. Submitted August, 1957, for publication in the American Society of Animal Production.
- 1785—(Abstract) Effect of Constant Environmental Temperature (50 and 80° F) on Thyroid I<sup>131</sup> Activity of Holstein, Brown Swiss, and Jersey Calves During Growth,

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- 1786—(Abstract) The Role of Butylated Hydroxy Anisole and Sodium Meta Bisulfite in the Utilization of Rations Containing Nitrate, by J. L. Ketchum, G. B. Garner, L. M. Flynn, and W. H. Pfander, Department of Animal Husbandry, University of Missouri. Submitted, August, 1957, for publication in the American Society of Animal Production.
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- 1788—Effect of Ration on Control of Undesirable Microorganisms in the Rumen of Sheep, by G. B. Garner, W. H. Pfander and M. E. Muhrer, Departments of Agricultural Chemistry and Animal Husbandry, University of Missouri. Submitted August, 1957, for publication in the American Society of Animal Production.
- 1789—Effect of the Physical Form of Grain on the Rate of Volatile Fatty Acid Production in Ruminants, by G. B. Garner, W. H. Pfander, and M. E. Muhrer, Departments of Agricultural Chemistry and Animal Husbandry, University of Missouri. Submitted August, 1957, for publication in the American Society of Animal Production.
- 1790—Integration of the Sciences for Effective Research, by Elmer R. Kiehl, Department of Agricultural Economics, University of Missouri. Submitted August, 1957, for publication in the Journal of Farm Economics.
- 1791—Anthocyanin Synthesis in Maize—A Gene Sequence Construction, by E. H. Coe, Jr., Department of Field Crops, University of Missouri. Submitted August, 1957, for publication in American Naturalist.
- 1792—Preliminary Results on the Preservation of Liquid Bovine Semen in a Milk-Egg Yolk-Glycerol Extender, by J. D. Sikes and C. P. Merilan, Department of Dairy Husbandry, University of Missouri. Submitted August, 1957, for publication in the Journal of Dairy Science.
- 1793—Relationship of Physical and Product and General Acceptability Ratings, by V. James Rhodes, Department of Agricultural Economics, University of Missouri. Submitted September, 1957, for presentation at "Conference on Consumer Studies and Meat Quality."
- 1794—Thyroxine Secretion Rates of Two Strains of New Hampshire Chickens Selected for High and Low Response to Thiouracil, by B. N. Premachandra, G. W. Pipes and C. W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted September, 1957, for publication in the Journal of Poultry Science.
- 1795—Blood Volumes of Dairy Calves Comparing Cr<sup>51</sup> Tagged Red Blood Cells and T-1824 Plasma Dilution Methods<sup>1</sup>, by Perry Ruth Stahl and Homer E. Dale, Departments of Dairy Husbandry and Veterinary Physiology, Division of Agricultural Science, University of Missouri. Submitted September, 1957, for publication in the American Journal of Physiology.
- 1796—Release and Restoration of Pituitary Lactogen in Response to Nursing Stimuli in Lactating Rats, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted September, 1957, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1797—Survey of Frozen Meat Retailing in the Kansas City Area, Spring, 1957, by Richard C. Maxon, Department of Agricultural Economics, University of Missouri. Submitted September, 1957, for publication in a trade Journal in the Frozen Food Fields.
- 1798—Arginine Metabolism in the Growing Chick, by B. L. O'Dell, Osm. A. Laerdal, Ana Muniz Jeffay and J. E. Savage, Departments of Agricultural Chemistry and Poultry Husbandry, University of Missouri. Submitted September, 1957, for publication in Poultry Science.
- 1799—Relationship Between Temperature and Carbon Dioxide Loss from Shell Eggs, by O. J. Corterill, F. A. Gardner, E. M. Funk, and F. E. Cunningham, Department of Poultry Husbandry, University of Missouri. Submitted September, 1957, for publication in Poultry Science Journal.
- 1800—Some Random Thoughts on Product, Product Design and Meat Quality in the Future, by Elmer R. Kiehl, Department of Agricultural Economics, University of Missouri. Submitted September, 1957, for publication in Proceedings of the Consumer Studies and Meat Quality Conference.
- 1801—Effects of Clipping and Spraying on Various Homeothermic Responses of Rabbits at 39.4° C (103° F) Environmental Temperature, by Harold C. Johnson, Chu Shan Cheng, and A. C. Ragsdale, Department of Dairy Husbandry, University of Missouri. Submitted October, 1957, for publication in the Journal of Nature.
- 1802—Missouri Council Strengthens Farm Activities, by Kenneth L. McFate, Department of Agricultural Engineering, University of Missouri. Submitted October, 1957, to be published in the Farm Electrification Publication.
- 1803—Available Moisture Storage Capacity in Relation to Textural Composition and Organic Matter Content of Several Missouri Soils, by V. C. Jamison and E. M. Kroth, Department of Soils, University of Missouri. Submitted October, 1957, to be presented at the Soil Science Society of America November 18-22, and published in the Proceedings, Soil Science Society of America.
- 1804—(Abstract) Control of Vegetation Under Bearing Apple Trees, Department of Horticulture, University of Missouri. Submitted October, 1957, for publication in the Research Report, North Central Weed Control Conference—1957.
- 1805—(Abstract) Chemical Weed Control in Sweet Potatoes, by D. D. Hemphill, Department of Horticulture, University of Missouri. Submitted October, 1957, for publication in the Research Report North Central Weed Control Conference—1957.
- 1806—Chemical Weed Control in Transplanted Tomatoes, by D. D. Hemphill, Department of Horticulture, University of Missouri. Submitted October, 1957, for publication in Research Report, North Central Weed Control Conference—1957. (Abstract)
- 1807—(Abstract) Pre-emergence Weed Control in Snap Beans, by D. D. Hemphill, Department of Horticulture, University of Missouri. Submitted October, 1957, for publication in the Research Report, North Central Weed Control Conference—1957.
- 1808—Breeding High Amylose Corn, by M. S. Zuber, De-

