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Work of the Agricultural Experiment Station

F. B. MUMFORD AND S. B. SHIRKY

The Report of the Director for
the Year Ending June 30, 1932

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Work of the Agricultural Experiment Station

Progress of the Agricultural Experiment Station During the Year Ending June 30, 1932

F. B. MUMFORD, *Director*

S. B. SHIRKY, *Assistant to the Director*

The Agricultural Experiment Station was established by an Act of Congress approved in 1887. The purpose of the original law providing for agricultural experiment stations in the several States was to establish an agency through which the methods of scientific research could be applied to a solution of the problems of agriculture.

The problems of agriculture are related to almost every known division of science. Geology, chemistry, physics, biology, physiology, and pathology of plants and animals have each made their contribution. Investigations of economic and social problems which have come to have so great an importance in the agricultural industry are specifically mentioned in the provisions of the latest Experiment Station Act known as the Purnell Bill.

During the forty years and more of the existence of the Experiment Station discoveries of enormous economic importance have been made. Hog cholera, once so disastrous, is no longer a menace to the livestock farmer. Contagious abortion, tuberculosis, and other diseases of the domestic animals have been brought under control. Blights, rusts, insects, and other destructive pests have been eliminated or brought under some sort of reasonable control. New varieties of established farm crops and entirely new crops, such as soybeans, cowpeas, and lespedeza in Missouri have been introduced and widely disseminated through the activities of the Experiment Station.

Thousands of farmers have applied the results of discoveries by the Experiment Station to their farm business greatly to their profit. The Experiment Station is continually discovering new methods of treatment for destructive and dangerous diseases of both plants and animals. The need for discovery will never be ended so long as the pests of agriculture continue to exist and the difficulties of economic production become more and more complicated.

Experiments in Progress During the Year Ending June 30, 1932

SOILS

M. F. MILLER, *Chairman*

The Fineness of Grinding Limestone (W. A. Albrecht).—Inoculation studies have shown that finely ground limestone should be used in contact with the seed. Experiments have been started on fifty farms in various parts of the State to determine whether lime serves to supply calcium as a nutrient or to correct soil acidity, or both. The results of these trials can not be given until the clover is in its second year. Preliminary trials have been encouraging.

Crop Rotation and Fertilizer Experiments (M. F. Miller, L. M. Turk, H. F. Rhoades).—Corn yields on Sanborn Field for 1931 were very good. A plot in continuous corn with no treatment yielded 40 bushels per acre. It was the forty-third consecutive crop. This was the highest yield obtained on this plot since 1890. The timothy yields averaged more than two tons per acre and the hay was free of weeds and of very good quality. The timothy on the plot that was supposed to be in continuous timothy has completely disappeared and its place has been taken by red sorrel and some field grasses. The plot in continuous timothy with manure yielded over two tons to the acre. The plot in continuous wheat yielded 29.5 bushels per acre for the forty-third crop. It is very evident that on the plot in continuous wheat the available plant nutrients have become low, yet in exceptional seasons a sufficient supply is present to provide for large yields.

Correlation Between Adsorbed Ions and Pasture Vegetation (Hans Jenny, E. R. Shade, E. Cowan).—Redtop and weeds grow well with small amounts of exchangeable bases. Bluegrass has not been found on soils with less than 12 milliequivalents of bases per 100 grams of soil. Good bluegrass sod seems to be associated with soils having a relatively high content of exchangeable bases.

The Effect of Cultivation on the Nature of Soil Colloids (Hans Jenny, E. R. Shade, E. Cowan).—Cultivation of Putnam silt loam resulted in diminishing the power of the available plant nutrients (adsorbed cations) and in decreasing the water-holding capacity of the soil. The organic part of the colloidal complex was partly destroyed.

Utilization of Adsorbed Ions by Plants (Hans Jenny, E. R. Shade, E. Cowan).—Calcium ions adsorbed on soil colloids seemed almost as available for plant growth as free calcium ions in the

soil solution. The plants liberated adsorbed calcium ions by exchange with excreted H ions. This replacement was almost stoichiometrical. The number of H ions found on the colloid was about twice the number of calcium ions that entered the plant.

Release of Fixed Potassium by Lime (Hans Jenny, E. R. Shade, E. Cowan).—Experiments with Missouri soils (Putnam silt loam) colloidal Putnam clay, bentonite clay, permutit, and artificial soils have shown that the liberation of fixed potassium is unquestionably one of the beneficial effects of liming. Calcium exchanges adsorbed potassium independently of clay concentration,

Fig. 1.—Sanborn Field at the Missouri Agricultural Experiment Station. These rotation and fertility plots have been in continuous operation since 1888.

amount of lime added, the soil reaction, the bicarbonate concentration and nature of an ion. Micro-organisms disturbed the normal exchange of potassium by lime but reduced the potassium outgo.

The H Ion in Ionic Exchange and Hydration (Hans Jenny, E. R. Shade, E. Cowan).—The hydrogen ion was the most powerfully adsorbed monovalent cation and was the most difficult to replace. Colloidal particles which adsorb H ions were most hydrated. This has been explained on the basis of crystal lattice cavity water and constitutional water.

The Influence of Nitrogen Fertilizer on Crop Growth (M. F. Miller, R. L. Lovvorn).—On four crops of corn nitrate of soda, applied in different ways and at different rates on three experiment fields, increased the yields from two to eleven bushels. The use of side applications when the corn was 12 to 18 inches high gave the best results. Wheat yields were increased from 1 to 7 bushels, the most effective method being top dressings applied in early spring. Such applications did not raise the nitrogen content of the grain or straw. Yields of pasture grass were doubled where several light applications of nitrate were made during the summer on medium fertile soil. Only small increases were observed on the poorer pasture lands. The protein content of non-leguminous crops can be increased to make them approximate some of the legumes in feeding value by heavy applications of nitrate of soda.

Soil Erosion (M. F. Miller, L. M. Turk, H. F. Rhoades).—A report on this project has been prepared for publication covering investigations of fourteen years' duration. Additional information verifying the results of previous years has shown that a good cropping system has been a material aid in controlling erosion. This applies to terraced land, as well as unterraced soil.

The Measurement of Phosphate Deficiency of Soils (L. D. Baver).—All chemical methods for testing phosphate deficiency of soils must be used with care. The results secured by using the methods of Bray, Demolon and Barbier, Dirks and Sheffer, Lemmermann, Nemec, Truog, and von Wrangell have been found to conform with actual field tests in about 70 per cent of the cases.

The Size and Stability of Granules in Various Soil Types (L. D. Baver, H. F. Rhoades, H. H. Krusekopf).—A method for measuring the aggregation of soils has been devised. The older and more thoroughly leached soils have a low state of aggregation. Those types of soils containing a high amount of organic matter and that were not distinctly acid possessed a high state of aggregation. Marion silt loam, a thoroughly leached soil was found to be 19.25 per cent as compared with 45.1 per cent for Marshall silt loam. Cultivation of Putnam silt loam resulted in a decrease in its state of aggregation from 44.5 per cent to 13.0 per cent.

The Effect of Different Soil Treatments Upon Bacterial Activity in the Soil (W. A. Albrecht).—Studies of nitrifying rate and green manure decompostion were made on various plots in Sanborn Field. A low level of nitrification was shown on these plots, due to the past treatment. These soils all showed the need for limestone, the applications of which increased the nitrate production on all except one plot.

Soil Plasticity (L. D. Baver).—It has been shown conclusively that plasticity is a function of the surface tension forces of the

liquid films between the particles. The plasticity number of a soil decreased with a decrease in the surface tension of the liquid with which the soil is moistened. Plasticity measurements on soil from cultivated and from virgin Putnam silt loam showed that cultivation lowered the lower plastic limit from 27 to 22 per cent. The upper plastic limit was also lowered from 32 to 26 per cent. These decreases were due to the loss of organic matter.

Fig. 2.—The effect of sweet clover as a green manure crop on the growth of wheat on level Northeast Missouri prairie soils. (Upper) Wheat two years after a crop of sweet clover. (Lower) Wheat after no sweet clover.

Methods of Improving Heavy Clay Subsoils (L. D. Baver).—The plowing under of sweet clover as a green manure crop has resulted in a marked improvement of the productivity of the Putnam silt loam at the Moberly experiment field. The sweet clover has furnished nitrogen and improved the physical properties of the soil.

Water Absorption by Soil Colloids (L. D. Baver, Glen M. Horner).—Two distinct breaks in the rate of water removal from soils upon heating showed that there were at least two methods of holding water by the colloids. The temperature at which these breaks occurred depended upon the chemical nature of the colloid. Hygroscopicity of colloids saturated with various cations followed the order: $H > Ca > Li > Mg > Na > Ba > K$. The total water given off followed the order: $H > Mg > Ca > Li > Ba > Na > K$. This order for different types of colloid material was: H-permutit > H-Putnam clay > H-bentonite. The presence of organic matter had little effect upon the nature of water absorption.

The Nitrogen and Carbon Accumulation or Depletion of Soils Under Different Systems of Treatment and Management (M. F. Miller, W. A. Albrecht).—During the twelve years of this investigation there has been some accumulation of nitrogen and carbon for each of the cropping and green manure treatments with the exception of continuous rye. On this plot there has been a consistent decline in nitrogen. The increases in nitrogen have not been very high. In the latitude of Columbia the possibilities of raising the level of nitrogen in ordinary field soils are not great. A good nitrogen turn-over through the use of legumes, manure, and fertilizers should be attained, rather than the maintenance of a high nitrogen level.

Missouri Pastures (M. F. Miller, H. H. Krusekopf).—In cooperation with the Departments of Animal Husbandry and Field Crops pasture experiments have been established at Sni-A-Bar Farms. Sets of fertilized plots have shown outstanding results from nitrogen and much less returns from the other elements.

Soil Experiment Fields (M. F. Miller, L. M. Turk, E. E. Smith Jr.).—The fields at Stark City and Cuba were discontinued. At Stark City on Hagerstown silt loam of medium fertility at Cuba on Lebanon silt loam, an Ozark soil of low fertility, the best returns from fertilizers were secured from applications of manure, phosphate, and lime.

ANIMAL HUSBANDRY

E. A. TROWBRIDGE, *Chairman*

Protein Supplements for Yearling Steers Full Fed on Bluegrass Pasture (E. A. Trowbridge, H. C. Moffett).—Cottonseed cake was compared with a mixture containing 30 per cent ground alfalfa, 30 per cent molasses, 20 per cent reground oat feed, and 20 per cent choice cottonseed meal as a protein supplement for yearling steers full fed on pasture. One part cottonseed cake to 12 parts corn produced as rapid and economical gains as 1 part cottonseed cake to 8 parts corn. The mixed supplement (14 per cent protein) produced more rapid and economical gains than corn

Fig. 3.—Yearling steer cattle at the close of experiment in which they had been wintered on a ration of corn fodder with legume hay and finished on a ration of 12 parts shelled corn and 1 part cottonseed cake on bluegrass pasture.

alone, but less rapid and less economical than where cottonseed cake was fed. Cattle which received a supplement during the early part of the summer made as rapid and economical gains during the last 112 days of the feeding period as similar cattle which received the supplement only during the last 112 days.

Handling and Feeding Native Spring Calves (E. A. Trowbridge, H. C. Moffett, M. W. Hazen).—This investigation is in cooperation with Sni-A-Bar Farms and the Bureau of Animal Industry, United States Department of Agriculture. Feeding ground corn in place of shelled corn to suckling beef calves in a ration of

corn 8 parts and cottonseed meal one part increased the grain consumption slightly but did not increase the gains. The addition of a 15 per cent protein feed to a ration of corn 8 parts, and cottonseed meal one part did not increase either the gains or the feed consumption.

During the subsequent feeding period of 196 days in dry lot the cattle fed ground corn and cottonseed meal consumed slightly more feed and gained more rapidly and economically. The addition of the 15 per cent protein feed to the ration of corn and cottonseed meal did not increase the feed consumption or the rapidity of gain in the subsequent feeding period.

Self Feeding Native Fall Calves (E. A. Trowbridge, H. C. Moffett, M. W. Hazen).—In cooperation with Sni-A-Bar Farms and the United States Department of Agriculture, two year's tests have shown that self fed calves made approximately 4 per cent more rapid gains, but required 3 per cent more concentrates to produce 100 pounds gain. Self fed calves have been valued at a higher price per hundredweight. A carload lot of these cattle shown in the carlot fat cattle division of the 1931 American Royal Live Stock Show won first prize.

