UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BULLETIN 272

How the Experiment Station Solves Farm Problems

One Year's Work, Agricultural Experiment Station
(Report of the Director: July 1, 1927, to June 30, 1928)

"To science, pilot of industry, conqueror of disease, multiplier of the harvests, explorer of the universe, revealer of Nature's law, eternal guide to truth."

(Inscription on building of National Academy of Sciences and National Research Council, Washington, D. C.)

COLUMBIA, MISSOURI
MAY, 1929

TABLE OF CONTENTS

How the Experiment Station Solves Farm Problems

F. B. MUMFORD, Director

S. B. SHIRKY, Assistant to the Director

Scientific research is the most important instrument available to mankind for the conservation of all our resources.

The age in which we live is distinguished from all other periods of the world's history for its dependence upon, and faith in, scientific research. Man's success in a material sense is altogether dependent upon the control he is able to exercise over his external environment. His control over his environment is based upon knowledge gained either by hard experience as the result of his struggle upward through the generations or by knowledge gained through scientific research. Knowledge by experience comes slowly at an enormous cost of materials and sometimes even life itself. Knowledge gained through scientific research may come quickly at a minimum cost of materials and human energy and may in a very short time result in revolutionary changes in the lives of men.

The application of science to industry, commerce, and communication has fundamentally changed the civilizations of the world. Those industries which have most completely based their methods and practices on research have enjoyed the most rapid advancement.

Agriculture is no exception either in its dependence upon science or in respect to the changes which may come as the result of investigation. Agriculture has lagged somewhat behind other industries in fully utilizing the possibilities of science.

This is not the fault of the farmer. It is due primarily to the difficulty of organizing the agricultural industry in such a manner as to take full and immediate advantage of the important results of scientific investigation. Notwithstanding this fact, agricultural enterprise is today more dependent upon the work of the agricultural experiment stations than ever before.

As the result of the work of the experiment stations, the farmer is now able, in large measure, to control the factors of production, to prevent wastes, and to protect his plants and animals from destructive diseases.

The reports included in this publication apply only to one year of scientific work by members of the Missouri Experiment Station staff.

To obtain a clear picture of the accomplishments of the Station would require that the reader examine the successive annual reports for the past twenty years. The types of investigation now most promising are those researches dealing with the fundamental bases of plant and animal life and the reaction of these to the soil and climate. This Experiment Station is placing greater and greater emphasis upon fundamental research.

CHANGES IN STATION STAFF

Appointments

Edna P. Amidon, Assistant Professor of Home Economics
James E. Comfort, Assistant Instructor in Animal Husbandry
E. Jack Coulson, Assistant in Agricultural Chemistry
Richard L. Crouch, Instructor in Veterinary Science
George Z. Doolas, Assistant in Soils
Adella Eppel, Assistant Professor of Home Economics
E. M. Funk, Instructor in Poultry Husbandry
Hans Jenny, Instructor in Soils
Eleanor Larrabee Lattimore, Assistant Professor of Rural Sociology
Hubert C. Moffett, Assistant Instructor in Animal Husbandry
Mary Elizabeth Polson, Assistant Professor of Home Economics
Preston Richards, Assistant in Agricultural Economics
Leston V. Taylor, Assistant in Agricultural Chemistry
Lloyd M. Turk, Assistant in Soils

Resignations

E. Jack Coulson, Assistant in Agricultural Chemistry
B. B. Branstetter, Instructor in Field Crops
C. N. Davis, Assistant in Entomology
J. S. Matthews, Assistant Instructor in Dairy Husbandry
Fred F. McKenzie, Instructor in Animal Husbandry

PUBLICATIONS

A. A. JEFFREY, *Agricultural Editor*

Twenty-eight new publications were issued. These included eleven research bulletins, eight bulletins, and nine circulars. The research bulletins reported in detail the results of fundamental scientific studies. The bulletins presented experimental results in more popular language. The circulars printed brief presentations of agricultural truth of current agricultural problems.

The following table is the detailed information regarding publications of the Missouri Agricultural Experiment Station for the year ending June 30, 1928.

Table 1.—Publications of the Agricultural Experiment Station for the Year Ending June 30, 1928

Series and Number	Title	Pages	Copies	Total Pages
	Research Bulletins			
107	Studies in Animal Nutrition VI. The Distribution of the Mineral Elements in the Animal Body as Influenced by Age and Condition	48	2,500	120,000
108	Soil Treatments and Seasonal Changes in the Sour Cherry	28	2,500	70,000
109	The Determination of the Surface Area of Young Women and Its Use in Expressing Basal Metabolic Rate	32	2,500	80,000
110	Community Relations of Rural Young People	80	3,000	240,000
111	Varietal Resistance and Susceptibility to Wheat Scab	16	2,500	40,000
112	The Mode of Inheritance of Yearly Butterfat Production. An Analysis of the Progeny Performance of Jersey Sires and Dams	132	2,500	330,000
113	Corn Root Rot Studies	80	2,500	200,000
114	The Effect of Gestation and Lactation Upon the Growth and Composition of Swine	62	2,500	155,000
115	Growth and Development XI. Further Investigations on Surface Area with Special Reference to Its Significance in Heat Metabolism	60	2,500	150,000
116	Growth and Development XII. Additional Illustrations of the Influence of Food Supply on the Velocity Constant of Growth and on the Shape of the Growth Curve	16	2,500	40,000
117	A Comparison of Steer Carcasses, Mature and Immature	28	2,500	70,000
	Total Research Bulletins	582	28,000	1,495,000
	Bulletins			
253	Cooperative Marketing for Missouri	100	10,000	1,000,000
254	Controlling Horn and Stable Flies on Cattle	12	10,000	120,000
255	Land Valuation	84	8,000	656,000
256	Solving Farm Problems by Research	104	6,000	624,000
257	Testing Fertilizers; Spring, 1927	12	5,000	60,000
258	Artificial Manure Production on the Farm	20	10,000	200,000
259	Three Years of Dust Spraying Under Missouri Conditions	12	10,000	120,000
260	Testing Fertilizers for Missouri Farmers; 1927	64	4,000	256,000
	Total Bulletins	408	63,000	3,036,000
	Circulars			
160	The European Corn Borer	8	10,000	80,000
161	Breeding Cages Are Solving the Codling Moth Problems	4	5,000	20,000
162	Unusual Meats	12	10,000	120,000
163	Feeding for Egg Production	16	20,000	320,000
164	Peach Growing in Missouri	24	10,000	240,000

TABLE 1.—PUBLICATIONS OF THE EXPERIMENT STATION (Continued)

Series and Number	Title	Pages	Copies	Total Pages
165	The Relation of Electricity to Missouri Agriculture	12	10,000	120,000
166	Inferiority of Foreign Red Clover Seed	4	5,000	20,000
167	Vegetable Growing in Missouri	64	5,000	320,000
168	Controlling the Insect Pests of Strawberries	12	5,000	60,000
110	The Missouri Colony Brooder House (Reprint)	2	10,000	20,000
	Total Circulars	158	90,000	1,320,000
	Grand Totals	1148	181,000	5,851,000

Distribution.—All new publications were mailed to the public libraries, agricultural extension agents, and agricultural teachers throughout the State. Large numbers of bulletins were distributed to agricultural classes and high schools, and by county and district extension agents. Publications were distributed to every county in Missouri, in every state of the United States, and to fifty-three foreign countries. Of the total number distributed, 153,859 were sent to residents of Missouri, 54,239 went elsewhere in the United States, and 9,684 went to foreign countries. A total of 218,772 distributed directly from Columbia.

Additional Information Service.—With the cooperation of the Agricultural Extension Service, the Station has issued a five-column clipsheet, the Missouri Farm News Service, containing about 4,000 words weekly to all newspapers and farm journals in the State.

Information by Radio.—Members of the Station and Extension staff broadcasted two lectures a week from September to June over equipment supplied by Stephens College of Columbia, Missouri.

Synopses of New Publications

Cooperative Marketing for Missouri, by F. L. Thomsen and G. B. Thorne (Missouri Agr. Exp. Sta. Bul. 253; July, 1927; pp. 5-97; figs. 24).—Missouri has 1068 local associations and 23 cooperative sales organizations covering a wide territory. A questionnaire was sent to these organizations. Replies were received from 66.2 per cent of all cooperatives in the State. Cooperatives in Missouri have met with varying success, but their record compares favorably with that of private business concerns.

Controlling Horn and Stable Flies on Cattle, by Leonard Haseman (Missouri Agr. Exp. Sta. Bul. 254, July, 1927; pp. 3-10). Formulae are given for the killing and repellant sprays that were found most

effective. About fifty per cent more horn flies were counted on dark-colored cows than on light-colored cows, but slightly more stable flies on light-colored cows than on dark-colored cows.

Land Valuation, by several authors; introduction by F. B. Mumford (Missouri Agr. Exp. Sta. Bul. 255; August, 1927; pp. 5-79; figs. 9). The papers published in this bulletin are abstracts of lectures and addresses delivered at the first Short Course in Land Valuation at the College of Agriculture of the University of Missouri, held on July 26 and 27, 1927, under the direction of S. B. Shirky, Superintendent of Short Courses. The essential content of each lecture is presented in this bulletin.

Solving Farm Problems by Research, by F. B. Mumford and S. B. Shirky (Missouri Agr. Exp. Sta. Bul. 256; September, 1927; pp. 5-103; figs. 13). This bulletin reports the progress during the year ending June 30, 1927 on 112 separate investigations. This work is reported under thirteen departmental classifications. The bulletin also reports the activities of the Station's service projects, lists the publications issued during the year, and gives an account of the funds received and expended.

Testing Fertilizers; Spring of 1927, by F. B. Mumford, Director, and L. D. Haigh (Missouri Agr. Exp. Sta. Bul. 257; pp. 3-11). The analyses of 62 samples of fertilizer obtained in the spring inspection are recorded. The bulletin also contains an article by M. F. Miller, chairman of the Department of Soils, on "The Use of Fertilizers in Missouri", with special reference to recent trends, the use of high grade fertilizers, and the needs of Missouri soils.

Artificial Manure Production on the Farm, by W. A. Albrecht (Missouri Agr. Exp. Sta. Bul. 258; November, 1927; pp. 3-20; figs. 11). A simple chemical mixture was designed containing 45 per cent ammonium sulphate, 40 per cent finely ground limestone and 15 per cent acid phosphate. The chemicals are applied to straw through the thresher, and straw piles are made flat in order that they will take the rainfall as water needed for the process. In 1926, straw was rotted by December. In 1927 the process was complete by November. The process produced about 3 tons of manure for each ton of straw, and at a cost of less than 85 cents a ton.

Three Years of Dust Spraying Under Missouri Conditions, by K. C. Sullivan (Missouri Agr. Exp. Sta. Bul. 259; April, 1928; pp. 3-12). Three years' experiments with dust sprays on apples. In 1925 two strengths of sulphur dust were used. Both strengths were applied at the rate of 2 and 5 pounds per tree. It was found that 2 pounds per tree gave as good results as 5 pounds per tree and the mixture of 90 pounds of sulphur with 10 pounds of arsenate of lead gave as good results as the

85-15 mixture. Home-mixed copper dusts were also used, but the results were not as good as from the sulphur dusts. Dust sprays were more costly than liquid sprays and a greater number of applications had to be made. In 1926 the same sprays were used but only at the rate of 2 pounds per tree. The home-mixed copper dusts failed to give sufficient control. In 1927 a commercial copper dust gave favorable results.

Testing Fertilizers for Missouri Farmers; 1927, by L. D. Haigh (Missouri Agr. Exp. Sta. Bul. 260; April, 1928; pp. 3-62; fig. 1). The results of the administration of the Missouri Fertilizer Law for the fall of 1927 are reported. Detailed analyses of 423 samples of fertilizer collected during the fall are given.

The European Corn Borer, by Leonard Haseman (Missouri Agr. Exp. Sta. Circ. 160; July, 1927; pp. 108; figs. 5). The advance of the European corn borer has been followed closely, and even though it is still far from the boundaries of the State it has been assumed that the pest will inevitably reach Missouri, and the latest facts on its advance and control are presented in this bulletin.

Breeding Cages Are Solving the Codling Moth Problem, by Leonard Haseman (Missouri Agr. Exp. Sta. Circ. 161; July, 1927; pp. 1-4). The breeding cages now in use by apple growers are described. Local dates of emergence of each successive brood of worms are determined so that sprays may be applied at a time that will insure the best possible control.

Unusual Meats, by Jessie Alice Cline and Rosalie S. Godfrey (Missouri Agr. Exp. Sta. Circ. 162; August, 1927; pp. 1-11; figs. 13). The internal organs of the animal, such as the liver, heart, etc., are much richer in vitamins than the more frequently used muscular tissues. It is urged that they be used more generally for food. Directions are given for the preparation, cooking, and serving of brains, sweetbreads, liver, heart, tongue, kidneys, and pigs' feet.

Feeding for Egg Production, by H. L. Kempster (Missouri Agr. Exp. Sta. Circ. 163; October, 1927; pp. 1-16; figs. 5). The recommendations in this bulletin are based on the results of investigations by this Station, and confirmed by the experience of 327 Missouri farmers who maintained demonstration flocks throughout the year 1926. By following these recommendations these flock owners obtained an average of 130 eggs per hen during the year and a cash return of two dollars for every dollar's worth of feed consumed by their flocks.

Peach Growing in Missouri, by T. J. Talbert and H. D. Hooker (Missouri Agr. Exp. Sta. Circ. 164; November, 1927; pp. 1-23; figs. 11). All the practices essential to success with peaches under Missouri conditions are presented. The bulk of the production in Missouri is con-

fined to two rather small areas; one in St. Louis county, and the other in Howell and Oregon counties. Consideration is given to varieties, planting, care of the young orchard, pruning, cultivation, spraying, thinning, disease and insect control, harvesting, and grading.

The Relation of Electricity to Missouri Agriculture, by R. R. Parks and J. C. Wooley (Missouri Agr. Exp. Sta. Circ. 165; January, 1928; pp. 3-11; fig. 1). A working outline and explanation of the Missouri project on rural electrification research is presented. The statement of the problems and sub-projects that are to be investigated, a list of the elctro-test farms already located, and lists of the members of both the State and National Committees on Rural Electrification are included.

Inferiority of Foreign Red Clover Seed, by B. M. King (Missouri Agr. Exp. Sta. Circ. 166; February, 1928; pp. 1-4; fig. 1). Ten to twenty per cent of the red clover seed used in the United States is imported from France, Italy, Chile, England, Germany, Poland, and Canada. Much of this foreign seed, inferior from the beginning because of its origin, is held in storage for comparatively long periods before it finally reaches American farms. A lowered vitality and, consequently, a further reduction in general value are the results of this treatment. Harmful weed seed are frequently found in this seed. Foreign seeds are strikingly inferior.

Vegetable Growing in Missouri, by J. T. Quinn and T. J. Talbert (Missouri Agr. Exp. Sta. Circ. 167; March, 1928; pp. 2-64; figs. 19). This circular is a handbook of instruction for the practical gardener. Its recomendations include the practices that have been found most successful in the production of all the staple garden and truck crops.

Controlling the Insect Pests of Strawberries, by Leonard Haseman (Missouri Agr. Exp. Sta. Circ. 168; March, 1928; pp. 1-12; figs. 8). The most effective methods in the control of the strawberry crown-borer, the strawberry leaf-roller, the strawberry weevil, the tarnished plant bug, the strawberry thrip, the white grub, the strawberry root louse, root worms, and the black-marked strawberry slug are reported.

Studies in Animal Nutrition VI. The Distribution of the Mineral Elements in the Animal Body as Influenced by Age and Condition, by Albert G. Hogan and John L. Nierman (Missouri Agr. Exp. Sta. Res. Bul. 107; July, 1927; pp. 5-45; figs. 6). Thirty-three cattle ranging from birth to four years of age were analyzed for sodium, potassium, calcium, magnesium, iron, phosphorus, chlorine, and sulphur.

Soil Treatments and Seasonal Changes in the Sour Cherry, by H. D. Hooker and A. G. Anderson (Missouri Agr. Exp. Sta. Res. Bul. 108; September, 1927; pp. 3-27; figs. 17.). Spurs and shoots collected at monthly intervals for about one year from three plots of sour cherry trees were analyzed for moisture, total and water-soluble nitrogen,

sugars, and starch. One plot was tilled, one was in sod, and the third plot, likewise in sod, received annual spring applications of nitrate of soda.

The Determination of the Surface Area of Young Women and Its Use In Expressing Basal Metabolic Rate, by Hannah Stillman Bradfield (Missouri Agr. Exp. Sta. Res. Bul. 109; September, 1927; pp. 5-31; figs. 5) A critical study was made of the methods of estimating surface area in order to determine their reliability when applied to women. The results obtained from the use of the surface integrator on forty-seven women on the basal metabolism of sixteen of the forty-seven subjects are given.

Community Relations of Rural Young People, by E. L. Morgan and Henry J. Burt (Missouri Agr. Exp. Sta. Res. Bul. 110; October, 1927; pp. 5-77). This is a study of the community relations of young people in four typical trade-area rural communities in Missouri. The attitudes of the several groups, as farmers, townspeople, business men, young people, etc., are reported. Young people are leaving these communities faster than they are moving into them or returning to them. The chief reason for these migrations is the desire for greater income.

Varietal Resistance and Susceptibility to Wheat Scab, by I. T. Scott (Missouri Agr. Exp. Sta. Res. Bul. 111; November, 1927; pp. 3-14). The comparative resistance of 189 varieties and strains of winter wheat to wheat scab or head blight caused by *Gibberella saubinetii* (Mont.) Sacc. was determined by field tests at Columbia. Several well known varieties showed relatively low resistance to scab, notably strains of Fulcaster, Michigan Wonder, and Red May.

The Mode of Inheritance of Yearly Butterfat Production. An Analysis of the Progeny Performance of Jersey Sires and Dams, by C. W. Turner (Missouri Agr. Exp. Sta. Res. Bul. 112; November, 1927; pp. 5-130; figs. 9). A report is made of a study of the progeny performance of all Jersey sires having ten or more daughters in the Register of Merit. Conversion factors were used to convert all fat records to their "mature equivalent". Dam and daughter comparisons were made by groups according to the sire's progeny performance.

Corn Root Rot Studies, by B. B. Branstetter (Missouri Agr. Exp. Sta. Res. Bul. 113, November, 1927; pp. 5-80; figs. 13). Most of the kernels on practically every ear of corn grown in Missouri are internally infected with one or more of the following organisms: *Diplodia zeae*, *Fusarium moniliforme*, and *Cephalosporium acremonium*. Yield tests comparing heavily infected and lightly infected seed showed that reduction in yield from planting heavily infected seed was due to reduced field stands caused by seedling blight and not to corn root rot. Inoculation trials with these same organisms showed that they were capable of

producing a certain amount of seedling blight but not corn root rot. Corn root rot in Missouri is probably caused by a soil-borne Pythium-like fungus.

The Effect of Gestation and Lactation Upon the Growth and Composition of Swine, by D. J. Griswold, P. F. Trowbridge, A. G. Hogan, and L. D. Haigh (Missouri Agr. Exp. Sta. Res. Bul. 114; February, 1928; pp. 5-62; figs. 4). Ten gilts, all seven months old at the initial date of the experiment were used. One was slaughtered at the beginning of the experiment, seven were bred, and the remaining two left open as control animals. One pregnant animal was slaughtered after 88 days of pregnancy, another just before farrowing, and two others just after farrowing. One of the open gilts was slaughtered at the farrowing time of the pregnant gilts, and the other carried along with the three gilts which were conducted through the lactation period. These were slaughtered at the close of the lactation period, 68 days after the farrowing date. Chemical analyses were made of the separated parts of each gilt. Analyses were also made of newly born pigs and of 88-day pig embryos. Other chemical data include the composition of the feeds used, of the feces and urine from the digestion trials, and of the composite ash of each gilt.

Growth and Development XI.—Further Investigations on Surface Area, with Special Reference to Its Significance in Energy Metabolism, by Samuel Brody, James E. Comfort, and John S. Matthews (Missouri Agr. Exp. Sta. Res. Bul. 115; March, 1928; pp. 5-60; figs. 66). (1) Data are presented on the relation of surface area to body size of 482 dairy cattle, 341 beef cattle, 11 horses, and 16 swine. (2) Mathematical (graphical) analysis is presented of these original data, as well as of the available published data on the relation of area to body size and on the relation of heat production to body size.

Growth and Development XII. Additional Illustrations of the Influence of Food Supply on the Velocity Constant of Growth and on the Shape of the Growth Curve, by Samuel Brody (Missouri Agr. Exp. Sta. Res. Bul. 116; April, 1928; pp. 5-16; figs. 11). Additional comparisons are made between the age curves of growth of animals under several degrees of normality of food supply. The nearer the approach to an optimum food supply, the steeper is the age curve. The mature weight is also increased by the relatively improved food supply, but the relative increase in mature size is negligible as compared to the relative increase in the speed of approach to the mature weight. It is suggested that body weight rather than age be used as a criterion for first breeding of farm animals, and that dairy heifers be first bred when reaching two-thirds of their expected mature body weight.

Comparison of Steer Carcasses, Mature and Immature, by M. T. Foster (Missouri Agr. Exp. Sta. Res. Bul. 117; May, 1928; pp. 28;

figs. 11). Carcass studies of a mature nine-year-old steer and an immature one-year-old steer, are here reported. Chemical analyses were made from composite samples of each wholesale cut. The economy of the various cuts was determined. A palatability test was made.

List of Technical Papers Published by the Missouri Station in Scientific Journals and Periodicals

ALBRECHT, W. A. *Farm Trials of Artificial Manure.* Jour. Amer. Soc. Agron. Vol. 20, Feb. 1928.

BRADFIELD, HANNAH STILLMAN. *The Determination of the Surface Area of Women and its Use in Expressing Basal Metabolic Rate.* The Amer. Jour. of Physiology, Vol. 82, No. 3, pp. 571-576. Nov. 1927.

BURCH, J. W. *The Missouri Beef Herd Demonstration,* Proc. Amer. Soc. An. Prod. (July), 1927, 282-285.

CLINE, JESSIE ALICE. *The Story of Soft Wheat Flour for Light Bread.* The Home Economist, Vol. 6, No. 1, pp. 10-12. Jan. 1928.

GIFFORD, WARREN, AND ELTING, ERWIN C. *The Effect of the Ages of Sire and Dam on the Average Butterfat Production of Offspring in Dairy Cattle.* Jour. of Dairy Sci., Vol. XI, No. 1, January, 1928.

HOGAN, A. G., SHREWSBURY, C. L., AND KEMPSTER, H. L. *Rapid Growth of Chicks on Rations of Natural Foodstuffs.* Jour. Agr. Res. 37, No. 4, 1928.

HOGAN, A. G., CASIDA, L. E., AND MCKENZIE, F. F. *Calcium Requirements of Breeding Swine.* Proc. Amer. Soc. An. Prod. (January) 1928, pp. 82-84.

HOGAN, A. G., HUNTER, J. E., AND KEMPSTER, H. L. *Acceleration of Growth Rates by Dietary Modifications.* Jour. Biol. Chem., 1928, LXXVII, pp. 431-436.

HOGAN, A. G., AND HUNTER, J. E. *The Plural Nature of Vitamin B.* Jour. Biol. Chem., 1928, LXXVIII, pp. 433-444.

HOOKER, H. D. *Movement of Fat in Apple Shoots.* Proc. Amer. Soc. Hort. Sci. pp. 185-188. 1927.

JENNY, HANS. *The Relation of Climatic Factors to the Amount of Nitrogen in Soils.* Amer. Soil Survey Proc., Vol. 19, March, 1928.

MUMFORD, F. B., HOGAN, A. G., AND MCKENZIE, FRED F. *Swine Breeding: The Effect of Age, Unfavorable Dietary Conditions and the Normal Oestrous Cycle.* Proc. Amer. Soc. An. Prod., (July) 1927, pp. 85-88.

MURNEEK, A. E. *The Selection of Proper Material for Horticultural Research.* Proc. Amer. Soc. Hort. Sci. pp. 201-204. 1927.

Murneek, A. E. *Correlation and Cyclic Sterility in Cleome.* Proc. Int. Conf. of Flower and Fruit Sterility in Mem. N. Y. Hort. Soc. 3: 65-72. 1927.

Murneek, A. E. *Effects of Pruning on the Carbohydrate-Nitrogen Ratio in the Tomato.* Proc. Amer. Soc. Hort. Sci. pp. 180-184. 1927.

Murneek, A. E. and Yocum, W. W. *A Modified Van Thiegem Cell for Physiological Studies of Pollen Germination.* Plant Physiology. 2:4: 506-507. 1927.

Murneek, A. E. *The Pressure Test for Maturity.* Fruits and Gardens. pp. 6 and 11. October, 1927.

Murneek, A. E. *For Additional Profits—Thin Your Fruit. Parts I and II.* Amer. Fruit Grower Mag. May, pp. 5 and 28. June, pp. 4 and 21. 1928.

Quinn, J. T. *Bordeaux Sprays and Hopper-burn.* Proc. of the Potato Assoc. of America. Vol. 14. 1927.

Reid, W. H. E. *Homogenization: Its Effect on Physical Properties of Ice Cream.* The Ice Cream Review, January, 1928.

Scanlan, Robert W. *Calcium as a Factor in Soybean Inoculation.* Soil Science, Vol. 25, Apr., 1928.

Stadler, L. J. *Genetic Effects of X-Rays in Maize.* Proc. Nat'l. Acad. Sci., 14, 1, pp. 69-75. 1928.

Stadler, L. J. *Mutations in Barley Induced by X-Rays and Radium.* Science, 48. 1928 (in press).

Talbert, T. J. *Spraying Investigations.* Proc. Amer. Soc. Hort. Sci. 1927.

Talbert, T. J. *Transplanting Fruit Trees, Part I and II.* Amer. Fruit Grow. Mag. pp. 5 and 15. October; pp. 4 and 18, November, 1927.

Talbert, T. J. *Pruning Apple and Pear Trees, Part I and II.* Amer. Fruit Grow. Mag. pp. 1 and 14, December, 1927, pp. 1 and 24, January, 1928.

Talbert, T. J. *Spray Calendar for the Middle West.* Amer. Fruit Grow. Mag. p. 10, February, 1928.

Talbert, T. J. *Starting the Commercial Peach Orchard, Part I, II, and III.* Amer. Fruit Grow. Mag., pp. 5 and 37, April; The Care of the Commercial Peach Orchard, pp. 7 and 27, May; Serious Peach Pests and Their Control, pp. 6, 7 and 14, June, 1928.

Talbert, T. J. *Why Not a Home Orchard?* Fruits and Gardens, pp. 1 and 13, January, 1928.

