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Fred Denton Fromme

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*Report of the West Virginia Agricultural
Experiment Station for the Biennium
Ending June 30, 1930*

AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE, WEST VIRGINIA UNIVERSITY
F. D. FROMME, Director
MORGANTOWN

An adequate livestock program must be built on a foundation of research

Report of the West Virginia Agricultural Experiment Station for the Period from July 1, 1928, to June 30, 1930

by F. D. FROMME

DIRECTOR'S STATEMENT

PREVIOUS REPORTS

THIS ISSUE resumes the series of reports of the West Virginia Agricultural Experiment Station which was discontinued in 1916. The work of the Experiment Station from its establishment in 1888 to 1916 is recorded in a continuous series of annual and biennial reports. The series was interrupted in 1916 because of activities associated with the war emergency and until now it had not been resumed. Since the present report dates from July 1, 1928, the lapse in the series is the period from July 1, 1916, to June 30, 1928, a period of twelve years.

The first report, issued in 1889 by John A. Myers, covered the work of the first year, ending June 30, 1888. This was followed by a series of annual reports, fifteen in all, to and including the year 1902. The first eleven reports by Director Myers cover the period from 1888 to 1898, and the last four by James H. Stewart cover the fiscal years 1899 to 1902.

A series of eight biennial reports succeeds the annual reports and covers the period from 1901 to 1916, inclusive. As will be noted, the first biennial report, that for 1901 and 1902, overlaps the period of the annual reports. It is essentially a statement of work and expenditures of State funds for the control of San Jose scale and other injurious insects and plant diseases. The next four reports, 1903-1904, 1905-1906, 1907-1908, and 1909-1910 were similar in character. The biennial reports for 1911-1912, 1913-1914, and 1915-1916 deal with the general work of the Experiment Station and also include reports of resident instruction and extension work. The first five reports of this series were prepared by James H. Stewart, the next two by E. Dwight Sanderson, and the last by John Lee Coulter.

Although the publication of separate reports was discontinued in 1917, the biennial reports of the West Virginia State Board of Control provide a continuous record of the business affairs of the Experiment Station and also contain brief statements of progress in research. These reports cover the period from October 1, 1908, to date and include reports of the directors of the Experiment Station together with similar reports of other State institutions. The reports which deal with the periods covered, together with the names of the directors, are included in the following citations:

Biennial Report, West Virginia State Board of Control, v. I., p. 253-260, Oct. 1, 1908-Sept. 30, 1910, James H. Stewart; v. II:2, p. 63-76, Oct. 1, 1910-Sept. 30, 1912; v. III:2, p. 565-597, Oct. 1, 1912-June 30, 1914, E. Dwight Sanderson; v. IV:2, p. 521-564, July 1, 1914-June 30, 1916; v. V:2, p. 453-469, July 1, 1916-June 30, 1918; v. VI:2, p. 501-524, July 1, 1918-June 30, 1920, John L. Coulter; v. VII:2, p. 467-502, July 1, 1920-June 30, 1922; v. VIII:2, p. 440-474, July 1, 1922-June 30, 1924; v. IX:2, p. 109-131, July 1, 1924-June 30, 1927, Henry G. Knight; v. X:2, p. 71-94, July 1, 1927-June 30, 1930, F. D. Fromme.

The new series of reports as planned with this first issue will deal primarily with progress reports of research, and will be published biennially. Changes in personnel, publications, plans of work, and important additions to equipment, buildings, and land will also be included. The reports to the State Board of Control will continue to be more essentially reports of business activities, while the new series of separate reports will deal essentially with progress in research.

CURRENT RESEARCH IN REVIEW

The results of the research work conducted during the biennium are presented as brief summaries which are intended to afford the reader a general picture of the scope and character of the work of the Experiment Station, with much of the detail omitted. The 80 summaries which follow relate the most salient features of as many distinct research studies. The volume of the research program and the great amount of detail that supports the brief statements of conclusions will not be apparent except to the reader who is acquainted with the conduct of research and with the exacting requirements necessary to establish the truth of a conclusion.

The object of research is to learn and record the truth. Although a truth once learned usually may be stated in simple terms, the process by which the truth is established is rarely a simple one. This is especially true of research dealing with animals and plants because of the great variability inherent in living matter and in the conditions which surround it.

It might be assumed, for example, that the truth of the simple statement, "Feed has no appreciable effect on the color of beef", could be established by relatively simple means, even by general observation.