- partment of Field Crops, University of Missouri. Submitted October, 1957, for presentation at the Hybrid Corn Industry Research Conference in Chicago, and also published in the Proceedings of that organization.
- 1809—Estrogen Content of Colostrum and Milk of Dairy Cattle, by Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted October, 1957, for publication in the *Journal of Dairy Science*.
- 1810—Milk Let-Down Activity of Synthetic Oxytocin (Syn-tocinon) and Relaxin in Lactating Rats, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted October, 1957, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1811—Gaseous Nitrogen Losses from Different Soil Types, by G. H. Wagner and G. E. Smith, Department of Soils, University of Missouri. Submitted November, 1957, for publication in Proceedings, Soil Science Society of America.
- 1812—Physico-Chemical Properties of Solid-Liquid Interfaces in Soil Systems, by C. E. Marshall, Department of Soils, University of Missouri. Submitted November 1957, for publication in the Proceedings, Soil Science Society of America.
- 1813—Effects of Oxytocin and Blocking Agents Upon Pituitary Lactogen Discharge in Lactating Rats, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted November, 1957, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1814—The Absorption of Streptomycin by Bean Plants as Influenced by Growth Regulators and Humectants, by R. N. Goodman and W. M. Dowler, Department of Horticulture, University of Missouri. Submitted November, 1957, for publication in the U. S. D. A. Journal, "Plant Disease Reporter."
- 1815—Mammary Desoxyribose Nucleic Acid: Preparation of Tissues and Effects of Time and Hormone Dose, by Henry C. Damm and Charles W. Turner with technical assistance of Mary E. Powell, Department of Dairy Husbandry, University of Missouri. Submitted November, 1957, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1816—Processing and Organoleptic Characteristics of Hams From Medium, U. S. No. 1 and U. S. No. 2 Grade Pork Carcasses, by E. Birmingham, H. D. Naumann, D. E. Brady, V. J. Rhodes, E. R. Kiehl, and R. H. Cook, Departments of Animal Husbandry, and Agricultural Economics, University of Missouri, and Foreign Marketing Branch, Livestock and Meats Product Division, F.A.S., U.S.D.A., Washington, D. C. Submitted November, 1957, for presentation at the A. S. A. P. Meetings.
- 1817—Weed Control in Established and New Strawberry Plantings, by D. D. Hemphill, Department of Horticulture, University of Missouri. Submitted December, 1957, for publication in the North Central Conference Proceedings—1957.
- 1818—Air Distribution Patterns from Lateral Ducts in Grain Storage Structures, by D. B. Brooker, Department of Agricultural Engineering, University of Missouri. Submitted December, 1957, for presentation at the annual winter meeting of the American Society of Agricultural Engineers at Chicago, Illinois.
- 1819—Soil Nutrient Balance and Fruiting of Cotton, by J. A. Roth and G. E. Smith, Department of Soils, University of Missouri. Submitted December, 1957, for publication in Proceedings Soil Science Society of America.
- 1820—The influence of Varied Cellulose and Nitrogen Levels Upon Ration Digestibility and Nitrogen Balance of Lambs Fed Semi-Purified Rations, by W. C. Ellis and W. H. Pfander, Department of Animal Husbandry, University of Missouri. Submitted December, 1957, for publication in the *Journal of Nutrition*.
- 1821—Growth Hormone and Lactation, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted December, 1957, for publication in the Federation of American Societies for Experimental Biology.
- 1822—Effects of Temperature and Age on Growth Rate, Blood GSH and PBI<sup>131</sup> Levels, by H. D. Johnson and Taymour Kamal, Department of Dairy Husbandry, University of Missouri. Submitted December, 1957, for presentation at the annual meeting of the American Society for Experimental Biology, April 17-19, 1958, in Philadelphia, Pa. (Abstract)
- 1823—Effect of Environmental Temperature on Time of Puberty in Beef Calves, by Homer E. Dale, A. C. Ragsdale, and Chu Shan Cheng, Departments of Veterinary Physiology and Dairy Husbandry, University of Missouri. Submitted December, 1957, for presentation at the annual meeting of the Federation of American Societies for Experimental Biology, April 17-19, in Philadelphia, Pa. (Abstract)
- 1824—(Abstract) Factors Affecting Thyroid Activity in Domestic Animals as Shown by Radioiodine (I<sup>131</sup>), by G. W. Pipes, B. N. Premachandra and C. W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted December, 1957, for presentation at the Second International Conference on the Uses of Atomic Energy.
- 1825—Cr<sup>51</sup> Blood Studies in Dairy Calves Under Controlled Environmental Conditions, by P. R. Stahl and H. E. Dale, Departments of Dairy Husbandry and Veterinary Physiology. Submitted December, 1957, for presentation at the second International Conference on the Peaceful Uses of Atomic Energy, Sept. 1-13, 1958.
- 1826—Use of I<sup>131</sup>, Pm<sup>147</sup>, and Tl<sup>204</sup> in Studying the Effect of Climatic Factors on Productivity of Cattle, by H. D. Johnson, A. C. Ragsdale, H. H. Kibler, and C. S. Cheng, Department of Dairy Husbandry, University of Missouri. Submitted December, 1957, for presentation at the second International Conference on the Peaceful Uses of Atomic Energy, Sept. 1-13, 1958.
- 1827—(Abstract) Effect of Constant Environmental Temperature and Growth on Blood Volume of Calves, by P. R. Stahl and H. E. Dale, Department of Dairy Husbandry, University of Missouri. Submitted December, 1957, for presentation at the annual meeting of the American Society for Experimental Biology, April 17-18, in Philadelphia, Pennsylvania.
- 1828—The Likelihood of Extended Dry Periods in Northeast Missouri, by Wayne L. Decker, Department of Soils, University of Missouri. Submitted December, 1957, for publication in the Bulletin American Meteorological Society.
- 1829—Some Virus-Like Disorders of Pome Fruit Trees in Missouri, by A. F. Posnette and D. F. Millikan, Department of Horticulture, University of Missouri. Submitted December, 1957, for publication in the Plant Disease Reporter. (Abstract)