Talbert, T. J. *The Strawberry Leaf Roller.* Fruits and Gardens, pp. 10 and 11.

TROWBRIDGE, E. A., *Methods for Feeding Experiments.* Amer. Soc. An. Proc. (July) 1927, 14-16.

TURNER, C. W. *A Comparison of Guernsey Sires. III. Based Upon the Average Persistency of Fat Secretion During the Lactation of the Daughters.* Jour. of Dairy Sci., Vol. X, No. 6, November, 1927.

TURNER, C. W. *A Theory of the Mode of Inheritance of Fat Secretion.* Proc. Amer. Soc. of Animal Production. 1927.

TURNER, C. W. *Fetal Resorption in Cattle.* The North American Veterinarian, Vol. VIII, No. 11, November, 1927.

WEAVER, L. A., *Supplements to Corn for Fattening Hogs on Alfalfa Pastures.* Proc. Amer. Soc. An. Prod. (January) 1928. pp. 92-94.

NEW EQUIPMENT

Potentiometer
Gabanometer
Draw Rite overrun control
2 thermometers, graduated to one-tenth degree Centigrade
Microtome
Dissection instruments
Stains and chemicals
Milk pressure sphygmomanometer
Glassware
6 5 c.c. Leur syringes
24 B & S 20-gauge hypodermic needles
Metabolism crate
Respiration chamber for calves
Benedict-Collins aliquating table
Sauter Balance
Collins blower
2 Holdane gas-analysis apparatus
Engelhard thermal conductivity cell with a 12-volt battery
Trickle charger and milliammeter
2 10-liter dry gas meters
Insecticides
Tree bands
6 Taylor oven thermometers
24 open iron roasting pans
Mercury vapor quartz lamp
2 ceiling fans
30 animal cages
Yarn twist counter
Scott tensil strength machine
Drying oven
150 clay pots
Statistical machine to tabulate data
Threshing machine
Hog Shed
Virus laboratory
Boiler
2 fire extinguishers

SERVICE PROJECTS

The College of Agriculture is rendering various services, requiring skill and laboratory technique, to the farmers of Missouri. There is maintained a seed testing laboratory, a laboratory for the preparation of anti-hog-cholera serum, a laboratory for the preparation of legume bacteria and for the testing of soils to determine their lime needs. The Director of the Experiment Station is also authorized to administer the fertilizer law of this state enacted for the purpose of protecting farmers in the use of fertilizers.

The department of veterinary science has made more than 7,000 diagnostic examinations of pathological material received at the laboratory. The department of plant pathology has identified hundreds of plant diseases and recommended remedies. The department of field crops has identified hundreds of weeds sent to the institution for identification. The department of entomology has examined great numbers of insects and prescribed remedies to prevent injury to plants and animals. The department of agricultural chemistry has made many chemical analyses, at cost, of agricultural materials.

The correspondence of the institution is very great. More than 100,000 letters are received and answered annually, covering every phase of agricultural enterprise.

Many of the services here described are incidental to the main activities of the Experiment Station but are exceedingly valuable to those desiring information and represent a very large amount of work.

Seed Testing Laboratory (W. C. Etheridge, Clara Fuhr).—During the year 4022 lots of seed and plants were tested and examined by the seed testing laboratory. Of these tests 3528 were made for Missouri farmers and seedsmen and 34 were Custom House samples under the Seed Importation Act. For farmers and seedsmen of other States 494 tests were made as follows: Nebraska 140, South Dakota 96, Iowa 69, Colorado 65, Kansas 48, Arkansas 32, Oklahoma 21, Wisconsin 8, Illinois 7, Minnesota 2, Tennessee 2, Utah 2, Texas 1, and Indiana 1.

Classification of Tests.—Germination only 2395, purity and germination 1202, identification 216, purity only 98, examination only 56, examination and germination 49, examination, purity and germination 2, examination and purity 1, total 4019. Three Custom House samples not subject to Act were received but not tested.

In the past year 215 more lots were tested for purity than in the previous year. The greater number of these were of red clover, alfalfa, and Kentucky bluegrass.

Official Testing of Dairy Cows (Warren Gifford).—During the year 1273 one-day tests and 873 two-day tests were conducted on a total of

396 Advanced Registry and Register of Merit cows, owned by 34 different breeders in Missouri. Of this total number of cows, 263 were placed on test during the year, while 133 were on test at the beginning of the year.

During the same period there were 24 seven-day and one fourteen-day official tests supervised in six Holstein herds.

Since January 1, there have been 952 Holstein Herd Improvement tests made on a total of 170 cows. This includes all purebred Holstein cows in four herds.

The following Guernsey cows became state champions in their classes during the year:

Class	*Name and Number*	*Milk*	*Fat*	*Owner*
AA	Lady Rose Allen 2d 115293	13,825.8	734.0	L. E. Vaughan, Oronogo
DD	Dorothy's Pearl of Fern Hill 157527	9,028.5	538.2	L. E. Vaughan, Oronogo

The following Jersey cows were awarded gold medals by the American Jersey Cattle Club:

Name and Number	*Milk*	*Fat*	*Owner*
Campus Love D 508265	11,871.0	705.7	University of Missouri, Columbia
Campus Virginia S 387621	12,636.0	762.3	University of Missouri, Columbia

The Production and Distribution of Anti-Hog-Cholera Serum (O. S. Crisler).—The serum laboratory furnished swine owners, either directly or through veterinarians and county extension agents 3,051,300 cubic centimeters of anti-hog cholera serum. This was distributed in 2,665 orders going into seventy-nine counties and St. Louis city. A demand for serum has continued although there has been less cholera than in previous years.

Hog cholera serum drawn by the department during the year amounted to 751,867 c.c., of which 579,225 c.c. were used for hypering, 161,642 c.c. for simultaneous treatments, and 11,000 c.c. were condemned.

Various repairs, improvements and additions to the equipment in the serum laboratory have been made. Improved methods in technic have been adopted so as to make as good anti-hog-cholera serum and virus as possible.

Reports from the field showed that serum and virus have been satisfactory.

Testing Fertilizer for Missouri Farmers (F. B. Mumford, director, L. D. Haigh, E. W. Cowan, A. R. Hall, L. V. Taylor, R. W. Pilcher).—The Missouri Fertilizer Law requires the Agricultural Experiment Station to collect samples of fertilizer sold in the State of Missouri and to see that a guaranteed analysis is placed on each package of fertilizer and that the fertilizer actually contains as much plant food as guaranteed. In order to do this, samples are collected, analyzed, and the results published.

In the fall of 1927 inspectors visited 138 towns in 54 counties and collected 496 samples of fertilizer. In the spring of 1928 inspectors visited 36 towns in 23 counties and collected 111 samples.

The results of the analyses of a year's samples are given in Bulletin 260. Violations of the law in regard to registration, labelling, and tagging were 2.3 per cent of the total number of requirements.

Samples deficient in value of plant food amounted to 15.8 per cent of the total samples analyzed. This is an improvement of 10 per cent over the results of the previous year.

The number of samples showing deficient value in the quality of nitrogen used was 8.5 per cent of the total nitrogen containing samples analyzed.

On an average each manufacturer furnished $1.01 excess value of plant food on each ton of fertilizer sold.

Testing Soils for Their Lime Need (M. F. Miller, R. E. Uhland).—During the past year 1114 samples of soil have been tested for acidity. This brings the total number of samples tested since this service project was started to 9358. Soil samples have been received from every county in the State, and the tests showed that 44 per cent of the soils of Missouri required more than 4,000 pounds of limestone per acre. Seventy-five per cent of all the soils in the State showed a lime need of more than 2,000 pounds.

Table 2.—Summary of Acidity Tests Made on 9,358 Soil Samples From the Seven Soil Regions of the State

Regions	Percentage of Soils Requiring:				
	No lime	Less than 1 T.	1 to 2 T.	2 to 3 T.	Total samples tested
1. N. E. level prairies	7%	8%	24%	61%	2765
2. Rolling prairie	8%	7%	30%	55%	1023
3. Black prairie	15%	16%	38%	31%	1066
4. S. W. prairie	6%	12%	36%	46%	1649
5. Ozark border	15%	19%	35%	31%	1614
6. Ozark upland	17%	26%	37%	20%	971
7. S. E. lowland	22%	20%	33%	25%	270
Entire State	11%	14%	31%	44%	9358

While there is a general need for lime throughout Missouri, there is quite a difference in the degree of acidity of the soils of the different regions. This is shown by Figure 1 and Table 2.

As an aid in helping the farmers to secure the proper kind of limestone, tests have been made to determine the fineness of grinding of all samples submitted. During the past year 120 samples of ground limestone were tested. These tests not only enabled the farmer to select a better grade of limestone, but they also encouraged the producers to improve and standardize their products.

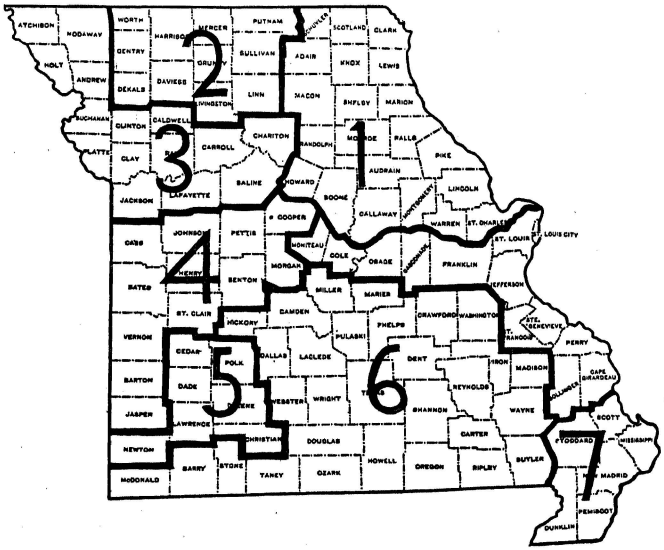


Fig. 1.—Soil Regions of Missouri. 1. Northeast level prairies. 2. Rolling prairie (glacial). 3. Black prairie (loess). 4. Southwest prairies. 5. Ozark border. 6. Ozark upland. 7. Southeast lowland (Mississippi bottom).

The Production and Distribution of Bacteria for Legumes (W. A. Albrecht, R. E. Uhland).—For a number of years the Agricultural Experiment Station has been supplying legume inoculation to Missouri farmers for the purpose of teaching them the importance of inoculation and of disseminating bacteria widely through the soils of the State. This service has been carried on as a part of an intensive campaign for greater legume acreages that has been in progress for several years under the Agricultural Extension Service. During this time sufficient bacteria have been distributed to treat 267,452 bushels of legume seed, and these were supplied to 50,000 individuals. This represents sufficient seed to plant more than one million acres of legumes.

The total number of bushel units distributed during the past year was 50,517. The numbers of cultures for the various legumes were as follows: Soybeans 38,522, sweet clover 4,353, alfalfa 3,906, red and alsike clover 2,103, cowpeas 1,537, and miscellaneous 96.

A marked increase was noted in the use of soybean inoculation over the preceding year, this doubtless being due largely to the severe winter and dry spring which destroyed much wheat and made for very poor meadows. This year, as well as the year 1925, demonstrated how soybeans might be used as a substitute or an emergency crop. The past spring was unfavorable for the seeding of clovers and as a consequence slightly fewer cultures for sweet clover and red clover were distributed than during the two years immediately preceding.

Since this project has brought contact with thousands of farmers, located on different soil types, many important problems regarding inoculation practices have been suggested. This project has, therefore, in addition to serving the needs of the farmer, made possible a great deal of research work. Much of this work has been carried on in the laboratories and greenhouses, and there are now under way several cooperative experiments with farmers.

Experiments in Progress During the Year

AGRICULTURAL CHEMISTRY

A. G. Hogan, Chairman

New Rations for Chicks (A. G. Hogan, C. L. Shrewsbury).—In last year's report rations were given formulated from nutritional foodstuffs which supported an unusually rapid rate of growth. Wheat has been substituted for corn in one of these rations, No. 564. If wheat replaced the corn then tankage could be substituted for liver meal. The rate of growth on the wheat-liver meal combination is shown in Figure 2.

The quantities of food consumed indicated that the chicks compared very favorably with other animals in the economy of gains. It required about 3 pounds of food to produce a chick weighing 1 pound; 8 pounds to produce a chick weighing 2 pounds, and 13.5 pounds to produce a chick weighing 3 pounds.

Continued efforts to formulate a synthetic ration that would support normal growth of chicks have been unsuccessful. The basal ration has been supplemented with large quantities of the Osborne-Wakeman vitamin B concentrate. In others it has been supplemented with the Minot-Murphy extract prepared from fresh liver. Some of the chicks have been given skim milk to drink. All of these supplements seemed

TABLE 3.—BLOOD AND BONE ANALYSES OF NORMAL CHICKS, AND OF CHICKS WITH NUTRITIONAL DISEASE

Nature of Ration	Bone Analysis* Ash (percentage) †	Blood Analyses‡					
		Ca	P	Glucose (Milligrams)	Non-Protein Nitrogen (percentage)	Urea	Uric Acid
Normal	48.6	12.4	5.3	184	45.2	4.2	4.6
Synthetic Deficient in	49.8	13.7	5.4				
A	49.0	13.0	5.2	177	42.9	3.9	4.9
B	46.2	13.1	4.9	248	47.2	3.8	4.2
D	41.3	10.4	2.8	190	41.3	3.3	4.8

*Selected chicks, age approximately 70 days.
†Calculated to lipoid-free, and water-free basis.
‡Averages.

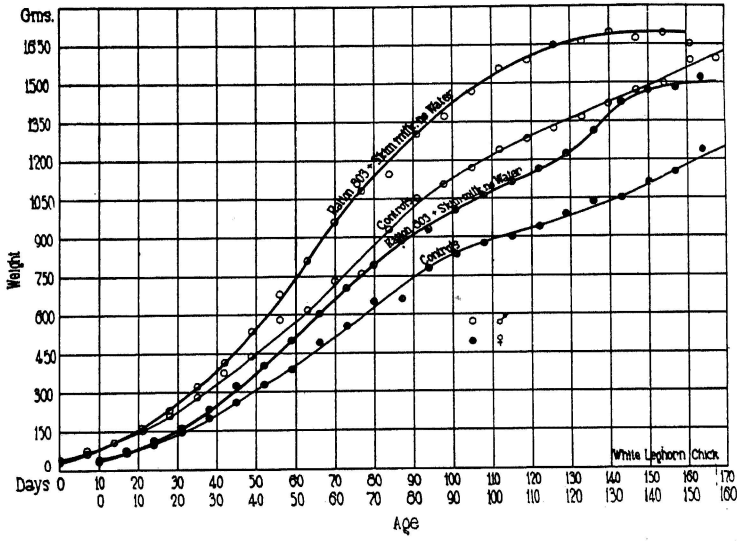


Fig. 2.—Rapid growth of chicks on a ration of natural foodstuffs. The controls shown were the most rapidly growing chicks that had been previously described.

RATION 803

Wheat	65.5	Alfalfa meal	5.0
Dried liver (Armour's)	15.0	Sodium chloride	1.0
Dried buttermilk	10.00	Calcium carbonate	1.5
Cod liver oil	2.0	Skim milk	ad lib.

decidedly helpful at times, but in many cases the final result was nutritional disaster. Figure 3 illustrates such a failure, described as paralytic leg weakness.

Chicks on a ration deficient in vitamin D were below normal in bone ash, and in inorganic phosphorus of the blood. Chicks on ration deficient in vitamin B were low in bone ash also. In acute attacks of polyneuritis due to a deficiency of vitamin B, there was a marked increase in the glucose of the blood. If samples were taken before the crisis was reached, however, the blood sugar was normal in amount.

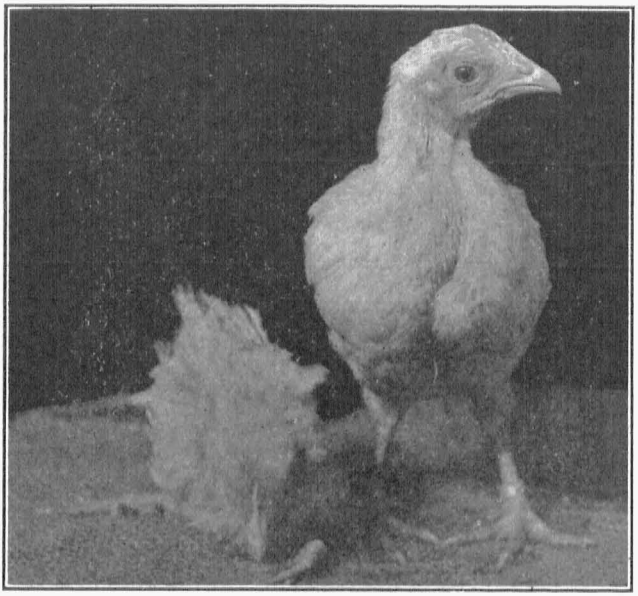


Fig. 3.—Chick 3456, age 33 days, weight 2.1 ounces; reared on a synthetic ration, illustrates the type of leg weakness often encountered. Chick 3432 same age as No. 3456, weight 10.5 ounces. Reared on Ration 564 plus skim milk. This ration is similar to No. 803, but contains yellow corn instead of wheat.

Quantitative Studies of Color of Meat (A. G. Hogan, W. S. Ritchie, Robert Boucher).—An effort has been made to develop a chemical method to determine the amount of pigment in muscle tissue. The carbon monoxide method of Whipple has been used successfully, but his acid hematin procedure was not successfully used. When apparently the entire amount of pigment had been extracted, about one-fourth of the original amount of iron remained in the residue. Thus samples that appeared completely colorless contained 25 per cent as much iron as the unextracted tissue.

The Proteins of Meat (A. G. Hogan, W. S. Ritchie, Robert Boucher).—Previous studies indicated that the soluble proteins of muscle were of two kinds, an albumin, and a globulin. Three methods of separation were used, (1) saturation with sodium chloride, (2) dialysis,

and (3) irradiation with ultra violet rays. An attempt has been made to refine these methods so that more consistent results could be obtained The most important point was the control of the hydrogen ion concentration during precipitation of the globulin. A p_H value of about six was the most satisfactory. This was less important in the dialysis procedure since the acidity adjusted itself to a considerable extent. The samples were exposed to ultra violet rays for six to eight hours and the samples dialysed were kept in the dialysers for 72 hours at a low temperature. Table 4 shows a typical separation.

TABLE 4.—TYPICAL SEPARATION OF THE SOLUBLE PROTEINS OF MUSCLE
(Calculations in terms of extracted nitrogen.)

Total Nitrogen in Tissue---------- 2.941 per cent
Total Nitrogen in Extract---------- 1.996 per cent
Percentage Extraction----------67.2

Nitrogen Fractions	Methods of Separation			
	Saturation with NaCl p_H 6.0	Exposure to ultra-violet light	Dialysis	Heat to 100° C. CCl_3 COOH
Globulin N.	51.30	57.30	54.30	
Albumin N.	23.50	21.30	19.30	
Total coagulable Nitrogen	74.80	78.60	73.60	78.10
Non-Protein Nitrogen	22.00	19.40	17.70	19.70
Total Nitrogen	96.80	98.00	91.30	97.80

Chemical Analyses Made During the Year (L. D. Haigh, W. S. Ritchie, A. R. Hall, E. W. Cowan, L. V. Taylor, C. L. Shrewsbury).—Correspondence relative to chemical analyses and information of a chemical nature consisted of 1032 letters written, of which 205 were to farmers, county agents, and other agricultural workers. In addition about 1500 reports on limestone tests were mailed out.

The chemical analyses made in the laboratory include the following:

Departmental Studies: 227 samples of chicken bones for moisture, ether and alcohol soluble material, ash, calcium, phosphorus, involving 1135 determinations; 752 nitrogen determinations in the work of meat studies on rabbits; analyses of 39 samples of meat from slaughtered steer for nitrogen, moisture, fat, ash and phosphorus, involving 195 determinations; 36 samples of feed used in quantitative feed studies for moisture, fat, nitrogen, 108 determinations; 13 special samples of fertilizer for studies in variation of composition by sacks, involving 39 determinations; 11 fertilizer materials for study of nitrogen availability involving 46 determinations; 9 fertilizer samples for A. O. A. C. studies on chlorides and acidity involving 18 determinations; 1579 limestones

or related materials for test of their value to correct soil acidity. This is done cooperatively with the soils department. Experimental studies on rate of solubility of limestone in acid in cooperation with soils department included approximately 200 determinations. The total number of determinations involved in departmental studies was 4072.

Fertilizer Control: Chemical studies of 519 samples of fertilizer obtained by State inspectors were made for the following analyses: 350 total nitrogen determinations, 1076 total and available phosphoric acid determinations, 276 water soluble potash determinations, 339 water soluble nitrogen determinations, 204 neutral and alkaline permanganate determinations for nitrogen activity, 10 fertilizer samples sent in by farmers and dealers involving 30 determinations for nitrogen, phosphoric acid and potash; total 2275 determinations.

Commercial Materials.—Commercial feeds and other materials sent in as follows: 4 feeds for complete analysis, 4 feeds for protein, fat and fiber, 4 feeds for protein only, 1 skim milk powder for protein and fat, 9 mineral feeds and stock powders for qualitative test, 13 waters for qualitative examination of solids, 2 insecticides for determinations of lead, arsenic, and sulphur, 2 stomachs and contents for examinations for poison, 5 powders of miscellaneous nature for qualitative examinations; total 78 determinations.

Chemical Analyses for Other Departments

Animal Husbandry: 54 mixed feeds and simple feed materials for complete feed analysis and for calcium and phosphorus, 245 determinations; 10 metacarpal bones for moisture, ether extract, ash, calcium and phosphorus, 50 determinations; 68 back fat samples for iodine absorption, 68 determinations; total 313 determinations.

Dairy Husbandry: 51 milk samples for solids, ash, lactose, total nitrogen, casein, albumin, globulin and nonprotein nitrogen, 368 determinations.

Field Crops: 3 samples of hay for complete feed analysis also calcium and phosphorus, 24 determinations.

Horticulture: 15 samples of apple seeds for ether soluble material, total and water soluble nitrogen, 45 determinations; 121 samples of apple wood, leaves and spurs, for total and water soluble nitrogen, 242 determinations; total 287 determinations.

Soils: 33 samples of composted materials (artificial manure) for total water soluble, water insoluble nitrogen and for nitrogen availability, 130 determinations; 1 soil for moisture nitrogen, phosphorus and potassium, 4 determinations; 12 water samples leaching for lysimeters for solids, total nitrogen, nitrogen as nitrites and nitrates, phosphorus,

potassium, sulphur, calcium and magnesium, 100 determinations; 54 samples of original and eroded soil for nitrogen, moisture, phosphorus, potassium, sulphur, 335 determinations; 12 samples of soil (organic accumulation experiment) for moisture, nitrogen and lime requirements, 36 determinations; total 595 determinations.

Veterinary Science: 2 bone samples (from animals suffering from malnutrition) for moisture, nitrogen, ash, phosphorus and calcium, 10 determinations.

Grand Total: 8022 determinations.

AGRICULTURAL ECONOMICS

O. R. JOHNSON, *Chairman*

Farm Organization and Operation in a Central Missouri County (O. R. Johnson, Preston Richards).—All sources of information have been searched to learn the trend of land values, tax burdens, mortgage debt in Boone county, and trends of farm operation expenses, income and cropping system. The following sources of information have been used: U. S. Census, reports of the State Board of Agriculture and the State Statistician, reports of the State Tax Commission, and an analysis of thirty-five farm management survey records from farms in Boone county.

In the last fifteen years the percentage of improved land in crops has decreased, while the size of the farm has increased. A smaller percentage of the county is being tilled. The average valuation of land per acre is pre-war in dollars and considerably below pre-war in exchange value. Approximately one-half the land is not now being farmed in tilled crops. There is an annual interest charge of $7 per acre of land in crops. This means that if land not in crops is not being well utilized, the burden on the crop land for interest is very heavy.

In the face of a decreased utilization of land for crops there is also a considerable decrease in the number of acres of land in pasture. From 1921 to 1925 the pasture acreage decrease was 18 per cent. There also has been, between 1910 and 1925, a decrease of more than 20 per cent in the amount of livestock. This means that much land is not being used at all. Valuing pasture land on the basis of average value per acre for the farm, the pasture investment for each animal unit of livestock was more than $200. At six per cent interest the annual pasture cost per animal unit was $13.

Wheat has been the chief cash crop in this county, but considering the average yield secured and the cost of growing, the wheat crop is not profitable. There has been rather a serious reduction in acreage of wheat in recent years, for this reason. This county once placed great dependence on the raising of horses and mules. This industry has practically disappeared. Where there were large numbers of sheep at one time,

fewer are now found. Cattle and hogs are the chief livestock enterprises and these have not increased sufficiently to maintain the importance of this county as a live stock county.

More than half the owned farms are rather heavily mortgaged. The tax burden falls too heavily on the acres that are in use.

Distribution of the Labor Necessary for Caring for Brood Sows Producing Two Litters per Year and for Brood Sows Producing One Litter per Year (O. R. Johnson).—Records for this study cover the years 1916 to 1926. Labor requirements per brood sow on farms producing two litters were slightly less than on farms producing one litter per brood sow. This seems contrary to normal expectations. However, this may be explained on the grounds that the farms producing two litters per year were the better hog farms and used more efficient methods of handling hogs and ordinarily handled larger numbers of brood sows. Table 5 shows the labor distribution and labor cost on brood sows producing one litter and on brood sows producing two litters per year.

Table 5.—Labor Distribution and Labor Cost on Brood Sows Producing One and Two Litters, Respectively, 1916-1926 Inclusive

Month	Aver. man labor expended per brood sow on one litter farms	Aver. man labor expended per brood sow on two litter farms	Total aver. cost per brood sow on one litter farms	Total aver. cost per brood sow on two litter farms
January	1.744	1.452	$0.355	$0.315
February	1.815	1.965	.35	.437
March	2.033	2.911	.406	.598
April	2.914	2.657	.57	.595
May	1.731	1.788	.377	.386
June	1.81	1.520	.358	.304
July	1.6	1.19	.313	.263
August	1.740	1.674	.345	.37
September	1.975	1.861	.407	.413
October	2.504	1.946	.534	.416
November	2.469	1.556	.497	.335
December	2.29	1.559	.443	.335
Totals	24.625	22.079	4.945	4.767

Note: Two litter farms include 72 farms, 908 brood sows.
One litter farms include 25 farms, 174 brood sows.

Table 6 shows the labor distribution and labor cost on other hogs on farms which produce one litter per year and on farms which produce two litters per year.