As a matter of fact, however, general observation has led to the belief that color may be affected by feed and that grass-fed beef is likely to be darker in color than grain-fed beef. Because of this belief a degree of prejudice and discrimination against grass-fed beef has existed on certain markets. In order to learn the truth as exactly and fully as possible it was necessary for the department of animal husbandry to make accurate comparisons of the meat of a considerable number of steers. Steers of similar breeding were obtained. They were selected for uniformity, were fed under similar conditions for identical periods, and were killed and dressed alike. Color readings were made on identical cuts with the spectrophotometer, which gives an accurate measure of color, eliminating the errors inherent in the human eye. The readings showed no appreciable difference between the grass and grain-fed beef, and because of the careful regulation of the conditions of the experiment it was possible to state as a fact that feed does not affect color.

Again, the simple statement that Gopher oats is superior to other varieties for West Virginia can be made only after a series of trials in several localities under an average range of seasons. The seed of varieties under comparison must be pure. The seeding must be planned so that inequalities in soil are avoided or minimized. The rate of seeding, condition of maturity at harvest, and moisture content at threshing must be regulated to afford exact comparisons. Yields must be accurately recorded and calculations checked for possible errors.

In order to have a complete report of the research of the Experiment Station it is necessary, therefore, that we read between the lines of the brief summaries something of the details of planning and execution of the experiments, of the knowledge of previous experience on which they are built, of the technical skill, equipment, and facilities employed, and of the requirements of time and place.

Completed researches are published from time to time as bulletins or as technical papers in scientific journals. The number of these publications from the Experiment Station during the biennium has been larger than for any like period in its history. A complete list is shown on pages 48 to 55 of this report.

COOPERATION WITH OTHER RESEARCH AGENCIES

If agricultural production and distribution were a self-sufficient enterprise, limited within the confines of each state, our experiment stations might be institutions serving but their own commonwealths. But farming is a national occupation, and the host of problems facing the producer are of nation-wide significance. The lines of research must reach beyond the boundaries of states, particularly if regional and national problems are to be solved.

Nine projects now mark the cooperative research work between the West Virginia Station and the United States Department of

Agriculture. Of these, three are pursued jointly as regional projects with neighboring stations. In the field of agronomy, joint investigations have been under way both with pasture lands and tobacco crops. The Office of Tobacco Investigations of the U. S. Department of Agriculture cooperates with the department of agronomy at the Lakin Experiment farm in Mason County. On rich bottom lands crosses have been made between Maryland Mammoth, Kelley, and Pepper, all high-yielding strains but susceptible to rootrot, and a standup and non-standup strain of Burley, both of them resistant to rootrot. The progeny is being studied with the aim to isolate a strain which combines the desirable features of both Burley and Maryland Mammoth tobaccos.

In order to determine the best practice, from the dairymen's viewpoint, in pasture fertilization, extensive pasture studies were begun in the spring of 1930 by the departments of agronomy and dairy husbandry in cooperation with the federal Office of Forage Crops Investigations. At the Reymann Memorial Farms at Wardsville about 50 acres are devoted to this experiment. Different kinds and amounts of fertilizers are applied to pasture plots, which are grazed by a herd of from 40 to 50 Ayrshire cows. A record is kept of the pasture days and of the amount of milk produced from each of the treated plots, and changes in the character of the pasture grasses due to treatment are noted. Outlying trials also are conducted in Monongalia, Preston, and Grant counties. The pasture problem is one of the most important farm problems in West Virginia, where much of the land area is suited to pastures, and where some of the choicest bluegrass pasture land in the country is found.

The effect of breed of sire on the production and quality of lambs has been the subject of a cooperative project between the department of animal husbandry and the federal Bureau of Animal Industry. At Hillsboro, Pocahontas County, rams of the Southdown, Shropshire, Hampshire, and Cheviot breeds were mated to 120 native ewes. The West Virginia Station carried the study up to the marketing stage, when the government undertook a detailed carcass study of the lambs in pursuit of a national project on a study of the factors influencing the quality and palatability of meat. A similar agreement is in force between the federal Bureau and the department of animal husbandry in a project at Lewisburg, Greenbrier County, on fattening 40 two-year-old steers on grass with and without a grain supplement. The facilities of a large research institution such as the U. S. Department of Agriculture in carrying out intensive meat studies thus are made available for the mutual benefit of both State and Nation.