- 1830—(Abstract) Effect of Phosphorus on Magnesium Requirement, by B. L. O'Dell, E. R. Morris, and W. O. Regan, Department of Agricultural Chemistry, University of Missouri. Submitted January, 1958, for publication in the Federation Proceedings and presentation at the spring meetings of the Society of Experimental Biology and Medicine in Philadelphia, April, 1958.
- 1831—An Approach to More Efficient Vegetable Fertilization, by Dr. V. N. Lambeth, Department of Horticulture, University of Missouri. Submitted January, 1958, for publication in the journal of Better Crops and Plant Food.
- 1832—Field Tests of Materials for Control of the Cotton Leafworm, by Perry L. Adkisson, Department of Entomology, University of Missouri. Submitted January, 1958, for publication in the journal of Economic Entomology.
- 1833—Control of Vegetation Beneath Bearing Apple Trees, by D. D. Hemphill, Department of Horticulture, University of Missouri. Submitted January, 1958, for presentation at second meeting of "Weed Society of America", Memphis, Tennessee, January 14, and publication in "Weeds", Journal of the Weed Society of America.
- 1834—The Desoxyribonuclease (DNA'ase) Activity of the Rat Mammary Gland During Pregnancy and Lactation, by David R. Griffith and Charles W. Turner, with technical assistance of Mary E. Powell, Department of Dairy Husbandry, University of Missouri. Submitted January, 1958, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1835—The Etiology and Possible Preventive Measures in the Dark Cutter Syndrome, by Harold B. Hedrick, Department of Animal Husbandry, University of Missouri. Submitted January, 1958, for publication in Veterinary Medicine.
- 1836—Electrochemical Properties in Relation to Two Methods of Preparation of Colloidal Clays, by Wm. T. Higdon and C. E. Marshall, Department of Soils, University of Missouri. Submitted January, 1958, for publication in the Journal of Physical Chemistry.
- 1837—Progress Report on Experimental Stimulation of Milk Secretion, by C. W. Turner and H. L. Ruppert, Jr., Department of Dairy Husbandry, University of Missouri. Submitted January, 1958, for presentation at the Dairy Science Association meetings in June, 1958.
- 1838—Turnover of  $I^{131}$ -Labelled Thyroxine in Cattle, by B. N. Premachandra, G. W. Pipes and C. W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted January, 1958, for presentation at the Dairy Science Association meetings in June, 1958.
- 1839—Optimal Hormone Levels and Lactation, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted January, 1958, for presentation at the Dairy Science Association meetings in June, 1958.
- 1840—Effects of Constant Environmental Temperature ( $50^{\circ}$  and  $80^{\circ}$ F) on Growth Responses of Brown Swiss, Holstein, and Jersey Calves, by H. D. Johnson, C. S. Cheng, and A. C. Ragsdale, Department of Dairy Husbandry, University of Missouri, Columbia. Submitted January, 1958, for presentation at the Annual Meeting of the American Dairy Science Association June 17, 18, and 19, 1958, at the North Carolina State College, Raleigh. (Abstract)
- 1841—Effect of Rising Environmental Temperatures ( $35^{\circ}$ - $95^{\circ}$ ) on Thyroid  $I^{131}$  Activity of Holstein, Brown Swiss and Jersey Heifers, by H. D. Johnson.
- 1842—The Effect of  $KNO_2$  and  $KNO_3$  on Vitro Cellulose Digestion by Bovine Rumen Microorganisms, by V. H. Viebrock and C. P. Merilan, Department of Dairy Husbandry.
- 1843—A New Technique for Rearing Carpenterworms, by Alfred M. Rivas and W. D. Buchanan, Department of Entomology, University of Missouri, and Central States Forest Experiment Station, Forest Service, U.S.D.A. Submitted February, 1958, for publication in the Journal of Economic Entomology.
- 1844—The Small Oak Barkbeetle Transmits the Oak Wilt Disease Under Caged Conditions, by W. D. Buchanan, Department of Forestry, University of Missouri. Submitted February, 1958, for publication in the Plant Disease Reporter.
- 1845—The Small Oak Barkbeetle Transmits the Oak Wilt Disease, by W. D. Buchanan, Department of Forestry, University of Missouri. Submitted February, 1958, for publication in the Journal of Forestry.
- 1846—The Effect of Pentachloronitrobenzene (PCNB) on Mushroom Production, by R. N. Goodman, Department of Horticulture, University of Missouri. Submitted February, 1958, for publication in the Plant Disease Reporter.
- 1847—Knowledge and Consumption of Frozen Meats by Selected Kansas City Households, by Richard C. Maxon and Gale C. Hankins, Department of Agricultural Economics, University of Missouri. Submitted February, 1958, for publication in the journal of Quick Frozen Foods.
- 1848—Designation of High Amylose Gene Loci in Maize by H. H. Kramer, Department of Agronomy, Purdue University, Lafayette, Indiana; R. P. Bear, Bear Hybrid Corn Co., Decatur, Illinois; and M. S. Zuber, Department of Field Crops, University of Missouri. Submitted February, 1958, for publication in the Agronomy Journal.
- 1849—Some Observations on the Pathology and Pathological Histology of Downy Mildew, *Sclerophthora Macrospora*, of Corn, Sorghum, Wheat, Oats, Barley, and Crabgrass, by Marvin D. Whitehead, Department of Field Crops, University of Missouri. Submitted February, 1958, for publication in Phytopathology.
- 1850—Assay of Lactogenic Hormone, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted February, 1958, for publication in Endocrinology.
- 1851—A New Species of Rake-legged Mite from Missouri (Acarina, Caeculidae), by Wilbur R. Enns, Department of Entomology, University of Missouri. Submitted February, 1958, for publication in the Kansas Entomological Society.
- 1852—The Church in the Changing Rural Community, by Charles E. Lively, Department of Rural Sociology, University of Missouri. Submitted February, 1958, for presentation before the 18th Annual Town and Country Conference for Laymen and Pastors, Kansas State College, January 21, 1958.
- 1853—Developing a Consumer Panel, by Elmer R. Kiehl, Department of Agricultural Economics, University of Missouri. Submitted February, 1958, for presentation at the Association of Southern Agricultural Workers Conference, Little Rock, Arkansas.