Average Horse Hours and Equipment Cost on Missouri Farms (O. R. Johnson, Preston Richards).—Table 7 shows the average horse hours per farm from 1917 to 1926 and the cost of using machinery per horse hour through the war period.

TABLE 6.—LABOR DISTRIBUTION AND LABOR COST ON OTHER HOGS

Month	Aver. man labor expended per other hog on one litter farms	Aver. man labor expended per other hog on two litter farms	Total aver. cost per other hog on one litter farms	Total aver. cost per other hog on two litter farms
January	.762	.531	$0.161	$0.128
February	.628	.467	.133	.125
March	.574	.522	.128	.128
April	.385	.35	.086	.088
May	.307	.348	.065	.108
June	.368	.309	.064	.072
July	.347	.346	.069	.079
August	.356	.384	.082	.083
September	.40	.349	.088	.077
October	.444	.341	.103	.085
November	.619	.403	.134	.086
December	.646	.392	.136	.095
Totals	5.836	4.742	1.249	1.154

Note: Two litter farms include 72 farms, 5201 other hogs.
One litter farms include 25 farms, 941 other hogs.

TABLE 7.—AVERAGE HORSE HOURS AND AVERAGE EQUIPMENT RATES PER HORSE HOUR

Year	Horse hrs. per farm	Rate per hr.
1917	5906.08	3.48c
1918	6961.62	2.95
1919	5619.88	4.80
1920	5468.62	6.60
1921	4334.67	4.85
1922	4052.77	3.78
1923	3641.00	4.88
1924	5129.31	3.36
1925	4727.94	3.29
1926	4441.66	4.13

TABLE 8.—COST OF PRODUCING WHEAT IN MISSOURI DURING THE YEAR 1927

Breaking	per acre	$2.36
Disking, harrowing, etc.	per acre	1.39
Sowing	per acre	.74
Seed 1.2 bushels at $1.30	per acre	1.56
Manure and fertilizer	per acre	1.75
Cutting	per acre	.88
Shocking	per acre	.51
Twine	per acre	.27
Threshing	per acre	1.55
Threshing rate 7.5c per bushel	per acre	.75
Fuel, sacks, etc.	per acre	.40
Abandoned acreage 11% (1927 U. S. D. A. Yearbook)	per acre	.86
Land rent 2/5 of crop	per acre	4.48
Total cost per acre		17.50
Cost per bushel at farm		1.75
Average yield (1927 U. S. D. A. Yearbook)		10 bu.

The total equipment cost is distributed on the basis of horse hours put in at farm work. The rate per hour for use of machinery depends on two things; the amount of horse labor per farm and the actual cost of maintaining equipment and interest on that equipment.

Cost of Producing Wheat in Missouri (O. R. Johnson and Preston Richards).—The cost of producing a bushel of wheat in 1927 in Missouri is shown in Table 8.

The average yield of wheat in Missouri in 1927 was unusually low, 10 bushels per acre. The abandoned acreage was relatively high, so the cost per bushel is somewhat more than in 1926. The average farm price for Missouri in September, 1927 was $1.28.

The Cost of Keeping a Farm Flock of Sheep (O. R. Johnson and Preston Richards).—An analysis of the cost of keeping a farm flock of sheep from 1914 to 1926 inclusive was made. Table 9 shows a summary of this study.

Table 9.—The Cost and Income from the Breeding Flock; 1914-1926 incl. (Average size of flock 37.7 mature sheep)

Cost Items:	Amount per Mature Sheep
Feed	$3.985
Man labor	1.028
Horse labor	.098
Equipment	.034
Building charge	.335
Miscellaneous cash expense	.658
Taxes	.049
Interest	.590
Overhead	.680
Total costs	7.457
Income:	
Lambs	3.132
Wool	2.725
Sheep sold	2.978
Miscellaneous	.038
Total income	8.873

The feeds actually charged made up slightly more than half the cost of keeping the farm flock, and the total labor cost was almost exactly one-fourth of the feed cost. The miscellaneous cash expenses were mostly for buying rams and medicines and paying for shearing the sheep, interest, and overhead. These results are not conclusive on account of the small number of flocks under observation.

The Cost of Keeping a Farm Work Horse (O. R. Johnson and Preston Richards).—The feed cost of keeping a farm work horse is shown in Table 10. This table covers a period of sixteen years.

A new horse feed price index has been computed for correcting the original cost figures for price level. This index was derived by weighting

the index farm price of corn, oats, and hay according to the proportion each of these feeds makes of a Missouri farm work horse ration. This proportion is an average of sixteen years.

TABLE 10.—RELATION BETWEEN THE FEED COST OF THE FARM WORK HORSE AND LABOR PERFORMED. 1912–1927

Year	Cost	Corrected*	Hrs. worked
1912	$87.12	$82.19	1035
1913	63.58	69.11	975
1914	49.98	48.52	689
1915	46.90	39.08	738
1916	50.36	39.96	699
1917	60.39	27.83	565
1918	90.05	39.84	674
1919	81.90	35.45	617
1920	77.41	33.51	728
1921	45.28	40.43	552
1922	45.08	42.93	567
1923	39.94	35.03	561
1924	48.59	37.66	729
1925	57.84	37.08	722
1926	43.25	33.53	715
1927	49.59	38.74	859

*Feed cost has been corrected for price level by using the Bureau of Agricultural Economics index of farm prices of grain for the year in question.

Feeding Record.—Table 11 shows the feed cost per hour corrected for price level.

TABLE 11.—RELATION BETWEEN THE FEED COST OF THE FARM WORK HORSE AND LABOR PER FARM, 1912-1927

Year	Feed Cost			Hrs. Worked	Feed Cost per Hour of Labor		
	Actual	Corrected[1] for Price Level	Corrected[2] for Price Level		Actual	Corrected[1]	Corrected[2]
1912	87.12	82.19	79.05	1036.	8.41	7.93	7.63
1913	63.58	69.11	68.44	975.	6.52	7.09	7.02
1914	49.98	48.52	48.19	689.	7.25	7.04	6.99
1915	46.90	39.08	45.13	738.	6.36	5.30	6.12
1916	50.36	39.96	47.96	699.	7.20	5.72	6.86
1917	60.39	27.83	35.95	565.	10.69	4.92	6.36
1918	90.05	39.84	46.13	674.	13.36	5.91	6.84
1919	81.90	35.45	40.23	617.	13.27	5.75	6.52
1920	77.41	33.51	38.28	728.	10.63	4.60	5.26
1921	45.28	40.43	46.97	552.	8.20	7.32	8.51
1922	45.08	42.93	48.52	567.	7.95	7.57	8.56
1923	39.94	35.03	35.53	562.	7.11	6.23	6.32
1924	48.59	37.66	38.62	727.	6.68	5.18	5.31
1925	57.84	37.08	45.12	723.	8.00	5.13	6.24
1926	43.25	33.53	40.73	715.	6.05	4.69	5.70
1927	49.59	38.74	44.04	859.	5.77	4.51	5.13

[1]Corrected by using U. S. Bureau of Agricultural Economics index of prices paid to the farmer for grain. In this case the 6 is reduced from 2.3 to 1.1.

[2]Corrected by using a weighted index for prices of corn, oats, and hay. In this case the 6 is further reduced to 1.0.

Reactions in Production to Changes in Prices and Market Conditions (F. L. Thomsen, G. B. Thorne).—It is known how producers, as a whole, generally react to changes in prices. It is not known, however, whether such changes are the result of radical changes by a few farmers or minor changes in the production programs of a majority of producers. The answers to these questions have an important bearing on price forecasting.

Records from local assessors in Missouri containing an enumeration of crops and farm animals on individual farms over a period of years have been secured from the State Board of Agriculture and partially analysed.

The individual reports of the last three pig surveys have been secured from the office of the state statistician. Tabulations have been made of the individual increases and decreases in hog production by (1) size of farm, (2) size of herd, (3) closeness to market and (4) hog population. It is the purpose of this analysis to determine whether there is any class of farmers who react to price changes differently from other classes. This work should be a contribution to more accurate analysis of pig surveys, and a more effective dissemination of outlook material.

The farmers in Missouri who cooperated in the pig survey by filling out reports on their own production have received an analysis of the survey. They were, therefore, better informed on the importance and possibilities of application of the surveys than the majority of producers. The changes in production of these farmers have been studied as compared with the changes in producers with the mass of producers.

Marketing Strawberries and Grapes (F. L. Thomsen, G. B. Thorne).—A complete study of "The Economics of Strawberry Production and Marketing" has been made and published in Bulletin 266. A similar report on grapes is now being arranged for publication.

Marketing Butter (F. L. Thomsen, W. H. E. Reid).—Collection of data has been completed and tabulations made in semi-final form.

There has been built up in Missouri and surrounding states a system for assembling butterfat which has as its operating unit the centralizer creamery. This market outlet is adapted to the peculiar production conditions existing in this region.

Due to higher procurement costs and poorer quality of cream, the centralizers do not pay such high prices for butterfat as do creameries, cheese factories, and condenseries located in northern dairy states. While this price difference is justified in centralizer territory, higher prices could be expected from other market outlets.

Volume of butterfat production is the principal test to be applied to any community in judging its ability to support new market outlets. There are sections of the State where other market outlets might now be profitably established.

Whole milk markets such as condenseries and cheese factories, have only a slight advantage over creameries in their ability to pay higher prices for butterfat.

Cooperative creameries may be of two types, local and centralizer. The latter, in Missouri, are more likely to be successful. Because of high efficiency of the operating and sales methods of private centralizers, cooperative centralizers have to depend on two probable advantages: lower procurement costs and better quality cream. Their success depends on a full understanding by producer-members.

It takes time to develop the dairy industry in any one community. Local enterprises started with inadequate supplies would probably fail. This acts as a damper to dairy production. A marketing agency can not be expected to operate at a loss over an extended period in order to build up production. Good local dairy marketing units help build up the dairy industry but they must first have a minimum amount of raw material for economical production. Dairying must come before new dairy markets.

Factors Affecting Local Prices (F. L. Thomsen, G. B. Thorne).—The collection of data has been completed and tabulation is now in progress. Approximately seven thousand reporters volunteered their services. Each report covered eighteen commodities. They included 193 towns reporting for every month in the year and 157 towns reporting for less than twelve months.

Marketing Truck Crops (F. L. Thomsen, G. B. Thorne).—Conditions in the produce market of St. Louis have long been unsatisfactory from the grower's standpoint. It is known throughout the country as a low quality, low price market. Being a principal diversion point for shipments of fruits and vegetables, there are always many cars on track beyond local requirements. Any temporary shortage which might result in higher prices means additional unloads. Methods of buying and production have resulted in poorer quality and low prices. As a result of these conditions a cooperative commission house was established in 1926. This cooperative has not received the required support of growers.

The work on this investigation thus far has consisted of the study of comparative prices paid by private dealers and the cooperative commission company. One hundred representative growers kept records of every sale made during the year. There were 9,400 such sales. Analysis of these records showed that the cooperative was not obtaining as high prices for some commodities as private firms were paying when allowance was made for the selling commission.

All of the records of the cooperative's transactions have been sorted and tabulated in order to secure data on seasonal price movements, and the effect of grade and other conditions on price.

AGRICULTURAL ENGINEERING

J. C. Wooley, *Chairman*

The Use of Electricity on the Farm (R. R. Parks, M. M. Jones).—What farm operations can be economically performed by electricity, and what is the cost compared with other methods, are the questions which this investigation is designed to answer. Forty farmers are keeping accurate records of some work done by electricity on their farms.

Feed Grinding.—Motors of from two to five horse power are quite practical for grinding corn for herds of twenty to thirty cows. Small hammer grinders or buhr mills, when properly installed, grind shelled corn satisfactorily and more economically than many larger grinding outfits. From 225 to 325 watthours of energy were required to grind 100 pounds of shelled corn. Buhr mills driven by motors as small as three horse power ground ear corn and gave good service on the farms of some cooperators. Energy requirements range from 325 to 400 watthours per 100 pounds of ear corn ground.

Milking Machines.—From ten to twelve minutes were required to milk a cow by hand. The average time per cow per man when a milking machine was used was from five to seven minutes. The energy required was from 28 to 30 kilowatt hours per month for ten cows.

Cream Separators.—On the average, 300 to 450 watthours of energy were required to separate 1000 pounds of milk. With an energy rate of five cents per kilowatt hour, the energy cost about one-quarter of one cent per day to separate the milk from seven or eight cows.

Washing Machines.—With energy at five cents per kilowatt hour, the cost of running a washing machine was from ten to fifteen cents per month for the average farm family.

Water Pumps.—Household water systems pumping water from shallow wells and cisterns required from 1 to 2½ kilowatt hours per 1000 gallons of water pumped. The amount of water used varied from 1000 to 5000 gallons per month.

Individual Electric Plants.—One cooperator generated his energy at a cost of seven cents per kilowatt hour for fuel. When overhead costs and interest on his investment and depreciation were figured, his total cost was twelve to thirteen cents per kilowatt hour. Where small amounts of energy were used the cost sometimes ran as high as twenty to fifty cents per kilowatt hour.

The Effect of Manuring on Plow Draft (M. M. Jones, A. H. Glaves).—Tests of the draft of a plow in ground that has received different treatments for 38 years were made in April, 1928. One plot received six tons of manure annually; one plot, six tons once in four years; and one plot no treatment. These plots were on a Putnam silt loam soil, and the

cropping system was a wheat and clover rotation. There was no appreciable difference in the draft of the plow on the different plots.

Comparison of the Draft of Wide-Bottom Plows and Narrow-Bottom Plows (M. M. Jones, A. H. Glaves).—Draft tests were made on two tractor plows at four different points in a field. The soil was a Putnam silt loam. One plow was equipped with two 18-inch bottoms and the other with three 12-inch bottoms, each plow cutting 6 inches of ground. The plow with narrow bottoms had an average draft of 1420 pounds, as compared to an average draft of 1290 pounds for the plow with wide bottoms.

Sewage Disposal for Farm Homes (J. C. Wooley, M. M. Jones).—Plans have been developed for satisfactory methods of sewage disposal for farm homes without water systems, for farm homes with only a kitchen sink and drain, and for farm homes with a complete pressure water system. These various systems are fully described in Extension Circular 203.

Methods of Prolonging the Serviceable Life of Wood Fence Post (M. M. Jones).—In 1913 twenty-seven different varieties of wood posts were set. Some posts of each variety were given treatments as follows: no treatment, set in gravel, butts charred, brush coat of hot carbolineum, two brush coats of hot creosote, two-hour double tank treatment of creosote, five-hour double tank treatment of creosote.

Seven varieties showed a slight increase in service resulting from being set in gravel, but not enough to justify the practice. Charring the butts of sycamore, red oak, and Kentucky coffee bean posts increased the serviceable life, but showed no beneficial effects on the other varieties. Painting with hot carbolineum doubles the life of many of the soft woods. This treatment was more effective than hot creosote applied in the same manner. Painting with hot creosote was not effective. In the fourteen varieties that have failed to date, the two-hour double treatment with creosote has increased the serviceable life 2.9 times. The five-hour double tank treatment of creosote has increased the serviceable life three times. For the varieties that have failed to date, the two-hour treatment was practically as good as the five-hour treatment.

Dairy Barn, Hog House, and Machinery Shed (J. C. Wooley, M. M. Jones).—Complete detailed plans and drawings have been made for an addition to a barn to be used for housing and milking cows. Two plans have been developed for eighteen-cow modern dairy barns. One is a standard barn 34x66 with gambrel roof, hay and straw storage being overhead. The other is a T-shape barn with a two-story section for hay storage, the remainder of the barn being one-story. Both plans have provision for calf, bull, and maternity pens, as well as bin space for corn,

oats, and other feeds. Plans have been developed for a modern 36-cow dairy barn. In addition to the dairy barn plan, blue prints are also available for five types of movable hog houses, and two types of implement and machinery sheds.

Blue print plans of any of these barns may be secured for a small charge by writing to the College of Agriculture, University of Missouri.

ANIMAL HUSBANDRY

E. A. TROWBRIDGE, *Chairman*

The Relation of Sex and Age in Cattle and the Kind, Quality and Quantity of Carcasses Which are Produced (E. A. Trowbridge, H. C. Moffett).—In this experiment seven lots of cattle were included, as follows:

Lot 1. Steer calves full fed in dry lot for 196 days and marketed in June.
Lot 6. Heifer calves full fed in dry lot for 196 days and marketed in June.
Lot 2. Steer calves fed half as much grain as Lot 1 and roughness ad libitum until spring; pasture without grain 56 days and then full fed 112 days.
Lot 3. Steer calves fed half as much grain as Lot 1 and roughness ad libitum until spring; and then full fed on grass 168 days.
Lot 4. Steer calves fed corn silage and legume hay ad libitum during winter, 56 days on grass without grain then full fed for 112 days.
Lot 5. Steer calves fed corn silage and legume hay ad libitum through winter then full fed on grass 168 days.
Lot 7. Heifer calves fed half as much grain as Lot 1 and roughness ad libitum until spring, then full fed on grass 168 days. (Same as Lot 3).

TABLE 12.—RESULTS OF FEEDING TRIALS WITH STEERS AND HEIFERS

Lot No.	1 Steers	6 Heifers	2 Steers	3 Steers	4 Steers	5 Steers	7 Heifers
Days on experiment	196	196	336	336	336	336	336
Gain per animal	412.2	358	557	593	482.5	535	541
Corn—lbs.	1632	1628	2208	2730	1581	1969	2367
Cottonseed meal—lbs.	204	204	276	341	198	246	295
Alfalfa—lbs.	468	489	573	577	586	627	651
Silage—lbs.	1464	1549	1799	1745	2349	2388	182
Bluegrass pasture—days	None	None	168	168	168	168	168
Pork per Steer—lbs.	17.9	17.9	56.1	59	48	50.5	66.4
Dressing per cent	57.1	60.0	59.7	60.0	57	58.5	60.5
Selling Price	$11.50	$11.00	$16.25	$17.00	15.50	$16.50	$14.75
Profit per 100 lbs. above cost of steer and feed (pork included)	$2.55	$2.36	$5.37	$5.41	$4.45	$5.30	$3.70

Range bred high grade Hereford calves averaging in weight approximately 340 pounds, were used. All seven lots of cattle were sold on the National Stock Yards Market, East St. Louis, Illinois. When a concentrate (grain and supplement) was fed it consisted of shelled corn, about number three grade, and cottonseed meal pea-sized, guaranteed forty-three per cent protein, mixed in the proportions of eight parts corn

and one part cotton seed meal. The roughage was good alfalfa hay and corn silage, and the pasture was blue-grass. Table 12 shows the results.

Fig. 4.—Spring steer calves (Lot 3) at weaning time. They ran in grass lot where they had access to a creep and were allowed to nurse twice daily. Weight 655 pounds.

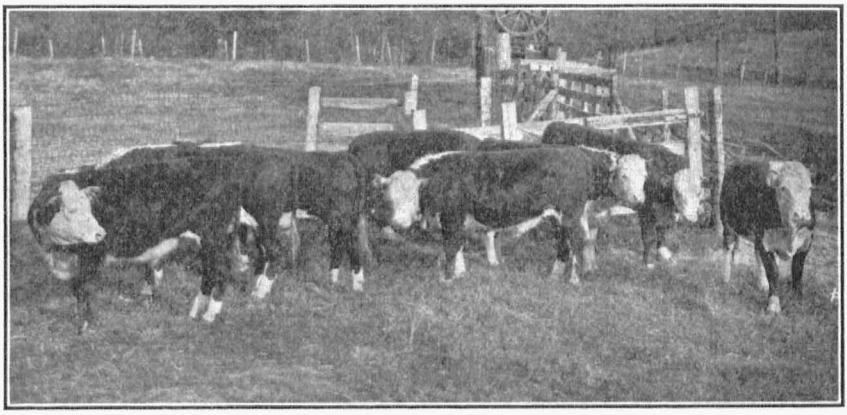


Fig. 5.—Steers (Lot 4) roughed on corn silage and legume hay 168 days during winter, grazed 56 days on bluegrass without grain, then full fed 112 days.

Steer calves made somewhat greater and more economical gains than heifer calves. Heifers showed a satisfactory market condition in thirty days less time than steers. Light weight steers (around 700 pounds) and heifers when fat usually have sold with little difference in price.

Fat heifers weighing around 900 pounds sold for materially less than steers of similar weight and condition.

Lots 4 and 5, wintered on silage and hay, made greater and more economical gains during the following summer when on feed than cattle wintered on silage, hay, and on half the grain ration. Their small gains made in winter were relatively expensive, however.

Steers wintered on a part grain ration, then put on grass without grain, grew but made only slight gain in weight during the fifty-six day period on grass.

Feed cost per hundred pounds gain was least with the thinner cattle which were on feed only 112 days, but the cost increased as the condition advanced and the feeding period lengthened. Cattle fed only 112 days needed at least sixty days more, to be comparable with the fattest cattle. The selling prices showed the relative condition of the cattle.

In a third trial a lot of native calves were full fed 196 days and were compared with a lot of western steer calves. The native calves gained 416.5 pounds. They sold for $14.65 per hundred pounds and graded "choice". They returned $3.09 more per hundred pounds than the cost of the steer and the feed.

The western steer calves gained 429 pounds and sold for $14.50 per hundred pounds which was $3.83 more per hundred pounds than the cost of the steer and feed. Their carcasses graded "choice".

Feeding Spring Beef Calves Previous to Weaning Time and Ultimately Finishing Them for Market (E. A. Trowbridge, E. M. Jones).—This project was in cooperation with the Sin-A-Bar farms and the United States Department of Agriculture.

Native calves born in the spring of 1927 were handled prior to weaning as follows:

Lot 1. Eight steer calves ran with cows on pasture and received no grain.

Lot 2. Eight steer calves ran with cows on pasture and had access to grain in a creep.

Lot 3. Seven steer calves in grass lot by themselves, allowed to nurse twice daily. Calves had access to grain.

Lot 4. Seven steer calves ran with cows on pasture and received no grain until October 13. Calves had access to grain in creep after that date.

Lot 5. Ten heifer calves ran with cows on pasture and had access to grain in a creep. Sold at weaning time (December 9).

After weaning, Lots 1, 2, 3, and 4 were full fed in dry lot until June 21.

When high grade native spring calves were to be sold at weaning time they yielded greater profit when they were fed grain while nursing their dams. Self fed calves separated from their dams and allowed to nurse twice daily made slightly better daily gains than calves which were "creep fed" and ran in the pasture with their dams. There was not much difference in the net returns of these two methods of handling.

Calves fed grain fifty-six days before weaning yielded a return of $10.00 less than the calves fed grain the entire period.

The farm values per hundred pounds on the calves at weaning time were:

Steer calves fed no grain while nursing	$10.00
Steer calves creep fed grain while nursing	12.75
Steer calves fed grain and nursed twice daily	12.50
Steer calves fed grain 56 days before weaning	10.50
Heifer calves creep fed grain while nursing	13.00

When the production of these calves was figured on the basis of the return for the ownership and keep of the cow, it ranged from $49.29, where the calves were fed no grain and sold at weaning time, to $59.57 when the calves were nursed twice daily.

Heifers fed grain while running with dams on pasture ate less grain and made less daily gains, but were somewhat fatter, selling at weaning time for $13.50 or 25c higher than the estimated price for a lot of steers handled similarly.

From the four lots of steers that were fed grain six months after being weaned, the calves fed grain before weaning made less economical and slower gains than calves which had had no grain while nursing or than calves which received grain for two months before weaning. As the fattening period advanced the rate and economy of gain of all lots showed less divergence. The calves fed grain before weaning time were very fat at the close and would have yielded greater profit if sold thirty to sixty days before the experiment closed.

Steer calves born in the fall were divided into three lots and fed as follows:

Lot 1. These calves ran with their mothers on pasture, and received no grain.

Lot 2. The calves in this lot ran with their mothers on pasture, fed grain and alfalfa hay in a creep.

Lot 3. Calves were separated from their mothers, fed grain and alfalfa and allowed to run in a grass lot.

All calves had a shed for shelter.

Two lots of grain fed calves showed greater net returns at weaning time than the calves which had had no grain. The grain fed calves

weighed 115 pounds more per head than calves receiving no grain. They were fat enough for slaughter at eight months of age.

There was little difference in the rate of gain between calves creep fed on pasture and calves separated from their mothers, fed grain and alfalfa, and allowed to nurse twice daily. The calves creep fed grain and hay while running with the cows returned $65.76 above feed costs for keep of cow; the calves nursed twice daily, $60.69; and the calves which did not receive any grain, $55.97.

The twenty-four cows, the mothers of the fall calves in Lots 2 and 3, during the period of January 6 to April 14, 1928, consumed the following amounts of feed per head: corn silage, 2,280 pounds; alfalfa, 142 pounds; cottonseed meal, 79 pounds; plus pasture. With silage at $6.50 per ton, alfalfa hay $15.00 per ton, cottonseed meal $55.00 per ton, the feed cost per head for the ninety-nine days was $10.65 exclusive of the winter pasture.

Grading Cattle on Foot and in the Carcass (E. A. Trowbridge, H. C. Moffett).—The seven lots of cattle fed as described under the project "The Relation of Sex and Age in Cattle to the Kind, Quality, and Quantity of Carcasses Which Are Produced." were graded by a Federal Grading Committee, as feeder calves and slaughter cattle. The carcasses were "ribbed down" and graded after they had been in the cooler forty-eight hours.* Table 13 shows the numerical score and corresponding grade for each lot of cattle.

Table 13.—Numerical Score and Grade for Each Lot of Cattle

Lot Number	Grade as Feeder Calves	Grade as Slaughter Cattle	Carcass Grade
1 (Steers)	Choice — (81.45)	Good + (81.19)	Good + (78.60)
6 (Heifers)	Good + (80.42)	Choice — (81.33)	Good + (81.23)
3 (Steers)	Good + (80.82)	Choice — (83.44)	Choice — (83.64)
7 (Heifers)	Good + (80.90)	Choice — (83.24)	Choice — (84.27)
2 (Steers)	Choice — (82.63)	Good + (81.02)	Choice — (82.08)
4 (Steers)	Choice — (82.08)	Good + (79.84)	Good (75.83)
5 (Steers)	Choice — (81.76)	Good + (81.13)	Good + (79.61)

The treatment each of these lots received are described in the first paragraph of the project "The Relation of Sex and Age in Cattle and the Kind, Quality and Quantity of Carcasses Which Are Produced".

*For completed detailed description of these grades see U. S. Department of Agriculture Circular No. 28, Department Bulletin No. 1464 and Department Bulletin No. 1246.