Processing Roughages for Wintering Stock Calves (E. A. Trowbridge, H. C. Moffett).—Shocked fodder, corn silage, corn stover ground with a hammer mill, and corn stover cut with a silage cutter, have been compared for wintering stock calves. Also whole alfalfa hay has been compared with alfalfa hay ground with a hammer mill. Table 1 shows the gains made by six different lots, fed as indicated.

TABLE 1.—VARIOUS PROCESSED ROUGHAGES FOR WINTERING STOCK CALVES

Lot No.	I	II	III	IV	V	VI
Ration	Silage Whole Alfalfa	Silage Ground Alfalfa	Corn Fodder* Whole Alfalfa	Ground Stover* Whole Alfalfa	Cut Stover* Whole Alfalfa	Ground Fodder* Whole Alfalfa
Avg. Init. Wt. (lbs.)	358.0	355.9	357.2	355.5	358.3	358.2
Total Gain (lbs.)	109.4	130.3	111.9	119.3	114.2	120.1
Total Feed Consumed						
Corn Silage	2368.0	2368.0				
Corn Fodder			1319.0	1319.0	1319.0	1319.0
Alfalfa Hay	539.0	538.0	538.0	538.0	538.0	538.0

The corn that grew on the stover was taken off to be weighed. It was fed with the stover as broken ear corn in each case except Lot VI where it was ground along with the stover.

Cost of Processing Roughages (E. A. Trowbridge, H. C. Moffett, D. D. Smith).—Table 2 shows the cost of processing the various roughages for wintering stock calves.

TABLE 2.—COST OF PROCESSING FODDER, STOVER, AND HAY

	Ground Fodder	Ground Stover	Ground Hay	Cut Fodder
POWER AND MACHINE COSTS				
Electricity at 5c per KwH	.55	.75	.51	.18
Motor Costs* at 18c per hr.	.40	.64	.43	.18
Machine Costs**	.27	.42	1.21	.50
TOTAL (per ton)	$1.22	$1.81	$2.15	$ .86
LABOR COSTS				
30c per Man Hour	.68	.94	.73	.30
Total Cost Per Ton	$1.90	$2.75	$2.88	$1.16
Average Fineness Modulus	4.18	4.07	3.10	5.94

*Based on 200 hours use per year. Includes depreciation, repairs, interest, and taxes.
**Based on 80 hours use per year for ensilage cutter, and 150 hours use per year for hammer mill. Includes depreciation, repairs, interest, insurance, and taxes.

Systems of Grazing Bluegrass Pastures (J. E. Comfort, E. Marion Brown).—In cooperation with Sni-A-Bar Farms and the United States Department of Agriculture, a 25-acre pasture has been separated into three divisions, each of which has been grazed for one week and allowed to rest for two weeks in regular rotation. Grazing began in April and continued to November. The heifers on this pasture made an average daily gain of .57 pounds. Another pasture of 25 acres was subjected to grazing continuously. Under this system an average daily gain of .74 pounds was made. On a third pasture of 25 acres, where grazing was deferred for a period of two weeks at the beginning of the pasture season and the cattle were transferred to a 10-acre pasture of Korean lespedeza for seven weeks during the midsummer period, average daily gain of .94 pounds on bluegrass and 1.2 pounds on the lespedeza were made.

Rations for Fattening Hogs (L. A. Weaver).—Sudan grass made a satisfactory emergency hog pasture. The length of the grazing season, however, was shorter than that of alfalfa, clover, rape and oats, or bluegrass. The crop withstood drought well but was very susceptible to damage from chinch bugs. Complicated protein mixtures showed no advantage over simple ones. The supplement which furnished the largest amount of protein per unit cost produced the cheapest gains. Self feeding as compared to hand feeding made little difference in the amount of feed consumed. The self fed hogs made slightly cheaper gains because they gained faster on a little less feed.

Rations for Weanling Pigs (L. A. Weaver).—The addition of either dried skim milk, fish meal, liver meal, or semisolid buttermilk to the standard supplement of tankage, linseed oil meal, and alfalfa meal improved the ration for weanling pigs. The ad-

dition of two or more of the first three of these feeds produced better results than when a single one was used. The addition of shorts decreased the rate of gain and increased the feed requirement per unit of gain.

Wheat for Fattening Swine (L. A. Weaver).—Six lots of fifteen hogs each were fed in dry lot as shown in Table 3.

TABLE 3.—RATIONS CONTAINING WHEAT FOR FATTENING SWINE

			Manner Fed	Lbs. of Cereal Consumed With Each Lb. of Supplement
Lot I	Shelled corn	+tankage 3 parts, linseed oil meal 1 part, alfalfa meal 1 part	self-fed free choice	8.16
Lot II	Whole wheat	+tankage 3 parts, linseed oil meal 1 part, alfalfa meal 1 part	self-fed free choice	31.83
Lot III	Ground wheat	+tankage 3 parts, linseed oil meal 1 part, alfalfa meal 1 part	self-fed free choice	16.67
Lot IV	Whole wheat	+tankage—self-fed free	choice	40.91
Lot V	Ground wheat	+tankage 3 parts, linseed oil meal 1 part, alfalfa meal 1 part	hand-fed	15.00
Lot VI	Whole wheat	+tankage 3 parts, linseed oil meal 1 part, alfalfa meal 1 part	hand-fed	15.00

All lots were self-fed a mineral mixture of equal parts precipitated calcium phosphate, bone meal and salt.

Lot I fed corn, made the most rapid gain, which was 33 per cent faster than was made by Lot II, which gained the slowest. There was no significant difference between the rate of gain made by hogs in the other lots. Lot I also produced 100 pounds gain with the smallest amount of feed. Lot I required 392 pounds of feed to produce 100 pounds of gain; Lot II, 468 pounds; Lot III, 435 pounds; Lot IV, 433 pounds; Lot V, 471 pounds, and Lot VI, 470 pounds.

Rations for Sows During the Reproductive Cycle (A. G. Hogan, S. R. Johnson).—A group of sows fed a ration of commonly used concentrates and with the addition of liver meal produced unusually heavy pigs at weaning time. The pigs averaged 33.1 pounds at the end of eight weeks. This group made far better gains than the other three groups in the investigation that were fed as follows: one group, a ration of concentrates commonly used

for sows during the reproductive cycle; another group, the same ration as the first group with the addition of green rye; and a third group, the same ration as the first group, with the addition of skimmilk.

Growth in Draft Colts (E. A. Trowbridge, D. W. Chittenden, Samuel Brody).—Three colts fed liberally on grain with free access to pasture have been compared with three colts fed only half as much grain but with free access to pasture. During the summer period (195 days) the colts gained approximately the same. During the winter period (99 days) oats straw and hay were substituted for pasture and the liberally fed group gained 111 pounds while the other group gained 71 pounds.

Function of the Dartos Muscle (F. F. McKenzie, R. W. Phillips).—The dartos muscle in the wall of the ram's scrotum has been found to respond to changes in temperature. Within limits, increased temperature caused the muscle to relax and decreased temperature caused it to contract. This produced variations in the length of the scrotum, the thickness of the scrotal wall, and the surface area of the scrotum. These changes served to maintain the testes at a fairly constant temperature.

Determining Fertility in the Boar (F. F. McKenzie, R. W. Phillips).—Fertility of boars has been determined within limits by an examination of their semen. The number of abnormalities of the spermatozoa correlated with the degree of fertility. Boars that produced semen containing spermatozoa with from 62 to 104 abnormalities per 1000 sired litters consistently large in numbers and of strong vitality. Boars that produced semen containing abnormal spermatozoa in the ratio of 146 to 501 per 1000 sired small litters containing mummies or weak pigs. The abnormalities that seemed to be most indicative of affected fertility were appreciable numbers of small heads, tapering heads, and enlarged middle-pieces.

Fertility in Aged Rams as Affected by Diet and Hormones (F. F. McKenzie, R. W. Phillips).—Diet, whether low, medium, or high in protein, caused no detectable difference in reproductive capacity or vigor in rams. Changing from one protein level to another did not cause a change in fertility. A luteinizing hormone was used with five aged rams in an effort to stimulate the mating desire or sex vigor. In the dosages used there were no changes sufficiently definite to pronounce it beneficial or detrimental.

The Effect of Temperature and Diet on the Onset of the Breeding Season (estrus) in Sheep (F. F. McKenzie, R. W. Phillips).—Temperature seemed to cause no significant difference in the length of time required for ewes to come in heat. During the first ten days of August while outside temperatures varied from a minimum of 70° at night to a maximum of 95° during the day, a group of seven ewes was kept in an iced cellar where the tempera-

ture varied from 44° to 48° during the day. A second group of eight ewes was kept in the same cellar during the night and fed grass. A third group was fed sudan grass each morning but kept out of doors at all times. A fourth group was used as a control. There was no significant difference in the average number of days required for the ewes in each group to come in heat. These trials were repeated during the first week of September with no differences noted.

The Estrual Cycle in the Ewe; A Histological Study of the Genital Tract of the Non-pregnant Ewe (F. F. McKenzie, A. Uren, J. C. Miller).—Published in Research Bulletin Number 170.

Embryos and Fetuses of the Sheep (F. F. McKenzie, F. H. Woods).—Three embryos have been sectioned and stained for examination. A description of the degree of development of the alimentary canal and its derivatives in a 20 m. m. embryo has been prepared. The development of the central nervous system in the same embryo has been studied.

A Cytological Study of the Ovaries of Pregnant and Non-pregnant Ewes (F. F. McKenzie, Mary J. Guthrie, V. Warbritton).—The changes observed in ovaries taken from recently killed ewes were: (1) Corpora lutea of maximum size were found at about the middle of the cycle of their formation. (2) Color changes in the corpora lutea graded from a blood red to an opaque pink during the cycle of their formation and from an opaque to a yellow during the succeeding cycle. (3) The mean diameter of follicles 2 m. m. or larger in size appeared to increase during the first one-third of the cycle.

Ovulation and Tubal Ova in the Ewe (F. F. McKenzie, E. Allen).—A complete series of tubal ova in the ewe has been found. Fertilized ova were recovered from ewes as shown in Table 4, the number of hours given being the interval following the onset of estrus.

TABLE 4.—FERTILIZED OVA RECOVERED FROM EWES

Ova	Interval Following Onset of Estrus	Recovered From
1-cell	23¾-28⅙ hrs.	tube
1-cell with polar body and showing male and female pronuclei	34⅓ hrs.	tube
2-cell	42-44 hrs.	tube
4-cell	53½-55 hrs.	tube
6-8-cell	93-98 hrs.	tube
16-cell (approx.)	5 days	uterin horn
blastocyst	11 days	uterin horn

FIELD CROPS

W. C. ETHERIDGE, *Chairman*

Genetics and Physiological Effects of the Irradiation of Crop Plants (L. J. Stadler, W. R. Tascher, S. F. Goodsell).—Experiments have shown that the frequency of deficiency for each of four chromosome regions was directly proportional to radiation intensity (doses ranging from 115 to 920 *r*), and that temperature (8° to 43° C.) had no appreciable effect on the frequency of induced deficiency. It also has been shown that the frequency of induced mutation was directly proportional to dosage and was unaffected by temperature. Thus, induced chromosomal deficiency parallels induced mutation in response to those factors.

A systematic relation between deficiencies involving the three linked endosperm genes *C, Sh,* and *Wx* has been shown. Deficiencies involving *Wx* always involved *Sh* and *C*. About one-third of the deficiencies involving *Sh* and *C* did not involve *Wx*. A small number of deficiencies involving *C* did not involve *Sh*. Apparently, the three genes are located on one arm of the chromosome in the order *C-Sh-Wx,* with *C* lying nearest the end of the chromosome and *Wx* nearest the point of attachment. A break at any point resulted in a loss of the part of the chromosome severed. More extensive investigation of the relative frequency of loss resulting both from pollen treatment and from treatment applied after fertilization has confirmed the previous results and has shown also the rare occurrence of losses of *Wx,* not accompanid by *C* and *Sh*. These represent internal deficiencies or "deletions" in which a region of the chromosome not extending to the end is lost and the terminal region is re-united to the portion of the chromosome retained. Cytological studies have confirmed the occurrence of internal deficiencies.