The heart of the eastern apple-producing region of the United States is the scene of a cooperative study between the experiment stations of West Virginia, Virginia, and Pennsylvania and the U. S. Department of Agriculture, concerning the influence of climate, topography, soil, varieties, and cultural practices on the yield of apples. This includes a study of orchard management and of the

place of orchards in the farm organization of the apple section of eastern West Virginia, as well as a study of markets, costs, and methods of marketing apples in that section. Another project pursued in cooperation with the federal Bureau of Agricultural Economics and the Virginia Polytechnic Institute, now come to a close, concerns the systems of livestock farming in West Virginia and southwestern Virginia as observed in the leading livestock producing counties of these two states. A study of the status, trends, place, and outlook of the finewool sheep industry in the northern part of West Virginia is matched by a like study in both Ohio and Pennsylvania. The government cooperates in the matter of providing the world outlook on fine-wool sheep and in interpreting price trends. A three-year study of boys' and girls' club work in the State, concluded during the biennium, has been carried on in cooperation with the Division of Farm Population and Rural Life, U. S. D. A.

A single project between the department of dairy husbandry and the Bureau of Dairy Industry of the U. S. Department of Agriculture concerns an investigation of the effects of the continued use of proven sires on the milk-producing ability of purebred dairy animals. The project is carried on with the Reymann Memorial Farms herd of Ayrshire cattle at Wardensville and with the Station's Holstein herd at Morgantown.

FIELD DAYS

Of practical value in acquainting large numbers of farmers with the nature and results of experimental work in the several fields of production are the Field Days held annually at Morgantown and at branch stations under the auspices of the Experiment Station. The summer of 1928 witnessed the first one-day field meeting held at Morgantown, with visits to the agronomy, dairy, horticulture, livestock, and poultry farms; explanations of research projects by the heads of the respective departments; and addresses by University and Station officials. The field day has become an annual event with steadily increasing attendance. At the Lakin Experiment farm, field days offering inspections of agronomic and vegetable research work have been held annually since 1927.

NEW LAND AND BUILDINGS

The most important addition to the facilities and equipment of the Experiment Station in recent years was made during the latter part of the biennium through the purchase of an experimental farm in Jefferson County. Although the Station has contributed much in the past to the development of fruit growing in West Virginia through studies conducted at Morgantown, its efforts have been handicapped for lack of opportunity to work under the same conditions of soil and climate as occur in the large commercial orchard sections. The new experimental farm, which lies in the heart of the

LOCATION OF EXPERIMENTAL WORK
IN AGRICULTURE - 1930

● Central Experiment Station
● Branch Experiment Station
Chief outlying projects clas-
sified by type as follows -

- Livestock
- ⊥ Soils and Crops
- Δ Insect Pests
- ▽ Plant Diseases
- Farm Economics
- + Fruits and Vegetables

extensive orchard belt of the Eastern Panhandle, supplies this opportunity in very satisfactory measure. Except for a few acres occupied by farm buildings the entire 160 acres are available for experimental work. Plans for the new farm, which becomes one of three branch stations of the Agricultural Experiment Station under the name of University Experiment farm, include an extensive study of root stocks for apples in cooperation with the U. S. Department of Agriculture; also studies of orchard cover crops, orchard fertilization, pruning, orchard management, and disease and insect control. Problems of peach and cherry production will also receive attention. Other studies in contemplation include the production of crops of interest to dairymen and livestock farmers. Studies of the value of deep tillage for field crops and orchards are also planned. The large residence at the farm has been remodeled to provide offices and laboratories for the experimental work, and a stationary spray plant operated by electric motor has been installed for studies of the hydrant system of orchard spraying.

New buildings erected on the farms of the Experiment Station during the biennium include a greenhouse on the University campus at Morgantown for the use of the departments of agronomy and plant pathology; a modern hospital barn on the Dairy farm for housing stock employed in a study of infectious abortion; a sheep barn, an experimental shed for the study of parasitic diseases of sheep and calves, and a quarantine shed for sick animals on the Livestock farm; two metal brooder houses on the Poultry farm; and on the Lakin Experiment farm two hot-water heated hotbeds, with capacity for 30,000 plants, used for the forcing of tomatoes, egg plants, and peppers in variety tests.