Carcass Studies (E. A. Trowbridge, A. G. Hogan, M. T. Foster, W. S. Ritchie, Jessie Alice Cline).—A fat steer and a fat heifer approximately eighteen months of age were slaughtered. These animals received a half grain ration for 168 days through the winter then were given a full grain ration on pasture for 168 days. They were graded as "good" at the beginning of the feeding trial. At the end they were graded as "choice". The carcasses produced were graded as "choice".

The heifer had a higher dressing percentage, a greater yield of hindquarters, loins and flank.

A physical analysis showed that the steer carcass contained 56.099 per cent lean, 29.92 per cent fat, 13.98 per cent bone. The heifer carcass contained 54.68 per cent lean, 32.81 per cent fat, and 12.51 per cent bone.

A chemical analysis of the eye of beef from the 9th, 10th, and 11th rib showed that the lean meat from the steer contained more moisture, ash and nitrogen, but considerably less fat.

Three carcasses from steers approximately fourteen months old that had been wintered by different methods were studied. Steer 20 received a full grain ration for 196 days. Steer 517 received a half grain ration for 196 days. Steer 136 received a ration of roughness only for 196 days.

The physical analysis showed that the steer 20 carcass contained 55.57 per cent lean, 28.09 per cent fat and 16.34 per cent bone; steer 517 carcass contained 64.32 per cent lean, 14.56 per cent fat and 21.12 per cent bone; steer 136 carcass contained 65.40 per cent lean, 8.25 per cent fat and 26.35 per cent bone.

In the chemical analysis the eye of beef from the 9th, 10th, and 11th rib of Steer 20 was lowest in moisture and highest in fat, nitrogen and ash. Steer 517 ranked second and steer 136 last in these respects.

Cooking data on the 9th, 10th and 11th rib roast showed that steer 20 lost 8.85 per cent through evaporation and 3.9 per cent through drippings. Steer 517 lost 11.2 per cent through evaporation and 2.5 per cent through drippings. Steer 136 lost 8.8 per cent through evaporation and 1.6 per cent through drippings. In palatability a committee ranked the roasts 20, 517, and 136.

The Plural Nature of Vitamin B (A. G. Hogan, J. E. Hunter, R. W. Pilcher).—The effect of ultra-violet rays on vitamin B, using rats, chicks, and pigeons as experimental animals, has been studied. The chief carrier of vitamin B employed was a concentrate prepared by the method of Osborne and Wakeman. Limited use was also made of dried yeast.

As vitamin B supplements were exposed to ultra-violet rays they lost their potency in some respect and were unable to maintain life. The material was, however, potent in curing polyneurities of pigeons.

Since it was known that the antineuritic factor was destroyed at high temperatures these observations suggested that vitamin B was a mixture.

In order to prove this the animals were divided into four groups. Group one received a vitamin B supplement that had been heated. Group two received the irradiated material. Group three received half of the heated supplement and half of the irradiated supplement. Group four received the untreated preparation.

The observations on chicks were the least satisfactory, since their nutritional requirements are uncertain in some respects. Chicks receiving the mixture of irradiated and heated yeast did as well as those receiving untreated yeast and much better than those receiving either irradiated or heated material alone.

Of the rats and pigeons receiving either heated or irradiated material alone there were no survivors. Those receiving the mixture, however, did as well as those that received the untreated material.

It seems, therefore, that vitamin B is a mixture of at least two factors, one is antineuritic, and the other less clearly understood but essential in maintaining life.

Rations for Pigs at Weaning Time (L. A. Weaver).—The objects of this investigation were to determine whether cottonseed meal will take the place of all or a part of the tankage necessary to supplement corn; to find the value of adding a small amount of cured legume hay (alfalfa) to the fall pig ration; to find out if bluegrass pasture will take the place of alfalfa meal in rations for fall pigs; to compare the relative value of linseed oil meal and cottonseed meal when fed with corn, tankage and alfalfa meal; and to compare the relative value of some mixed protein supplements and tankage when fed with corn to fall pigs.

Nine lots of hogs were fed corn and in addition enough protein supplement to balance the ration. The protein supplement fed each lot was as follows: Lot 1, tankage; lot 2, tankage 80%, alfalfa meal 20%; lot 3, tankage 60%, cottonseed meal 20%, alfalfa meal 20%; lot 4, tankage 40%, cottonseed meal 40%, alfalfa meal 20%; lot 5, tankage 20%, cottonseed meal 60%, alfalfa meal 20%; lot 6, cottonseed meal 80%, alfalfa meal 20%; lot 7, tankage 60%, linseed oil meal 20%, alfalfa meal 20%; lot 8, mixed 25% protein supplement; lot 9, tankage 60%, cottonseed meal 20%, bluegrass.

No significant difference in the rate of gain was apparent when cottonseed meal was used instead of one-fourth to one-half of the tankage. Cottonseed meal, as a substitute of more than one-half of the tankage, resulted in a decrease in rate of gain.

There was little difference in the amount of feed required to produce 100 pounds gain when cottonseed meal was used as a substitute for one-

fourth to one-half of the tankage. When used as a substitute for more than one-half the tankage then the ration became less efficient, requiring more total feed to produce a unit of gain.

The addition of alfalfa meal to the supplement increased slightly the rate of gain and decreased the amount of feed required to produce a unit of gain.

In these experiments 11.06 pounds of alfalfa meal replaced 31.97 pounds of corn and 4.26 pounds of tankage. With corn worth 70c per bushel and tankage $4.00 per hundred pounds, the alfalfa meal would have been worth more than $5.00 per hundred pounds.

The pigs on bluegrass pasture made more rapid gains and less concentrate was required to produce 100 pounds gain than when pigs were fed in dry lot, even though alfalfa meal was included in the ration.

There was no significant difference in either the rate of gain or feed requirement per unit when the supplement contained 20% cottonseed meal as compared to the same amount of linseed meal.

The addition of a small amount of cottonseed or linseed meal and of alfalfa meal increased the rate of gain slightly and decreased the feed requirement per unit of gain as compared with results obtained when tankage was the sole supplement. Substituting large amounts of cottonseed meal for tankage decreased the rate of gain and increased the amount of feed required per 100 pounds gain.

Corn and tankage produced more rapid and more economical gains than did a mixed supplement containing 25% protein. Approximately twice as much supplement was needed to balance the corn as when tankage was the supplement used.

Calcium Requirements of Breeding Swine (A. G. Hogan, L. E. Casida).—During the preceding year gilts were used in a study of the amount of calcium required for growth and for pregnancy and lactation. The animals were given a ration containing approximately 0.25 per cent of calcium with no decided effects. The weaning weights of the pigs were low but the ration was not necessarily responsible. At the same time other gilts were reared on a ration that was precisely the same except that it contained a supplement of bone ash as a source of calcium. The sows receiving this ration grew well and were apparently normal but they failed almost completely in rearing their litters. They apparently secreted a liberal amount of milk but most of the pigs died within the first week.

It was thought that the form in which the calcium was supplied may have been responsible. Six groups were fed. One received a control ration which contained large amounts of calcium. Two received low calcium rations, one containing 0.19 per cent calcium, the other 0.25

per cent. In addition three other groups received exactly the same ration as the low calcium groups, except these groups were given calcium supplements. One was given calcium carbonate, another tri-calcium phosphate, and the third bone ash. Table 14 shows the composition of the rations.

Table 14.—Composition of Rations

Constituents	Control	Experimental
	Per Cent	*Per Cent*
Corn	80	75
Alfalfa Meal	5	5
Liver Meal	--	8
Tankage	10	--
Linseed Oil Meal	3	8
Cod Liver Oil	--	2
Mineral	2	2

Table 15 shows the calcium content of the rations.

Table 15.—Calcium Content of Rations

Ration and Lot. No.	Low Calcium*		Control	High Calcium		
	1	2	3	4	5	6
Nature of Ca Supplement	$CaCO_3$	$CaCO_3$	none	$CaCO_3$	$Ca_3(PO_4)_2$	Bone ash
Per cent Calcium	0.19	0.25	0.98	0.75	0.74	0.89

*Small amounts of $CaCO_3$ were added to this ration in whatever amount was necessary to keep the calcium content constant.

The animals were given distilled water to drink and were maintained in restricted quarters, on board floors, in order to control the calcium intake.

As to the effect of the low calcium intake, the gilts grew normally and developed no obvious symptoms of calcium deficiency. Table 16, however, shows that their records for farrowing and for lactation were not satisfactory.

The sows receiving bone ash as a calcium supplement did not follow the behavior of the group in the previous test. The first group receiving bone ash farrowed pigs normal in appearance and secreted a normal amount of milk but all of the pigs died within a few days, except where the ration was changed.

During the test this year, however, there was a uniform failure of the sows to eat a sufficient quantity of food. They lost rapidly in weight, the milk flow was scanty or ceased entirely, and the pigs grew poorly. Considering the feed intake of the sows the pigs did surprisingly well.

It seemed certain that a deficiency of calcium interfered seriously with the reproductive process. In groups one and two there were seven sows and only four became pregnant. Of these four, one died at farrowing, another became paralysed and was discarded.

TABLE 16.—SUMMARY OF FARROWING AND OF LITTER RECORDS. GROUP AVERAGES.

Lot No.	1	2	3	4	5	6
No. of sows* that farrowed	2	2†	3	3	3	4
Wt. of sow after farrowing, (lbs.)	310	283	321	307	340	333
Wt. of sows 5 weeks after farrowing, (lbs.)	235	235	265	203	305	220
Daily feed consumption 10 days before farrowing, (lbs.)	5.0	4.0	4.7	4.7	5.3	5.0
Daily feed consumption 5 weeks after farrowing, (lbs.)	1.5	3.0	3.3	2.7	4.7	3.3
No. of pigs farrowed alive	4.0	5.0	6.0	8.3	7.7	8.8
No. of pigs farrowed dead	3.5	6.0	1.3	0.3	0.7	0.5
Birth weight of pigs farrowed alive, (lbs.)	2.4	2.9	2.7	2.6	2.8	2.4
No. of pigs alive at 5 weeks,	1.5	3.5	4.7	6.7	5.0	6.0
Wt. of pigs at 5 weeks, (lbs.)	11.9	7.5	12.1	9.9	10.0	9.7

*There were originally 4 gilts in each lot.
†One gilt died.

BOTANY

W. J. ROBBINS, *Chairman*

Physiological Studies of the Tomato Wilt Organism, *Fusarium lycopersici* (I. T. Scott). More extensive studies of the behavior of living mycelial mats of a monosporic strain of *F. lycopersici* in buffered and unbuffered single-salt solutions have further verified previous findings, and emphasized the point of view that a critical H-ion equilibrium point existed for this fungus, i. e., at or near p_H 5.5. It was necessary to use mycelial mats which had been "leached" in distilled water thus eliminating the effect of certain acids and salts which may have diffused out of the tissue into the suspending salt solution and produced anomalous results. In no case has the change in reaction produced by unwashed mats in salt solutions of different H-ion concentration coincided with that produced by washed mats in similar salt solutions. In the latter case the final equilibrium point with a great variety of salts such as sodium phosphate, potassium phosphate, potassium acid phthalate, sodium acetate, magnesium sulphate, magnesium chloride, potassium chloride, sodium chloride, potassium iodide, manganese chloride, barium chloride, sodium nitrate, potassium nitrate, potassium oxalate, and calcium chloride, was at or near p_H 5.5.

Titration curves of both the dialyzable portion of ground dried mycelium and the non-dialyzable residue showed buffer effect. It was assumed that the buffer effect of the former was due to certain organic salts and acids, while that of the latter was due to proteinaceous materials.

The first washings of fresh mycelial mats showed considerable buffer effect when titrated against dilute hydrochloric acid and sodium hydroxide. This was due to the adhering culture solution and the organic salts and acids leached out of the mycelium. In all previous work with this fungus only mats which had been thoroughly washed were used in determining the H-ion equilibrium point in single-salt solutions of different reactions.

Miscellaneous Investigations (I. T. Scott).—Various phases of the following plant diseases have been investigated: Narcissus leaf-blight, or die-back, caused by a Phoma-like fungus. Peony bud-blight caused by *Macrosporium* sp. Corn root-rot caused by *Pythium* sp. Potato blackleg caused by *Bacillus atrosepticus*, etc.

A Study of the Metabolism of Roots (W. J. Robbins).—The failure of excised roots to grow continuously when maintained under sterile conditions and supplied with glucose and mineral salts may be due to one or more of the following causes:

1. Toxicity of the mineral nutrient solution used due to a lack of balance or antagonism between the salts making up the solution.
2. Failure of the roots to absorb glucose rapidly enough to supply the growth needs.
3. Lack of some essential mineral element not generally considered essential and needed in traces only.
4. Lack of an accessory food or a vitamin.
5. Some disturbance in the respiratory process.

Certain phases of these possible causes have been investigated. Glutathione, a substance associated with respiration by Hopkins and co-workers, has been found in corn root tips and some attempts to determine it quantitatively and extract it in sufficient quantity to use experimentally have been made. The effect of methylene blue and of traces of various heavy metals has been tried.

DAIRY HUSBANDRY

A. C. RAGSDALE, *Chairman*

Normal Growth Rate of Dairy Cattle (A. C. Ragsdale, Samuel Brody, E. C. Elting).—A complete record of growth in weight and five linear dimensions was kept on 35 additional males and 25 additional females in the Experiment Station herd during the past year. The total number of animals on which records are available is 151 males and 135 females of the Ayrshire, Guernsey, Holstein, and Jersey breeds. The data on 15 Ayrshire, 70 Holstein and 50 Jersey females extend from birth to 44 months of age. The data on 9 Ayrshire, 5 Guernsey, 77 Holstein and 60 Jersey males range from birth to 29 months of age.

Weights and five linear measurements were taken on 52 Holsteins and 237 Jerseys, in representative dairy farm herds in various sections of the State. The majority of the animals in these farm dairy herds were found to be considerably smaller at corresponding ages than those in the herds of the Missouri, Kansas, Nebraska, and Iowa Experiment Station herds. This difference, however, seemed to be largely overcome with advancing age.

When growth is retarded in young animals, much time is lost before the animals have matured sufficiently for breeding. This comes at a time when animals make gains at the greatest rate, which means the most economical growth. If dairy animals are bred at a given age, regardless of size, it means that they come into lactation while undersized. Lactation materially retards growth. It is believed that the greatest economy in growth will ordinarily be secured when animals are grown at maximum rapidity from birth. This might not be the case if feed was abnormally high in price. Dairy animals grown with maximum rapidity have a longer and more economical productive life.

A method of computing weights from linear measurements has been devised.

Growth Efficiency of Dairy Cattle (A. C. Ragsdale, Samuel Brody, E. C. Elting).—Complete feeding records are available on 69 females and 79 males, of the Ayrshire, Holstein, Jersey and Guernsey breeds. The data on the females cover a period from birth to 29 months of age; on the males, from birth to 16 months of age. The relation between feed consumption and gains in live weight has been determined. The efficiency of growth decreased with advancing age.

Relation Between Surface Area and Body Weight (A. C. Ragsdale, Samuel Brody, E. C. Elting).—The purpose of this investigation was to find the relationship between surface area and body size, and heat production and body size. Measurements of surface area have been taken

on 189 Holsteins, 154 Ayrshires, 96 Jerseys, 43 Guernseys, 229 Shorthorns, 114 Herefords, 8 Angus, 11 horses, and 16 swine. A mathematical analysis of these data has been made. The numerical value of the exponent of weight in the equation relating surface area to weight varies from 0.4 to 0.7. The formulae of Meech, Dubois and Dubois and of Cowgill and Drabskin, have been subjected to critical analysis; likewise the so-called surface area law of Rubner. It is shown to be more logical to relate heat production to body size raised to some power than to surface area.

Influence of Food Supply on the Velocity Constant of Growth and on the Phase of the Growth Curve (A. C. Ragsdale, Samuel Brody, E. C. Elting).—A graphic and mathematical comparison has been made of the age curves of growth of rats on the "improved" diet of Osborne and Mendel with age curves of rats on "normal" diets. These comparisons have been supplemented with growth curves of children from laboring and nonlaboring classes, and with growth curves of "original entry" and "re-entry" Jersey cattle. Variations in a normal food supply exert a profound influence on the earliness of maturity and on the speed of growth. On this basis the following two applications to farm practice are given: (1) Since the cost of maintenance is the largest item in the cost of growth, farm animals should be grown as rapidly as possible and therefore save as much of the cost of maintenance as possible. (2) Since earliness of maturity is dependent on food supply as well as on age, animals should be bred for milk production (which retards growth) not at a given age but after reaching a reasonable fraction of the mature weight. Dairy cattle should be first bred so that lactation will begin on reaching three-fourths of the expected mature weight.

Respiration Chamber—The Age Changes in Energy Metabolism of Growing Domestic Animals (Samuel Brody).—The object of this investigation is to determine whether the cost of maintenance for a unit time is the same for animals, whether growing rapidly or slowly. In other words, is there a saving in maintenance cost, and if so, how much when the speed of growth is increased?

Equipment has been installed for determining the respiratory change in farm animals.

The Thermal Death Point of Mycobacterium Tuberculosis in Colostrum and in Milk (A. C. Ragsdale, C. W. Weber, C. W. Turner).—Colostrum, pasteurized at 140 degrees Fahrenheit, for thirty minutes, retains the beneficial qualities of raw colostrum as food for new-born calves.

The thermal death point of the most heat-resistant milk-borne pathogene, *mycobacterium tuberculosis*, has been generally accepted as

being below 140 degrees Fahrenheit for thirty minutes. Since there are physical and chemical differences between colostrum and milk, it was thought there might be some difference in the thermal death point.

The thermal death point of this organism was determined in seven samples of colostrum and in seven samples of milk. The samples were inoculated with approximately fifty thousand tubercle bacilli per cubic centimeter. These were then pasteurized. Samples of colostrum and milk were added to and removed from the pasteurizer simultaneously. Guinea pigs were used as test animals. Nine or eleven animals were used for each sample of colostrum or milk, a total of 136 animals being used. The resistance of the test organism to heat was determined from the macroscopic and microscopic post-mortem findings in the guinea pigs. Table 17 shows the results.

TAPLE 17.—THERMAL DEATH POINT OF MYCOBACTERIUM TUBERCULOSIS BOVIS (RAVENEL) IN COLOSTRUM AND MILK

	Time in minutes required to render the samples non-infectious to guinea pigs. (Temperature 140° Fahrenheit).							
Sample No.	1	2	3	4	5	6	7	Maximum
Colostrum	20	15	20	20	15	15	20	20
Milk	5	10	10	5	5	5	10	10

This strain of tubercle bacilli was two to three times as thermoresistant when suspended in colostrum as in milk. However, the thermal death point was well below 140 degrees Fahrenheit for 30 minutes.

Chemical Composition of Pre-Colostrum (A. C. Ragsdale, C. W. Weber, C. W. Turner).—Several cows and heifers have been milked for a variable length of time preceding parturition to determine the yield and composition of the secretion produced. Attention was centered on the protein fraction and especially the globulin of this pre-colostrum.

In the first-calf heifers, a viscid, yellowish, honey-like secretion, which rapidly became horny upon exposure to air, was obtained as early as the fourth month of pregnancy. A similar secretion was also obtained from cows which had previously lactated. This secretion was characterized by the high content of globulin (18 per cent) and albumin (7 to 10 per cent). The casein was low, although in some samples was higher than in normal milk. The yield of milk increased very rapidly preceding calving, and with the increased yield there was a decrease in the globulin to less than 0.2 per cent at calving time. The analyses clearly showed that when cows were milked daily for a period of ten days or more previous to

parturition, the chemical composition of the milk was practically that of normal milk, rather than colostrum.

Influence of Milking Pregnant Animals Before Calving on the Physical Condition and Well-Being of the Progeny (A. C. Ragsdale, C. W. Weber, C. W. Turner).—Three pregnant heifers were milked at regular intervals prior to calving. The calf of one appeared at all times to be in normal condition and was raised successfully. The calf of the second died on the fifth day after birth. The calf of the third died at two and one-half months of age. Bacterial cultures from the visceral organs indicated abundant *bacillus coli* infection.

Four cows were milked at intervals of ten days to two weeks before calving. The progeny of one died ten days after birth with a *Bacillus Coli* infection. The other three survived and are apparently in good health. The information is too limited to draw any definite conclusions.

An Analysis of the Progeny Performance of Holstein, Jersey and Ayrshire Sires and Dams (Warren Gifford, C. W. Turner).—A study of the Advanced Register records of Holsteins has been continued to determine the mode of inheritance of yearly butterfat production in Holsteins, in order that better breeding stock may be selected. All sires of the Holstein breed, having ten or more daughters with Advanced Register records were compared as to the average butterfat production of their progeny. A statistical analysis of the records of the daughters of dams with records showed that there was only 18 pounds constant increase in the yearly production of daughters per 100 pounds increase in the dams' production. A unit increase in the yearly production of the dams affected their sons' daughters' yearly production to about the same extent that the same unit increase in a sire's average progeny record influenced his sons' daughters' yearly production. These results do not conform to those reported for the Jersey, Guernsey and Ayrshire breeds.

Missouri Agricultural Experiment Station Research Bulletin 112 reports the study of the progeny of Jersey sires having ten or more daughters in the Register of Merit records.

A similar study of 175 Ayrshire sires with four or more daughters has been completed.

A Comparison of Guernsey Sires Based Upon Average Persistency of Fat Secretion During the Lactation of the Daughters (Warren Gifford, C. W. Turner).—A comparison has been made of all Guernsey sires having ten or more tested daughters, based on the average persistency ratio. The quantitative relationship between the persistency of dams and daughters indicated that the persistency of the dam, as measured by the record of production, did not supplement the sire's potential transmitting ability to any extent.

The Productive Ability of Cows to Which Proven Sires of the Guernsey Breed Are Mated (Warren Gifford, C. W. Turner).—Data were collected giving the mature or the mature equivalent records of all daughters of proved Guernsey sires that sired daughters after the age of six years, to determine whether or not breeders of Guernsey cattle are using the proved sires of a breed to the best advantage by mating them with superior cows. A study of the relationship between the age of these sires and the yearly fat production of 2974 daughters was made by means of correlation surfaces. There was a coefficient of correlation of 0.068 ± 0.123 between the two groups of variates. Since there was not a significant correlation, it was an indication that the daughters of the mature and older bulls were not superior to those sired at an earlier age. The records of 1574 dams with which these sires were mated at the various ages show that the mean average production for these dams was approximately the same for all groups.

Size and Forms of Spermatozoa of the Bull (Warren Gifford, C. W. Turner).—Length and width measurements of the heads of spermatozoa of the bull are being taken in order to determine the size, form and classes present. Earlier investigators report two distinct classes present. To date over seven hundred have been measured, and there is a single mode in the distribution of the length measurements, and no indication of demorphism. These spermatozoa are being measured direct from the plate on a photo-micrographic camera, and are being magnified 2500 times.

The Effect of Processing Ice Cream Mixtures at Different Pressures When the Milk Solids-Not-Fat Content Is Varied (W. H. E. Reid, E. R. Garrison).—Ice cream mixtures containing 9, 10, 11, 12, and 13 per cent milk solids-not-fat, and a fat, sugar, and gelatin content of 10, 13, and one-half of one per cent, respectively, were processed with a Gaulin two-stage homogenizer at different pressures subsequent to being pasteurized at 65.55 degrees Centigrade for thirty minutes. Samples were obtained from each differently processed mixture to be used for viscosity, surface tension and microscopic study.

After aging for 24 hours, 52 pounds of each sample were frozen. Samples were then taken at the freezer and hardened for 24 hours to be used in hardness determinations, stability tests, and scoring.

Processing the ice cream mixture decreased the size of the fat globules and caused clumping to occur. An increase of the pressure on the first valve of the homogenizer resulted in an increase in surface tension and viscosity of the ice cream mixture. When the pressure was increased on the second valve of the homogenizer, the viscosity was not always increased. Increased applications of pressure on one or both valves of the homogenizer resulted in a greater ease of air incorporation

when the mixture was frozen. The temperature of the cream, when drawn from the freezer, was lowered by an increase in the milk solids-not-fat content, resulting in a smoother ice cream which was more resistant to summer temperatures. The ability of an ice cream to withstand a summer temperature was reduced by processing, while the flavor, body, and texture were improved.

The Effect of Different Homogenization Pressures on Ice Cream When the Percentage of Fat is Varied (W. H. E. Reid, E. R. Garrison).—Ice cream mixtures containing 10, 12, 14, and 16 per cent fat and a milk solids-not-fat, sugar, and gelatin content of 11, 13, and one half of one per cent, repectively, were processed at different pressures with a Gaulin two-stage homogenizer subsequent to being pasteurized at 65.55 degrees Centigrade for 30 minutes. Samples were obtained from each differently processed mixture, to be used for viscosity, surface tension, and microscopic study.

After aging for 24 hours, 52 pounds of each sample were frozen. Samples were taken at the freezer, and hardened for 24 hours, to be used in hardness determinations, stability tests, and scoring.

Homogenization of an ice cream mixture disintegrated the fat globules, thereby increasing the surface area of the fat. An increase in the fat content of the ice cream mixture increased its viscosity and surface tension. Homogenization of the ice cream mixtures caused them to be more receptive to the incorporation of air and lessened the stability of the ice cream at summer temperature. There was no relation between the length of time of freezing and the quality of the resulting ice cream, when drawn at the proper consistency. When the fat content of an ice cream was increased, and the solids-not-fat held constant, the pressure judged as producing the best quality ice cream decreased. A simultaneous increase of pressure and decrease of the fat content and maintenance of the solids-not-fat at a constant did not produce an ice cream comparable to a product manufactured from a mixture containing a higher percentage of fat.

The Effect of Freezing on Milk and Cream (W. H. E. Reid, E. R. Garrison).—Milk often becomes frozen in transportation and this investigation was started to determine the effect this condition produces on the physical and chemical properties of milk.

Treated and untreated samples of milk were studied to determine the effect of freezing on the viscosity, surface tension, specific gravity and emulsion of fat as shown by the micro-photograph.

Pasteurization of milk reduced the milk globules and decreased the surface tension. The surface tension of milk exposed to freezing increased as the freezing temperature was decreased and the time of exposure prolonged. The exposure of milk to different freezing temperatures

increased its viscosity and caused the milk fat to form into clumps. The extent and the severity of the clumping was in direct relation to the temperature at which the milk was frozen and the length of the freezing period. The length of the cream column was decreased when exposed to freezing temperatures before and subsequent to pasteurization, the decrease becoming greater as the length of the exposure to freezing temperatures was prolonged.