Genetic Analysis of Maize (L. J. Stadler, R. T. Kirkpatrick).—Twenty-six seedling mutations were found in the progenies of X-rayed maize plants crossed with linkage testers. Ten of the mutants gave significant indications of linkage with standard markers in the single-ear progenies in which they first appeared. Another phase of this project has been published in Research Bulletin 163.

Corn Breeding (W. C. Etheridge, L. J. Stadler, R. T. Kirkpatrick, W. R. Tascher).—Selection and self-fertilization were continued in about 500 strains. Crosses have been made involving 90 of the better strains. Ten of the best have been designated as group A and the remaining 80 as group B. Strains of group A were intercrossed and strains of group B were crossed with each group A strain, and all were top-crossed on a commercial strain of Reid Yellow Dent. Hybrid seed was harvested from 324 different crosses. Owing to crop failures of 1929 and 1930 there were only 48 single-cross stocks for

testing in 1931. One single-cross (W10 x R3) was outstanding on all fields. Yield tests of double crosses in comparison with standard varieties and commercial hybrids were conducted at Maryville, Shelbyville, Grain Valley, Green Ridge, Columbia, Newtonia, and Sikeston. The superiority of the hybrids to the check variety was consistent on all fields. The margin of superiority of the best hybrid varied from 30 to 68 per cent. Of the thirteen commercial hybrids tested the best one gave an average increase of seven per cent over the check. An unusually good record was made by an Oklahoma commercial variety, Franklin County Yellow Dent, which averaged only twelve per cent below the best hybrid.

Missouri Pastures (W. C. Etheridge, E. M. Brown)*.—The feeding results under three systems of grazing on pastures at the Sni-A-Bar Farms are reported under the title, "Systems of Grazing Bluegrass Pasture" in the Animal Husbandry section of this report. Nitrogenous fertilizers materially stimulated these bluegrass pastures during April and May, improving the palatability of the grass. After May the yields were not significantly increased. Phosphate, either alone or in combination with nitrogen, failed to increase the yield of grass. The addition of potash resulted in no increase.

Wheat Breeding (W. C. Etheridge, W. R. Tascher).—The highest yielding varieties of wheat in the plot tests were Fultz, St. Louis Grand Prize, Nabob, T. N. 1047, and Fleming. Fultz, the highest yielding strain, yielded 33.7 bushels per acre and Fleming, the lowest, 32.0 bushels. On the eleven experiment fields Poole yielded best at Columbia; Michigan Wonder at Golden City, Grain Valley, Stark City, Elsberry, Green Ridge, and Maryville; Mediterranean at Cuba; Currell at Shelbyville; Fulcaster at Sikeston; and Red Wave at St. Charles. Selections of Harvest Queen have been tested. Two lines of Fulcaster have been selected as the best from 63 pure lines; W545 slightly higher yielding, and W544 slightly better quality. Fourteen varieties of wheat from Russia were tested in the observation plots.

Spring Barley (W. C. Etheridge, R. T. Kirkpatrick).—The higher yielding varieties of barley in the nursery tests were as follows: Success Beardless, 27.7 bushels per acre; Eagle, 26.7; Hero, 26.4; Minsturdi, 24.8; Sirroche, 23.8; Improved Manchuria, 22.6; Ruble, 22.4. Tests in seven different sections of Missouri showed an average yield per acre of 29.7 bushels for Trebi, 27.9 for Oderbrucker, and 26.9 for Velvet.

The Breeding of Oats (W. C. Etheridge, R. T. Kirkpatrick).—The better varieties of oats and their yields in the nursery tests were as follows: Columbia, 55.1 bushels per acre; Fulghum, 52.0; Selection from Texas Red, 50.6; Selection from Burt, 49.9; Fulghum, 49.2; Burt, 48.4; Kanota, 48.2. In nine different sections of Missouri

*In cooperation with U. S. Department of Agriculture and Sni-A-Bar Farms, Grain Valley, Mo.

the better varieties and their yields were as follows: Columbia, 50.5 bushels per acre; Fulghum (Kanota), 48.5; Fulghum, 47.2; Albion, 45.9; Burt, 44.9; Kherson, 42.0. Columbia, the new oat first distributed to Missouri Farmers in 1930, was the high yielding variety in both tests. Selections made in 1929 from hybrids made in 1926 were tested for the first time in 1931. The yields varied from 41.6 to 67.5 bushels, while the Fulghum check yielded 62.1 bushels per acre.

Comparison of Grain Sorghum with Corn for Grain and Hay Production (C. A. Helm).—In rotation with wheat and red clover where lime and fertilizer have been used grain sorghum has yielded 5 bushels more per acre than corn during a five-year period. Without such treatment the margin of grain sorghum over corn has been about 6 bushels per acre. This year at Stark City the three most productive fields of corn yielded 39.8 bushels while the three best fields of grain sorghum yielded 67.1 bushels per acre. With no soil treatment the yields were 25.7 bushels of corn, as compared with 43.3 bushels of grain sorghum. At Cuba yields of grain sorghum and corn were almost identical.

Grain Sorghum in Missouri (C. A. Helm).—Pink Kafir yielded 58.9 bushels of grain and 3.2 tons of fodder at Stark City. The leading variety of sweet sorghum, Atlas, yielded 54.1 bushels of grain and 6.5 tons of fodder. At Cuba Pink Kafir produced 41.6 bushels of grain and 1.6 tons of fodder and Atlas yielded 25 bushels of grain and 1.4 tons of fodder.

Varieties and Selections of Soybeans (W. C. Etheridge, B. M. King).—In 37 varieties and strains of soybeans tested at Columbia, Elsberry, and Sikeston, several promising selections for hay and seed production were found.. One hundred seventy-five plant selections were made from the F_3 generation of a group of artificial hybrids.

Promising varieties of soybeans were tested at Columbia, Green Ridge, Stark City, Cuba, Elsberry, and Sikeston. Wilson and Virginia led in hay and seed production at Cuba and were high in tests at other fields. Manchu produced the highest yield of seed at Stark City, Green Ridge, and Sikeston, and Illini at Elsberry. In hay production Laredo was superior in all tests as to quantity produced. Its usefulness, however was limited by its prostrate growth habits and lateness of maturity. The yields of Wilson and Virginia were good, both as to quality and quantity of hay yields.

The Effect of Crop Rotation on Cotton Yields (W. C. Etheridge, B. M. King).—A series of seven crop rotations, each including cotton, was started at Sikeston to determine the effect of rye, seeded in cotton middles and plowed under the following spring on the succeeding crop; the effect of soybeans planted in corn on

the yield of the corn and on the yields of the crops that follow corn; and the relative yields of cotton grown in various balanced rotations. Since this is the first year of the rotation no data are available.

Varieties of Cotton (W. C. Etheridge, B. M. King).—Cotton variety tests were conducted on rich, heavy land at Hayti and on fine sandy loam of moderate fertility at Sikeston. The acre yields of seed cotton produced were as follows:

TABLE 5.—COMPARATIVE YIELDS OF COTTON VARIETIES

Variety	Pounds Cotton Per Acre	
	Hayti	Sikeston
Price	2096.0	1466.2
Delfos	2175.0	1683.7
Rowden 40	1740.0	1151.2
Cleveland (Wilson)	1985.5	1218.7
Acala 5-37	1612.2	1353.7
Stoneville No. 1	2251.5	1282.5
Stoneville No. 3	1997.5	------
Half-Half	------	1308.7

Fertilizer Tests With Cotton (W. C. Etheridge, B. M. King).—At Hayti only a slight increase in yield resulted from the fertilizer treatments used. In previous tests 400 pounds of 4-12-4 usually resulted in a substantial increase in yield. At Sikeston an application of 400 pounds of 4-10-6 gave the largest increase in yield, amounting to 675 pounds of seed cotton per acre.

DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

The Hormone of the Anterior Pituitary (Galactin) (C. W. Turner, W. U. Gardner, A. B. Schultz).—In rabbits at the end of pseudo-pregnancy or after a short period of involution, three or four days' treatment with the hormone of the anterior pituitary (galactin) produced mammary glands as thick or thicker than those following normal parturition. In cases where involution has progressed further a longer period of treatment was required. Lactation also has been induced in gonadectomized male and female rabbits in which the duct system was grown with theelin, and then the lobule system grown with theelin plus corporin. Perhaps these are the first experimental animals in which the entire growth and lactation of the mammary gland were induced by the proper sequence in the administration of the hormones. Galactin was found to be ineffective in stimulating directly the growth either

of the ducts or lobules of the mammary gland. Further investigation indicated that galactin was not identical with the sex maturing hormone, although the luteinizing hormone appeared to be present in the crude extracts of galactin. Efforts have been made to purify the crude extract.

The Use of Galactin in Different Species (C. W. Turner, W. U. Gardner, A. B. Schultz).—Extracts of galactin which were used successfully with rabbits were found to be ineffective in stimulating renewed lactation in castrated mature rats in which the mammary glands were involuted (non-lactating). Some secretory activity was induced in rats by the use of theelin, corporin, and galactin. The ovarian hormones, theelin and corporin were necessary in the induction of lactation with rat pituitary implants. The observations on guinea pigs were similar to those with rabbits. Lactation was obtained in a male guinea pig which had previously received theelin. Lactation also was induced in matured spayed females.

The Estrogenic Hormones (C. W. Turner, A. H. Frank, A. B. Schultz, E. T. Gomez).—Long continued injections of the crude extract of the estrus producing hormone from the urine of dairy cattle into immature castrate female rats induced only duct development with the limited lobule proliferation characteristic of the adult virgin female. Both theelin and theelol produced duct growth in castrate immature females. Neither small amounts nor large amounts of theelin for periods of twenty days were capable of initiating secretory activity in the mammary glands of either castrate or normal female rats. The injection of the estrogenic hormones over a long period of time into male rabbits has shown that the slight lobule development resulting from hormone injection for short periods was not extended. Theelin and theelol had the same physiological effect upon the mammary gland. The injection of the estrogenic hormone into the male mice produced similar growth of the duct system and long continued injections did not result in lobule development. However, in the case of guinea pigs subcutaneous injections of the hormones caused not only rapid growth of the duct system, but an extensive proliferation of lobules.

The Corpus Luteum Hormone (Corporin) (C. W. Turner, A. H. Frank, A. B. Schultz, E. T. Gomez).—In rabbits rapid growth of the lobules of the mammary gland was induced by the injection of corporin and the estrogenic hormones. Similar results have been obtained in the rat and the mouse. Attempts to extract corporin from the urine of pregnant cattle have been unsuccessful.

The Normal Growth of the Mammary Gland of Albino Mice (C. W. Turner, E. W. Gomez).—The entire cycle of development of the mammary gland in Albino mice from the earliest

embryonic stages to birth and during extrauterine life, pregnancy, lactation, and involution has been studied and described.

The Relative Cell and Plasma Volume of the Blood of Lactating, Non-lactating, and Growing Dairy Cattle (C. W. Turner, H. A. Herman).—Research Bulletin 159 is a report upon this investigation.

Changes in the Composition of the Blood of Dairy Cattle During Milk Fever (Parturient Paralysis) (C. W. Turner, H. A. Herman).—Analyses made on the blood of seventeen affected cows have shown that although both hypophosphatemia and hypocalcemia exist in cows suffering from milk fever it appeared that as the calcium was lowered the phosphorus also was lowered, and the calcium to phosphorus ratio was maintained. The treatment of milk fever has been by the injection of 500 to 1000 c. c of a ten per cent solution of calcium gluconate.

The Functional Individuality of the Mammary Glands of the Udder of the Dairy Cow (C. W. Turner).—It has been shown that the persistency of milk secretion is an orderly process declining from month to month at a fairly constant percentage of the previous month's production. The rate of decline of the four quarters was remarkably uniform, although there were many individual animals that showed considerable variability. An attempt has been made to determine the physiological mechanism controlling the decline of milk secretion and regulating the rate of activity of the gland.

The Course of Growth in Weight and Linear Size and Feed Consumption With Age (A. C. Ragsdale, Samuel Brody).—Data have been accumulated on 313 individuals from the Holstein, Jersey, Ayrshire, and Guernsey breeds. Individual variations have been determined in order that the differences in the efficiency of individual animals may be measured and the reasons for these differences determined.