- 1854—A New Method for Labeling Seed Envelopes, by C. O. Grogan and M. S. Zuber, Department of Field Crops, University of Missouri. Submitted February, 1958, for publication in the *Agronomy Journal*.
- 1855—Mortality in Wilt Infected Oaks, by T. W. Jones, Department of Forestry, University of Missouri. Submitted February, 1958, for publication in the *Plant Disease Reporter*.
- 1856—Significance of Dietary Zinc for the Growing Chicken by B. L. O'Dell, P. M. Newberne and J. E. Savage, Departments of Agricultural Chemistry and Poultry, University of Missouri. Submitted February, 1958, for publication in the *Journal of Nutrition*.
- 1857—Lactogen Discharge and Milk Secretion in Lactating Rats, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy, University of Missouri. Submitted March, 1958, for publication in the *Journal of Endocrinology*.
- 1858—Intergenomic Chromosome Relationships in Hexaploid Wheat, by E. R. Sears and M. Okamoto, Department of Field Crops, University of Missouri and U. S. Department of Agriculture. Submitted March, 1958, for publication in the *Proceedings of the 1958 Genetics Congress in Montreal, Quebec, Canada*, (Abstract)
- 1859—Present Status and Prospects of Research Relating to the Diffusion and use of New Farm Practices, by Herbert F. Lionberger, Department of Rural Sociology, University of Missouri. Submitted March, 1958, for publication in the *Journal of Rural Sociology*.
- 1860—A Crossover Analysis of Mutable Alleles at the *A* Locus in Maize, by M. G. Nuffer, Department of Field Crops, University of Missouri. Submitted March, 1958, for publication in the *International Congress of Genetics*. (Abstract)
- 1861—A Continuing, Non-Reverting Conversion-Type Phenomenon at the *B* Locus in Maize, by E. H. Coe, Jr., Department of Field Crops, University of Missouri. Submitted March, 1958, for publication in *International Congress of Genetics*. (Abstract)
- 1862—Oak Wilt Distribution Through 1957, by T. W. Bretz and T. W. Jones, School of Forestry, University of Missouri, in cooperation with the Central States Forest Experiment Station, Forest Service, U. S. Department of Agriculture. Submitted March, 1958, for publication in the *U. S. Department of Agriculture Plant Disease Reporter*.
- 1863—Four Years' Experience with Diazinon in Missouri, by Wilbur R. Enns, Department of Entomology, University of Missouri. Submitted March, 1958, for publication in the *American Fruit Grower*.
- 1864—Alteration of Dominance and Apparent Change in Direction of Gene Action by a Mutation at Another Locus Affecting the Pigmentation of the Seed Coat of the Soybean, by L. F. Williams, Department of Field Crops, University of Missouri. Submitted March, 1958, for presentation at the Tenth International Genetics Congress, Montreal, August 20-27, 1958.
- 1865—Changes in Livestock Marketing Patterns, by Elmer R. Kiehl, Department of Agricultural Economics, University of Missouri. Submitted April, 1958. This paper was presented to a conference of marketing officials held in Kansas City on February 12.
- 1866—Factors Affecting Poultry Flavor, by William C. Hurley, O. J. Kahlenberg, E. M. Funk, Leta G. Maharg, and Nancy L. Webb, Departments of Poultry Husbandry and Home Economics, University of Missouri. Submitted April, 1958, for publication in *Poultry Science Magazine*.
- 1867—Variation in the Thyroxine Secretion Rate of Cattle, by B. N. Premachandra, G. W. Pipes and C. W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted April, 1958, for publication in the *Journal of Dairy Science*.
- 1868—A Power Company Sponsored Community Development Program, by John S. Holik, Department of Rural Sociology, University of Missouri. Submitted April, 1958. This paper was presented before the Midwest Sociological Society April 25, 1958, at Curtis Hotel, Minneapolis, Minnesota. Also to be submitted for publication in the *Midwest Sociologist*.
- 1869—Preliminary Studies Utilizing Paper Electrophoresis As a Tool in Insect Systematics, by Jerome Brezner and Wilbur R. Enns, Department of Entomology, University of Missouri. Submitted April, 1958, for publication in the *Journal of Kansas Entomological Society*.
- 1870—Significant Relationships in Pork Carcass Evaluation, by S. E. Zobrisky, D. E. Brady, J. F. Lasley, and L. A. Weaver, Department of Animal Husbandry, University of Missouri. Submitted April, 1958, for publication in the *Journal of Animal Science*.
- 1871—Effect of Estrogen and Progesterone on Thyroid Function of Cattle, by G. W. Pipes, B. N. Premachandra and C. W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted May 1, 1958, for publication in the *Journal of Dairy Science*.
- 1872—A Simple Method for In Vitro Storage of Insect Hemolymph, by J. Brezner, R. A. Hart, and W. R. Enns, Department of Entomology, University of Missouri. Submitted May, 1958, for publication in *Journal of Science*.
- 1873—A Note on Stages in the Adoption Process, by Edward Hassinger, Department of Sociology, University of Missouri. Submitted May, 1958, for publication in *Rural Sociology*.
- 1874—Antimicrobial Treatments on the Stored Potato Microflora, by M. R. Johnston, N. Finley and J. D. Edwards, Department of Horticulture, University of Missouri. Submitted May, 1958, for publication in *Food Research*.
- 1875—Significant Relationships in Pork Carcass Evaluation II. Fat Cuts and Total Fat as Criteria for Live Hog Value, by S. E. Zobrisky, D. E. Brady, J. F. Lasley, L. A. Weaver, Department of Animal Husbandry, University of Missouri. Submitted May, 1958, for publication in the *Journal of Animal Science*.
- 1876—Further Investigation of Plastic Covers for Cucumber Fermentation Vats, by M. R. Johnston, N. Finley, and J. D. Edwards, Department of Horticulture, University of Missouri. Submitted May, 1958, for presentation at the 18th Annual Meeting of the Institute of Food Technologists, May 25-29, 1958, Chicago, Illinois.
- 1877—The Effect of Household Table Salt on the Whipping Quality of Egg White Solids, by Carol Sechler, Leta G. Maharg, and Margaret Mangel, Department of Home Economics, University of Missouri. Submitted May, 1958, for publication in the *Journal of Food Technology or Food Research*.
- 1878—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,