Fetal Development of the Mammary Gland in Dairy Cattle (C. W. Turner, E. C. Elting, Warren Gifford).—This investigation has involved the histological examination of a graded series of about 100 male and female cattle embryos and fetuses. The collection ranged from 0.8 centimeters to 2.4 centimeters in length. In an embryo 1.7 centimeters long, milk lines were observed. This is the first time milk lines have been reported in cattle embryos.

The milk line in cross section appeared as a thickening and condensation of the epidermal cells. Its length was much less than that reported in mammals having abdominal glands. The milk lines were symmetrically placed and ran parallel to the axis of the embryo. At intervals along the milk line lens-shaped thickenings developed by an increase in the rows of epidermal cells. With this development the streak between gradually disappeared, leaving only the "mammary buds". This lens-shaped thickening enlarged into a spherical mass with a sharply differentiated basement membrane. The full growth of the bud was completed in the embryos of 5 centimeter length or two months of age.

The mesenchyme around and at the sides of the mammary bud now grew very rapidly, carrying the bud upward as a projection above the surface of the embryo. There was also a thickening and development of the form of the udder at this time.

When the embryos were between 10 and 12 centimeters long (about 11 weeks of age), a new growth took place from the base of the mammary bud. This solid ingrowth of the epithelial cells was called the primary sprout and formed, as it lengthened out, the future excretory duct, the teat cistern, and the gland cistern. By the time the embryo was nineteen or twenty centimeters long, the primary sprout began to open up at the proximal end to form the gland cistern. From the cistern secondary sprouts developed which grew upward into the mesenchyme to form the main duct system of the future gland.

The primary sprout differentiated into the strichcanal, the teat cistern, and the gland cistern. The short beginning part of the primary sprout became the strichcanal. It remained narrow after canalization. The second portion of the primary sprout showed a tendency toward an active dilation, beginning at the upper end and proceeding toward the part located in the teat. This dilation continued to the completion of a

cavity which remained somewhat narrower in the teat part than in the gland part. From this stage until birth the changes were chiefly growth, rather than development.

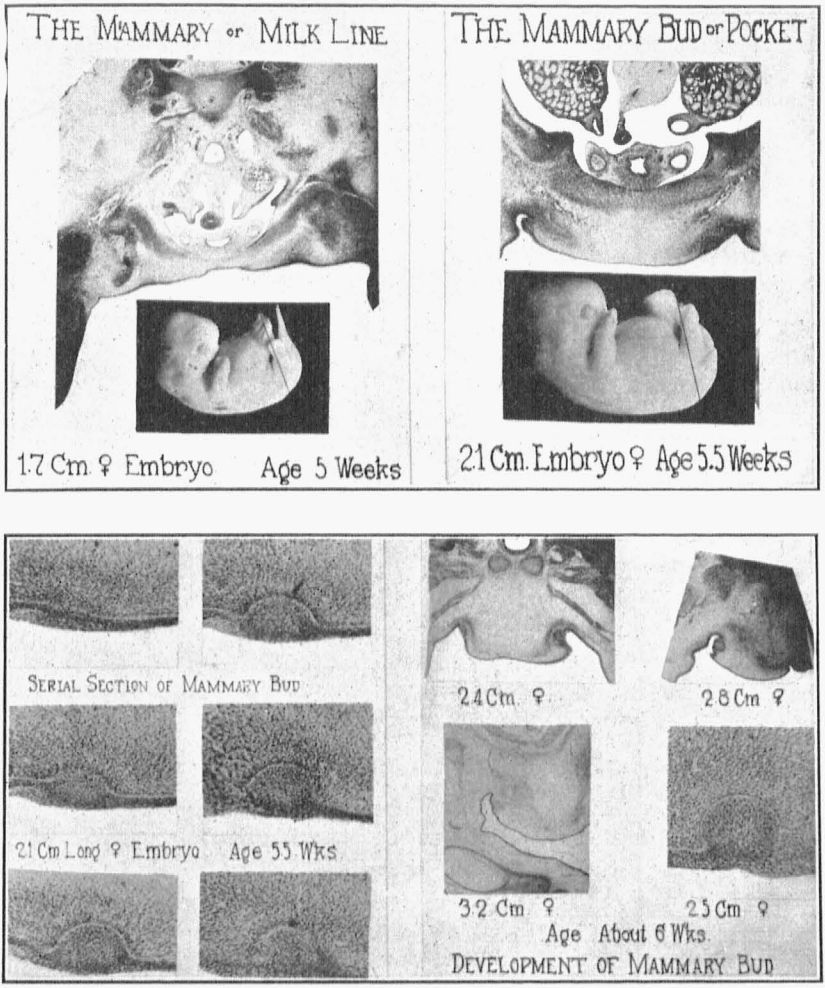


Fig. 6.—Fetal development of the mammary gland in cattle. Upper left: The mammary or milk line in embryo 1.7 cm. long (age 5 weeks). Upper right: The mammary bud or pocket in embryo 2-1 c.m. long (5.5 weeks). Lower left: Serial section of mammary bud in embryo 2.1 c.m. long (5.5. weeks. Lower right: Development of mammary bud in embryos 2.4 to 3.2 c.m. long (age about 6 weeks).

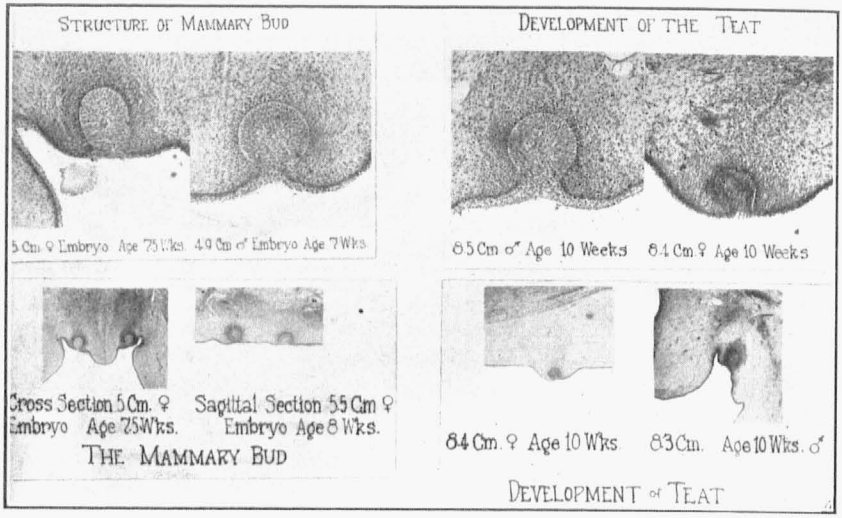
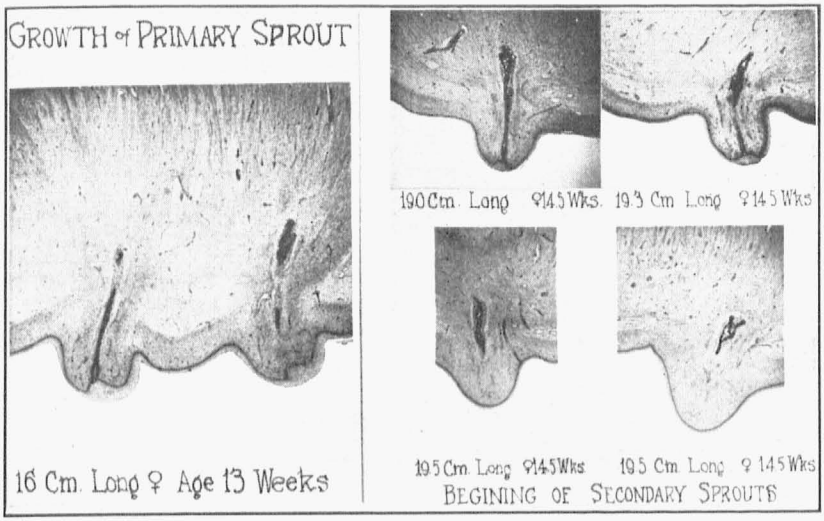


Fig. 7.—Fetal development of the mammary gland in cattle. Upper left: Structure of the mammary bud in embryo 5 c.m. long (7.5 weeks of age), and in embryo 5.5 c. m. long (8 weeks of age). Upper right: Development of the teat in embryos 10 weeks of age. Lower center: Development of the primary sprout in embryo 11.5 weeks of age.



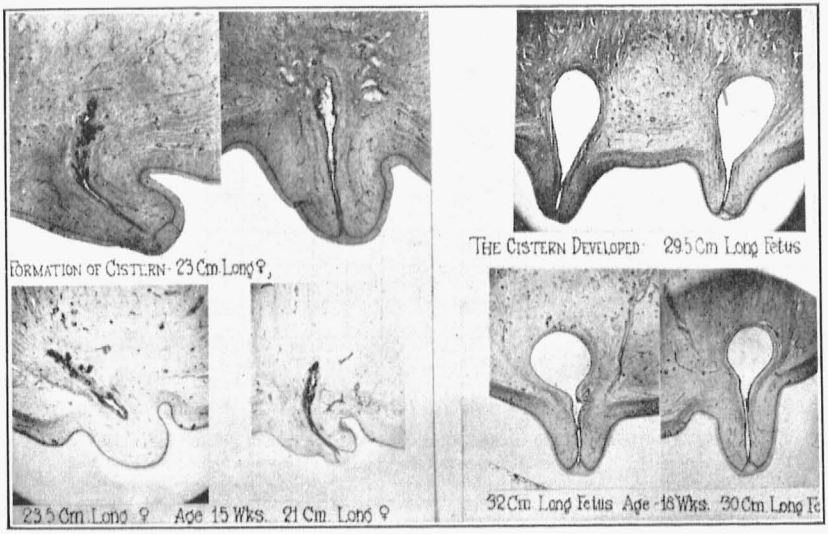


Fig. 8.—Fetal development of the mammary gland in cattle. Upper left: Growth of primary sprout in embryo 16 c.m. long (13 weeks of age). Upper right: Beginning of secondary sprouts in embryos 14.5 weeks of age. Lower left: Formation of cistern at 15 weeks. Lower right: The cistern developed at 18 weeks.

The Relation Between Live Weight and Yearly Fat Production (C. W. Turner, E. C. Elting, Warren Gifford).—A study based on 2,700 records showing the relation between age, weight, and fat production of Guernsey cows, has been made. The increase of fat secretion with increasing body weight with age was determined in the form of a regression equation:

GUERNSEY BREED

Yearly Fat production = 0.77 weight — 304.7 pounds

JERSEY BREED

Yearly Fat Production = 1.04 weight — 472.3 pounds

The Jersey breed equation is given for comparison. An increase of 100 pounds in live weight accompanying age gave an increase of 77 pounds of fat per year above 304.7 pounds.

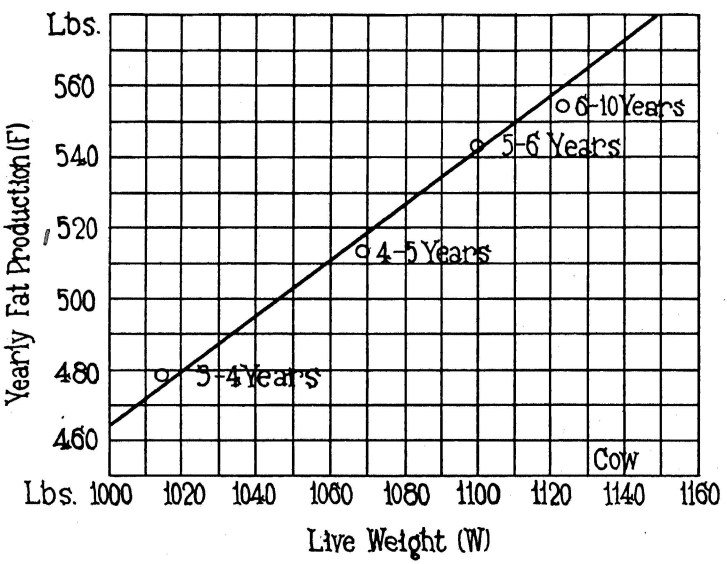
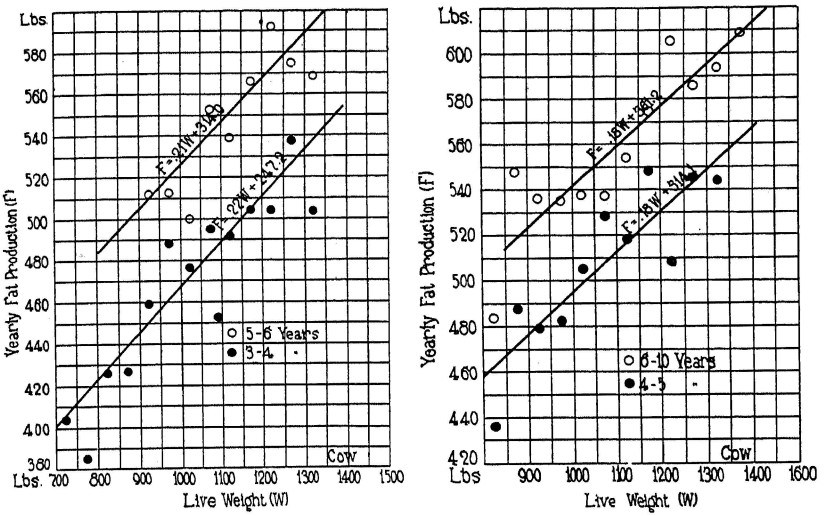


Fig. 9.—The increase of yearly fat secretion with increase in age and live weight in Guernsey cattle. The line passing through the observed values was fitted by the method of least squares. With the determinations of the parameters, the equation takes the form $F = 0.77\ W - 304.73$, in which F is the yearly fat production for any live weight W. This equation indicates that with an increase of 100 pounds in live weight accompanying age there is an increase of 77 pounds of fat per year above 304.73 pounds. The corresponding equation for the Jersey breed was $F = 1.042W - 472.32$.

A study of the relation between the production of animals varying in live weight at the same age was made. For each increase of 100 pounds in live weight there was an approximate increase of 20 pounds in yearly fat production.



Figs. 10 and 11.—The increase of milk secretion with increasing body weight at constant age. The smooth lines passing through the observed values were plotted from the equation $F = aW + b$ in which F is the yearly milk fat production for the body weight (W) at the constant ages indicated on the curves; a is the constant increase of yearly fat production for each added pound of body weight. From the values of a indicated on the curves, an increase of 100 pounds in the weight of the body is accompanied by an increase of about 20 pounds of milk fat product on per year.

Initiation of Milk Secretion in Non-pregnant Heifers (C. W. Turner, E. C. Elting, Warren Gifford).—Only very slight changes occurred in cattle in the development of the mammary gland from birth to puberty. From puberty until the beginning of pregnancy cell division was observed in the epithelial cells of the mammary gland during the recurring heat periods (oestrus). At each recurring heat period there was usually a noticeable increase in the secretion of milk. During the interval between, the production usually reached at the heat period was maintained. It was possible to induce a considerable secretion in virgin heifers which approached normal milk in composition and appearance. The initiation of this secretion is believed to be due to a hormone which has been isolated from the ripe follicle of the ovary.

Milk Secretion During the First Pregnancy (C. W. Turner, E. C. Elting, Warren Gifford).—Regular milking throughout pregnancy has shown two interesting facts. There was a lack of any further increase in secretion for a considerable period after breeding. There was a significant increase in milk secretion starting from 20 to 40 days before calving. The yield of milk gradually increased so that at calving time from 10 to 20 pounds per day was being produced.

The Quantity of Milk Present in the Udder at Milking Time (C. W. Turner, E. C. Elting, Warren Gifford).—An injection of pituitary extract was made in three cows 30 minutes before killing the cows. In each case the udder was removed and milked. One cow gave 10.7 pounds of milk as compared with 10.5 pounds of milk at the corresponding milking time previous to her death. Another cow gave 10.5 pounds as compared with 15 pounds. The third cow gave 8.3 pounds post-mortem production as compared with 12.7 pounds. Pituitary extract was not of great value in obtaining a larger post-mortem yield.

The Effect of Pituitary on Milk Yield (C. W. Turner, E. C. Elting, Warren Gifford).—Varying amounts of an extract of the posterior lobe of the pituitary body were injected into a cow immediately at the close of the regular evening milking. The cow was then remilked 30 minutes later. With 2, 4, and 6 cubic centimeters of extract, the yield of milk obtained was 233 cubic centimeters, 504 cubic centimeters, and 870 cubic centimeters. The injection of a larger amount did not further increase the yield of milk. One-half cubic centimeter per 100 pounds live weight produced maximum effect. Increasing amounts of pituitrin decreased the yield at subsequent milkings.

The inhibitory effect of 10 cubic centimeters of pituitrin lasted approximately 9 hours. Pituitrin had no effect on any of the constituents of milk except the fat percentage which was much higher after the injection.

Ovarian Grafts in Male and Female Calves (C. W. Turner, E. C. Elting, Warren Gifford).—To test the theory as to the source of stimulation for the growth of the mammary gland and of milk secretion a Guernsey bull was castrated at the age of 7.5 months and a Jersey heifer was spayed. One ovary was split open and grafted into the muscle of the neck of the male and the second ovary was grafted into the neck of the heifer from which it was obtained. The grafts healed quickly without infection. No obvious development of the glands has resulted to date.

The Relation of Conformation and Anatomy of the Dairy Cow to Her Milk and Butterfat Producing Ability (C. W. Turner, E. C. Elting, Warren Gifford).—Five dairy animals of known producing ability of each of the Jersey, Holstein, and Ayrshire breeds were slaughtered. Complete weights and measurements of the carcasses and of the vital organs were taken. Records on but nine animals are available. This number is insufficient to warrant definite conclusions. There is a close relationship between the depth of the chest and the weight of the lungs and heart, but very little relationship between the width and length of the chest cavity and the size of these organs. There was a considerable variation in the size of the various organs in different individuals.

The Anatomy of the Cistern and Duct Systems in the Mammary Glands of Dairy Cattle (C. W. Turner, E. C. Elting, Warren Gifford).—The form of the cistern and ducts in the mammary glands of cattle has been studied by making injections into five animals which have been slaughtered. A number of different injection fluids have been tried including paraffin, plaster of paris, cellodin dissolved in acetone, Wood's alloy, and equal parts of beeswax and resin. Beeswax and resin have given the best results for the duct systems.

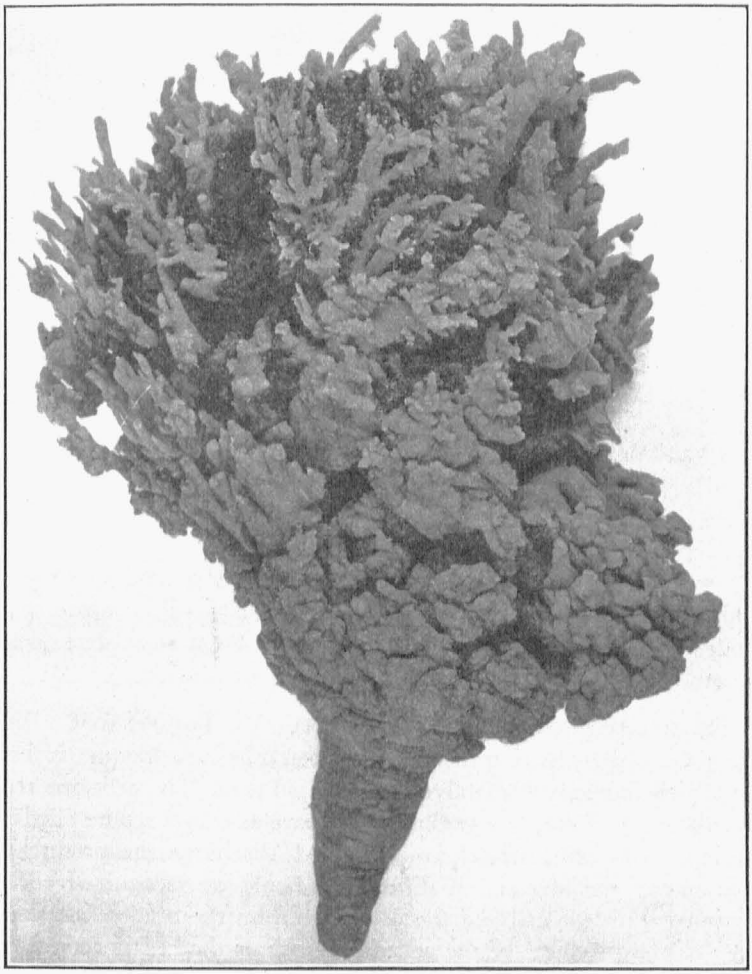


Fig. 12.—Cistern and duct system of the mammary glands of cattle Cast composed of beeswax and resin. (Seven-tenths natural size.)

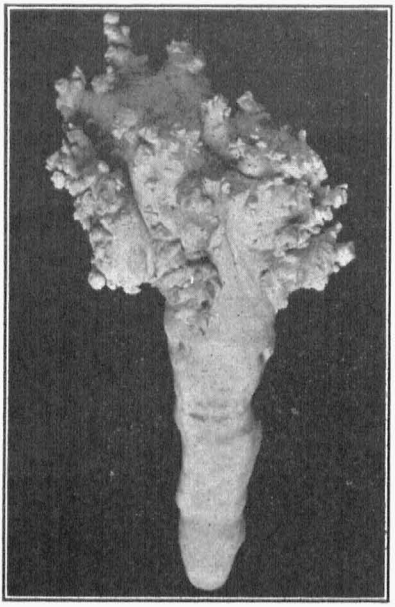


Fig. 13.—Plaster of Paris cast of the cistern system of the cow udder. (One-half natural size.)

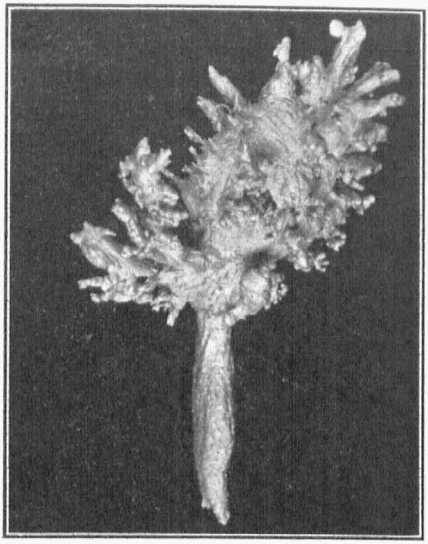


Fig. 14.—Wood's metal cast of the cistern system of the cow. (Six-tenths natural size.)

Stimulating Milk Secretion (C. W. Turner, E. C. Elting, Warren Gifford).—A dry cow producing about 0.3 of a pound of milk per day was fed ground placenta and the yield of milk increased to 2.1 pounds. Three days later a larger amount of placenta was fed at one time. There was not much change in the yield of milk. Nine days later seven pounds of placenta were fed. Two days later the yield of milk jumped to four pounds. The increase in the yield of milk up to the present time does not seem sufficient to permit drawing any definite conclusions.

Physiology of the Milking Process (C. W. Turner, E. C. Elting, Warren Gifford).—During the time between milkings the milk is formed in the epithelial cells of the alveoli at a rapid rate. The cells are at first low, cuboidal in form, but gradually elongate as they become filled with secretion. The cells, after becoming filled, discharge the product into the lumen of the alveoli. A difference should be recognized between secretion within the cell and the discharge from the cell. With the discharge of the products of the cell the height of the cell is reduced and the cell becomes ready for another period of secretion. As the fine capillary tubes, the larger milk ducts, and finally the cistern of the gland become filled with milk the pressure gradually increases and the

cells have greater and greater difficulty in discharging their contents. A change then occurs in the method of discharging the contents. Only the constituents of milk which are soluble in water pass out as they are formed. The fat, casein, and possibly other constituents remain behind in the cell. This causes a change in composition of milk as the interval between milkings lengthens.

At milking time the cistern, duct system, and the lumen of the alveoli are filled with milk which is low in fat and the other constituents mentioned, and the cells of the gland are filled with a secretion higher in fat content. With milking, the cells gradually discharge their contents as the pressure decreases. The last milk removed is thus richer in fat than the first.

With milking, a nervous reflex causes a contraction of the muscle elements of the gland. This forces the contents of the lumen and fine capillary ducts into the larger ducts. Smooth muscle elements in the larger ducts are arranged longitudinally, which upon contraction, shortens the ducts, and forces the milk into the cistern. Extremely rapid milking at this time promotes complete milking. After a period of time the relaxation of the muscular elements occurs and milk not yet removed is drawn up in part to the capillary ducts and can not be removed. There is probably always a considerable quantity of milk which can not be removed under ordinary conditions.

The Size of Fat Globules in Milk (C. W. Turner, E. C. Elting, Warren Gifford).—A method of measuring the size of fat globules in milk has been developed by employing microphotographs. A rapid enumeration of the globules in the picture can be made by comparison with a transparency having a graduated series of holes.

Seventy-five samples of milk were studied and the size of over 21,000 fat globules determined. The mean diameter of 2727 fat globules in Jersey milk was 3.34 micra, with a standard deviation of 1.33 micra; of 14,853 fat globules in Holstein milk, 2.5 and 1.19 micra; and of 3490 fat globules in Ayrshire, 2.34 and 1.16 micra.

ENTOMOLOGY

L. Haseman, *Chairman*

An Investigation of Various Insecticides (L. Haseman, K. C. Sullivan).—It is the purpose of this project to develop new types or to improve types of insecticides and to test the efficiency of new commercial materials as they come on the market so as to be able to advise farmers and fruit growers as to the value of these materials.

During the year an unusually large number of new insecticides appeared on the market and the department has made tests on thirteen of these and is able to advise Missouri farmers as to their value.

An Investigation of the Codling Moth (L. Haseman).—For three years codling moth infestation has been unusually serious, but has now shown a definite tendency to subside. The use of sprays timed according to the dates of moth emergence has undoubtedly been one factor aiding in the reduction of the pests to normalcy. The breeding of the pest and the emergence of the spring brood of moths also returned to normal and the cause of this has not been determined. A considerable percentage of the over-wintering worms failed to emerge as moths, due in part to the work of fungus and bacterial diseases. Due to unfavorable weather at emergence time the moths of the spring brood laid fewer eggs than usual this spring.

Mosquitoes in Missouri (K. C. Sullivan).—A number of species of mosquitoes found in Boone county have been collected and studied. Over forty species have been found and identified in Missouri. The *Anophelene* or malaria bearing mosquitoes are not common in Boone county. The common mosquitoes found in Boone county belong to the genera *Culex* and *Prophora*.

The Effect of Heat Upon Insects and Seeds (K. C. Sullivan).—Heat was used at different temperatures and for different periods of time on the following insects: pea weevil, rice weevil, red rust flour beetle, bean weevil, codelle, museum pest, confused flour beetle, dark meal worm, Angoumois grain moth. Their ability to stand heat varied to some extent. A temperature of 125°F. maintained for a period of 24 hours was sufficient to kill all the insects tested in all the different stages. Twenty different kinds of seed were tested. The seeds were able to stand 140°F. for a period of 24 hours without injury.