RESEARCH AN INVESTMENT, NOT AN EXPENDITURE

The Agricultural Experiment Station is a State institution supported in part from State funds, in part from Federal funds, and in part from the sale of produce. Its business is to conduct research directed toward the improvement of agriculture, not only in the production of crops and livestock but also in their utilization and disposal. The problems of marketing have received especial attention in recent years and demand still larger services in the future. The problems of the farm home and those pertaining to rural community life likewise fall within the scope of the Station and deserve more attention than present limited facilities can provide.

Although directed especially to the problems of agriculture, the benefits of agricultural research are shared in large measure by the entire population.

Improvements in methods of production have reduced costs to the consumer of farm products; they have increased the labor output of the individual, thus releasing surplus man power to industry; and they have insured adequate supplies of wholesome food and raw

materials to the State and Nation as an essential guarantee of prosperous growth and a major bulwark of defense.

Improvements in processing, transportation, and storage have reduced the wastes of perishable products and insured ample supplies in seasons and years of inadequate yield. Famine as a factor in human welfare has been eliminated by those nations which support an adequate agricultural program.

Improvements in marketing, especially those resulting through the cooperation of producers, have reduced the costs of distribution and have insured more uniform supplies of graded, quality produce to the consumer.

The public is served again through the knowledge of food values and balance in diets, the greater part of which has been contributed by agricultural experiment stations. Studies of the role of the vitamins in nutrition have revolutionized the food habits of the nation.

The use of public funds for the continued and increased support of research in agriculture is clearly in the public interest.

REPORTS OF RESEARCH

The reports which follow concern the status of research work in the Experiment Station for the biennium 1928-30.

AGRICULTURAL CHEMISTRY

Composition of Skeletons

In view of the large amount of work being done on mineral deposition in the skeletons of animals and because of the wide diversity of methods used by various investigators in securing and applying data on skeletal composition, it seemed worth while to make a detailed study of the various parts ordinarily used in such work. The results of this investigation will materially assist in determining what bones, if any, are most representative of the skeleton and which are first to show mineral deficiency.

A study was begun by R. B. Dustman and C. E. Weakley, Jr., in 1929, representing the outgrowth of various bone analyses requested by the departments of animal husbandry and dairy husbandry. To date the moisture and ether extractable material on several hundred individual hog bones has been determined. The results secured with these determinations show that when the different bones are compared with one another they fall into a definite sequence in which they are paired. Further work on the ash, calcium, and phosphorus content of these bones is going forward. In addition to the hog bones, samples of rat bones have been taken and are being held for similar analysis.

Miscellaneous Chemical Investigations

Miscellaneous chemical investigations by R. B. Dustman and L. P. Hansen include one on the effect of various gases of ultra-violet light on colored and uncolored fruit. This phase has been extended into a separate investigation of pigmentation and ripening phenomena.

In a study begun in 1927, broomsedge (*A. VIRGINICUS*) and poverty grass (*D. SPICATA*) were analyzed at regular intervals of growth. The early growth of both grasses was found characterized by a high protein and low fiber content when compared to the later growth stages. Best utilization of the pasturage afforded by them involves reasonably early, close, and continuous grazing before the mid-summer decline in nutritive value takes place. By frequent cutting it has been found possible to maintain a relatively high protein and low fiber content throughout most of the summer months. Analysis of orchard grass (*D. GLOMERATA*) showed a very high protein content in early May and a higher protein content when grown in shaded areas than when grown in the open.

Other investigations include color reactions of certain aldehydes, ketones, quinones, and oximes with compounds containing active methylene groups; a quantitative study of certain sources of error involved in the Munsen-Walker method; condensation of naphthalene and chloracetyl chloride; and a study of methods for the determination of pectins.

The work of the department also includes analyses of grains, grasses, silage, feedstuffs, spray materials, fruit buds, blood, bones, etc. for the several departments of the Experiment Station.

ANIMAL HUSBANDRY

Feed has no Appreciable Effect on Color of Beef

The studies of J. H. Longwell on the color of beef contradict a popular belief that the meat of grass-fed cattle is darker than that of grain-fed cattle. Spectrophotometric color determinations have been made on samples of beef from about 100 experimental cattle. These cattle received various feeds such as pasture alone, pasture and grain, and pasture alone followed by grain and hay. There was no evidence that grass-finished beef is different in color from grain-fed beef showing the same degree of finish.