The Efficiency of the Growth Process at Various Ages Under Various Conditions of Management, Fattening, Milk Production, etc. (S. Brody, Warren Hall, U. S. Ashworth; and A. G. Hogan, H. L. Kempster, A. C. Ragsdale, E. A. Trowbridge, and their associates cooperating).—The energy expended by dairy and beef cattle, sheep, horses, swine, chickens, and rats, has been related to body weight and to age. The average energy expense of quiet standing was about nine per cent greater than quiet lying; the average heat increment of normal feeding was about 25 per cent above basal metabolism in cattle and 30 per cent in sheep, horses, and swine. Males had a 10 per cent higher metabolic level than females. The metabolic level in castrated animals was the same as for females. The heat production level in lactating dairy cattle was 30 to 60 per cent higher than in dry animals; in lactating beef cattle about 27 per cent higher. The least (endogenous) nitrogen

excretion in rats was between 100 to 150 mg. of nitrogen per kilogram of body weight, depending somewhat on age.

Evaluating Dairy Sires (Warren Gifford).—The average procator for succeeding daughters. Their yearly production in butterfat may be expected to be within 50 pounds of the average production of the first ten daughters.
duction of the first ten daughters of a sire may be used as an indi-

The Effect of Forced Production Records on the Transmitting Ability of Dairy Cows (Warren Gifford).—A study of high producing Guernsey cows showed that there was no significant difference between the production records of daughters that were born before their dams had been tested under the so-called forced system, and the daughters born after the Advanced Registry tests.

The Effect of Frequency of Milking on the Annual Production of Dairy Cows (Warren Gifford, J. E. Crosby).—Cows milked four times daily produced approximately 20 per cent more butterfat than cows milked three times daily and 38 per cent more butterfat than those milked twice daily.

A Study of Polythelia in Dairy Cattle (Warren Gifford).—The udders of 4,829 female and 135 male dairy cattle have been examined for the frequency and location of the supernumeraries. In general, three types have been found: (1) Those at the rear of the normal, (2) those between the normal, and (3) those attached at the base of the normal teats. About one-fourth of all cows observed had one or more supernumeraries. There was no significant difference between the production records of cows with, and those without supernumeraries.

The Relationship of the Quality of Raw Milk to the Quality of the Resultant Dairy Products (W. H. E. Reid, F. O. Briggson).—Butter and skim milk powder manufactured from high grade milk scored from one to five points higher than that made from low grade milk. It also stored better. The quality of the milk received varied with the methods of handling and the equipment used. There was almost a direct relationship between the temperature of the milk when delivered at the plant and the bacterial count.

The Effect of Heat on the Colloidal, Physical, and Chemical Changes Occurring in Milk (E. R. Garrison, Hans Jenny).—Milk was subjected to electro-dialysis. Anions were removed at a much slower rate than cations at first, but after approximately 33 minutes anions were removed more rapidly than cations. During the first period of electro-dialysis cations were removed more slowly from milk that had been boiled one hour than from raw milk. After approximately seven minutes the cations were removed at a faster rate from boiled milk than from raw milk. Boiling did not affect the rate of removal of anions. The cations studied were adsorbed in the following order:

Calcium > Barium > Lithium > Sodium > Potassium. The anions studied were adsorbed in the following order: $PO_4 > SO_4 > Cl$.

Processing Skim Milk Powder in Cottage Cheese (W. H. E. Reid, C. L. Fleshman).—There was a direct relationship between the acidity of the curd and whey, the percentage yield, and the physical properties of the finished cheese. The curd acidity served as an indicator of the best time to cut the curd. Cottage cheese manufactured from reinforced skim milk compared favorably with cottage cheese manufactured from normal skim milk. Skim milk powder manufactured by either the spray or vacuum drum process was satisfactory.

The Removal of Undesirable Flavors from Milk (W. H. E. Reid, W. E. Painter).—Compounds of a chlorine nature used properly, enhanced the keeping qualities of cheddar and cottage cheese and removed some foreign flavors. Some compounds were very satisfactory and others were objectionable. The flavor and keeping qualities of cottage cheese were improved by chlorination of the rinse water.

Relation of Instant Freezing and Quick Hardening to the Physical Properties of Ice Cream, Sherbets, and Ices of Different Flavors (W. H. E. Reid, M. W. Hales.—Photo-Micrographs of ice cream instantly frozen showed that the ice crystals were very small. Semi-frozen ice cream that was permitted to rise in temperature and to partially melt lost its delicate flavor, fineness of texture, and smoothness of body. Photo-micrographs showed that the minute ice crystals had lost their individuality and fused to form large spiney ice crystals. It therefore was important to maintain the ice crystals in this small size. Hardening ice cream by forced air circulation produced a much improved product.

The Effect of the Quality of the Cream Used in Ice Cream Mixtures Upon Pasteurization Efficiency (E. R. Garrison, in cooperation with B. W. Hammar, Iowa State College).—Pasteurization efficiency of ice cream mixtures at 145° F. ranged from 89.1 to 99.7 per cent. Mixtures pasterized at 160° F. for 30 minutes frequently contained over 50,000 bacteria per c. c. In sweet cream mixtures high reduction in bacterial count was secured at 150° F. although in a few samples a high bacterial content was maintained when pasteurized at 155° F. Mixtures from cream of poor quality contained several thousand bacteria per c. c. when pasteurized at 155° F. A high pasteurization efficiency was obtained at 160° F. in most cases. Raising the temperature instantly to 150° F. gave better pasteurization efficiency than when the temperature was raised slowly over a two-hour period.

AGRICULTURAL ECONOMICS

O. R. JOHNSON, *Chairman*

Cost of Farm Operation in Northwest Missouri (O. R. Johnson, E. E. McLean).—Of 140 farms surveyed the twenty most profitable showed labor incomes of $226 per farm. The twenty least profitable showed a loss of $4,496 and the average of the 140 showed a loss of $1,440.

Economic Aspects of the Farm Poultry Enterprise (O. R. Johnson, Ben H. Frame).—This project is in cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture and the Department of Poultry Husbandry. Table 6 shows the profit per hen in flocks of varying sizes.

TABLE 6.—PROFIT PER HEN FROM 69 FARM POULTRY RECORDS, 1924-1931

Number in Flock	Number of Records	Income Per Hen	Cost Per Hen	Profit Per Hen
25- 74	9	$1.97	$2.08	−$.11
75-124	21	2.49	2.52	− .03
125-174	10	2.60	1.92	+ .68
175-224	15	2.20	2.16	+ .04
225-274	6	2.95	2.29	+ .66
275-324	7	3.00	2.72	+ .28
325-374	1	2.73	3.17	− .44

Cost of Family Living on the Farm (Ben H. Frame).—During the years 1927 to 1930 inclusive total cash expenses ranged from $754.144 to $1,051.52 for owner- and tenant-operated farms. Farm products used (not including residence) ranged from $259.21 to $388.90. The total living cost varied from $1,072.49 to $1,328.55. The total living cost was lower for owners than for tenants.

The Relation of Farm Improvements to Earnings and Value of Farm Land (O. R. Johnson, J. C. Wooley).—The Linn County records have been summarized and individual reports made to the farm cooperators. Final analysis has not been completed. The net income per acre on the 30 most profitable farms in the 110 surveyed was $9. The 30 least profitable showed a loss of nine cents per acre. The average net income per acre of all farms surveyed was $4.78.

Marketing Livestock (F. L. Thomsen, W. R. Fankhanel).—Published in Research Bulletin 165.

Operating Problems of Farmers' Elevators (F. L. Thomsen, W. R. Fankhanel, W. J. Hart).—Published in Station Bulletin 311.

Grades and Prices of Eggs (F. L. Thomsen).—On account of poor quality and lack of uniform grading and selling prices, Mis-

souri eggs sell on eastern markets at discounts. By producing higher quality eggs and grading them prices may be improved. Dealers in some sections of the State have started to buy on this basis. The weighted average price paid for graded eggs in 1931 was nearly two cents more per dozen than the usual price paid in the same territory.

Seasonal Hog Marketing (F. L. Thomsen, W. R. Fankhanel).—Owing to difficulty in securing accurate and complete data on shipments of live stock the original purpose of this project has had to be temporarily abandoned. Data on hog prices at the different markets serving Missouri show striking changes in price relationships between markets. Prices at the different markets have been compared to determine whether or not greater net returns can be secured through more careful choice of markets.

The Farm Real Estate Situation in Missouri (C. H. Hammar, R. P. Callaway).—Published in Research Bulletin 172.

Technique of Rural Real Estate Assessment (C. H. Hammar).—Published in Research Bulletin 169.

Tax Delinquency on Farm Real Estate in Missouri (C. H. Hammar).—A large amount of delinquency in the payment of taxes on rural real estate exists in all counties studied. Delinquency of one year is much larger than that of longer duration. However, there is much of from two to five years' standing. Apparently two major causes produced this delinquency: (1) The continued depression in agriculture and the particularly severe price declines since 1929; (2) the inaccuracy and inflexibility of assessment and equalization.

The Rural Tax Problem in Missouri (C. H. Hammar).—An index to farm property taxes has been constructed. These taxes have grown rapidly and in 1928 they were 285.6 per cent above the 1914 figure. However, in 1929 they decreased somewhat and further declines since have been registered.

Types of Farming in Missouri [C. H. Hammar, W. J. Roth (U. S. D. A.)]—The agriculture of Missouri is unusually complex, ranging from the heavily specialized growing of cotton in the Southeast Lowlands to the almost equally specialized production of corn, hogs, and beef cattle in Northwest Missouri. An important dairy area is located in the Southwestern Ozark Plateau, and a notable fruit country is in the southwest corner of the State. Around the City of St. Louis is a truck crop and wheat area. Dairying and wheat production occupy a large place in the Northeastern Ozark border counties.

BOTANY

W. J. ROBBINS, *Chairman*

The Control of Smuts of Small Grains (C. M. Tucker).—The formaldehyde dust and soak treatments and DuBay dust No. 1134 gave satisfactory smut control. Both formaldehyde treatments resulted in slightly decreased germination. Seeds treated with DuBay No. 1134 germinated slightly better than untreated seeds. Exposure to an X-ray dosage of 4080 *r* reduced smut infection about one-third. Increasing the dosage resulted in no further decrease of smut infection. Loose smut in barley was reduced from 5 per cent to .2 per cent by soaking the seeds three hours at 45° C. Shorter soaking periods at higher temperatures failed to control the smut. X-radiation of dry, dormant barley up to 16,320 *r* failed to control smut. Soaked, aerated, and dried seeds X-rayed with 3840 *r* eliminated the smut entirely, but caused a very large reduction in germination and reproduction.

Virus Diseases (C. M. Tucker).—Cowpea mosaic was found to be transmitted through the seeds. Attempts to cultivate the virus of tobacco mosiac were unsuccessful.

Morphologic and Physiologic Studies on the Genus Phytophthora (C. M. Tucker).—Cultures have been received from Holland, Hawaii, Canada, and India. *P. manoana,* isolated in Hawaii is synonymous with *P. palmivora.* Another Hawaiian isolation, proposed as a new genus, Pseudopythium, is P. *cinnamomi.*

Environmental Factors and Infections of Seedlings by Pythium sp. and Rhizoctonia sp. (C. M. Tucker).—The use of copper carbonate, formaldehyde dust, and organic mercury preparations for damping-off varies widely with the different species in which it is used. Scarlet flax (*Linum sp.*) was adversely affected by formaldehyde dust, gaillardia and calendula by copper corbonate, and gypsophila by both copper carbonate and formaldehyde dust. Formaldehyde dust and DuBay dust No. 738 both gave satisfactory control of damping-off of carnation, sweet william, and petunia.

Flag Smut Survey (C. M. Tucker).—A survey has been made in St. Charles, St. Louis, Buchanan, Platte, Audrain, and Holt Counties. In surveys in 1923 and 1930 flag smut was reported in these vicinities. The disease was found in three fields of Red Wave Wheat in St. Charles and St. Louis Counties. The loss was very slight. In the northwestern counties no flag smut was found. This survey was made in cooperation with the U. S. Department of Agriculture, and the Missouri State Board of Agriculture.