- University of Missouri. Submitted May, 1958, for publication in the Journal of Animal Science.
- 1879—Role of Relaxin in Stimulating Mammary Gland Growth in Mice, by Hiroshi Wada and Charles W. Turner, with technical assistance of Mary E. Powell, Department of Dairy Husbandry, University of Missouri. Submitted May, 1958, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1880—Leaf Content of Phosphorus and Potassium Under Moisture Stress, by A. D. Hibbard, Department of Horticulture, University of Missouri, and Mohsen Nour, Middle Rio Grande Experiment Station, Albuquerque, New Mexico. Submitted June, 1958, for publication in the American Society for Horticultural Science Journal.
- 1881—Stalk Lodging Studies in Corn, by M. S. Zuber, Department of Field Crops, University of Missouri. Submitted June, 1958, for publication in the Yearbook and Proceedings of the American Seed Trade Association, 1958.
- 1882—Significant Relationships in Pork Carcass Evaluation—IV. Loin Equivalents 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, University of Missouri. Submitted June, 1958, for publication in the Journal of Animal Science.
- 1883—An Abnormality of the Proventriculus Caused by Feed Texture, by B. L. O'Dell, P. M. Newberne, and J. E. Savage, Departments of Agricultural Chemistry and Poultry Husbandry, University of Missouri. Submitted June, 1958, for publication in the Journal of Poultry Science.
- 1884—Optimal Hormone Levels and Lactation in the Rat, by Clark E. Grosvenor and Charles W. Turner, Department of Dairy Husbandry, University of Missouri. Submitted June, 1958, for publication in the Proceedings of the Society for Experimental Biology and Medicine.
- 1885—First Report of Tree Mortality From Fomes Annus Root Rot in Missouri, by T. W. Jones, and T. W. Bretz, Pathologist, Central States Forest Experiment Station, Forest Service, U. S. Department of Agriculture, Columbia, Missouri, and Professor of Forestry, School of Forestry, respectively. Submitted June, 1958, for publication in the Plant Disease Reporter.
- 1886—Dental Care Among Rural People in a Northwest Missouri County, by Edward Hassinger and Robert L. McNamara, Department of Rural Sociology, University of Missouri. Submitted June, 1958, for publication in the Journal of the Missouri State Dental Association.
- 1887—The Sealed Container Effect of Farm Egg Coolers, by Owen Cotterill, Department of Poultry Husbandry, University of Missouri. Submitted June, 1958, for publication in Poultry Processing and Marketing.
- 1888—Prechilled vs. Non-prechilled Germination of Sorghum Vulgare Pers., by Viola Stanway, Department of Field Crops, University of Missouri. Submitted June, 1958, for publication in the Proceedings of the Association of Official Seed Analysis.

## RESEARCH GRANTS

(For the year ending June 30, 1958)

- U. S. Public Health Service**  
Study of the chemistry and physiology of spermatozoa and ova.
- U. S. Public Health Service**  
Endocrine control of mammary gland growth and function.
- U. S. Public Health Service**  
To provide supplies for Dr. Newberne
- U. S. Public Health Service**  
To provide supplies for Dr. Grosvenor.
- U. S. Public Health Service**  
Grant for Dr. Water F. Williams, post-doctorate fellow.
- U. S. Public Health Service**  
To study the relation of vitamin B<sub>12</sub> to congenital malformations in the rat.
- Hales and Hunter Company**  
To promote graduate study in the field of livestock and poultry nutrition.
- Upjohn Company**  
To further disease control in fruit trees.
- Upjohn Company**  
Development of agricultural chemicals.
- Upjohn Company**  
Further studies on acti-dione to control horticultural crop diseases.
- Missouri Farmers Association**  
To further the development of hybrid seed corn.
- Missouri Farmers Association**  
Study of gypsum on Missouri soils.
- National Livestock and Meat Board**  
To study "stress" in the marketing of livestock.
- Swift and Company**  
Study of the kinds, amounts, and balance of minerals for feeding.
- Swift and Company**  
Studies on influence of soil composition and treatment on the composition of forages and the resulting development of animals.
- Hoffman-LaRoche**  
Color stability of cured meats.
- Cryovac Company**  
For studies concerning feasibility aspects as they apply to grade, fabrication, freezing technology, and packaging.
- American Angus Breeders Association**  
Tests for the detection of carriers of dwarf genes.
- American Hereford Association**  
Study physiological causes of dwarfism and testing for the dwarf gene.
- Leon Falk Family Trust**  
Physiological causes of dwarfism in cattle and identification of causative gene.
- Ralph L. Smith Foundation**  
Physiological basis of dwarfism in cattle and determina-