High-Grade Calves Better Than Low-Grades for Beef Production

In a two-year test conducted by E. A. Livesay, high-grade Hereford calves proved to be more valuable for beef production than low-grade calves. The cost of gains was about equal for the two grades, but when marketed as two-year-old steers it was found that the low-grade calves had proved to be worth only three-fifths as much as the high-grade calves at the start of the test. This work emphasizes the value of the use of purebred bulls and that low-grade calves should

be marketed as veals and not developed into two or three-year-old steers. Complete details of this work are published in Bulletin 225.

Representative carcass produced from good-to-choice lot of calves on the right and from common lot of calves on the left. Note the fuller and smoother appearance of round, loin, rib, and chuck of the carcass on the right

Advantages of Grain Supplements for Grass-fed Steers

A supplement of corn and cottonseed meal fed to good and medium three-year-old steers on pasture increased the summer gains 37 percent as an average of 3 years' experiments conducted by C. V. Wilson and E. A. Livesay in cooperation with the Bureau of Animal Industry, U. S. D. A. The feeding of grain increased the selling price of both grades of steers more than 10 percent, the medium grade having a slight advantage. Medium steers fed grain made a margin of \$6.07 per 100 pounds as compared to \$5.62 for the corresponding lot of good grade. Medium and good steers on grass alone made a margin of \$4.85 and \$4.38 per 100 pounds, respectively.

The gains and finish of three-year-old steers on good pasture can be increased sufficiently by the feeding of a grain supplement to more than offset the additional expense under conditions comparable to those existing at the time the experiments were conducted.

Tests under way with two-year-old steers indicate that satisfactory gains, finish, and yield of meat may be secured by the feeding of a grain supplement on grass. Two-year-old cattle on grass alone do not make satisfactory beef.

Good West Virginia Calves Make Choice Baby-Beef

West Virginia-bred calves fed and marketed as baby beefs gave an average value of \$54.64 at the time they were placed on feed in a series of tests by E. A. Livesay extending over a period of six years (1924-1930). Spring calves were bought during the late fall and started on feed each year during the first half of December. These calves were fed a period of about 200 days and sold on the Pittsburgh market. They were considered choice baby beefs weighing an average of slightly more than 900 pounds. These calves were fattened on a ration of corn, oats, linseed meal, cottonseed meal, corn silage, and mixed hay. The average return per calf for the six-year period (counting cost of all feeds fed) was \$54.64. This was considered a very good price for calves during the period of the tests. It is not recommended that farmers in general try to market their calves through the baby-beef route. However, there are some farmers producing their own calves who could follow such a system for a period of years with the assurance that the calves will give a fair return.

Alfalfa and Rape Excellent Forage Crops for Hogs

In feeding trials conducted by J. H. Longwell which have included a number of forage crops, alfalfa and rape have consistently given good results. Among the perennials alfalfa has no equal. It furnishes pasture from early spring until fall and is quite palatable. Pigs eating it developed into thrifty, strong-boned individuals.

Rape has also proved highly satisfactory. If seeded by the middle of April it is ready for pasture by June 15. Pigs on rape pasture

were thrifty, grew rapidly, and made economical gains. The Dwarf Essex variety was used in all trials.

Buckwheat Middlings a Good Protein Supplement for Pigs

Buckwheat middlings, when used to supply a part of the protein in rations for pigs, has proved equal to or slightly better than linseed oilmeal and cottonseed oilmeal. Protein supplemental mixtures consisting of 2 parts tankage, 1 part linseed oilmeal, and 1 part alfalfa meal; the same proportions of tankage, cottonseed oilmeal, and alfalfa meal; and tankage, buckwheat middlings, and alfalfa meal, have all given excellent results when fed as supplements to corn. Other mixtures, the same as the above except that tankage was replaced with fishmeal, gave equally good results. But those mixtures containing buckwheat middlings resulted in more rapid gains and required less feed to produce gains.

These trials have been conducted by J. H. Longwell with pigs from weaning time until the pigs were marketed, weighing 200 to 250 pounds.

Vitamins in Oats

Previous work at this Station indicated the presence of sufficient vitamins A and D in oats to correct the deficiency of white corn with respect to these two vitamins.

Pig showing typical posterior paralysis developed on basal ration deficient in vitamins A and D

Four lots of five pigs each were used in a new series of tests by J. H. Longwell. The pigs in all lots were similar as to breeding, age, size, and sex. Lot 1, the check lot, received a ration in which adequate amounts of vitamins A and D were provided by using yellow corn and alfalfa meal; Lot 2 was deficient in vitamins A and D, containing white corn, buckwheat middlings, and tankage; Lots 3 and 4 received the white corn ration with oats added. Lot 3 was con-

fined to the barn; Lot 4 was allowed to run in an outside pen where they were exposed to sunlight.