Identification of Plant Diseases (C. M. Tucker).—Several new or unusual plant diseases were discovered in Missouri. A pink mold of cultivated mushrooms caused by an undescribed species of Diolo-

cladium, a canker of the young branches of *Albizzia Julibrissin* caused by a *Nectria sp.*, a stem canker of snapdragons caused by *Botrytis sp.*, a rot of pepper fruits, caused by an unreported species of diaporthe, a foot and root rot of false dragon head and annual and perennial *Delphinium spp.* caused by *Sclerotium Delphinii.*, bacterial blight of Gladiolus caused by *Bacterium Gummisudans.*, a root rot of rooted cuttings of English ivy caused by *Pythium de Baryanum*, anthracnose of California privet caused by *Glomerella cingulata*, a canker of branches of Magnolia caused by *Diplodia magnoliae*, leaf spot of alfalfa caused by *Thyrospora sarcinaeforme.*, bacterial spot of tomato caused by *Bacterium vesicatoriu.*, root rot of rhubarb caused by *Phytophthora parasitica.*

AGRICULTURAL ENGINEERING

J. C. WOOLEY, *Chairman*

Power, Labor, and Machinery Costs (M. M. Jones, D. D. Smith).—The cost of horse labor varied from 5 to 20 cents per hour, depending upon the number of hours worked annually. Where tractors were used they replaced approximately four horses. The tractor farms had a considerably higher labor efficiency as indicated by the crop acres per man. Tractors were used mostly in peak seasons and should not be considered as competing with horse labor, but rather as complementary to horse labor.

Soybean Harvester (J. C. Wooley, O. E. Hughes).—There is a need for a small soybean harvester which will cut and thresh soybeans and not crack or split the seed. A machine with a five-foot cut and using a five-foot cylinder or beater has been constructed. Straw walkers carry out the straw and scatter it on the land. Pods and beans are collected together.

Tile Drains for Missouri Soils (J. C. Wooley).—Lines of tiles placed 3½ feet deep and spaced 200 feet apart on bottom land soil were effective in lowering the water level in the soil with sufficient rapidity to prevent damage to crops. Tile lines located under headlands were more satisfactory than under open ditches. On Mississippi bottom land soil at Elsberry tile lines must be laid shallow and at intervals as small as 50 feet. The cost of such an installation is not justified at present.

Rural Electrification in Missouri (R. R. Parks).—There are now 16,000 farms with high line electricity. Over 7,500 additional farms have their own individual plants. During the year there has been an 11 per cent increase in the use of electricity on Missouri farms. The average annual consumption per farm was 789 kilowatt hours.

Electric Brooding (R. R. Parks).—A total cost of 34 cents each was recorded for 1684 chicks brooded to 12 weeks of age. The cost of different methods of brooding varied from 30 cents for one of the new type combination brooders to 38 cents where coal was used.

Grain Harvesting (M. M. Jones, D. D. Smith).—A small plot of Harvest Queen wheat remained in good condition standing in the field for 7½ weeks after binder cutting time. At any time during this period it could have been harvested with a combine. During the same period the effect of the weather upon the moisture content was noted in shocked grain, windrowed grain, and standing grain. The test weight at the beginning of the period was 59½ pounds in all cases. After a three-day wet period beginning on the 23rd day of the trial the test weight of the shocked grain was 59 and that of the windrowed and standing grain 57. At the end of 7½ weeks the weight was 51 for windrowed grain, 52 for standing grain, and 54 for shocked grain.

Milk Cooling (D. D. Smith, E. R. Garrison).—Stirring the milk or circulating the water in the cooling tank shortened the time required for cooling. However, when milk was stored in water 35° to 45° F. neither stirring nor circulating the water gave a lower bacteria count. Cooling milk with water at a temperature of 65° to 72° F. did not give satisfactory results. Different methods of cooling did not affect the flavor of the milk.

ENTOMOLOGY

L. HASEMAN, *Chairman*

The Establishment of a State Wide Series of Codling Moth Breeding Cages (L. Haseman, Paul H. Johnson).—In the Ozark area 17 cages have been placed with 17 cooperators who have reported on moth emergence. In Central Missouri 9 cages have been placed with 8 cooperators and in Northern Missouri 13 cages with 10 cooperators. From 75 to 100 worms were placed in each cage, the exact number being recorded. Reports have been received twice a week on the number of moths that emerged. Local weather conditions also were reported. From these data the spray dates for each area were determined.

The Effect of Latitude, Longitude, Elevation, and Exposure on Moth Development (L. Haseman, Paul H. Johnson).—The Hopkins bioclimatic law seemed to apply to the codling moth in general. That is, for each five degrees longitude and for each 400 feet in elevation there was a delay of four days in the life activities to the north and east in the spring and the reverse in the fall. However, the exposure and variation in local winter conditions materially affected moth emergence.

Bait Traps to Supplement Breeding Cages (L. Haseman, Paul Johnson).—After the over-wintering worms have emerged it is difficult to restock the breeding cages to give an accurate record of moth activity for the rest of the summer. Bait traps have been used to supplement the cages for the later records. The record of the trap catch of moths indicated the moth emergence. The traps were of value as indicators, rather than as a means of reducing moths and worms.

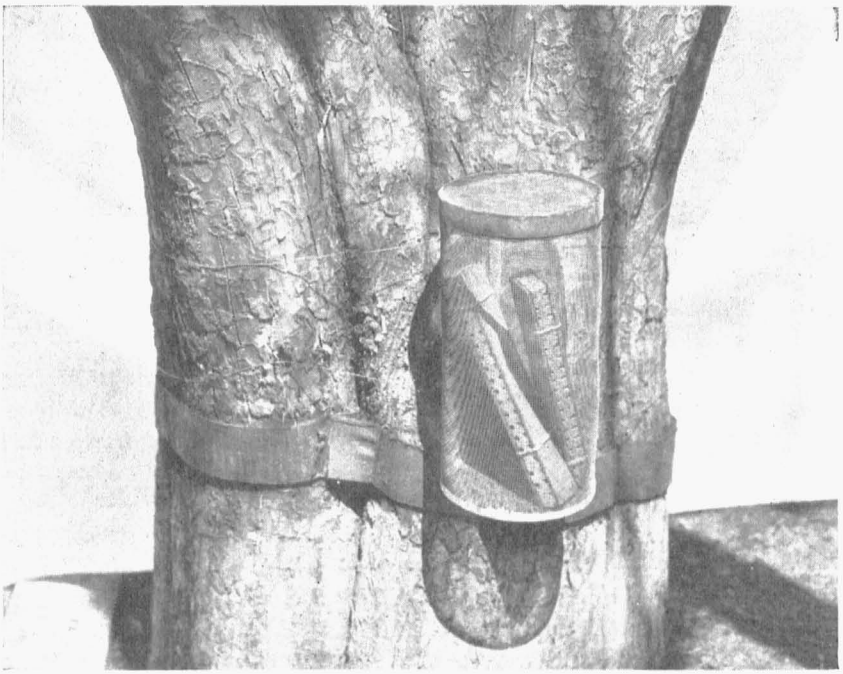

Fig. 4.—Codling moth breeding cage and tree band in position.

Use of Tree Bands for Determining Late Brood Moth Activity (L. Haseman, Paul H. Johnson).—Tree bands have been used during July, August, and September for collecting and observing worm, pupa, and moth development. In addition to following moth development the grower also may destroy many worms by this means.

Spray Control of Apple Worms (L. Haseman, Paul H. Johnson).—By using the proper dosage and proper timing, losses from worms may be reduced to as low as 8 or 10 per cent of the picked fruit where the worm populations are not too high. To accomplish this the dosage of lead arsenate must be increased from 1 pound to 1½ or 2 pounds to 50 gallons of spray. Summer oil did not add to the effectiveness of the spray. The timing of sprays by moth emergence has been developed as well as can be expected.

Chemically Treated Bands as Supplement to Spray Control of Codling Moth (L. Haseman, Paul H. Johnson).—Where populations of worms have been allowed to build up to unreasonable numbers sprays will not control them. Tree bands treated with a mixture of engine oil and beta napthol and applied to the tree trunks early in June have proved a valuable supplement. Unfortunately, bands get the worms after the damage has been done but it prevents the worms' offspring from damaging more fruit. Cleaning the orchard and packing house helped greatly.

The Lethal Action of Arsenic on Codling Moth Larvae (L. Haseman, Paul H. Johnson).—No actual resistance to arsenic has been found in worms from Colorado, Virginia, or Missouri. The worms were equally susceptible. It was thought that perhaps worms in some localities were becoming more resistant to arsenic.

Tarnished Plant Bug (L. Haseman, Paul H. Johnson).—Tarnished plant bug has been causing a large number of buttoned berries. The following sprays seemed to give better control. Four ounces of potash vegetable soap to 1 gallon of water, The addition of 40 per cent nicotine sulphate diluted 1 - 1600 seemed to improve this spray. Red Arrow (Pyrethrum) plus soap gave good control.

Strawberry Crown Borer (L. Haseman, Paul H. Johnson).—At Cassville spraying with two pounds of arsenate of lead to 50 gallons of water proved far more satisfactory than dusting with 1 pound of arsenate of lead and 5 pounds of hydrated lime. At Sarcoxie infestation was light and the plants failed to show much difference.

Hessian-fly-resistant Varieties of Wheat (L. Haseman).—This project is in cooperation with the Department of Field Crops. Illini Chief, which formerly was the least susceptible variety, showed heavy infestation. Fulcaster, usually considered average in susceptibility, showed less than one-third as heavy infestation as Illini Chief. The percentage of straws infested ranged from 11.4 for the Fulcaster to 36.9 for Michigan Wonder.

The Use of Insecticides (L. Haseman, Paul H. Johnson).—Barium fluosilicate and synthetic cryolite were effective as dusts for protecting cucurbits from striped and spotted cucumber beetles. Barium fluosilicate and calcium arsenate applied as dusts cleared late potatoes of infestation by blister beetles in three hours. Neither insecticide killed the beetles and they returned after rains had washed the insecticides off. The use of coal-tar dye for coloring arsenate of lead and calcium arsenate did not affect their insecticidal value. Several commercial brands of pyrethrum used as sprays for controlling the tarnished plant bug on strawberries were unsatisfactory. A cheap homemade soft soap as a contact insecticide for tarnished plant bug on strawberries gave the most encouraging results.

Periodical Recurrence of Insect Pests (L. Haseman).

Grasshoppers. In Central Missouri grasshoppers reached the peak of abundance during the summer and fall of 1931. Rainfall, disease, parasitic mites, and blister beetles have helped reduce their number.

Chinch Bugs. The cold dashing rains practically eliminated the early spring generation of young bugs in some regions.

Hessian Fly. This scourge of wheat is on the decline due to parasites, disease, and weather conditions.

Harlequin Cabbage Bug. The mild open winter enabled this pest to live over in such numbers that it has reached the proportion of a real scourge on cabbage and related crops.

Blister Beetles. Since some of these species feed on the eggs of grasshoppers the abundant crop of hoppers' eggs during the fall of 1931 caused this year's crop of beetles to increase materially.

Insect Pests of Melons (L. Haseman, Preston B. McCall).

Striped Cucumber Beetle. Arsenicals and barium fluosilicate have proved the most economical controls for striped cucumber beetles. Plowing under the vines and green fruits as soon as the crop is harvested and the destruction of leaves and rubbish materially reduced the number of beetles the following summer.

Melon Louse. This insect attacks cotton and the two crops should not be grown adjoining each other. When first signs of lice are observed the infested hills should be covered with dirt or treated with nicotine.

Squash Bug. The squash bug was far less abundant this year than last. Sanitation about the garden and surrounding grounds reduced the number of over-wintering bugs. The destruction of residue of an infested crop was helpful. The use of a trap crop and prompt hand destruction saved much later loss. No practical control with contact chemicals has been perfected.

AGRICULTURAL CHEMISTRY

A. G. HOGAN, *Chairman*

Chemical Service (L. D. Haigh, W. S. Ritchie, E. W. Cowan, A. R. Hall).—Materials have been analyzed for other departments of the University and for individuals and companies from various parts of the State. During the year 1199 determinations have been made.

Nutritive Properties in Meat (A. G. Hogan, W. S. Ritchie). —Muscle meat as the sole source of protein proved entirely satisfactory through six generations of albino rats. Liver has proved adequate through three generations. Kidney has been used through two

generations, but is somewhat less satisfactory than muscle or liver tissue.