Effect of Carbon Bisulphide Upon Insects and Seeds (K. C. Sullivan).—One pound of CS_2 per 500 cubic feet of space at a temperature of 90°F. and in a tight container was sufficient to kill all insect life in 24 hours. Seeds were able to stand one pound of CS_2 per 25 cubic feet of space without injury.

Effect of Paradichlorobenzene Upon Insects and Seeds (K. C. Sullivan).—Paradichlorobenzene used at the rate of 1 pound per 100 cubic feet for a period of 48 hours was sufficient to kill all insect life. Used at the rate of 1 pound to 1 cubic foot of space caused no injury to seeds.

Control of the Strawberry Crown Borer (K. C. Sullivan).—The habits of the strawberry crown borer have been found to render control measures very difficult.

The following biological facts have been determined: The insect passes the winter as an adult in the trash and soil in the strawberry beds. On warm days during the winter feeding may occur. Fertilization occurs in March. Considerable feeding is done before egg deposition takes place. This is an important factor, as a spray applied at this time will help greatly in their control. The adults may live and continue to deposit eggs throughout the spring and into July and August. During this entire period the adults do considerable feeding on the foliage.

A badly infested strawberry field in Southwest Missouri was found to harbor 3⅓ adults per foot of row, or approximately 33,989 adults per acre.

Control work is being carried on in two heavily infested areas in Southwest Missouri. Arsenical sprays applied in March and April materially reduced the damage caused by this insect.

The following sprays were used:

Dust—85 lbs. hydrated lime, 15 lbs. arsenate of lead.

Liquid—50 gals. water, and two lbs. arsenate of lead.

Two plots received four applications and two plots two applications of each.

The average yield of the sprayed plots was 258 quarts of berries per acre more than the unsprayed.

Dust Spraying for the Control of Apple Insects (K. C. Sullivan).—This project has been carried on in the Riverview Orchards at McBaine, Missouri, on a commercial scale. Each plot contained about fifty trees. Dust sprays drift to such an extent that it is practically impossible to secure accurate results on small plots. The following dusts have been used in addition to the regular liquid sprays.

Copper Dust	Copper sulphate 20%	Arsenate of lead 10%
Copper Dust	Copper sulphate 28%	Copper arsenite 15%
Sulphur Dust	Arsenate of lead 15%	Superfine dusting sulphur 85%

These dusts have been used in two ways. (1) Straight. (2) As a supplement to the regular liquid sprays.

The time of making applications has been based on the emergence records of the codling moth. The 1928 schedule is shown in Table 18.

The 70-20-10 copper dust used early in the season caused very serious burning. This was probably augmented by the prevailing weather conditions. The dust sprays apparently controlled the insects just as well

TABLE 18.—DATES AND SPRAYS USED

Date	Plot I	Plot II	Plot III	Plot IV	Plot V
4/10/28	Copper 70-20-10	Sulphur 85-15	Regular Liquid	Regular Liquid	Regular Liquid
5/ 1/28	Copper 70-20-10	Sulphur 85-15	Regular Liquid	Regular Liquid	Regular Liquid
5/ 8/28	Copper 70-20-10	Sulphur 85-15	Regular Liquid	Regular Liquid	Regular Liquid
5/23/28	Copper 70-20-10	Sulphur 85-15	Regular Liquid	Regular Liquid	Regular Liquid
6/ 7/28	Copper 70-20-10	Sulphur 85-15	Sulphur 85-15	Copper 57-28-15	Regular Liquid
6/ 9/28	Copper 70-20-10	Sulphur 85-10	Sulphur 85-15	Copper 57-28-15	Regular Liquid
7/ 7/28	Copper 70-20-10	Sulphur 85-10	Sulphur 85-15	Copper 57-28-15	Regular Liquid
7/14/28	Copper 70-20-10	Sulphur 85-10	Sulphur 85-15	Copper 57-28-15	Regular Liquid

as the regular liquid spray of lime sulphur and arsenate of lead. The dust sprays covered the foliage better, but did not stick as well. Chemical analysis also verified this conclusion.

Grams of As_2O_3 per square inch on foliage

Seven days after application
Copper dust .242
Sulphur dust .103

Fifteen days after application
Copper dust .112
Sulphur dust .0424

Liquid spray, lime sulphur and arsenate of lead

Five days after application
.239 Gr. As_2O_3 per square inch

Twenty-one days after application
.237 Gr. As_2O_3 per square inch

The lethal dose for a codling moth larvae is *.005 grams*. It may be possible to eliminate the spray residue problem by using dust sprays for the late summer applications.

Prevalence of Insects Injurious to Nursery Stock in the State (L. Haseman).—The following insect pests were found in nurseries to the extent indicated in Table 19.

TABLE 19.—PREVALENCE OF INSECT PESTS IN NURSERY STOCK

Leaf folders	60 reports	San Jose scale	18 reports
Leaf hoppers	55 reports	Peach tree borer	11 reports
Wooly aphis	38 reports	Apple tree borer	8 reports
Tarnished plant bug	29 reports	Oyster shell scale	2 reports
Skeletonizers	23 reports	Scurfy scale	2 reports

With scattered records of other less important pests.

The Importance of Timing the Spray Schedule by the Dates of Codling Moth Emergence (L. Haseman).—The investigation has been conducted at Marionville in the Jonathan orchard of I. D. McCullah, at St. Joseph in the Jonathan orchard of the Connett Estate, at Mountain Grove in cooperation with the Missouri Fruit Experiment Station. Six plots of apples one acre each were included in the Marionville and St. Joseph experiments. Two of these were straight dust plots beginning with the calyx application; two were sprayed with arsenate of lead and lime sulphur; one was treated with Volck and one received three sprays followed by two dust applications. In these orchards and at Columbia breeding cages were run to follow moth emergence closely, so as to properly time the spray applications. Chemically treated and dry tree bands to attract and kill apple worms when they spin upon the tree trunks have been tested. Table 20 shows the tree counts on first brood worms made the first week in July.

Table 20.—Tree Counts of First Brood Worms First Week in July

Plot No.	Treatment	No. applications	Percentage worms Marionville	Percentage worms St. Joseph
1	2 lbs. ars. lead, 3 gal. lime sulphur, 100 gal. water	4	0	0
2	4 lbs. ars. lead, 3 gal. lime sulphur, 100 gal. water	4	0	?
3	Volck	4	1.5%	1%
4	Same as No. 1 but to receive two July dustings	4	4%	0
5	90-10 sulphur lead dust	4	7%	0
6	Copper-lime-lead-dust	4	8%	0
Check	Dusted orchard	0	9%	0

The moths of the spring brood began to emerge almost on time, rapidly increased to a peak around the 20th to 25th of May and a few stragglers followed later. Such emergence makes control easier. The same thing occurred at St. Joseph except a few days later than at Columbia. At Marionville because of late snow the blossoms were behind those at Columbia. However, the moths began emerging at the same time.

A first peak of moth emergence occurred at the same time as at Columbia but the moths continued to emerge in small numbers for nearly a month, when on June 17 to 20 a second peak occurred. This made control difficult and worms from eggs of the June peak entered the

apples at Marionville in alarming numbers on check and poorly sprayed, or dusted plots. No considerable numbers of worms had spun up under either treated or untreated bands.

FIELD CROPS

W. C. ETHERIDGE, *Chairman*

Corn Breeding (L. J. Stadler, R. T. Kirkpatrick).—The inbreeding of corn varieties and the crossing of inbred strains were continued on a more extensive scale. About 180 strains inbred from two to nine generations are included in this investigation. Two hundred fifty single-cross and double cross hybrids were produced for comparison with standard corn varieties.

A new series of inbred strains was selected with special reference to qualities important under corn borer infestation. The type sought is a stocky, vigorous hybrid able to mature a large yield from late planting. Fifty well known productive stocks of medium early varieties were planted and a small number of exceptional plants were selected for inbreeding. About 200 of these inbred strains will be continued.

At Golden City, Barton county, and Grain Valley, Jackson county, preliminary yield tests of first generation hybrids and commercial varieties were begun. At Golden City, an isolated detasseling field was used in producing hybrid seed in quantity for yield tests.

Selected Missouri stocks of standard varieties were compared at Grain Valley to determine their relative value. Of thirty-two stocks tested, the yields varied from 37.2 to 79.8 bushels to the acre.

A "Commercial Yellow" variety was produced at Golden City, in order to combine the desirable qualities of Commercial White with the superior feeding quality of yellow corn. This was done by mass selection and detasseling methods. The production of a pure breeding yellow strain otherwise practically identical with Commercial White will require six years.

A Genetic Analysis of Maize (L. J. Stadler, R. T. Kirkpatrick).—Studies of variation in crossing over in the *C-Sh-Wx* region in maize were continued with special attention to genetic differences between families and individuals, and to the effects of X-rays on cross-over frequency. The results have been published in part in an article appearing in the Proceedings of the National Academy of Science, Volume 14, pages 69-75, 1928.

The chromosome aberration resulting in mosaic endosperm was greatly increased in frequency by X-ray treatment.

The normal frequency of mutation of eight genes for endosperm characters in maize, *R*, *C*, *Pr*, *I*, *Y*, *Su*, *Sh*, and *Wx*, was determined

on an extensive scale by the method described in Missouri Agricultural Experiment Station Bulletin 256, 1927. Apparent mutations of seven of the eight genes were found. No mutations of *Wx* occurred in untreated plants, among more than one million germ cells tested.

The attempt to induce mutation by X-ray and radium treatment of barley, as described in Missouri Agricultural Experiment Station Bulletin 244, pages 38 and 39, 1926, was successful.

Wheat Breeding (L. J. Stadler, R. T. Kirkpatrick).—Eighteen leading varieties of wheat and selected strains of wheat were compared at Columbia.

Highest Yielding Varieties	Bu. per acre	Highest Yielding Selections	Bu. per acre
W29 Michigan Wonder	23.5	W31 Selection from Michigan Wonder	27.2
W104 Kanred	23.0	W529 Selection from Harvest Queen	26.0
W23 Harvest Queen	21.4	W87 Selection from Mediterranean	26.0
W49 Poole	21.1	W43 Selection from Michgan Wonder	24.7
W333 Currell	20.8	W84 Selection from Fulcaster	24.7

Two groups of new selections were tested in nursery plots in comparison with check plots of W84, a productive Fulcaster selection. A group of 126 Fulcaster pure lines selected in 1923 from fifty stocks of Fulcaster wheat previously studied and reported on in Missouri Agricultural Experiment Station Bulletin 244, page 37, gave average yields varying from 13.7 to 36.4 bushels to the acre. The check plot of W84 yielded 28.4 bushels to the acre.

Sixty-three pure lines of May wheat selected in 1925 gave yields of 22.0 to 35.3 bushels to the acre. Check plots of W84 averaged 24.8 bushels to the acre. The wheat from which these lines were selected is a beardless, brown-chaffed, soft wheat extensively grown in Platte county, Missouri. It matures about one week earlier than standard wheat varieties, yields well and is resistant to loose smut. Some of the selections seem extremely promising.

Variety, Rotation, and Fertilizer Experiments with Grain Sorghum on Outlying Experiment Fields (C. A. Helm, B. M. King).—On the Stark City experiment field, in a test of varieties of grain sorghum located on soil below the average of the field in fertility, the three leading varieties of grain sorghum yielded an average of 30.6 bushels of grain to the acre. The three leading varieties of corn yielded 21.4 bushels to the acre.

At Cuba, Sunrise kafir in a manured and fertilized rotation with soybeans, wheat and alsike clover yielded a four-year average of 19 bushels of grain to the acre. Sunrise kafir grown continuously on similar land during the same period yielded only 9 bushels to the acre. At Shelbyville, Sunrise kafir grown in a manured rotation with oats, orchard grass and alsike clover yielded an average of 36 bushels of grain

to the acre. In the same rotation but without manure the average acre yield was 24 bushels.

A Comparison of Grain Sorghums with Corn for Grain Production on Outlying Experiment Fields (C. A. Helm, B. M. King).—At Stark City, corn in a manured, limed, and fertilized rotation of crops including clover, produced an average of 30.7 bushels of grain to the acre. Sunrise kafir in a similar rotation, without lime or manure but including a fertilizer treatment to the wheat crop, yielded 16 bushels to the acre.

At Shelbyville corn in a rotation given the soil treatments adapted to local conditions, gave acre yields averaging 31.5 bushels. Sunrise kafir under similar conditions yielded 35.6 bushels to the acre.

Variety Tests with Cotton on Outlying Experiment Fields (C. A. Helm, B. M. King).—Experiments in cotton production in the Southeast Lowlands in 1927 were limited to a single soil type because excessive rains and floods made broader investigations impossible. In a variety test conducted on rich, heavy soil at Hayti, the superiority of Delfos for this type of soil was demonstrated for the fourth successive year. Among the group of short staple varieties, Mississippi Station Trice gave the highest acre yield. The results of the test are recorded in Table 21.

TABLE 21.—YIELDS OF DIFFERENT COTTON VARIETIES AT HAYTI, MO.

Variety	Pounds lint per acre
Delfos	283
Express	258
Trice (Burdette Plantation)	226
Trice (Mississippi Station)	276
Acala	270
Mexican Big Boll	232
Cleveland (Wilson Type)	271

Spacing Cotton Plants for Best Yields on Outlying Experiment Field (C. A. Helm, B. M. King).—A test was conducted at Hayti to determine the distance that cotton plants should be spaced in the row to give maximum yields.

TRBLE 22.—PLANTING DISTANCES FOR COTTON

Spacing	Pounds lint cotton per acre
2-4 plants per hill with hills 10-12 inches apart	307
1 plant every 12 inches	338
1 plant every 18 inches	323

The highest yield was secured from plants spaced in hills twelve inches apart with one plant per hill. In close spacing the plants made a slender whip-like growth and because of the excessive moisture they

failed to fruit normally. In previous tests the highest yields have generally been secured from closer spacing.

Variety Tests with Soybeans (C. A. Helm, B. M. King).—The 64 selections of Midwest soybeans previously reported (Missouri Experiment Station Bulletin 236, p. 53) were again tested for yield, completing a four-year test. The yields in 1927 varied from 12.7 to 17.8 bushels per acre, and the average yields for the four-year period varied from 16.0 to 21.1 bushels per acre.

Sixty pure-line selections of Wilson soybeans, tested for yield of hay, varied from 3683 to 5038 pounds per acre (on the basis of 12 per cent moisture content).

Variety Tests with Oats at Columbia and on Outlying Experiment Fields (C. A. Helm, B. M. King).—Of 24 varieties tested, the highest yields were as follows:

Table 23.—Highest Yielding Varieties of Oats

Varieties	Yield in bushels per acre	
	1927	1924-27 incl.
0149 Fulghum	70.1	50.5
065 Fulghum (Kanota)	67.8	46.9
0964 Red Rustproof	66.9	----
0328 Selection from Burt	66.8	49.8
015 Burt	66.2	49.4
01375 Selection from Fulghum	63.7	53.0
01243 Selection from Kherson	61.7	----
0832 Burt	61.3	----

Selections were made in 1924 and 1925 from the 7 commercial stocks of Fulghum previously studied and reported in Missouri Agricultural Experiment Station Bulletin 229. A majority of Fulghum selections gave a badly mixed progeny, including various "off-types". Most of these off-types were inferior in yield but 01375, the best selection from Fulghum, was an off-type of high productivity. A group of 160 selections of distinct Fulghum type were tested in 1927 and gave yields varying from 34.9 to 58.6 bushels per acre.

The Fulghum variety was practically free from smut for several years after its introduction into Missouri, but is now showing increasing percentages of infection. All selections are now being tested for smut resistance.

In widely distributed variety tests over the State, Fulghum consistently stands at the top. For instance, at Stark City in 1927, a very unfavorable season locally, the yields of the leading varieties were, Fulghum 28.2 bushels, Kherson 22.0 bushels, Burt 20.4 bushels, Texas Red 20.0 bushels.

HOME ECONOMICS

MABEL V. CAMPBELL, *Chairman*

A Study of Temperature and Time of Cooking on the Quality and Palatability of Meat (Jessie A. Cline, Celia W. Craghead).—Standing rib roasts were used. Each roast included the ninth, tenth, and eleventh ribs in accordance with directions in the revised edition of the National Cooperative Project, February 1927.

The general procedure was as follows:

Each roast was wiped with a damp cloth, weighed, and the weight recorded. No seasoning was used and no water was added unless stated. The roasts were then placed in open pans suited to the size of each roast, being sure that at least three inches were left between the roast and the sides of the pan. The pan was then weighed and the weight recorded; the thermometer to be used was then weighed and the weight recorded. These three individual weights were then added and checked with the weight of the pan, roast, and thermometer weighed together.

In placing the roast in the pan, the fat side was placed up, with the rib ends and the chine bone resting on the bottom of the pan. The thermometer was then inserted through the center of the eye so that the bulb of the thermometer reached the center of the roast.

The roasts cooked at a constant temperature of 110°C. and at a constant temperature of 163°C. were the most palatable. Those seared at 260°C. for thirty minutes, water added and the cooking continued, or those cooked at a constant temperature of 260°C. were the least palatable. A low roasting temperature therefore seemed desirable as regards palatability. The shrinkage in those cooked at a constant temperature of 110°C. was slight, and the shrinkage increased with the increased doneness of the meat. High temperature seemed to reduce flavor, juiciness, and tenderness.

A low initial temperature of the roast before it was put into the oven increased slightly the shrinkage and the time required per pound.

Searing did not hold in the juices but increased the shrinkage and lowered the palatability.

The rising temperature of the roasts after removal from the oven was noticed depending upon the internal temperature at which the meat was cooked, and also upon the temperature of the oven.

From the standpoint of shrinkage, palatability, ease of execution, freedom from odor, smoke and undesirable heating of the room, a constant oven temperature of 163°C. was the most desirable method of cooking.

Influence of the Method of Preparation on the Vitamin B. Content of Spinach and String Beans (Margaret C. Hessler, E. Charlotte Rogers).

—Albino rats were used as experimental animals. The usual technique for the standard rat growth method supplemented with observations on neuritic symptoms was employed. The moist food products were used and portions were analyzed and then calculated to the dry basis for comparison. Distinction was made between the antineuritic F and growth promoting G vitamins as well as the evaluation of their combination vitamin B.

The foods tested were: I Yeast; II Spinach, (1) raw, (2) open-kettle cooked 7 min. and 15 min., (3) home canned by method described in U. S. D. A. Farmers Bulletin 1476, and (4) commercial canned; III Green beans, (1) raw, (2) open-kettle cooked for 15 min., (3) home canned and (4) commercial canned; IV As vitamin F supplements to the spinach and beans, (1) whole wheat, and (2) corn concentrate prepared by Goldberger's method.

Cooking reduced the content of water soluble B vitamin in spinach. The vitamin B losses as measured by the growth unit were 33 - 41 per cent for that cooked seven minutes in the open kettle, 46 - 51 per cent for the fifteen minute cooked product. Losses in canning by household methods were 60 - 63 per cent, and 77 - 81 per cent in the commercial product. How much of this loss was due to the reduced amount of the F factor can not be stated quantitatively at this time.

Raw beans contained less F than raw spinach. Open kettle cooking and home and commercial canning do not appear to affect the content of G in string beans but do reduce the F content.

Vitamin C Content of Spinach and Jonathan Apples (Margaret C. Hessler, Georgya Craig).—Guinea pigs were used in testing the vitamin C content of spinach and Jonathan apples. These animals were started on the experiment without a fore period on a vitamin C free diet. The basal diet was that of Sherman and LeMer and did not include cod liver oil. The animals were exposed daily to the rays of a quartz mercury vapor arc.

Apples

When tested from September to December, twenty grams of raw apple did not appear to contain quite a unit of vitamin C. From December to February, 30 to 40 grams afforded approximately the same degree of protection from scurvy.

Spinach

Unit for fresh raw.....5 - 7 grams
Open-kettle cooked (15 min.)....more than 15 grams
Commercial canned.....7 - 9 grams

When calculated on the dry basis this apparent difference between the fresh and commercial canned product disappeared but that cooked in

the open kettle remained one-third to one-fourth as rich as the other two.

The Antiscorbutic Property of Apple and Rhubard (Margaret C. Hessler, Zulu Williams).— The purpose of this investigation was to determine the antiscorbutic property of apple when made into sauce by various methods which might be practical for household use. Comparisons were also made with rhubarb canned in different ways.

Guinea pigs were used as the test animals and the routine of feeding and care followed that of Sherman (1922). The basal diet was that used by Hogan. The animals were placed on the basal diet for from 7 to 14 days before the foods tested were fed. The amount of each of the test foods which would protect the guinea pig from scurvy was determined.

Twenty grams of raw apple seemed protective from November to January. New sauce from these apples seemed to be very nearly worthless as an antiscorbutic, while 25 grams of apple treated with salt solution and sterilized in glass jars contained considerably less than a protective dose. Evidence with respect to the addition of acid is conflicting. Twenty-five grams of an apple sauce (p_H 3.54) made by adding 0.056 grams citric acid to 20 grams apple was just short of the protective dose. Twenty grams of a sauce made by combining 0.8 c.c. of lemon juice with each 20 grams apple, thereby adding about one-third of a protective dose from the lemon, gave almost no protection after 15 minutes of open-kettle cooking.

Twelve grams of open-kettle canned rhubarb gave complete protection against scurvy after 4.5 months storage and was almost as effective after 15 minutes reheating. Sauce made, by 15-minute open-kettle cooking after 4.5 months storage, of rhubarb which had been canned in cold water seemed almost entirely lacking in vitamin C. No attempt was made to determine the minimum protective dose of rhubarb sauce with the acid partially neutralized before cooking (p_H 3.56). Fed at the high level of 25 grams per day it seemed to be no less potent than the untreated rhubarb (p_H 3.13) fed at the same level.

The Effect of Home and Commercial Laundering Upon the Wearing Quality of Ginghams and Similar Fabrics and the Reliability of the Consumer's Judgment in The Selection of These Fabrics (Adella Epple, Cleora Johnson).—A group of 18 ginghams and similar fabrics were laundered 45 times by home and commercial methods and tested after 5, 15, 30, and 45 launderings for thread count, weight, shrinkage, and tensile strength. Determinations for unit cost, weight, thread count, yarn number, yarn twist, sizing, and tensile strength were also made on the unlaundered materials. The materials were ranked according to wearing quality by two hundred consumers and their judgments were compared by laboratory tests.

The wear on ginghams and similar fabrics, as measured by tensile strength, was slightly affected by 45 launderings. The commercial method of laundering decreased the wear on ginghams, as measured by tensile strength after 45 launderings, slightly less than the home method.

The durability of fabrics can not be accurately predicted by tests on the unlaundered fabrics. Consumers need more reliable methods for judging wearing quality of ginghams and similar fabrics.

The Fastness of Color of Cotton Fabrics Guaranteed Fast to Laundry and Light (Jessie Coles, Margaret Kirkpatrick).—Tests have been developed to determine the degree of fastness of color of cotton fabrics to laundering and light. These tests were applied to cotton and rayon fabrics, 54 of which were guaranteed fast colors and 49 were not guaranteed (branded and nonbranded). Fabrics were classed as to their degree of fastness by using a graded scale.

None of the groups of fabrics were absolutely fast to laundering, but the guaranteed fabrics were decidedly superior to the non-guaranteed, and the branded were superior to the non-branded. None of the groups of fabrics were all fast to light. However, a higher percentage of the guaranteed than the non-guaranteed fabrics showed only very slight fading. Approximately the same number of branded and non-branded fabrics fell in the desirable grades, but a larger percentage of the non-branded fell in the undesirable grades. The guaranteed fabrics were decidedly superior to the non-guaranteed as to fastness of color and the branded were slightly superior to the non-branded fabrics. The majority of fabrics (approximately two-thirds of those tested) showed a very close correlation between fastness to laundering and to light. Some fabrics varied widely as to their fastness to laundering and to light. One-half of these were much more fast to laundering and the other half to light. The guaranteed fabrics were higher in price than the non-guaranteed, and the branded fabrics were considerably higher than the non-branded. Yellow showed the greatest degree of fastness; pink was more fast to laundering than to light; blue, yellow, lavender and green were more fast to light than laundering; pink and blue, quite generally, showed the same degree of fastness; lavender and green were consideraby less fast than the other three colors; green was consistently the least fast.

HORTICULTURE

T. J. Talbert, *Chairman*

A Study of the Factors Determining Hardiness in Bramble, Apple, and Grape Tissue (H. D. Hooker).—Samples of bramble tissue previously analyzed for moisture, nitrogen, total moisture and freezable moisture were analyzed for fat content. Samples of apple tissue and grape tissue

taken from plants receiving different hardening treatments were analyzed for moisture content and for carbohydrates. Fall applications of nitrogen fertilizers did not decrease hardiness. It is impossible at this time to state whether such applications increased hardiness.

Moisture determinations and microscopic examination showed that injury and death from low temperatures were not correlated with moisture content and occurred before all moisture had been removed from the cell. Death from low temperatures appeared to be determined by the rate of water loss from the cell and not solely by the amount of water retained. This explains the greater injury known to follow a rapid fall in temperature. This seems to give more importance to the water retaining capacity of the cell and the presence of hydrophilous colloids that retard water loss.

Sweet Cherries in Missouri (T. J. Talbert).—Investigations and surveys are being made throughout the State in an effort to secure, if possible, hardy productive sweet cherries. Cross-pollination is also being used in an effort to produce a sweet cherry for Missouri conditions.

The Home Orchard (T. J. Talbert).—A small orchard that can easily be maintained on the average Missouri farm for the production of Missouri fruits is now in its ninth year. Complete records of costs and returns have been kept. When the trees are twelve years of age it is believed that sufficient uniform and reliable data will be available to give definite information on the costs and returns from such a project.

Fertilizer Experiments with Apple and Cherry Trees and Grape Vines (H. D. Hooker and H. G. Swartwout).—A combination of fertilizer and pruning treatment has been applied to York apple trees. The results are not yet available but indications are that they will be very favorable.

In 1927 fall blooming occurred in cherry trees. Samples were collected for analysis to determine the nutritive conditions associated with this phenomenon. These samples are being analyzed.

Shoots of fertilized and unfertilized apple trees were girdled early in 1927, sampled 24 days later, and analyzed for fat and for nitrogen. Comparison with check shoots revealed a marked upward movement of fat during the spring which was interrupted by the girdling. In one hundred shoots 1.5 grams of nitrogen moved into the tips between April 2 and April 26. Movement of fat and nitrogen were closely correlated.