All the pigs in Lot 1 grew normally to weights of approximately 225 pounds, none of them showing any symptoms of vitamin deficiency.

The pigs in Lots 2, 3, and 4 grew normally for about 150 days. At this time some of the pigs began to show symptoms of vitamin A and D deficiencies. The seriousness of the symptoms gradually increased and finally included all the pigs in these three lots. Neither oats nor sunlight appeared to correct the deficiencies of the ration used.

Each pig was slaughtered when it reached a weight of about 225 pounds, or when it became unable to stand. Several bones were removed from each pig and subjected to a number of chemical determinations. There appeared to be no difference in the chemical composition of the bones of pigs from different lots. The deficiency of the white corn ration was apparently vitamin A and not D, and this deficiency was not corrected by adding oats.

Breed of Sire as a Factor in Lamb Production

Rams of the Southdown, Shropshire, Hampshire, and Cheviot breeds have been compared for the production of market lambs when used on native West Virginia ewes of grade Hampshire type in an experiment of four years' duration that has just been concluded. The work is cooperative with the Bureau of Animal Industry, U. S. D. A., with C. V. Wilson and E. A. Livesay actively engaged for the Experiment Station. Single lambs sired by Southdown, Shropshire, and Cheviot rams had an approximately equal birth weight of 9½ pounds, while lambs sired by Hampshire rams were approximately three-fourths of a pound heavier, averaging 10¼ pounds. Single lambs sired by each of the breeds were approximately 2 pounds heavier at birth than twin lambs by the same sire.

At 145 days old, single lambs by Shropshire and Hampshire rams were equal in weight and from 4 to 5 pounds heavier than lambs by Southdown and Cheviot rams that were likewise approximately equal in weight.

Single lambs by any of the sires used weighed on the average from 75 to 80 pounds at a mean age of 145 days.

In general, the results obtained to date from this experiment indicate no marked superiority of any one of the four breeds of rams over the other three for the production of market lambs. There is evidence that each breed has certain superior characteristics and would likely give a desired result when used for a definite purpose, such as to increase size, secure compactness, or change fleece characteristics of ewe lambs kept for breeding purposes. The type of ewe to which the ram is to be bred should influence the breed of ram chosen.

Based on the general results secured the use of any of the four breeds may be recommended.

DAIRY HUSBANDRY

Continued Use of Proven Sires

The long-time breeding experiment to determine the results of the continued use of proven sires on the Ayrshire herd at the Reymann Memorial Experimental farms is in progress by H. O. Henderson, R. A. Ackerman, and L. F. Sutton in cooperation with the Bureau of Dairy Industry, U. S. D. A. This herd consists of about 120 females. Only proven sires are used. The cows in the foundation herd were mated to Hilltop Major Douglas; his daughters were mated to Penshurst Schoolmaster and to Leto; and their daughters are being mated to Yellow Kate's Exchange of Penshurst, Willowmoor Peter Pan 93rd, and Penshurst Sir Robert. There are now several animals in the herd with four generations of proven sires in their pedigree. The heifers are all tested for Roll of Honor during their first lactation and the entire herd is in the Herd Test. Conditions as to feeding and management are kept as uniform as possible.

Linebreeding vs. Outcrossing

A study of line-breeding vs. outcrossing was begun with the Holstein herd eight years ago and is being conducted under the direction of H. O. Henderson and K. S. Morrow. The study has been changed in scope so that it is now a study of the effect of proven dairy sires. Not all of the sires used in the past have been proven.

The foundation sire was Meadowholm Ona Pontiac Hartog. Fourteen daughter-dam comparisons on mature-equivalent basis are available for this sire. The daughters produced an average of 15,029 pounds of milk and 524.6 pounds of butterfat while their dams averaged 15,783 pounds of milk and 525.2 pounds of butterfat. This would indicate that the sire just about maintained the production of the herd on the same level.

The second sire was Sir Colantha Ormsby Hero. He was used on the daughter of the proven bull. The average of his first six freshening daughters was 14,641 pounds of milk and 514.2 pounds of butterfat, while their dams produced 16,692 pounds of milk and 563.0 pounds of butterfat. He decreased the production by 2,051 pounds of milk and 49 pounds of butterfat.