- tion of dwarf gene.
- Haver-Lockhart Laboratories**  
Nutrients necessary for hemoglobin formation in pigs.
- Fair Oaks Ranch**  
To further studies of dwarfism
- Chas. Pfizer and Company, Inc.**  
Oxytetra cycline will be injected in live animals, or infused in carcasses so that spoilage will be reduced. High temperature aging and commercial handling will be used in conjunction with the use of the antibiotic.
- Chas. Pfizer and Company, Inc.**  
Effect of terramycin on reproduction in the bovine.
- Chas. Pfizer and Company, Inc.**  
Utilization of antibiotics to control diseases of plants.
- Chas. Pfizer and Company, Inc.**  
Determine the efficacy of certain *anthelmintics*. These studies will concern both the parasite and the animal hosts.
- American Cyanamid Company**  
To determine the value of aureomycin in creep rations for suckling lambs.
- American Cyanamid Company**  
Chemical control of Hessian fly on wheat and also of pea and spotted alfalfa aphids on alfalfa and nematodes on soybeans and cotton.
- Vitamins, Inc.**  
The determination of factors necessary for successful rumen inoculation at times of major ration changes.
- Pasteuray Corporation**  
Study shrinkage, bloom, and aging of beef as influenced by ultraviolet radiation.
- General Foods Corporation**  
Testing natural products for potency in prevention of an arthritis-like condition in the guinea pig.
- Poul-An Laboratory**  
Study functional activity of dried rumen bacteria.
- National Association of Artificial Breeders**  
Determination of physical and chemical effects of various methods of dehydration on bovine spermatozoa and the development of a practical technique of storing bovine semen in a dried state.
- Columbian Hog and Cattle Powder Company**  
Assay of cattle tissues for goitrogenic agents.
- American Cancer Society Inc.**  
Study of growth and function of the mammary gland with special reference to the enzymes of the gland.
- Atomic Energy Commission**  
Study of the inheritance of productive processes in domestic animals by endocrine methods using radio-isotopes as tracers.
- Atomic Energy Commission**  
Study the effect of environmental and body temperatures on metabolism of radioactive minerals by dairy cattle and rabbits. Special reference to study of Co<sup>60</sup> as related to the biosynthesis and utilization of vitamin B<sub>12</sub>.
- Producer's Creamery Company**  
To study distances from markets and availability of milk and production for bottling purposes. An analysis of areas of demand for bottled milk by distances from the market will be made. This will reveal the nature of the present distribution system and the inter-market relationships that currently exist.
- National Science Foundation**  
Study nutritional requirements of the guinea pig.
- National Science Foundation**  
Cytogenetic studies with polyploid species of wheat.
- National Science Foundation**  
Basic studies on cutting action in wood.
- Scott County Milling Company**  
Sources of stored grains, insect infestations and means for their control.
- Shell Chemical Corporation**  
Study effect of chemicals applied to soil for the control of nematodes of cotton, soybeans, and garden crops.
- U. S. Forest Service**  
To study carpenterworms.
- U. S. Forest Service**  
Methods of managing bottomland hardwoods
- U. S. Forest Service**  
Silvicultural studies in bottomland hardwoods
- U. S. Forest Service**  
Ways in which forest resources and forest industries can be made to contribute most to both rural and urban income in low income areas of Missouri.
- U. S. Forest Service**  
Evaluate amount of water available to trees growing on stony soils.
- Missouri Pest Control Association, Inc.**  
Purchase a B & L microscope camera
- Missouri Conservation Commission**  
An investigation of the systematics and biology of the insects which attacks acorns in Missouri with emphasis on the nut curculios or weevils.
- Missouri Conservation Commission**  
Further forestry research
- Velsicol Corporation**  
Study the biology, parasites, and chemical control of European Corn Borer and the importance of the pest in Missouri.
- Missouri Farm Electric Utilization Council**  
Study uses of electricity in productive enterprises on typical Missouri farms.
- Geigy Chemical**  
Study action of various herbicides on weeds and crops.
- National Soybean Processor's Association**  
Expand research leading to new disease resistant varieties of soybeans for Missouri conditions.
- National Soybean Processor's Association**  
Use of rotary hoe in control of weeds in soybeans.
- National Soybean Processor's Association**  
Cultural methods of weed control.
- Quaker Oats Company**  
Develop a white corn hybrid especially suited to the milling trade.
- Robert Cummings—California Spray Chemical Corporation**  
Test in-the-furrow fungicides.
- Dannen Mills, Inc.**  
Improvement of soybean crop in Missouri.

- Missouri Nursery**  
To aid in payment to Dr. Posnette of England for trip and advice.
- Missouri State Florists' Association**  
Study the factors affecting market demand for flowers and floral products.
- Stark Bro's. Nursery**  
To aid in payment to Dr. Posnette of England for trip and advice.
- Denny**  
Gift
- National Grape Cooperative Association, Inc.**  
Study nutritional requirements and fertilizer practices for the Concord grape.
- State Department of Agriculture**  
For indexing fruit trees.
- Welch Grape Juice Company**  
Culture of grapes.
- Stauffer Chemical**  
An evaluation of herbicidal, fungicidal and nematocidal properties of Sodium N-methyl dithiocarbamate (anhydrous).
- Carbide and Carbon**  
Herbicidal evaluation of sodium 2,4,5-trichlorophenoxyethyl sulfate in vegetable crops.
- W. F. Harrison**  
To pay part of the expenses of Dr. Robert Goodman to attend the International Plant Pathology Congress in Germany.
- Gordon Johnson**  
To further poultry processing.
- Gordon Johnson**  
To further poultry processing—Mechanical de-boning.
- Kraft Foods Company**  
Effects of chemical additives in altering the functional properties of egg whites.
- Armour Laboratories**  
To determine the nature of the biological activity of certain animal by products.
- Missouri Turkey Federation**  
Improving Rocheford Turkey Farm.
- Missouri Turkey Federation**  
Isolate causative agents and to reproduce disease in birds.
- National Turkey Federation**  
Investigation of diluents for turkey semen.
- American Farm Research Association**  
To study chlorides in the soil and the nutrition of plants.
- American Potash Institute Inc.**  
Study ratio of mineral nutrients in the soil as they influence organic composition.
- Potash Rock Company of America**  
Research—Heavy clays
- Phillips Petroleum Company**  
Study retention of anhydrous ammonia in the soil.
- U. S. Department of Commerce Weather Bureau**  
Characterizing drought from climatological data.
- U. S. Department of Commerce Weather Bureau**  
Relate measurements of total solar radiation, net radiation over representative soil, and crop surfaces, temperature, wind movement, humidity and precipitation to estimated and measured evapotranspiration from various cropped and fallow soils.
- International Minerals and Chemical Corporation**  
Maintenance and improvement of fertility level of Missouri soils.
- Cross Foundation, Inc.**  
Study trace elements in soils in connection with protein production by plants.
- Allied Chemical and Dye Corporation**  
Soil reactions to different forms of nitrogen and measurement of nitrogen losses under different conditions.
- Olin Mathieson Chemical Corporation**  
Solubilities of different kinds and amounts of phosphatic fertilizers in the soil and plant responses to these.
- Olin Mathieson Chemical Corporation**  
For horticultural sprays.
- Foundation for Research on Human Behavior**  
To determine TV coverage in rural areas.
- Union Electric Company**  
Analysis of data relative to dynamics of action. To learn the principles underlying small community behavior.
- J. C. Penney**  
In support of Foremost Guernsey Farm.
- U. S. Department of Agriculture**  
Improvement of nutritive value of low protein and high fiber and roughages by fermentation.
- U. S. Department of Agriculture, Marketing Administration, Greater Kansas City**  
Isolate and describe factors responsible for changes in the supply of milk in Kansas City. Also, to provide an estimate of future changes.
- U. S. Department of Agriculture, Animal Husbandry Research Division**  
To conduct poultry breeding investigations, particularly genetic studies to compare the rate of improvement obtained from several different methods of breeding for the same performance characters.
- U. S. Department of Agriculture, Animal Husbandry Research Division**  
To study the effectiveness of recurrent selection for maximum performance of strain crosses of swine. To develop more accurate and useful ways to measure the performance of swine.
- Norden Laboratories**  
To determine the efficiency of Otrhomin in the treatment of animal diseases caused by certain bacteria, more specifically porcine and bovine enteritis.
- Monsanto Chemical Company**  
Efficiency of chemical formulations for destroying *ascariidina galli* in the soil or litter.
- Hess and Clark**  
A study of the effectiveness of various therapeutic agents.
- Herman Frasch Foundation**  
Study of physiology and inactivation of plant virus diseases.
- University of Missouri**  
Overhead
- Alumni Organization**  
To aid research work of the College of Agriculture
- University of Missouri Alumni**  
For marketing research, agricultural research, and floriculture

culture.