A nitrogen fertilizer was applied to bearing Concord and Moore grape vines at intervals in the fall of 1926 and the spring of 1927. Six Moore vines and twelve Concord vines were used in each plot, fall fertilized, spring fertilized and check. Samples were taken from the

canes of each plot during the winter and again after growth had started in the spring. Analyses were made of the total nitrogen and water soluble nitrogen. Sulphate of ammonia has been used in place of nitrate of soda in the experiments during the present year.

Fig. 15.—View between two rows in York orchard under experimental treatment. Trees on right have received regular applications of nitrate of soda; trees on left have been untreated.

Breeding Apples for Late Blooming Habit (A. E. Murneek).—One hundred seedlings of the following 1926 crosses are ready to be transferred to a permanent planting: Ingram-Delicious x Jonathan, Ingram-Delicious x Delicious, Ingram-Delicious x King David, Daru-Delicious x Jonathan, Daru-Delicious x Delicious, Daru-Delicious x King David. Additional crosses between some of the more desirable late blooming Daru x Ingram seedlings and standard commercial sorts were made in 1928: 117 x Jonathan, 120 x Jonathan, 122 x Jonathan, 112 x King David, 117 x King David, 120 x King David, and 122 x King David.

Peach Breeding for Hardy Sorts (A. E. Murneek).—New additions have been made to the collection of hardy varieties. A number of unnamed seedlings are now being developed. Comparative cold resistance, especially flower bud injury, has been determined on all of these varieties. As soon as this material comes into flowering it will be used for hybridization with the more popular commercial varieties. Further search is being made for desirable and hardy peaches in northern United States and in Canada.

Improved Walnut, Pecan and Filbert Varieties (T. J. Talbert, A. E. Murneek).—New varieties have been introduced. Some promising seedling pecans, hardy under Missouri climatic conditions, have been located and are being established on the Fruit Farm.

Improved varieties of black walnut are being studied with reference to ease of graftage, growth, age of profitable bearing, production, cracking qualities of nuts and character of kernels.

Almost all of the varieties of filberts in the experimental plot have withstood the climatic conditions of Missouri. They have made good growth and should come into bearing in one or two years. Additional varieties and some new species of *Corylus* have been secured through the office of the Plant and Seed Introduction Bureau of the United States Department of Agriculture.

Investigations with the Cantaloupe (J. T. Quinn).—Hales Best cantaloupe was the earliest variety grown, being eight days earlier than Polloch 10-25. No differences could be noted in results from cantaloupe seed produced in Florida, California, Colorado, and Missouri.

In the fertilizer test the largest yields were obtained where the 3-12-4 fertilizer (plus barnyard manure) was applied in the hill at the rate of 250 pounds to the acre. The fertilizer plots bore fruit over a longer period than the unfertilized plots. Clay pots and veneer "bands" used in starting the cantaloupes increased the percentage of early fruit but decreased the total yield.

Cabbage Strains Resistant to Cabbage Yellows *Fusarium Conglutinans* (J. T. Quinn).—Strains of Copenhagen Market cabbage resistant to cabbage yellows produced satisfactory crops on badly infected fields at Columbia. In St. Louis county strains of Marion Market, Globe and Iacope varieties showed low percentage of infected plants. Strains of the late type of Hollander cabbage were the most resistant of the varieties and strains grown. Non-resistant and commercial varieties of Copenhagen, Wakefield and Golden Acre showed infections as high as 96 per cent.

Fertilizer and Seed Disinfectant Tests with Potatoes (T. J. Talbert, J. T. Quinn).—The Irish Cobbler variety of potato produced better in 1927 than either the early Ohio or Bliss Triumph. Of the eight principal strains of Irish Cobbler, the Canadian strain produced a larger yield and a more vigorous vine growth. The Hollandale strain was the best of the other strains from the Northern States.

Northern grown certified seed gave more satisfactory results than the spring home grown or the northern uncertified stock. Seed from fall home grown potatoes of the Irish Cobbler and the Early Ohio varieties were as good as northern grown certified seed in total yield but with a

higher percentage of culls. Fall home grown seed of the Irish Cobbler variety, one year from northern certified stock gave higher yields than fall home grown seed which had been grown in Missouri for a number of years.

For the fall crop the following varieties gave the most satisfactory yields: Colorado-grown Peach Blow, Missouri-grown McCormick, Minnesota-grown Cobbler and Idaho-grown Bliss Triumph.

Due to a very unfavorable season, potatoes grown under a straw mulch were a failure.

Fig. 16.—View of fertilizer, seed treatment, source of seed, and seed improvement potato experiment plots at Columbia. Note in the foreground the effect of commercial fertilizer on vine growth. Plot on left received 500 lbs. of a 3-12-4 fertilizer. Plot on right (513) received no fertilizer.

On a Putnam silt loam a 3-12-4 fertilizer, applied at a rate of 400 pounds per acre plus 8 tons of barnyard manure plowed under the previous fall, produced the highest yield

In the seed treatment experiments Semesan Bel. gave control for scab and rhizoctonia, equal to either the corrosive sublimate or hot formaldehyde treatments. Potassium permanganate and bordeaux gave satisfactory results as potato seed disinfectants. Different methods of mixing bordeaux spray for use on Irish potato plants were tried. No burning was noted in any case.

Variety and Fertilizer Experiments with Onions (J. T. Quinn).—Texas-grown plants of the Crystal White Wax, Yellow Bermuda and Red Bermuda varieties gave a higher yield in pounds per acre and a

smaller percentage of "splits" than plants of the same varieties grown at Columbia under greenhouse conditions.

Bermuda onion seed planted December 20 produced plants of a desirable size for transplanting by March 20.

The Yellow Bermuda variety showed a greater response to a 3-12-4 fertilizer at the rate of 500 pounds per acre than either the Crystal White Wax or the Red Bermuda variety.

The Development of a Wilt Resistant Tomato Variety (J. T. Quinn).—Thirty-four different strains and varieties of tomatoes were grown on highly infected soil which had grown tomatoes continually since 1920. Missouri selections of the Marglobe gave the highest yields. Selections of the Norton and Marvel showed the lowest percentage of infection. Under field conditions in St. Louis County, Missouri selections of the Marglobe tomato gave higher average yields on non-infected soils than the commercial Bonny Best variety. On wilt infected soil where the Bonny Best variety matured only few fruits, the Marglobe produced a normal crop.

Another strain of Marglobe has proved more suitable for forcing than the regular field strains. The Marvana was the earliest wilt resistant tomato variety grown. Marvelosa, a wilt resistant pink variety, should replace the common variety Ponderosa, which is susceptible to wilt.

Apple Pollination Investigations (A. E. Murneek).—Self-fertility and cross-fertility of the more important commercial varieties of apples involving over 75,000 blossoms, were studied. The following varieties gave a much better set of fruit when cross pollinated: Yellow Transparent, Wealthy, Gano, Maiden Blush, Ben Davis, Duchess, Jonathan, Grimes, King David, Rome, Winesap, Stayman, York, and Delicious. When self-pollinated some varieties in some years will not form fruit, or will produce a very small and unprofitable crop.

Delicious, Jonathan, Ben Davis, and Gano were found to be efficient pollinizers for most varieties. Winesap pollen was defective and of no value.

Unemasculated flowers, when crossed, gave a higher set than emasculated ones.

Physiology of Reproduction in Horticultural Plants (A. E. Murneek).—A detailed and complete investigation of changes in chemical composition of organs comprising the bearing apple spur was made on three varieties of apples with the following results: (1) Reproductive organs, especially the fruits, dominate the metabolism of bearing spurs. (2) Flowering is characterized by a marked increase in all active forms of carbohydrates and nitrogen, which are translocated to the blossoms at

this period. (3) The sudden increase of sugars at full bloom results from hydrolysis of starch and hemicellulose. (4) Large amounts of nitrogenous substances are moved into the bearing spurs during fertilization and fruit setting. (5) Both carbohydrates and nitrogen are absorbed from the dropping blossoms preparatory to their abscission. (6) The development of leaves and fruit is characterized by an accumulation of nitrogen in water-insoluble form. (7) Young fruits show a relatively high nitrogen concentration, older fruit more sugar, starch and hemicellulose.

A statistical study of the relationship between leaves and fruits of heavily bearing apple trees has shown the following average number of leaves per fruit: Benoni 9.15, Jonathan 13.95, King David 17.73, Ben Davis 12.28, Delicious 16.42. This being inadequate for the production of fruit of good marketable size, various methods of fruit thinning have been studied to increase the number of leaves per fruit to a maximum of fifty.

Combination Sprays for Deciduous Fruit Trees (T. J. Talbert, H. D. Hooker, H. G. Swartwout).—*A comparative study of the toxicity of some apple sprays.*—Several commercial varieties of apples were treated with lime-sulphur and bordeaux. The effectiveness of each material in controlling scab in the amount and character of russet injury and leaf injury to the fruit were noted. The results were somewhat complicated by wind burn of the leaves and frost injury to the fruit. However, some of the sprayed plots showed more injury than the checks.

A new magnesium arsenate spray was tried. On peaches the magnesium arsenate defoliated the trees. Little injury resulted from the use of lead arsenate. A mixed variety plot of apples sprayed commercially with the magnesium arsenate showed slight injury and gave as good control of codling moth and curculio as the lead arsenate. On Jonathan and Ingram the magnesium arsenate caused considerably more burning.

Dusting.—Dusting investigations have been started, employing standard dusting materials and equipment.

Oil emulsions.—Two per cent oil made by the Missouri cold-mix method and the boiled oil soap emulsion made according to government formula have given too much injury to both fruit and foliage to warrant their use in summer sprays. One per cent emulsions have not caused material injury to apples when added to the regular summer sprays except at the calyx period. Varieties have varied as to susceptibility.

One per cent oil has given good results as a spreader and seemed to be as effective as nicotine in the control of the grape leaf hopper and has not given an objectionable residue on the fruit at harvest time.

One per cent oil in every summer spray tends to hold San Jose scale

in check. However, a dormant application will be needed every two or three years. Codling moth control has been made easier where oil was used.

Mixing bordeaux.—Bordeaux made according to the following method has given no greater injury to the fruit and foliage of the grape and apple than when made by the old cumbersome platform method: Fill the spray tank two-thirds full of water and start the agitator. Pour through

Fig. 17.—Experimental dusting on the fruit farm of the Agricultural Experiment Station.

the strainer 3 gallons of the copper sulphate stock solution for every 50 gallons of spray. Add 4 gallons of the lime stock solution or 6 pounds of hydrated lime made into a thin paste for every 50 gallons of spray. Then add the required amount of arsenate of lead and enough water to bring the volume up to the required amount.

Bordeaux stock solutions, when mixed and allowed to stand from 24 to 48 hours, and then used at the usual dilute concentrations have given no greater injury to the foliage and fruit of the apple than the standard bordeaux made and applied in the usual manner.

POULTRY HUSBANDRY

H. L. Kempster, *Chairman*

Nutritional Requirements of Poultry (H. L. Kempster, E. M. Funk). —Exposure of chicks to direct sunlight was the most satisfactory supplement to the regular chick growing ration. This ration consisted of the chick scratch food of finely cracked yellow corn, which constituted one-half the ration and a mash of bran 28 pounds; shorts 28 pounds; yellow cornmeal 28 pounds; tankage 10 pounds; bone meal 5 pounds; and salt 1 pound. Skimmed milk and water were given as drink. The mash was before the chicks two hours daily until the fourth week, after which it was before them all the time. In Pen 1, the chicks were allowed access to a small platform exposed to direct sunshine. Pens 2, 3, 4, and 6 were housed behind window glass. Pen 2 received 2 per cent cod liver oil to the mash. Pen 4 was exposed for a period of 30 minutes daily to ultra violet light from a Uviarc Quartz Mercury Vapor Lamp. The chicks in Pen 5 were fed a regular laying mash consisting of equal parts by weight of bran, shorts, and yellow cornmeal to which 20 per cent tankage and 1 per cent salt were added. This mash was kept before the chicks all the time, otherwise they received the same treatment as Pen 1. The ration for Pen 6 consisted of boiled eggs and milk. Table 24 shows the results.

Table 24.—Effect of Various Rations on Growth of Chicks
(Weight in Grams)

Age in weeks	0	1	2	3	4	5	6	7	8	9
Supplement										
1. Sunshine	34	49	76	106	148	215	289	372	483	563
2. Cod liver oil	35	49	77	107	150	214	278	354	460	517
3. None	35	48	74	107	145	189	219	254	289	296
4. Ultra-violet exposure	34	47	74	103	143	210	291	378	445	512
5. Sunshine	35	50	75	103	148	224	304	389	471	490
6. Eggs and milk	34	57	90	135	190	266	334	420	480	558

Pen 3, in which there was no source of vitamin D, was the only pen which differed very greatly from the others. At the age of nine weeks the chicks in this pen were only slightly more than half as large as those in the other pens. They also possessed crooked breast bones, long curled toes, and other evidences of lack of mineral metabolism. They walked with unsteady gait and leg weakness developed at the age of five weeks. At seven weeks every chick in the pen was affected. Vitamin D or its equivalent must be provided and exposure to direct sunshine seems the best practice. However, up to the age of four weeks the growth of chicks not exposed or fed vitamin D was equal to the other lots.

The Effect of Feeding Cod Liver Oil on Egg Production (H. L Kempster).—Cod liver oil to the extent of 2 per cent of the mash, or

exposure to direct sunshine, proved effective supplements to the usual methods of feeding for egg production. One lot of Brown Leghorn hens kept behind glass supplemented with muslin frames and fed cod liver oil, averaged 92.6 eggs from November to May 31, as compared to 62 eggs where no oil was fed. Similar results were obtained with two lots of Anconas. However, with White Leghorn hens housed in a muslin front poultry house, the muslin frames being open in the day and the birds allowed range, the birds fed cod liver oil laid only three more eggs, the production for the two groups being 98.7 and 95.5 eggs. With Anconas and Brown Leghorns there was no marked difference in the winter egg records in favor of feeding cod liver oil. The failure to produce marked results for this period is thought to have been due to light filtering through adjacent pens. After covering the partitions so that this source of light was excluded, the hens fed cod liver oil laid approximately twice as many eggs as did the groups not fed cod liver oil. The less laying hens are exposed to direct sunshine, the more cod liver oil should be fed. Table 25 shows the influence of direct sunshine on egg production.

TABLE 25.—INFLUENCE OF DIRECT SUNSHINE OR COD LIVER OIL ON EGG PRODUCTION

Pen	Breed	Treatment	Winter Eggs Nov. 1-Feb. 29	Eggs Nov. 1-May 31
1	Wh. Leghorn	Sunshine, Range, + Cod Liver Oil	35.3	98.7
2	Wh. Leghorn	Sunshine, Range	33.	95.5
3	Anconas	Cod Liver Oil, Behind Glass	37.8	89.3
4	Anconas	Behind Glass	36.5	60.8
5	Br. Leghorn	Cod Liver Oil, Behind Glass + Muslin	29.8	92.6
6	Br. Leghorn	Glass + Muslin	25.7	62.

Value of Cotton Seed Meal, Ground Soybeans, Soybean Meal, Tankage Meat Scrap and Dried Butter-Milk in Rations for Egg Production (H. L. Kempster).—Table 26 shows the effect of these various protein concentrates with mineral supplements as indicated.

The basal mash consisted of equal parts by weight of bran, yellow cornmeal, and shorts. The grain consisted of a mixture of 2 pounds of yellow corn and 1 pound of oats. All mashes contained 1 per cent salt.

With reference to mineral supplements for protein concentrates of vegetable origin, bone meal seemed to have a slight advantage over rock phosphate, while ground soybeans were not as efficient as soybean meal. Tankage did not give as good results as meat scrap or dried butter-milk.

The Effect of the Time Pullets Start Laying on their Egg Production (H. L. Kempster).—A study of the records of 264 hens of the general purpose breeds indicated that there was no disadvantage in having them

Table 26.—The Effect of Various Protein Concentrates on Egg Production
(November 1, 1926 to September 30, 1927)

Pen No. and Ration	Per-centage	Grain per hen per year (lbs.)	Mash per hen per year (lbs.)	Average egg Production
1. Cottonseed meal Rock Phosphate Salt (NaCl)	30 8 1	51	25	125
2. Cottonseed meal Bone meal Salt (NaCl)	30 4 1	48	25	130
3. Ground soy beans Bone meal Salt (NaCl)	30 4 1	52	24	113
4. Soybean meal Bone meal Salt (NaCl)	30 4 1	55	24	132
5. Tankage Salt (NaCl)	20 1	55	27	125
6. Meat scrap Salt (NaCl)	20 1	64	28	139
7. Dried Buttermilk Salt (NaCl)	30 1	54	29	140

start laying at an early date. There was a slight advantage in having them start to lay before November as compared with those starting in November, the month which is commonly considered as the ideal month for pullets to begin their laying year. In determining the value of the eggs the following prices per dozen were used: November 1 to March 1, 40c; March 1 to July 1, 24c; July 1 to October 21, 30c. The mean date at which laying started was November 24 which was too late to realize the greatest profits. Only 17 per cent started laying before November. Poultrymen keeping general purpose breeds need not fear a winter moult, and should bring their pullets into laying at the earliest opportunity, provided that they are physically matured at the same time that they are sexually matured. The results are shown in Table 27.

Table 27.—The Effect of Time Pullets Start Laying on Future Production

Month hatched	No.	Per cent	Fall Eggs	Winter Eggs	Spring Eggs	Summer Eggs	Nov. 1 to Oct. 31	Value of Eggs
Sept.	7	2.65	28.3	75.3	65.3	33.4	174	4.65
Oct.	38	14.39	6.23	75.6	67.0	27.	170	4.53
Nov.	121	45.83	----	62.5	68.	36.5	167.	4.28
Dec.	73	27.65	----	48.	65.7	24.7	138.5	3.52
Jan.	15	5.68	----	25.5	60.8	19.	105	2.54
Feb.	10	3.79	----	9.4	47.	12.2	68.7	1.59

Weights of Offspring of Hens as Compared with Offspring of Pullets. (H. L. Kempster).—From the standpoint of weight of the female offspring from hens as compared to the weight of the female offspring of pullets there was no difference according to weights taken in December. Table 28 shows the data from three of the general purpose breeds hatched in 1927. Only normal sized eggs were used for hatching.

TABLE 28.—WEIGHTS OF OFFSPRING OF HENS AS COMPARED WITH OFFSPRING OF PULLETS

Month Hatched	February		March		April		May	
Breed	No.	Weight (lbs.)	No.	Weight (lbs.)	No.	Weight (lbs.)	No.	Weight (lbs.)
Barred Rock hens	8	6	7	5.5	6	4.7	4	4.1
Barred Rock pullets	9	5.4	4	4.5	5	4.01		
White Rock hens	7	5.2	25	5.	16	5.2	2	5.2
White Rock pullets	21	5.4	18	5.1	11	4.8	1	4.3
R. I. Red hens	16	5.55	75	5.54	16	4.66	6	4.33
R. I. Red pullets	41	5.8	43	4.88	38	4.52	1	4.3

Using Artificial Lights to Stimulate Winter Egg Production (H. L. Kempster, R. R. Parks).—Trials extended from October 13 to April 30. The lights were turned on automatically at 4:30 a. m. and used until daylight. Check pens were fed the same rations. The artificially lighted pen laid slightly better during November and December. A period of cold weather during December caused an abrupt stop in egg production in the lighted pen. This drop was not so noticeable in the unlighted pen. The value of the eggs produced in the two groups was the same while the feed consumption was ten per cent greater for the lighted pen.

From October 15 to March 1, 17½ kilowatt hours of electricity were consumed. Table 29 shows the effect of artificial lights on egg production.

TABLE 29.—THE EFFECTS OF ARTIFICIAL LIGHTS ON EGG PRODUCTION

Pen No.	Treatment	Average Number of Eggs Per Hen						
		Nov.	Dec.	Jan.	Feb.	March	April	Total
17	No lights	13.2	10.2	11.8	16.4	20.	20.7	92.3
18	Lighted	17.3	11.3	8.1	13.5	18.	19.	87.2

The Feed Purchasing Power of the Eggs Laid by a Hen (H. L. Kempster).—The amount of feed a hen's eggs would buy was highest in 1921. For the last five years the eggs produced by a hen would purchase 10 per cent more feed than for the pre-war period, 1910-14. This is based on an average production of 122 eggs per hen and the Missouri farm price for corn, wheat, oats, and eggs. The price of feed was the average price of a mixture of 5 pounds corn, 3 pounds oats, and 3 pounds

wheat. Table 30 shows the data for the last seventeen years. The egg feed ratio is the number of dozen eggs required to purchase 100 pounds of feed.

Table 30.—The Feed Purchasing Power of Eggs

Year	Pounds of Feed a 122-Egg Hen Would Purchase	Egg Feed Ratio
1910	140 lbs.	6.95 doz. eggs
1911	124	8.4
1912	132	7.5
1913	137	7.5
1914	132.6	7.5
1915	111	8.7
1916	128	8.2
1917	112	8.7
1918	119	8.4
1919	129	8.
1920	142	7.1
1921	191	5.5
1922	163	6.2
1923	153	6.6
1924	134	7.3
1925	143	7.2
1926	169	6.
1927	141	7.2

RURAL SOCIOLOGY

E. L. Morgan, *Chairman*

Movements of Rural Population in Missouri (E. L. Morgan).—The purpose of this study is to ascertain the causes of migration from farms as stated by migrants; to determine the relations between individual instances of migration and such environmental factors as soil types, economic status, social contacts, type of school and church, and conditions of transportation and communication; to discover whether migrants consider themselves worse off or better off economically, and in terms of human satisfaction, because of having left the farm; and to find the extent to which local organizations have been affected by the withdrawal of membership and leadership due to migrations.

Information has been secured by correspondence on the migration of 1000 farmers in Missouri. The study included 12 counties. Of these migrants, 81 per cent were owners and 19 per cent tenants. They moved an average of eight miles. Fifty-nine per cent were known as leaders in the community they left. Sixty-four per cent held membership in some farm organization, and 70 per cent held membership in the church. Eighty-four per cent left farms which were on improved roads. Forty-eight per cent moved because of a desire for better educational facilities

21 per cent for economic reasons and 10 per cent because of a desire for better church facilities.

Factors Influencing the Effective Location of Rural Groups (E. L. Morgan).—The purpose of this study is to show the conditions and circumstances under which local organizations and institutions are carrying on their work and the factors involved in the tenure and activity of local leadership.

Fifty-four institutions were studied including churches, libraries, hospitals, farm groups, community centers, and small-town chambers of commerce.

Of those organizations gaining in membership, 91 per cent were in communities which have gained in population during the last decade. Their leadership had an average tenure of service of three years and they were continually adapting their program of work to what appeared to be the needs of the community. They were located in communities included in the upper one-half in the public school teacher salary ratings of the State.

Of those declining in membership, 87 per cent were in communities which lost population during the last decade. Their leadership tenure of service was one and one-half years. There had been no perceptible change in the program of work during the three years. They were located in the lower one-fourth in public school teacher salary ratings in the State. They were also in the lower one-third of the ranking of public schools in the State. In 92 per cent of the cases they were located in communities in which there were active social cleavages.

The Process of Community Organization (Henry J. Burt).—This investigation was designed to show what services farm people received from their nearest village; what service they were seeking elsewhere; how this service distribution compared with that of two years ago; what happens to local institutions in the midst of this change of individual affiliation; and what should be the nature of the organization unit for future local agricultural extension work.

Thirty collaborators kept a three-month's record of attendance at all gatherings in the Ashland, Missouri, community to determine who attended each gathering, distance travelled, and the extent of participation.

A house to house census was taken of the community to ascertain the contacts made outside the community by the various members of the family, together with the distance travelled and the reason for going elsewhere for certain services.

A study was made of all organizations in the community to ascertain the number and distribution of adherents at this time compared to two years ago.

In this community there were 13 school districts which afforded facilities for social contacts. There were in the community 342 families, comprising 1297 persons. Of these families, 73 per cent were farm owners and 27 per cent tenants.

Of all the social contacts experienced by the people 89 per cent were within the community; 11 per cent were found outside the community. Twenty per cent of all contacts within the community were in the form of visiting. A marked difference in the average number of contacts per person was found in each school district. These varied from 1.9 to 50.2 contacts per person.

Contacts which the people of one school district area had within another school district area varied from 34 to 32,436 contacts.

The cost of providing contact facilities by organizations varied from one cent per contact per person to $1.14 per contact per person.

SOILS

M. F. Miller, *Chairman*

Crop Rotation and Fertilizer Experiments (M. F. Miller, H. H. Krusekopf).—The 1927 crops on Sanborn Field were uniformly favorable. The most outstanding results were the large timothy yields. This was probably due in part to the prolonged wet weather in the spring. With only one exception, on nine plots where crops were grown in rotation and either manured or fertilized, the yields ranged from 3 to 4 tons of high quality hay per acre. Plot 22, timothy continuously with six tons of manure annually, yielded 6,720 pounds per acre. The plot which had timothy continually with no soil treatment yielded 2,520 pounds per acre.

The corn on the continuous corn plots was badly infested with corn root worm. More than 25 per cent of the plants were affected, while corn on the rotated plots was not injured. The yield on the plot in corn continuously without soil treatment was 9.8 bushels an acre. The plot, in corn continuously and receiving manure annually, yielded 24.2 bushels an acre. The lowest yield on the four-year rotation plots without soil treatment was 52.6 bushels.

Soil Erosion (M. F. Miller, H. H. Krusekopf).—The rainfall during the year was 40.78 inches, which was near normal. The plots with 8½ degree slope had approximately the same percentage of run-off, but more than twice the amount of erosion as similar plots with a 6 degree slope.

The erosion on the soybean plot was the same as on the plot of continuous corn, averaging on the data available. However, for the

year 1927 the erosion on the corn plot was 50 per cent greater than for the soybean plot.

Analysis of erosion waters indicated that calcium, sulphur, magnesium and potassium in the order named were lost in greatest quantity. The loss of nitrogen was relatively small.

Commercial Fertilizer on Corn (M. F. Miller, H. H. Krusekopf).—Controlled plots at Columbia and on the outlying experiment fields were used. A careful study of weather records and yields from the Columbia plots indicated that there was no one factor which determined the return from fertilizers. The more important factors were the amount of rainfall, distribution of rainfall, high summer temperature, time of planting, and, spring conditions of the crop. Seasons which were particularly favorable for high yields did not always give maximum returns from fertilizers. All plots at Columbia averaged 52.89 bushels. The average increase from fertilizer treatments was only 4.6 bushels as compared with an average increase of 10.7 bushels for the last four years.