The third sire used was Varsity Piebe La Vertex. There are now 16 of his daughters in the herd but they have not come in milk in sufficient numbers to indicate his effect upon the herd.

Effect of Low Calcium and Low Phosphorus Rations on Growing Dairy Heifers

A continuation of the study of the effects of low-calcium and low-phosphorus rations upon the growth of dairy heifers is being conducted by H. O. Henderson and K. S. Morrow of the department of dairy husbandry in cooperation with R. B. Dustman and C. E. Weakley, Jr., of the department of agricultural chemistry. A previous study carried heifers fed rations low in calcium, or low in phosphorus,

or low in both calcium and phosphorus, until they had reached the age of two years without being bred. The present study will continue heifers on similar rations during the period of gestation and lactation.

This study is now in its second year of investigation with eleven animals receiving the various experimental rations. One group is fed a normal ration; one a ration low in calcium; one a ration low in phosphorus; and another a ration low in both calcium and phosphorus. Weekly weights and measurements are made, and the blood

"E 28" was fed a low-calcium-low-phosphorus ration

is analyzed monthly. At present all of the heifers appear in a fairly thrifty condition and no consistent difference can be noted due to the experimental rations. Depraved appetites as evidenced by chewing of the mangers is apparent with the older animals receiving the mineral-deficient rations. The effect of the low phosphorus rations on the inorganic phosphorus content of the blood is very evident, but the analyses of the blood calcium fail to show any definite correlation between that factor and the calcium contained in the food.

In the department of agricultural chemistry calcium and phosphorus determinations have been made on the blood from eleven heifers. It has been found possible to vary the inorganic phosphorus content of the blood by feeding rations high or low in phosphorus. The results with calcium are still uncertain. Large fluctuation in the inorganic phosphorus content of blood has been found from day to day. Phosphorus content is shown to decrease with age. There are some indications that daily withdrawal of blood from these animals may affect the calcium content, and that samples taken with disturbance to the animal, as from a nervous animal, likewise affect the calcium content. The daily fluctuations in calcium were found less pronounced than for phosphorus content.

Control of Infectious Abortion in Cows by Herd Management and Testing

A study of the control of infectious abortion (*Brucella abortus* infection) by herd management and testing has been inaugurated by J. H. Rietz, K. S. Morrow, and H. O. Henderson. Ten days previous to the time due to calve all animals in the dairy herd which react to the agglutination test are isolated in the hospital barn. They are retained in the barn until all uterine discharges cease. Monthly blood tests are made of the entire herd.

The study of abortion control by management and testing must necessarily be carried on over several years. With the present facilities of isolation it is hoped that valuable information will be accumulated in the University herd which may be applicable to farm conditions so that a definite program for the complete elimination of this disease may be offered to dairy farmers having infected herds.

Water Consumption of Dairy Animals

A study of the water consumption of dairy animals is being made by K. S. Morrow and R. A. Ackerman. Great variation has been found in the amount of water consumed by individual animals kept under the same conditions and fed the same rations. Some yearling heifers will consume as little as 25 pounds of water per day while others will consume 75 pounds under identical conditions.

The character of the ration is evidently a factor affecting water consumption. Two cows in milk, when receiving mangels in their ration, averaged, during 28 days, 40.39 pounds and 73.49 pounds of water daily. The following four weeks, when corn silage was fed in place of the mangels, the daily amount of water consumed was 75.08 pounds and 101.0 pounds respectively. No detrimental results have been noted in the health and growth of calves which are given water while being fed milk. Such a study has been continued until the heifers are 6 months of age.

Growth Study of Ayrshire Cattle

A study of the growth of Ayrshire cattle has been undertaken at the Reymann Memorial farms under the supervision of R. A. Ackerman and H. O. Henderson. During the first week of each month all animals in the herd are weighed and measured as to height of withers and depth of heart girth. Data are kept on both males and females. No attempt has been made to analyze these data.

Cost of Raising Dairy Heifers

A record of the amount of feed required to feed dairy heifers from birth until maturity has been kept at the dairy farm at Morgantown and in the Ayrshire herd at the Reymann Memorial farms at Wardensville. Data on about 50 individuals have been collected.

Along with the feed consumed, a record is kept of the growth of the heifers. They are weighed and their height at withers is determined every month. (No attempt has been made to assemble this material as it was thought advisable to get as many data as possible before appraising it.)