**Grace Chemical Company**

Study roughage and concentrate digestion and utilization by ruminants.

**Sears Roebuck Foundation**

To encourage improvement of poultry flocks in Missouri.

**American Plant Food**

For work in connection with the possible effects of sulfur in its various forms within the soil and its relation to plant production and resulting organic materials.

## CHANGES IN STATION STAFF FOR THE YEAR ENDING JUNE 30, 1958

### *Appointments*

Robert Lee Beck, Assistant in Agricultural Economics  
Carl C. Blickenstaff, Research Associate in Entomology  
Donald Boenker, Assistant in Animal Husbandry  
James B. Boillot, Assistant in Animal Husbandry  
Wilma Jean Brand, Assistant Agricultural Editor  
Curtis H. Braschler, Assistant in Agricultural Economics  
Robert E. Brown, Assistant in Horticulture  
Donald C. Buback, Assistant in Animal Husbandry  
James O. Butcher, Assistant in Animal Husbandry  
Oscar H. Calvert, Assistant Professor of Field Crops  
Burton F. J. Cargill, Instructor in Agricultural Engineering  
Jay Thornton Colburn, Assistant in Poultry Husbandry  
Donald Collins, Assistant Agricultural Editor  
George Cramer, Instructor in Experiment Station Chemical Laboratories  
Charles Edward Crowley, Assistant in Soils  
Franklin Cunningham, Assistant in Poultry Husbandry  
Henry C. Damm, Research Associate in Dairy Husbandry  
Frank S. Davis, Research Associate in Field Crops  
Benjamin T. Dean, Assistant in Animal Husbandry  
Krishnanath Bhaskar Deshpande, Assistant in Agricultural Chemistry  
Avalon Leroy Dungan, Assistant in Animal Husbandry  
Joe R. Eagleman, Assistant in Soils  
Richard F. Fallert, Assistant in Agricultural Chemistry  
J. H. Farrell, Research Associate in Forestry  
Noralee P. Faulkner, Instructor in Home Economics  
Richard W. Fenwick, Assistant in Soils  
Virgil Ferguson, Research Associate in Field Crops  
T. R. Fisher, Instructor in Soils  
Earnest W. Gerber, Assistant in Animal Husbandry  
Frederick Lee Gilbert, Assistant in Soils  
Donald F. Goerlitz, Assistant in Experiment Station Chemical Laboratories  
Mahendra P. Gupta, Assistant in Agricultural Economics  
Keith Harrendorf, Instructor in Entomology  
Delmar E. Hatesohl, Assistant in Agricultural Economics  
Robert E. Hensley, Assistant in Dairy Husbandry  
Raymond Hicks, Instructor in Field Crops  
John H. Hildebrand, Jr., Assistant in Agricultural Economics  
Estel H. Hudson, Assistant in Agricultural Economics  
Miriam Patricia Morton Irons, Assistant in Home Economics  
Fred Edward Justus, Assistant Professor of Agricultural Economics  
James I. Kennedy, Assistant in Dairy Husbandry  
Earl M. Kroth, Research Associate in Soils  
Floyd A. Lasley, Assistant in Agricultural Economics  
Hugh V. Leach, Assistant in Agricultural Economics

Mary Ann Lindsey, Assistant in Home Economics  
Jerry Leon McIntosh, Assistant in Soils  
Jo Ellen McKay, Assistant in Home Economics  
Robert T. Marshall, Assistant in Dairy Husbandry  
Edna F. Mathieson, Assistant Professor of Home Economics  
Moshio Matsumoto, Assistant in Agricultural Chemistry  
Geraldine Mier, Instructor in Home Economics  
Gordon E. Moore, Assistant in Entomology  
Kenneth E. Moore, Instructor in Forestry  
Mikio Muramatsu, Assistant in Field Crops  
Robert M. O'Neal, Assistant in Poultry Husbandry  
A. D. Partridge, Research Associate in Forestry  
Robert L. Pavey, Assistant in Animal Husbandry  
Don C. Peters, Assistant Professor of Entomology  
Elroy J. Peters, Research Associate in Field Crops  
James R. Phillips, Assistant in Dairy Husbandry  
Rodney L. Preston, Assistant Professor of Animal Husbandry  
Cecelia Pudelkewicz, Associate Professor of Home Economics  
V. Balakrishna Reddy, Assistant Professor of Animal Husbandry  
Alfred M. Rivas, Instructor in Entomology  
Ralph R. Rogers, Administrative Assistant, Office of the Dean and Director  
E. H. Rongey, Assistant in Animal Husbandry  
Clarence V. Ross, Associate Professor of Animal Husbandry  
Dale Alan Ross, Assistant in Poultry Husbandry  
Carl David Settergren, Assistant in Forestry  
John D. Sikes, Assistant in Dairy Husbandry  
Leonard L. Slyter, Assistant in Dairy Husbandry  
Ernest T. Smerdon, Instructor in Agricultural Engineering  
Frank A. Stanley, Instructor in Soils  
Gordon A. Stewart, Assistant in Dairy Husbandry  
William L. Swisher, Assistant in Animal Husbandry  
Ronald E. Talbert, Assistant in Field Crops  
Joseph W. Van Trump, Assistant Agricultural Editor  
Wilmer Wendel, Assistant in Soils  
Jerry Glenn West, Assistant Professor of Agricultural Economics  
Thomas W. White, Assistant in Animal Husbandry  
Linda Lee Whitworth, Assistant in Home Economics  
Dorwin L. Williams, Assistant in Agricultural Economics  
Dale W. Wilson, Assistant in Agricultural Economics  
Francis E. Wood, Assistant in Entomology  
Wendell Woods, Assistant in Agricultural Chemistry  
Maynard E. Yoes, Assistant in Poultry Husbandry