The Action of Radioactive Substances on Vitamins (A. G. Hogan, W. S. Ritchie).—Butter exposed to mesothorium for ten days was bleached and became inactive as a source of vitamin A. There was no increase in rancidity or any change in the iodine number. Low temperatures, one to two degrees C., did not affect the time required for bleaching.

Soluble Supplements for the Chick (A. G. Hogan, R. V. Boucher).—Satisfactory growth of chicks was secured with a ration of the following percentage composition: casein 35, starch 34, lard 11, cod liver oil 2, cellulose 3, salts 4 and soluble vitamin supplements (acid hydrolyzed yeast 4, ether extract of egg yolk 2, liver extract 4, tikitiki 1). The removal of any of these supplements resulted in a decreased rate of growth. These supplements apparently were not adequate for a complete life cycle.

Effect of Ultra-Violet Rays on the Dermatitis-Preventing Vitamin (A. G. Hogan, L. R. Richardson).—An earlier report stated that a factor of the vitamin B complex was destroyed by ultra-violet rays. Other workers and subsequent attempts at this Station were only partially successful in verifying this. Additional investigations have shown that if the mother of the experimental rats (after the litter was 15 days old) was given a ration entirely free of vitamin B, if lard was removed from the diet, and if irradiation was with a powerful lamp at a short distance, all animals developed dermatitis.

HOME ECONOMICS

MABEL V. CAMPBELL, *Chairman*

Durability of White and Colored Cotton Materials (Adella Eppel Ginter, Sophie Pearlmutter, Margaret Partlow).—The garments which have been analyzed at the present time showed that wear due to use as measured by tensile strength decrease was much greater fillingwise and about the same warpwise as was wear due to laundering. Tensile strength measurements varied greatly when taken before and after laundering. In ginghams the percentage loss in tensile strength per laundering was about the same fillingwise after the fabrics were laundered five times as after they were laundered 157 times, but the opposite occurred warpwise. In five muslins tested none was worn out as measured by the tensile strength until after 100 launderings. The original tensile strength values were changed by laundering so that they could not be used as indicators. It seems impossible to determine the tensile strength of the whole fabric since there are two values to consider, warp and filling. Wear was accompanied by a decrease in tensile strength, as well as in thickness and weight.

The Vitamin Content of Eggs (Bertha Bisbey, Sylvia Cover).—There was no significant difference in the vitamin D Content of eggs from White Rock hens (brown eggs) or eggs from White Leghorn hens (white eggs).

The Effect of Adding Base to a Diet Deficient in Vitamin D (Bertha Bisbey, Sylvia Cover).—The pH values of the intestinal contents and the percentage of calcium in green and dry extracted femurs were obtained for rats on the following diets:

1. A diet adequate in all respects except vitamin D
2. A minus D diet plus 10 or 30 minutes ultra violet irradiation
3. A minus D diet plus graded portions of viosterol as a source of vitamin D
4. A minus D diet made progressively more alkaline with $NA_2 CO_3$
5. A minus D diet made alkaline with NA OH
6. Diet 13 (stock diet which includes ⅔ whole wheat, ⅓ whole milk powder and salt equaling 2% of the weight of the wheat)

The data secured have not been analyzed.

Oven Temperatures for Broiling Steaks (Jessie Alice Cline, Myrtle E. Swanson).—Various steaks were broiled at oven temperatures of 150° and 235°. The higher broiling temperature increased the cooking losses; shortened the total cooking time; increased the rise in internal temperature upon removal from the broiling oven; and produced less uniformity of doneness. Heavier steaks required longer *totdl* cooking time, but shorter cooking time *per pound*. Palatability was unaffected by true broiling temperatures. A relatively low constant broiling temperature is recommended, both for the housewife and the scientific investigator because of ease of manipulation and duplication, lowered cooking losses, and uniformity of doneness.

The Effect of Oven Temperature on Beef Roasts (Jessie Alice Cline, Ruth Foster).—Low oven temperatures required a longer time per pound for roasting and gave less loss than high oven temperatures. Losses by evaporation were greater than losses by drippings. There was a very slight difference in tenderness in favor of the roast cooked at low oven temperatures. These results were secured by cooking beef roasts from animals of known history by three methods: A low constant oven temperature of 100° C.; a high constant oven temperature of 225° C.; and the standard method, sear at 260° C., and finish at 125° C. The method which seared the meat seemed to produce roasts which had a better flavor of lean. Because of the ease of manipulation and duplication it is recommended that a constant oven temperature method be adopted as the standard method of roasting ribs of beef in the cooperative meat investigations project. It is also suggested that a constant temperature method of roasting be recommended for general use.

POULTRY HUSBANDRY

H. L. KEMPSTER, *Chairman*

Normal Growth of White Leghorn, Rhode Island Red, and White Plymouth Rock Pullets (H. L. Kempster, E. M. Funk).—Table 7 shows the growth obtained with White Leghorn, Rhode Island Red, and White Plymouth Rock pullets during the 1932 season.

TABLE 7.—NORMAL GROWTH OF CHICKS—1932.
(Weights in Grams).

Number and Breed	Age in Weeks					
	0	4	8	12	16	20
105 White Leghorns	39.1	181.4	442.6	689.2	983.4	1146.1
320 Rhode Island Reds	41.2	172.1	444.6	790.3	1158.7	1426.2
209 White Rocks	40.0	154.6	438.1	774.3	1120.1	1396.3

The Relation of Date of Sexual Maturity to Egg Production (H. L. Kempster).—White Rock and Rhode Island Red Pullets that were brought into laying early produced more eggs than similar birds that did not start laying until a later date. They produced a liberal supply of fall eggs and also produced as many winter eggs as those starting later. There was no tendency for early laying to cause a fall or winter molt.

Artificial Lights and Winter Egg Production (H. L. Kempster, E. M. Funk).—Burning lights all night with White Rock pullets increased winter egg production 13.5 eggs per bird. However, during March and April these same pullets laid fewer eggs so that the total production from November 1 to June 30 was the same as for the unlighted pens. There was practically no difference in feed consumption during the winter months, but the birds under lights were a half pound lighter in weight on March 1 which probably accounted for the lower egg production during March and April.

Feed Purchasing Power of Eggs Laid by a Hen (H. L. Kempster).—The relationship between feed and egg prices for 1931 was more favorable for the poultryman than in 1930. Feed prices declined 35 per cent and egg prices 33 per cent. The eggs produced by an average hen would buy eight pounds more feed in 1931 than in 1930.

Commercial Fattening of Poultry (H. L. Kempster, E. M. Funk, C. G. Bryan).—Most satisfactory gains were obtained with Leghorn broilers, Rhode Island Red roasters, and Leghorn hens. The lowest loss in dressing was secured with Plymouth Rock broilers, roasters, and hens. The ration containing ten per cent dried skimmilk produced the most satisfactory gains. The ration did not influence the feed consumption materially. Smaller

birds made more rapid gains than larger. Condensed buttermilk produced the highest quality birds. A simple basal ration containing 70 pounds of yellow corn meal, 20 pounds of wheat middlings, and one pound salt properly supplemented with milk products produced as satisfactory gains as more complex basal rations.

Meat Scrap and Milk in Rations for Baby Chicks (H. L. Kempster, E. M. Funk).—A ration containing 10 per cent dried skimmilk and five per cent meat scrap proved as satisfactory as either dried skimmilk or dried buttermilk as the sole source of animal protein. Pullets fed combinations of meat scrap and milk were heavier at the age of eight weeks than those fed milk alone. However, at the ages of 16 and 20 weeks these pullets were the smallest.

Time of Hatching in Relation to Egg Production (H. L. Kempster).—February and early March hatched pullets of the general purpose breeds produced from two to three dozen more eggs up to July 1 of their first laying year than did pullets hatched in early April. The early hatched chicks made more rapid growth, experienced lower mortality, and a larger percentage was retained as layers.

Influence of Position in the Egg Cycle on Size of Eggs (E. M. Funk).—The term "cycle" designates the eggs laid on consecutive days. The first egg laid in two, three, or four egg cycles was the largest egg laid during the cycle. Eggs laid during the remainder of the cycle decreased in weight as the cycle advanced.

The Relation of Egg Production to Hatchability (E. M. Funk).—Correlation studies of the egg production and hatchability records of 609 hens showed that there was no significant relationship between winter (November to February), spring (March to June), or annual (November to October) egg production and hatchability of eggs.

Effect of Breed and Age Upon Hatchability of Hens' Eggs (E. M. Funk).—A higher percentage of chicks was produced from Leghorn eggs than from White Plymouth Rock or Rhode Island Red eggs. There was a higher degree of fertility and hatchability in eggs from this breed. Fertile eggs laid by White Plymouth Rock pullets hatched better than those laid by hens of the same breed.

HORTICULTURE

T. J. TALBERT, *Chairman*

Substitutes for Arsenical Spray (T. J. Talbert, H. G. Swartwout, C. G. Vinson).—Barium fluosilicate and sodium aluminum fluoride compared favorably with lead arsenate in toxicity to codling moth and Colorado potato beetle larvae. However, under field conditions the control of the fluorine materials was below that of lead arsenate due to other factors. New materials have been tested in the control of codling moth, comparing with lead arsenate as follows: Lead arsenate yielded 3.4 per cent wormy fruit; red pepper in 1 per cent summer

oil 9.5 per cent; pyrethrum 15.6 per cent; hellebore 17.1 per cent; and untreated trees 20.3 per cent.

Virus Diseases of Plants (C. G. Vinson).—Virus has been precipitated from the juice of diseased plants quantitatively by an aqueous solution of safranin. This precipitate has been decomposed readily by means of Lloyd's alkaloidal reagent yielding a purified preparation of the virus more infectious than the original juice. This preparation may be reprecipitated and again decomposed without measurable loss of virus. The radius of the virus particle in purified preparations has been less than five millimicrons.

Factors Determining Hardiness and Methods of Increasing It (T. J. Talbert, C. G. Vinson, H. G. Swartwout).—A method of increasing the concentration of carbohydrates in the parts of the Grimes and Stayman apple trees subject to winter injury has been sought. It has been found that leaves are necessary for the proper ripening of wood and that properly ripened tissues give better resistance to injury from low temperatures. Defoliating branches in the fall delayed the opening of flower and vegetative buds in the spring. Crotch angle and crotch location may be factors in determining hardiness of particular parts of the trunk.

Evaluating of Apple Pollination Methods (A. E. Murneek).—The branch-unit (cloth-bag) method of pollination and the screened-cage method have been compared with the Manila paper bag procedure. The first two methods have been more economical in time and labor, they permitted the use of more flowers and were less artificial; they reduced the amount of shading and interfered least with temperature and humidity conditions; and permitted the expression of the results in terms more nearly comparable to a normal set of fruit. However, there was a greater experimental error, due to unguarded pollination by very small insects. The initial cost of constructing cages was high and the cooperation of an apiculturist was necessary.

Comparative Efficiency of Certain Apple Varieties as Pollenizers (A. E. Murneek).—Jonathan, Delicious, and Ben Davis were exceptionally desirable pollenizers for other apple varieties. York was also a satisfactory pollenizer. Golden Delicious and Grimes produced pollen abundantly, but their efficiency was quite mediocre. Rome and King David could not be relied upon to pollenate successfully.

Biochemical Investigations of Photoperiodism (A. E. Murneek).—Experiments have been made on nitrogen metabolism in localized portions of stems of soybeans exposed to definite short and long photoperiods. The low concentration of nitrate, alpha amino, and amide nitrogen and the high concentration of coagulable, proteose, basic, and humin nitrogen in tips of long-day plants pointed to a rapid utilization of the low soluble forms of nitrogen for growth in these non-fruiting plants.

The Relation of Nitrogen to Potassium in Nutrition of Apple Trees (A. E. Murneek, E. J. Gildehaus).—Trees receiving an excessive amount of nitrogen showed a marginal burning of the foliage. Leaf scorch (due to potassium deficiency) appeared in the sand cultures given large nitrogen but reduced potassium supply. The Neubauer method was attempted with apple seedlings, but was unsuccessful, due to the irregular germination of apple seeds.

Natural vs. Synthetic Nitrate of Soda in Nutrition of Horticultural Plants (A. E. Murneek, J. H. Long).—Marglobe tomatoes, Nancy Hall sweet potatoes, and Turkish tobacco have shown no differences in growth and development due to the difference in natural and synthetic nitrate of soda.