Nitrogenous fertilizer as a side dressing for corn at the time of the second cultivation has given very good results on three outlying experiment fields.

Nitrogen Depletion in Soils Under Different Systems of Soil Treatment and Management (M. F. Miller, W. A. Albrecht, R. E. Uhland).—From the results secured thus far, it was indicated that upland soils in Central Missouri, even under the best systems of management, continued to lose nitrogen until a level was reached much lower than was anticipated. Nitrogen turnover seems, therefore, of greater importance than the maintenance of a high nitrogen level.

The surface soil has been removed from additional plots. Different cropping systems and methods of soil treatments have been started on these plots to find out what may be expected when started with a low nitrogen level.

A study has been made of the relation of climatic factors to the content of soil nitrogen. This included studies from the northern to the southern boundaries of the United States and from the humid to the semi-arid regions. Both moisture and temperature were important factors controlling the nitrogen level. The nitrogen content decreased from north to south and from humid to semi-arid regions.

The effect of certain soil treatments on the protein content and yield of soybeans, alfalfa, and sweet clover has been studied. The results with each of these crops, grown for the first time on soil receiving different fertilizer treatments, are shown in Table 31.

Lime caused a very marked increase in the protein content of soybeans and alfalfa. Phosphate alone caused some increase in the yield

of alfalfa, but did not affect the percentage of protein. The addition of a mixed fertilizer or a super-phosphate to the soil that had received a light application of lime caused a large increase in both the yield and the protein content of alfalfa and sweet clover. Where as much as three tons of lime was used the addition of phosphate gave no additional increase. A wide variation was found in the amount of nitrogen in the roots of the three legumes. As an average there was 34 per cent as much nitrogen in the roots of sweet clover as in the tops, while with alfalfa there was 43 per cent, but with soybeans there was less than 4 per cent.

Table 31.—Effect of Soil Treatment on Yield and Protein Content of Legumes

Plot No.	Treatment	Crop	Yield of hay lbs. per acre	Per cent protein	Total lbs. protein per A.
37	300 lbs. 4-10-4	Soybeans	4189	10.06	421.4
38	300 lbs. 4-10-4 & Lime	Soybeans	5443	17.88	972.2
Av. 2 Plots	No treatment	Alfalfa	878	11.75	103.4
Av. 4 Plots	Super-phosphate	Alfalfa	1352	11.19	151.3
Av. 2 Plots	1 T. lime	Alfalfa	1925	16.81	323.9
Av. 4 Plots	1 T. lime & superphosphate	Alfalfa	2338	19.38	434.2
Av. 2 Plots	3 T. lime	Alfalfa	2991	19.62	587.7
Av. 4 Plots	3 T. lime & superphosphate	Alfalfa	2624	19.94	524.1
5	2 T. lime	Sweet Clover	1398	16.75	234.2
2	2 T. lime & 300 lbs. 2-10-2	Sweet Clover	2668	19.44	518.7
6	2 T. lime & 200 lbs. 2-10-2	Sweet Clover	2113	18.75	396.2
12	2 T. lime & 105 lbs. super-phosphate	Sweet Clover	2262	19.94	451.0

Early fall cutting of sweet clover may cause a marked increase in winter killing. The roots of sweet clover increased very much in nitrogen content during October and early November. Cutting sweet clover on October 7 increased winter killing 21 per cent over that which was not cut until November 9. The spring yield on the plot harvested October 7 was only 4 per cent as large as the yield of the plot harvested November 9.

Sweet clover grown with wheat and turned under for corn showed that on the soil at Columbia it was possible to return from 100 to 155 pounds of nitrogen per acre without the loss of the use of the land and at a cost of only the price of the seed.

The Effect of Harvesting Sweet Clover at Different Dates for Hay (R. E. Uhland).—Roots of sweet clover were all dug April 26, 1929 from plants that had been harvested at different dates the previous fall. Figure 18 shows the results. It will be observed that there was a very large growth in roots in the month between October 7 and November 9. This is characteristic of sweet clover. There is a rapid transfer of food materials from stem to roots during this period. Sweet clover harvested in September or early in October will not make much root growth in the fall, and will often have a high per centage of winter kill. That harvested a month or six weeks later will have a large root growth and a much smaller amount of winter kill.

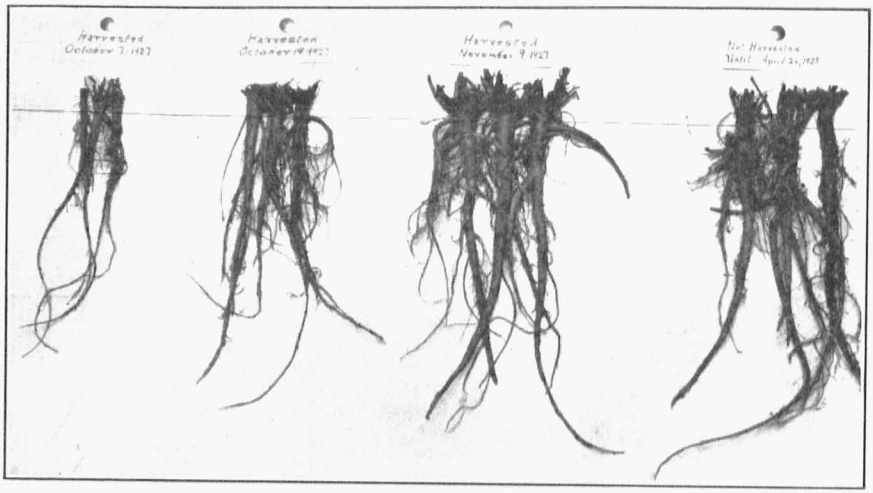


Fig. 18.—Roots of sweet clover from plants harvested on the following respective dates (from left to right): Oct. 7, 1927; Oct. 19, 1927; Nov. 9, 1927; and April 26, 1928.

Studies on the Longevity of B. Radicicola in the Soil (W. A. Albrecht, L. M. Turk).—The effect of artificial and ultra violet light on the organism *B. Radicicola* has been tested. Thin layers of sifted soil have been exposed to the light for long periods of time. Carefully controlled and measured amounts of light under specific soil conditions have been used. The organisms were not easily killed.

The Making of Artificial Manure from Straw (W. A. Albrecht).—Farm trials for the making of artificial manure from straw according to the methods devised by Hutchinson and Richards of Rothamsted, Eng-

land, were repeated. Low flat piles, depending on the rainfall for moisture, were made. Chemicals were added to the straw during threshing. The manure could be used as top dressing for wheat in November. Each ton of straw produced more than three tons of manure. This process fitted well into the farming scheme and the treatment on the wheat gave improved winter conditions for this crop.

Cornstalks were also used by chopping them into short lengths of one inch, and also unchopped. The winter was relatively dry and decay did not take place until late spring when rapid decay set in. The openness of the uncut stalks made them take the smaller amount of water better and they were more thoroughly decayed than those that were chopped. Temperature records were taken to find out if the heat produced would kill such insects as the cornborer.

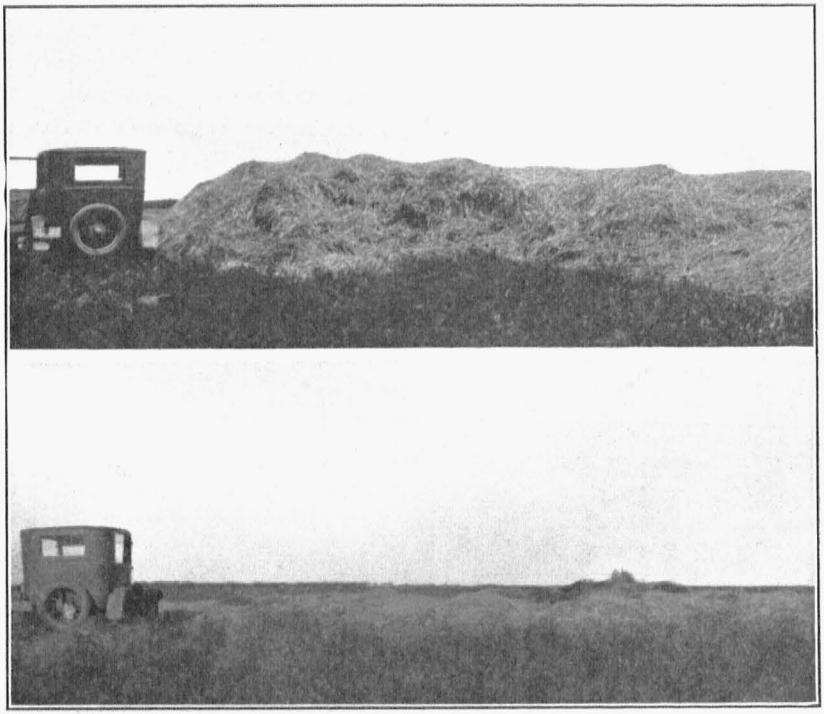


Fig. 19.—Straw can be converted into artificial manure. Above: Straw pile as threshed with chemical treatment in late July, 1927. Below: The same pile as manure in November 1927.

Trials were also made with waste from cotton gins. Farmers reported detrimental effects on the immediately succeeding crop when

this waste was plowed under. Converting it into manure would offset this danger and produce fertilizer of organic nature.

Investigations on Outlying Soil Experiment Fields (M. F. Miller, H. H. Krusekopf, Roy Hockensmith).—Experiment fields at Eldorado Springs, St. James, and Union were discontinued, after having been operated for nine, eighteen, and sixteen years respectively. A four-year cropping system including corn, wheat, clover and either cowpeas or soybeans, was used on all the fields. Various combinations of fertilizers, lime and manure were used. The use of fertilizer on wheat on the thin soils increased the yield over one hundred per cent. Lime was essential to clover growing. Manure gave the largest return when applied on corn.

The Kidder experiment field, established in the spring of 1927, was enlarged to include new projects on legume growing, corn fertilization and the value of sweet clover as a green manure.

A new field for trials with nitrate fertilizer, under the Chilean Nitrate of Soda Educational Bureau grant was established to take the place of the field at Marshall which was discontinued. Nitrate of soda used along with other fertilizers and as a side dressing on corn and as a top dressing on wheat and grass, gave good results.

Ammonia and Nitrate Production in Soils by Bacteria (W. A. Albrecht).—Plots 29 and 30 in Sanborn Field were used for this study. Both were in continuous wheat. Previous to 1914 they received manure at 6 to 7 tons per acre. Since that time they have received no manure, but Plot 29 has been given 49 pounds of ammonium sulphate per acre and

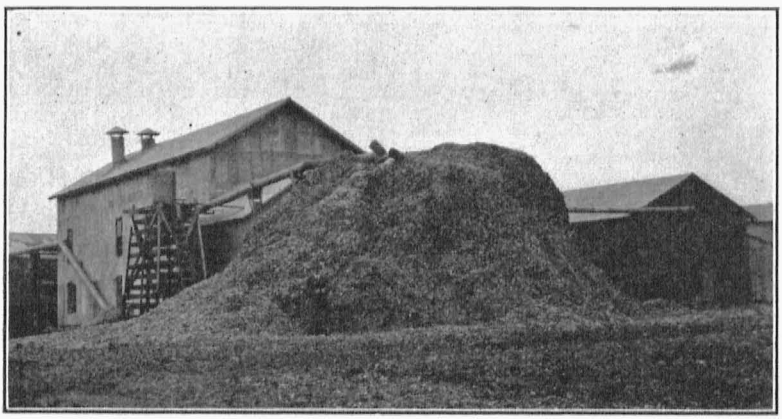


Fig. 20.—Waste from the cotton gins in southeast Missouri accumulates in large quantities that may well be converted into artificial manure.

Plot 30 has received 60 pounds of sodium nitrate as top dressing in the spring. Plot 29 had a pH of 5.9 and Plot 30 a pH of 6.0.

The soils were brought into the laboratory and, without change of tilth, were given the following treatments: check, lime, organic matter in the form of sweet clover, and lime and organic matter. The ammonia and nitrate nitrogen were determined at intervals of two weeks during a period of three months.

The check plots accumulated ammonia and nitrates at about the same rate and both were no lower than that obtained in the tests of other plots on the field. This suggested that these two plots were carrying on their activity of nitrate production at about the same rate.

Lime gave a greater increase in both ammonia and nitrate accumulations for the soil from Plot 29, getting ammonium sulphate, than it did for Plot 30, getting sodium nitrate.

The organic matter gave a more sudden ammonia production for Plot 30 than for Plot 29. The nitrate accumulation averaged about the same for both plots.

Lime and organic matter gave more vigorous activity in ammonia production on the plot fertilized with sodium nitrate and also a greater accumulation of nitrates.

This indicated that there was some difference in the speed with which the ammonium sulphate treated plot handled organic matter as compared with the speed of this process in the nitrate treated plot. Lime seemed more influential in stimulating nitrate production on the ammonium sulphate plot than on the sodium nitrate plot.

The Effect of Crop and Cultivation on Nitrate Production (W. A. Albrecht).—Nitrates were measured regularly on seventeen plots on the Station field. The following soil treatments were used: lime, nitrogen as ammonium sulphate, nitrogen as green manure, phosphates, and potash, where corn and wheat were grown continually. Mixed fertilizers were used in rotations where attention was given to the influence of these on nitrates through the legumes in the rotation. Straw mulch was included on treated soil growing corn, and observations showed a nitrogen shortage to corn under the mulch even though liberal amounts of nitrogen were turned under as green manure. Mulching the soil on which 2 tons per acre of legume tops were turned under caused the corn grown there to show a decidedly light green color in contrast to the dark green color of the unmulched plot.

Studies of the Tight Clay Layer in the Soils of the Level Prairies of Missouri (M. F. Miller, H. H. Krusekopf).—A 10-acre experiment field was established on level Putnam silt loam soil near Moberly. In August 1927, at a time when the subsoil was dry so that it would crumble, the

field was subsoiled with a Killefer deep tillage machine running every 3½ feet. The depth of the plow was set about 22 inches, so that the plow share penetrated to the heavy clay layer to a depth of 4 to 6 inches. The draught was so great that the 10-ton caterpillar tractor used could be run only in second and third speed.

The flocculating materials were applied to the bottom of the furrow by means of a modified end-gate seeder attached to the deep tillage machine. Applications were made at the rate of about three tons per acre. The materials used singly or in combination were calcium carbonate, calcium sulphate, calcium phosphate, and flowers of sulphur.

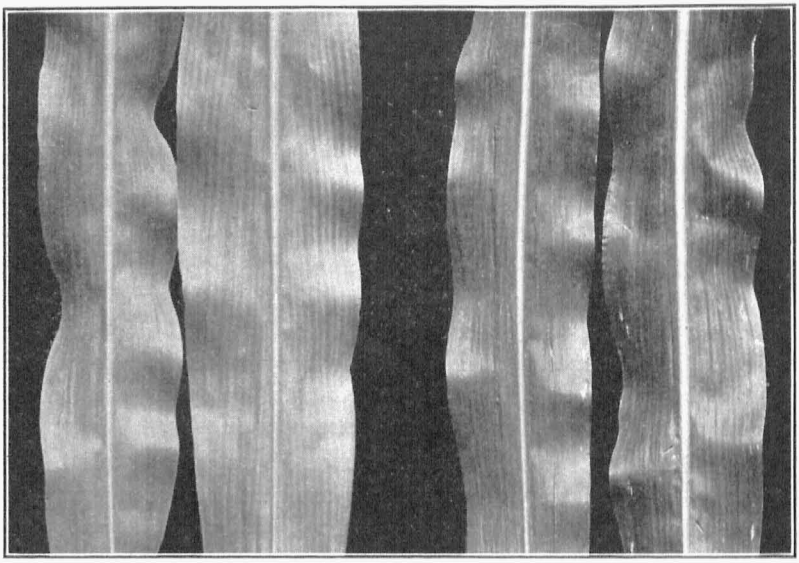


Fig. 21.—Low nitrate content of soil under straw mulch lessens green color in corn. Left: straw mulched. Right: no mulch

After deep tilling the field was surface plowed and limed at the rate of 3 tons per acre. Wheat was seeded in the fall and a mixture of sweet clover and red clover was sown in the spring of 1928.

Colloidal Material in Missouri Soils (R. Bradfield, H. Jenny).—*Soil reaction.* It has been demonstrated in connection with this project that the colloidal clay in the soil behaves like an acid, consequently the well known menace of acid mineral soils is directly associated with soil colloidals. The amount of exchange acidity of a large number of Missouri soils has been determined with the potassium nitrate and calcium acetate methods. Generally speaking, the most fertile soils have less acidity

and a rather abundant supply of exchangeable bases, while the poorer soils have more acidity and a lower supply of exchangeable bases. The examination of a large number of soils indicated that the amount of exchangeable bases became quantitatively smaller with increasing precipitation, while at the same time the acidity became greater.

Base exchange. Base exchange has a direct bearing on the availability of plant nutrients. Electrodialysis has been used effectively in these studies. The fertile Grundy silt loam for instance, showed a content of 10 to 12 milliequivalents of bases in one hundred grams of soil, while the less fertile Putnam silt loam showed 4 to 7 milliequivalents.

Retention of Phosphorus. The absorption by soil colloids differed widely from the absorption of bases. It has been found that the reaction of the solution was of great importance in determining the retention of phosphorus by clay, maximum retention taking place at about p_H 3.5 to 4. With electrodialyzed humus colloid from peat the same type of retention curve was obtained. The amount of phosphorus absorbed, however, was greater.

Use of Potassium Nitrate Method as an Indicator of Lime Requirement (M. F. Miller).—The relation of soil acidity to the response secured from lime applications has generally been considered a very definite one. However, some marked exceptions have been noted. The work of Duley and Fleetwood showed that soil reaction as determined by the Truog method and by the determination of p_H values failed to show a very close correlation to the response from lime. A much more definite relation existed between the amount of soluble calcium in the soil and the response to liming. The determination of the so-called exchange acidity by means of the potassium nitrate method was a better indicator of lime response than the Truog test or the p_H value. This was especially true when the acidity was high, while not so satisfactory for soil of low acidity.

VETERINARY SCIENCE

J. W. Connaway, *Chairman*

Susceptibility of the Progeny of Positive Reacting Dams and Grand Dams to Brucella Abortus (Bang) Infection Among Swine (J. W. Connaway, R. L. Crouch, A. W. Uren).—In previous reports it has been shown that in an experimental herd of swine which was originally badly infected with the Bang abortion infection the occurrence of positive reactors in the progeny grew less and less year by year. The susceptibility of the non-reacting progeny of this herd was tested by natural exposure to a *fresh strain* of *Brucella abortus* (Bang) infection.

An infected boar was given to the Experiment Station for experimental purposes by a breeder of purebred Poland China hogs. A sow which had a clean history for the Bang abortion disease and which was a non-reactor to the serological tests became infected by co-habitation with this boar for a period of about fifteen weeks. She was bred by the boar and conceived, but farrowed only four living pigs. The sow developed a positive reaction for the *Brucella abortus* (Bang) antibodies, this reaction appearing after farrowing. No other source of infection than the boar was possible.

The contaminated bedding from the farrowing pen of this infected sow was not disinfected, but was placed where a group of twenty-one non-reacting gilts and older sows, descendants of abortion infected dams, could have free access to it. Seven of the sows were pregnant when exposed, four of them became infected and two of these farrowed dead pigs. The three non-reacting pregnant sows farrowed living litters. The fourteen unbred sows all became reactors.

Transmission of Brucella Abortus (Bang) Infection from Infected Boar to Sow (J. W. Connaway, R. L. Crouch, A. W. Uren).—Two non-pregnant sows with negative histories for abortion infection and non-reactors to the serological tests were penned with a positive reacting boar for a period of fifteen weeks. One sow never became pregnant, neither did she develop a positive reaction to the serological tests for the *B. abortus* antibodies. The other sow became pregnant and was removed to a clean farrowing pen to avoid other sources of infection than that of the boar. The serological reaction at farrowing time was negative. A strong positive reaction, however, was shown at the next test period. The sow farrowed four pigs, all of which were alive, and developed into strong, thrifty pigs. The facts presented in the preceding project showed that this sow discharged a sufficient amount of *Brucella abortus* (Bang) infection to infect seventeen abortion free sows and five abortion free boars which were exposed to contaminated bedding. The sow evidently contracted the disease by association with the infected boar.

Transmission of Brucella Abortus (Bang) Infection from Infected Sows to Healthy Boars by Service and Cohabitation (J. W. Connaway, R. L. Crouch, A. W. Uren).—Two young boars, without previous service, were used in this experiment. Both boars had a clear history of freedom from abortion infection from birth, and both were negative to the serological tests at the beginning of the experiment. These boars were given breeding service and otherwise exposed to positive reacting sows. Both boars developed strong positive reactions to the serological tests.

Transmission of Brucella Abortus (Bang) Infection to Young Sexually Mature Boars Prior to Breeding Service by Exposure to Bedding from Infected Farrowing Pen (J. W. Connaway, R. L. Crouch,

A. W. Uren).—Five young boars farrowed by abortion free dams and negative to repeated blood tests from birth were exposed when nine months old to contaminated bedding from the farrowing pen of an abortion infected sow which had recently farrowed. Four of these young boars developed a positive blood reaction within sixty days following the exposure. The remaining boar gave a positive reaction a month later. All were strong reactors eleven months after exposure.

A Study of Thirty-two Strains of Brucella Abortus (Bang) for Differences in Agglutinability (J. W. Connaway, R. L. Crouch).—The strains of *Brucella abortus* (Bang) studied were of various origins, coming from six widely separated states. Ten of the strains were isolated at this Station. Twenty-seven strains were of bovine, and five of porcine origin. The isolation age of the several strains varied from three months to thirteen years.

Sera from thirteen animals, ten reactors and three non-reactors, whose clinical history was known, were used in the experiment. A composite field sample of sera from several positive reactors was also included. The sera dilutions employed ranged from 1-50 to 1-1000.

The variations in agglutinability of the different antigens were within the normal limits of error, and were no greater than the variations in a group of twenty antigens made from an individual strain.

All the strains of *Brucella abortus* studied could have been used for practical diagnostic purposes.

Experiments to Determine the Efficacy of Intravenous Injections of Acriflavin to Destroy the Bacillus Abortus (Bang) in Cattle (J. W. Connaway, A. W. Uren, R. L. Crouch).—Serological tests and clinical observations were continued on two herds of abortion infected cattle in which the positive reactors had been treated with three intravenous injections of a 1-200 aqueous solution of acriflavin at intervals of seven days. In a dairy herd eighteen cows had been so treated. During a period of nearly two years there was no evidence of a permanent loss of infection, altho short temporary negative blood phases have been observed.

In a herd of pure bred beef cattle fourteen abortion infected cows were given similar treatment with acriflavin. The results were similar to the foregoing.

It is evident that the treatment with acriflavin which seemed at first to promise good results, is not effective in the dilutions and dosage employed. The therapeutic and pathological effects of larger dosage and more prolonged treatment have not been determined.

Cecal Abligation for Prevention of Entero-Hepatitis (Blackhead) in Turkeys (A. J. Durant).—Data on the comparison of the resistance of abligated and unabligated two-year-old turkeys to entero-hepatitis

are shown in Table 32. These birds were part of a flock of 150 adults in which infection was present. Fifteen of the birds were abligated and fifteen unabligated birds were used as controls. Both of these groups were exposed to infected grounds at approximately the same period, and the average periods of exposure of the two groups were approximately the same, the abligated group being exposed for a slightly longer period (261.2 days), than the unabligated group (184.8 days).

TABLE 32.—A COMPARISON OF THE RESISTANCE TO ENTERO-HEPATITIS OF ABLIGATED AND NON-ABLIGATED TWO YEAR OLD TURKEYS

Group 1 Abligated			Group 2 Not Abligated		
No. of Bird	Results	No. days exposed	No. of Bird	Results	No. days exposed
825	healthy	184	571	healthy	731
1288	healthy	183	667	healthy	560
861	healthy	180	874	healthy	276
977	healthy	180	918	healthy	335
885	healthy	177	665	healthy	80
791	healthy	596	851	Contracted disease in	26 days
901	healthy	584	932	Contracted disease in	55 days
1204	healthy	130	575	Contracted disease in	43 days
2833	healthy	292	1206	Contracted disease in	47 days
1218	healthy	115	580	Contracted disease in	137 days
838	healthy	117	757	Contracted disease in	222 days
1282	healthy	235	560	Contracted disease in	45 days
1213	healthy	210	997	Contracted disease in	46 days
2333	healthy	652	1227	Contracted disease in	127 days
819	healthy	83	1207	Contracted disease in	53 days
Average number of days exposed		261.2	Average number of days exposed		184.8

None of the abligated birds developed evidences of entero-hepatitis during periods ranging from 83 to 652 days. Ten of the unabligated group contracted entero-hepatitis during exposure periods varying from 26 to 222 days. Seven of the ten birds developed the disease within a period of from 26 to 55 days. Five of the control group showed no visible signs of the disease during a period ranging from 80 to 731 days. In a group of birds a certain percentage is likely not to contract the disease, due to natural immunity or to the fact that a very slight attack of the disease may have rendered them impervious to infection.

It has been generally stated that twenty per cent of adults contract entero-hepatitis when exposed to infected grounds. In this case sixty-six per cent of the fifteen control birds contracted entero-hepatitis.

FINANCIAL STATEMENT

AGRICULTURAL EXPERIMENT STATION

For the Fiscal Year Ending June 30, 1928
Expenditures from Federal Funds

	Classification	Hatch Fund	Adams Fund	Purnell Fund
1.	Salaries	$8,798.92	$5,303.41	$17,763.09
2.	Labor	1,305.80	3,845.11	8,065.84
3.	Stationery and office supplies	98.21	51.91	432.30
4.	Scientific supplies, consumable	128.58	903.07	1,681.41
5.	Feeding stuffs	2,656.24	2,624.29	3,361.54
6.	Sundry supplies	542.69	421.53	1,611.55
7.	Fertilizers	none	none	none
8.	Communication service	29.12	5.17	29.51
9.	Travel expenses	334.93	100.08	1,137.05
10.	Transportation of things	48.31	242.22	274.28
11.	Publications	53.93	omit	1,508.50
12.	Heat, light, water, and power	90.76	101.98	335.24
13.	Furniture, furnishings, fixtures	12.00	184.21	604.36
14.	Library	503.72	none	20.49
15.	Scientific equipment	209.45	464.29	1,188.35
16.	Livestock	109.80	331.82	369.90
17.	Tools, machinery, & appliances	21.71	394.30	1,082.75
18.	Buildings and land	55.83	25.61	511.59
19.	Contingent expenses	none	1.00	22.25
	Total	$15,000.00	$15,000.00	$40,000.00

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

Agricultural Experiment Station