### *Resignations and Withdrawals*

Perry L. Adkisson, Assistant Professor of Entomology  
Mary B. Bowman, Assistant in Rural Sociology

Daniel E. Brady, Professor of Animal Husbandry  
Curtis H. Braschler, Assistant in Agricultural Economics  
Philip J. Bouckaert, Assistant in Agricultural Economics  
Chu Shan Cheng, Instructor in Dairy Husbandry  
Clifford Coffee, Assistant in Soils  
Ruth H. Cook, Associate Professor of Home Economics  
Eugene W. Cowan, Professor of Agricultural Chemistry  
(retired)  
Roberta M. Curry, Assistant Professor of Home Economics  
Adrian J. Durant, Professor of Veterinary Medicine (retired)  
Ralph Franklin, Assistant in Agricultural Economics  
Howard D. Friese, Assistant in Agricultural Economics  
Gale C. Hankins, Assistant in Agricultural Economics  
Charles N. Hinkle, Assistant in Agricultural Engineering  
Margaret A. Howard, Assistant Agricultural Editor  
Max F. Jordan, Assistant in Agricultural Economics  
John H. Longwell, Jr., Research Assistant in Field Crops  
(deceased)

Donald Thomas Lyons, Assistant in Animal Husbandry  
Clay R. Moore, Instructor in Agricultural Economics  
Auttis M. Mullins, Instructor in Animal Husbandry  
Jackie L. Pearson, Assistant in Horticulture  
Bill W. Pickett, Assistant in Dairy Husbandry  
Helen Ruth Poss, Assistant in Home Economics  
Allan W. Purdy, Administrative Assistant, Office of the Dean  
and Director  
Paul J. Spangler, Instructor in Entomology  
Perry R. Stahl, Assistant in Dairy Husbandry  
Helen Catherine Tobias, Assistant Professor of Home Eco-  
nomics  
Samuel Charles Turner, Assistant in Agricultural Economics  
Luther A. Weaver, Professor of Animal Husbandry (retired)  
Eugene L. Wood, Instructor in Agricultural Chemistry  
Joanne M. Yaeger, Assistant in Agricultural Chemistry  
Dale W. Zinn, Assistant in Animal Husbandry

FINANCIAL STATEMENT  
University of Missouri  
Agricultural Experiment Station  
July 1, 1957 to June 30, 1958

	Hatch Fund	Bankhead- Jones 9b <sup>3</sup> Fund	Marketing Act Title II	State Appro- priations	Fertilizer Fees	Station Sales	Station Grants	Working Capital	TOTAL
Receipts from the United States Treasury, Appropriation for the Fiscal Year ended June 30, 1958	\$622,070.00	\$96,100.00	\$42,000.00	xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx	
Receipts from State Appro- priations for the Fiscal Year ended June 30, 1958	xxxxxxxx	xxxxxxxx	xxxxxxxx	\$735,000.00	xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx	\$ 760,170.00
Cash Receipts for the Fiscal Year ended June 30, 1958	xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx	\$242,495.31	\$374,803.62	\$218,835.04	xxxxxxxx	836,133.97
<b>Total Receipts</b>	<b>\$622,070.00</b>	<b>\$96,100.00</b>	<b>\$42,000.00</b>	<b>\$735,000.00</b>	<b>\$242,495.31</b>	<b>\$374,803.62</b>	<b>\$218,835.04</b>	xxxxxxxx	<b>\$2,331,303.97</b>
Salaries and Wages	\$538,101.65	\$83,127.14	\$34,677.68	\$500,000.00	\$ 72,796.73	\$156,878.38	\$140,649.51	-----	\$1,526,231.09
Traveling Expense	16,649.35	4,913.86	1,001.92	28,680.63	10,263.36	9,616.29	15,031.27	-----	86,156.68
Transportation of Things	584.93	81.62	16.87	2,279.88	254.95	683.55	2,184.70	-----	6,086.50
Communication Service	102.19	27.29	154.76	2,704.23	6,136.75	2,965.72	802.52	-----	12,893.46
Rents and Utility Service	550.85	-----	74.15	21,588.30	22,674.19	23,689.63	1,447.90	-----	70,025.02
Publication and Printing	1,156.70	84.42	87.94	33,927.76	3,557.79	8,605.59	760.24	-----	48,180.44
Repairs and Replacements	6,424.92	605.04	381.09	32,711.96	23,575.84	48,784.60	10,984.07	-----	123,467.52
Supplies and Materials	48,740.14	5,825.25	4,732.26	98,327.49	52,371.96	99,437.09	46,799.57	-----	356,233.76
Land, Buildings and Equipment	9,743.06	1,435.38	873.33	14,584.96	48,214.01	58,752.54	20,166.96	-----	153,770.24
Other	16.21	-----	-----	194.79	12.75	22,807.99	67.02	-----	23,098.76
	<b>\$622,070.00</b>	<b>\$96,100.00</b>	<b>\$42,000.00</b>	<b>\$735,000.00</b>	<b>\$239,858.33</b>	<b>\$432,221.38</b>	<b>\$238,893.76</b>	-----	<b>\$2,406,143.47</b>
Excess Income over Expenditures	\$-----	\$-----	\$-----	\$-----	\$ 2,636.98	\$ 57,417.76-	\$ 20,058.72-	-----	\$ 74,839.50-
Unexpended Balance, July 1, 1957	-----	-----	-----	-----	7,568.09	130,128.67	119,717.49	\$187,000.00	444,414.25
Transfer from Other Gifts and Grants	-----	-----	-----	-----	-----	-----	175,000.00	-----	175,000.00
Return of Working Capital Unexpended Balance, June 30, 1958	-----	-----	-----	-----	-----	37,000.00	-----	37,000.00-	-----
	<b>\$-----</b>	<b>\$-----</b>	<b>\$-----</b>	<b>\$-----</b>	<b>\$ 10,205.07</b>	<b>\$109,710.91</b>	<b>\$274,658.77</b>	<b>\$150,000.00</b>	<b>\$ 544,574.75</b>