Nitrogen Applications to Grapes (H. G. Swartwout).—No definite responses have been obtained from nitrogen applications to grapes either in growth, production, or quality. A few vines making a feeble growth in a tight, poor soil showed some increase in vigor. Concord and Moore were the varieties under treatment.

Walnut, Pecan, and Filbert Investigations (T. J. Talbert, A. E. Murneek).—Adequate plantings for propagation stock of chinquapin (*Castanea pumila*), several varieties of hickory, black walnut, and butternut have been made. European varieties of filberts and hazelnuts have proved less hardy and fruitful in this locality than the American species and their varieties.

RURAL SOCIOLOGY

E. L. MORGAN, *Chairman*

Rural Community Organization in Public Welfare (E. L. Morgan, H. J. Burt).—The case studies of 59 farming families receiving poor relief from county funds in Boone County showed that 17 per cent were registered from 1921 to 1928 and 83 per cent from 1928 to 1931. The total number of children in the 59 families was 214. The causes for dependency were old age, one parent out of the home, physical or mental illness, adjustment of young people, and economic problems.

Rural Community Trends (H. J. Burt).—Research Bulletin 161, Rural Community Trends, is a partial report on this investigation. Two additional communities have been added to the project and the work continued. Eight years ago a study of the rural population groups of Boone County was published as Research Bulletin 74. A re-study has been made to determine the changes in population groups. Two communities have fallen back to the status of neighborhoods and one neighborhood has become a community. Where 59 neighborhoods were found eight years ago there are only 41 remaining. There also were evidences of 25 new neighborhoods having been formed.

Movements of Population in Missouri (E. L. Morgan, H. J. Burt).—The number of incorporated towns in Missouri has increased to an index of 127, using the data for 1890 as 100. During this same time the United States as a whole has increased to an index of 168. Among the places classed as rural the largest gains were made in the 100 to 500 population classification. Those from 2500 to 5000 showed the least gain. Both large and small places have grown at the expense of the farming population.

VETERINARY SCIENCE

A. J. DURANT, *Chairman*

Studies of Abortion-Infected Herds (Cecil Elder, A. W. Uren, A. M. McCapes).—Cattle vaccinated with a commercial product for the control of abortion still carried live organisms in their systems for as long as eighteen months after vaccination. Reactors in two large herds were separated and vaccinated in 1930. Since that time no further treatment has been given them. Monthly blood tests have been made. High blood titres have continued in a large number of cases. Pure cultures of *Brucellus abortus* have been isolated in nine cases from material collected at post mortem examinations. These nine cases were from eleven high reactors. Pure cultures could not be isolated from six medium to low reactors or from three negative reactors.

The Transmission of Abortion Infection in Cattle From Immune Dams to Progeny (Cecil Elder, A. W. Uren, A. M. McCapes).—Non-reacting progeny from immune dams were apparently susceptible to abortion infection. Three cows, all pregnant, were drenched with a large quantity of *Brucellus abortus*. Two cows were left untreated as controls. One of the three infected cows aborted 54 days after being dosed and cultures of *Brucellus abortus* were isolated, both from her colostral milk and placental membranes. A second cow came into estrum 37 days after exposure. It is believed that she aborted at pasture. The other cow, not due to freshen for 113 days, seems normal. Both control animals have calved normally.

The Effect of Length of Storage Period on Swine Blood Samples (Cecil Elder, A. M. McCapes).—A study of the effect of age and care of swine blood samples on the agglutination tests for Bang's disease showed that the titre of the sera did not vary appreciably in relation to the age of serum sample or kind of antigen used (bovine or porcine), and that the samples kept at room temperature (70° to 75° F.) for four days. Samples in which a clot was allowed to form and the serum to separate and remain in contact with the clot at room temperature showed no marked change in agglutination titre at four days or at eight days after the first test. However, three samples

hemolyzed to such an extent that testing was impossible. Blood samples shipped promptly from any section of the State will reach Columbia in good condition for testing.

Transmission of the Bang Abortion Infection of Swine to Cattle (Cecil Elder).—Attempts to cause abortion in cattle by infection from swine by placing infected sows in the same pasture and sheds with pregnant cows have been unsuccessful. Four sows were dosed with a known culture of *Brucellus abortus suis*. Three other susceptible sows were left as controls. The virulency of the organisms for swine was proved both in the treated and untreated sows. The blood titre in one cow showed a slight rise and this soon dropped. In another it raised very high but soon dropped to a medium titre. None of the cows has aborted or showed any evidence of abortion.

Low Agglutination Reactions in Unbred Virgin Gilts (Cecil Elder).—Unbred virgin gilts with low agglutination tests have been used to determine whether or not such animals are a source of real danger to a herd. They have been protected against outside infection and the blood reactions recorded. In all cases the reactions have remained steadily and consistently low.

Blackhead in Turkeys (A. J. Durant, H. C. McDougle).—The removal of the ceca from abligated turkeys by a second surgical operation apparently did not affect normal reproduction or the general health of the birds. Metabolism tests have shown that the digestive functions were undisturbed by abligation. Studies on the immunity of turkeys to blackhead have been started.

Leukemia in Fowls (A. J. Durant, H. C. McDougle).—Efforts to transmit leukemia by injecting and feeding blood and organs of infected birds to uninfected birds have been unsuccessful.

A New Disease Affecting Missouri Cattle (Cecil Elder).—A new disease affecting the legs of cattle was reported from several different parts of the State simultaneously. Trips were made to the affected herds and in all cases the same general condition was found. The cause has not been located, but on every farm where the trouble occurred the number of flies has been unusually large. Unsuccessful attempts have beeen made to prove whether or not the disease was infectious. The outstanding symptoms were swelling of the legs, the front legs more often than the hind; cracks in the skin on the posterior surfaces of the legs, especially in the region of the knee joints; the falling of small patches of hair from the affected areas; a yellowish serous exudation which formed small crusty scabs; loss of appetite; increased temperature; and pain with movement. In some cases secondary infections followed and resulted in death. The use of fly repellants and the provision of good water facilities are recommended as control measures.

TECHNICAL SERVICES TO FARMERS

The Experiment Station has been performing for the farmers of Missouri various services requiring knowledge, skill, equipment, and laboratory technique which are not usually available to any one farmer or group of farmers. Annually the staff answers thousands of questions relating to farm practices. These questions are extremely varied and require accurate knowledge. This is perhaps the greatest single service the Experiment Station renders.

In addition, the various departments examine thousands of specimens and make recommendations regarding them. The Department of Veterinary Science identifies animal diseases; the Department of Plant Pathology performs a similar service regarding plant diseases; seeds and plants are identified by the Department of Field Crops; insect pests are identified and methods of control recommended by the Department of Entomology; chemical analyses of agricultural materials are made by the Department of Agricultural Chemistry; the Department of Horticulture identifies and recommends control measures for various fruit and vegetable diseases. Special laboratories are maintained for testing seeds, producing anti-hog-cholera serum, the preparation of legume bacteria, testing soils for their lime needs, analyzing fertilizers, and the official testing of dairy cows.

More detailed information regarding some of these special services is given in the following paragraphs:

Seed Testing Laboratory (W. C. Etheridge, Clara Fuhr).—A total of 3,224 samples of seeds and plants were tested and examined. Of these, 2,900 were for Missouri farmers and seedsmen; 105 inspector's samples for the Missouri State Board of Agriculture in connection with the enforcement of the Missouri Seed Law; and 23 Custom House samples. One hundred ninety-six tests were made for farmers and seedsmen of other states. The number and purpose of tests are as follows: Purity and germination, 1,469; germination only, 1,005; identification, 384; examination and germination, 188; examination only, 92; purity only, 75.

Production and Distribution of Bacteria for Legumes (W. A. Albrecht, H. F. Rhoades).—During the year cultures have been distributed to treat 19,848 bushels of legume seed. The number of bushel units for the different legumes was as follows: Soybeans 13,834, sweet clover, 1,842, alfalfa 1,234, red clover, 1,087, cowpeas 359, Korean clover 972, miscellaneous 520.

Testing Soils for Their Lime Need (Harold F. Rhoades).—The number of samples tested during the year totaled 534, increasing the complete number of tests now available to approximatly 11,000 samples from all parts of the State.

Production and Distribution of Anti-Hog-Cholera Serum (O. S. Crisler).—The swine raisers of Missouri, directly or through vet-

erinarians, county agents, and teachers of vocational agriculture, have been supplied during the year with 1,750, 450 c.c. of anti-hog-cholera serum. This serum was distributed in 1,595 orders in 61 counties. There was not much hog cholera during the year.

Agglutination Blood Testing for Bang Disease in Cattle and Swine (A. M. McCapes).—Blood samples from 22,036 cattle were tested for contagious abortion. This was an increase of 2,685 tests over the previous year. Approximately twenty per cent showed infection. Abortion in swine seemed to be increasing.

The eradication program carried on in connection with the blood tests progressed satisfactorily and a number of farms have been freed of abortion disease.

Agglutination Blood Testing for Pullorum Disease in Chickens (A. J. Durant, H. C. McDougle).—Pullorum disease tests were made on 64,834 blood samples. Approximately ten per cent showed infection. The number of tests made for pullorum disease more than doubled that of the previous year. The demand of poultrymen for healthy chicks caused this increase.

Distribution of Chicken-pox Vaccine (A. J. Durant, H. C. McDougle).—During the year 40,755 doses of experimental chicken-pox vaccine were distributed to poultry producers. The results have been excellent.

Diagnostic Service (A. J. Durant, H. C. McDougle, A. W. Uren, O. S. Crisler).—Exclusive of the blood tests for pullorum disease and Bang abortion disease 2,243 specimens of diseased animals were examined and reports made. Brain examinations for rabies in domestic animals were made on 59 specimens. Positive evidence of rabies was found in 26 of the specimens. Fowl cholera was the most prevalent disease found in mature chickens. Pullorum disease was the most prevalent in chicks.

Fertilizer Control (L. D. Haigh, E. W. Cowan, A. R. Hall).—Three hundred thirty-six samples were collected in 107 towns and from 28 farms. Two hundred eight dealers and manufacturers were visited. The samples collected have been analyzed and the results published. The average analysis of all fertilizer inspected in Missouri showed that the manufacturer furnished 104.8 per cent of the amount of plant food guaranteed.

Official Testing of Dairy Cows (Warren Gifford, H. A. Herman).—During the year 1018 one-day tests and 832 two-day tests were conducted on a total of 531 Advanced Registry and Register of Merit cows. There were 959 one-day breed herd improvement tests conducted on 128 cows in six purebred herds. Of the cows tested 219 were placed on test during the year. These tests were conducted for 24 Missouri breeders.

PUBLICATIONS

A. A. JEFFREY, *Editor*

Twenty-nine publications were issued by the Station during the year ending June 30, 1932. Of this number 17 were research bulletins, 9 were bulletins, and 3 were circulars. The total number of copies issued was 112,000. During the same period the distribution of publications from the Station mailing room reached a total of 168,139 copies. Considerably more than two-thirds of this total, or 119,686 copies were sent to residents of Missouri, while 41,747 copies were used by residents of other states, and 6,706 copies were sent to libraries and agricultural leaders in foreign countries.

TABLE 8.—PUBLICATIONS OF THE MISSOURI AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1932

Serial No.	Series, Title, Author, and Number of Illustrations	Pages	Copies
	Research Bulletins		
154	The Missouri Farm Real Estate Situation for 1927-1930, by C. H. Hammar, July, 1931; figs. 13	84	3,000
155	The Analysis of Social Data, by Henry J. Burt, July, 1931; figs. 6	88	2,000
156	The Development of the Mammary Gland as Indicated by the Initiation and Increase in the Yield of Secretion, by C. W. Turner, August, 1931; figs. 18	48	2,000
157	A Study of the Causes of the Normal Development of the Mammary Glands of the Albino Rat, by C. W. Turner and A. B. Schultze, August, 1931; figs. 60	48	2,000
158	The Relation of the Anterior Pituitary Hormones to the Development and Secretion of the Mammary Gland, by C. W. Turner and W. U. Gardner, August, 1931; figs. 24	60	2,000
159	A Determination of the Blood and Plasma Volume of Dairy Cattle, by C. W. Turner and H. A. Herman, August, 1931; figs. 16	64	2,000
160	The Anatomy of the Mammary Gland of Cattle, by C. W. Turner, September, 1931; figs. 30	40	2,000
161	Rural Community Trends, by Henry J. Burt, October, 1931; figs. 6	48	2,000
162	Behavior of Potassium and Sodium During the Process of Soil Formation, by Hans Jenny, October, 1931; figs. 26	64	2,000
163	Cytological Observations of Deficiencies Involving Known Genes, Translocations and an Inversion in Zea mays, by Barbara McClintock, December, 1931; figs. 39,	30	2,000
164	The Influence of Age at First Calving on Milk Secretion, by C. W. Turner, February, 1932; figs. 13	40	2,000
165	Cost of Marketing Livestock by Truck and Rail, by F. L. Thomsen and W. R. Fankhanel, March, 1932; figs. 15	32	2,500
166	Growth and Development with Special Reference to Domestic Animals, XVII, XVIII, XIX, XX, XXI, XXII, XXIII, by Samuel Brody, April, 1932; figs. 45	104	2,000
167	The Calcium Requirement of Brood Sows, by A. G. Hogan, May, 1932; figs. 1	20	2,000

TABLE 8 (CONTINUED).—PUBLICATIONS OF THE EXPERIMENT STATION

Serial No.	Series, Title, Author, and Number of Illustrations	Pages	Copies
168	Swine Reproduction in Relation to Nutrition, by A. G. Hogan, May, 1932; figs. 3	24	2,000
169	The Accuracy and Flexibility of Rural Real Estate Assessment in Missouri, by C. H. Hammar, June, 1932; figs. 8	68	2,500
170	The Oestrous Cycle of the Ewe; Histology of the Genital Tract; by L. E. Casida and F. F. McKenzie, June, 1932; figs. 10	28	2,000
	Total pages and copies, Research Bulletins	890	36,000
	Bulletins		
306	Inspection and Analysis of Commercial Fertilizers; Spring, 1931, by F. B. Mumford and L. D. Haigh, and M. F. Miller, August, 1931	12	5,000
307	Home Orchard Income, by T. J. Talbert, March, 1932; figs. 2	12	10,000
308	Registration, Labeling, Inspection and Sale of Commercial Fertilizers; 1931, by F. B. Mumford and L. D. Haigh, March, 1932	32	5,000
309	The Value of Dried Skim Milk for Fattening Poultry, by E. M. Funk, H. L. Kempster, and C. G. Bryan, April, 1932; figs. 4	24	8,000
310	Experiment Station Research, by F. B. Mumford and S. B. Shirky, April, 1932; figs. 1	68	4,000
311	Operating Practices of Missouri Cooperative Elevators, by W. J. Hart, W. R. Fankhanel, and F. L. Thomsen, May, 1932	8	3,000
	Reprint Bulletins		
271	Control of Gullies	24	8,000
280	Korean Lespedeza (First Edition, February, 1930)	12	5,000
281	Feeding Dairy Cattle (First Edition, March, 1930)	40	10,000
	Total pages and copies, Bulletins	232	58,000
	Reprint Circulars		
135	Cedar Rust of Apples	8	8,000
160	The European Corn Borer	8	5,000
168	Controlling Insect Pests of Strawberries	12	5,000
	Total pages and copies, Circulars	28	18,000
	Total pages and copies, All Publications	1150	112,000

The Farm News Service.—The Missouri Farm News Service, a printed clipsheet containing about 4,000 words weekly, was issued throughout the year to all newspapers, farm journals, agricultural extension agents, and vocational teachers in the State. In addition to timely information and news stories, a new feature consisting of farm and home questions and answers was included in the News Service this year, beginning with the issue of December 9, 1931.

The questions and answers included each week from five to ten practical farm and home questions with answers contributed by the respective departments of the Station to which they were related by the nature of the subject matter involved. This feature of the News Service became immediately popular with the press of the State. Approximately 50 newspapers are using this feature regularly under

double-column headings which were supplied by the Station in the form of stereotype mats, while even a greater number of papers are using the questions and answers under headings of their own composition or in farm and home pages.

The Radio News Service.—A manuscript service designed to be read by radio announcers was issued every week during the year to the following radio broadcasting stations: KFRU, Columbia; KMBC, Kansas City; KMOX, St. Louis; WMAQ, Chicago, Ill; and KMA, Shenandoah, Iowa. This service covers practically the same ground as the Farm News Service, except that the articles are very greatly condensed.

Special Press Service.—News releases designed especially for the metropolitan newspapers of the State were issued in mimeograph form at irregular intervals throughout the year. These were mailed to the larger dailies of the State, or to their correspondents, and were supplied to the leading news syndicates. During the year this service included a total of 83 releases.

COOPERATION WITH OUTSIDE AGENCIES

During the year the Agricultural Experiment Station has carried on projects in cooperation with the following organizations: United States Department of Agriculture, Missouri Utilities Company, Sni-A-Bar Farms, Monsanto Chemical Company, American Dry Milk Institute, The Herman Frasch Foundation, National Research Council, Chilean Nitrate Company, Page Milk Company, and the Drumm Institute.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS AND PERIODICALS

325. Turner C. W., Frank, A. H., Gardner, W. U., Schultze, A. B., and Gomez, E. T.,*The Effect of Theelin and Theelol on the Growth of the Mammary Gland,* Anatomical Record, 1932.
326. Baver, L. D., *The Use of the Troemner Balance for Measuring the Upper Plastic Limit of Soils,* Jour. Amer. Soc. of Agron., 1932.
327. Albrecht, W. A., *Calcium and Hydrogen Ion Concentration in Growth and Inoculation of Soybeans,* Jour. of the Amer. Soc. of Agron., 1932.
328. Baver, L. D. and Rhoades, Harold F., *Aggregate Analysis as an Aid in the Study of Soil Structure Relationship,* Amer. Soc. of Agron., 1932.
329. Jenny, Hans, *The Significance of the Soil Organic Matter—Climate Relationship in Soil Classification Studies,* Soils Science, 1932.
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331. Turner, C. W., Gardner, W. U., and Schultze, A. B., *Relation of the Anterior Pituitary to Lactation,* Amer. Soc. of An. Prod. Proceedings for 1931, Jan., 1932.
332. Brody, Samuel, *Typical Heat Increments of Feeding and Pregnancy in Cattle, Sheep, Horses, and Swine,* Amer. Soc. of An. Prod. Proceedings for 1931, Jan., 1932.
333. Kempster, H. L., Brody, S., and Funk, E. M., *Age Changes in the Heat Production of Chickens as Measured by a Graphic Method.* A Preliminary Report to Poul. Sci., 1932.
334. Jenny, Hans, *Studies on the Mechanism of Ionic Exchange in Colloidal Aluminum Silicates,* Jour. of Physical Chem., 1932.
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337. Hogan, A. G., Shrewsbury, C. L., Breckenridge, G. F., and Ritchie, Walter S., *Action of Radio-Active Substances on Vitamins,* Jour. of Nutrition, Vol. V, July, 1932.
338. Jones, George D., *The Instruction in Entomology in the 4-H Club Camps in Missouri,* Jour. of Econ. Ent., 1932.
339. Hammar, C. H., *Economic Aspects of Conservation,* Jour. of Land and Public Utility Econ., Aug., 1931.
340. Hammar, C. H., *Soil Type as a Basis for Farm Management Research,* Jour. of Farm Econ., 1932.
341. Hammar, C. H., *The Functional Versus the County Consolidation Program for Obtaining Economy in County Government,* Nat'l Municipal Review, 1932.
342. Durant, A. J., and McDougle, H. C., *Pullorum Disease Infection of the Leg Joints in Baby Chicks,* Vet. Med., 1932.
343. Durant, A. J. and McDougle, H. C., *Malnutrition or Leg Weakness in Baby Chicks,* Vet. Med., 1932.
344. Tascher, W. R., *Experiments on the Control of Seed-Borne Diseases by X-Rays,* Jour. of Agr. Res., 1932.
345. Schultze, A. B., and Turner, C. W., *Experimental Initiation of Milk Secretion,* Jour. Dairy Sci., June, 1932.
346. Baver, L. D., *Some Soil Factors Affecting Erosion,* Amer. Soc. of Agr. Engineers, 1932.
347. Baver, L. D., *The Physical Properties of the Soil of Interest to Agricultural Engineers.* Paper presented at the Power and Machinery Division of the Amer. Soc. of Agr. Engineers at Columbus, Ohio, June, 1932.

CHANGES IN EXPERIMENT STATION STAFF

Appointments

J. A. Bailey, *Station Assistant in Entomology*
Bertha Bisbey, *Assistant Professor of Home Economics*
F. O. Briggson, *Research Assistant in Dairy Husbandry*
C. G. Bryan, *Research Assistant in Poultry Husbandry*
Cecil Elder, *Professor of Veterinary Science*
Ruth Foster, *Research Assistant in Home Economics*
W. U. Gardner, *Research Fellow in Dairy Husbandry*
M. W. Hales, *Research Assistant in Dairy Husbandry*
G. M. Horner, *Research Scholar in Soils*
Frank Horsfall, Jr., *Research Assistant in Horticulture*
Jesse E. Huffman, *Research Assistant in Horticulture*
O. E. Hughes, *Research Assistant in Agricultural Engineering*
Lee Jenkins, *Station Assistant in Entomology*
S. R. Johnson, *Research Assistant in Animal Husbandry*
C. D. Leonard, *Research Scholar in Soils*
Robert Meffert, *Station Assistant in Entomology*
Jack C. Miller, *Graduate Assistant in Animal Husbandry*
A. M. McCapes, *Assistant Professor of Veterinary Science*
C. W. McIntyre, *Assistant Professor of Dairy Husbandry*
W. E. Painter, *Research Assistant in Dairy Husbandry*
Margaret Parthlow, *Research Assistant in Home Economics*
Sophie Pearlmutter, *Research Assistant in Home Economics*
A. B. Schultze, *Research Assistant in Dairy Husbandry*
Frances Seeds, *Assistant Professor of Home Economics*
W. L. Studor, *Research Scholar in Animal Husbandry*
Myrtle E. Swanson, *Research Assistant in Home Economics*
C. M. Tucker, *Associate Professor of Botany and Plant Pathologist*

Withdrawals and Resignations

J. A. Bailey, *Station Assistant in Entomology*
F. O. Briggson, *Research Assistant in Dairy Husbandry*
C. G. Bryan, *Research Assistant in Poultry Husbandry*
W. R. Fankhanel, *Instructor in Agricultural Economics*
C. L. Fleshman, *Research Assistant in Dairy Husbandry*
Glenn M. Horner, *Research Scholar in Soils*
Jesse E. Huffman, *Research Assistant in Horticulture*
Lee Jenkins, *Station Assistant in Entomology*
C. D. Leonard, *Research Scholar in Soils*
Robert Meffert, *Station Assistant in Entomology*
Arthur Meyer, *Research Assistant in Horticulture*
Jack C. Miller, *Graduate Assistant in Animal Husbandry*
O. E. Palmer, *Research Assistant in Agricultural Economics*
Margaret Parthlow, *Research Assistant in Home Economics*
Sophie Pearlmutter, *Research Assistant in Home Economics*
A. B. Schultze, *Research Assistant in Dairy Husbandry*
Bessie Schwartz, *Research Assistant in Home Economics*
Frances Seeds, *Assistant Professor of Home Economics*
W. L. Studor, *Research Scholar in Animal Husbandry*
Myrtle E. Swanson, *Research Assistant in Home Economics*
W. L. Tayloe, *Research Assistant in Horticulture*
L. M. Turk, *Instructor in Soils*

FINANCIAL STATEMENT

For the Fiscal Year Ending June 30, 1932

Expenditures from Federal Funds

Classification	Hatch Fund	Adams Fund	Purnell Fund
Personal services	$13,606.58	$8,919.54	$39,690.54
Supplies and materials	543.48	3,851.12	9,949.73
Communication service	52.74	1.60	299.61
Travel expenses	126.88		1,727.45
Transportation of things	81.20	163.91	566.01
Publications			1,032.20
Heat, light, water, and power	1.36	64.04	94.20
Contingent expenses	3.15	9.00	169.45
Equipment	584.61	1,826.42	4,637.98
Buildings and land		164.37	1,832.83
TOTAL	$15,000.00	$15,000.00	$60,000.00