Varieties of Pasture for Milk Production

A study to determine the relative merits of different varieties of pastures for milk production and to establish a rotation of pasture which could be recommended to West Virginia dairymen has been inaugurated by H. O. Henderson, R. J. Garber, and R. A. Ackerman. At Wardensville a series of eight plots has been laid out, two of which have been seeded to bluegrass and white clover; two to oats, Canada field peas, sweet clover, and Sudan grass; two to oats and sweet clover; and two to Sudan grass. During the past year, the driest season on record, all of the pastures were practically worthless by July 15th. The sweet-clover pastures were found to withstand the drought better than did the bluegrass-white clover mixture, while the Sudan grass failed to make much growth because of the drought. The sweet clover furnished more pasture, remained green, and was pastured eleven days after the bluegrass—white clover pasture had “burned up”.

Sweet-clover pasture was not eaten well for the first two or three days, but beginning about the fourth day the cows ate it much better, and after a week or two they seemed to relish it. It had a good laxative effect on the animals, and no ill effects were noted.

Roots as a Feed for Dairy Cows

Of especial interest to those who keep a small number of cows and find it unprofitable to have a silo, but who still wish to supply some succulent feed for the winter season, is the investigation conducted by K. S. Morrow and H. O. Henderson on the comparison of mangels and corn silage. Mangels have yielded on the average from 25 to 30 tons per acre on the Station farm at Morgantown on land that will yield from 10 to 12 tons of corn silage. During some seasons, certain varieties have yielded as high as 40 to 50 tons per acre.

Analyses have shown that corn silage contains about $2\frac{1}{2}$ times as much dry matter as does an equal amount of mangels. Three trials have been conducted in which one group of dairy cows were fed corn silage with hay and grain, and another group were fed mangels with hay and grain, both groups being fed the same amount of dry matter. The rations were alternated by the reversal method, so that each group received the silage ration for a period of four weeks, and the ration containing mangels for a similar period. Under this procedure there was no appreciable difference in the amount of butterfat produced by cows when fed the two kinds of feeds. There did seem, however, to be a slight difference in milk production in favor

of the group receiving the mangels. This was probably due to the extra amount of water obtained from the mangels. The water consumption of the animals was measured by means of water meters attached to the individual drinking cups. Less water was consumed when the cows were receiving the ration containing mangels, but more data must be taken before drawing definite conclusions as to the effect of the water in the food upon milk and butterfat production. The data at hand, however, would indicate that mangels may be substituted for corn silage when fed on the equal dry-matter basis.

Soybean vs. Alfalfa Hay for Milk Production

A continuation of the study of soybean hay and alfalfa hay for milk production has been carried on by H. O. Henderson. The results of the first two feeding trials were slightly in favor of the soybean hay and were reported in Bulletin 181 of this Station. Two more trials have been run under the same plan by using the reversal feeding method, in which one group of cows were fed alfalfa hay and a grain ration for one period and then changed to soybean hay, while the other group were first fed soybean hay and later changed to alfalfa hay.

The results of these two trials were slightly in favor of the alfalfa hay. The alfalfa hay was home-grown and of a higher quality than that used in the previous trials, while the soybean hay was allowed to become rather coarse before harvesting. The cows refused 23 percent of the soybean hay by weight during the first of these trials and 10 percent during the second of these trials, while they refused only 3 percent of the alfalfa hay during the first and none during the second of these trials. This refuse consisted of the coarse stems.

During the first of these trials, the ten cows when fed alfalfa hay produced a total of 16.0 pounds of milk and 2.22 pounds of butterfat more than they did when they were fed soybean hay over a period of 21 days, while in the second trial the ten cows fed alfalfa hay produced 167.2 pounds of milk and 3.27 pounds of butterfat more than when fed soybean hay. The cows in both instances maintained their weight just as well on the one ration as on the other.

When all four trials are taken into consideration, it is found that there is less than 0.2 pounds of butterfat difference in the total amount of butterfat produced by the 40 cows when fed the different kinds of hay, over a period of 21 days. In conclusion it can be said that if the soybean hay is cut before it becomes coarse, it should equal alfalfa hay for the production of milk and butterfat.

Microflora of Raw and Pasteurized Grade-A Milk

A study of the microflora of high-grade milk before and after pasteurization has been made by L. M. Thurston and H. C. Olson.

Efficiency of pasteurization was determined for 103 samples of milk and was found to increase as the bacteria count of the raw

milk increased. Thus efficiency of pasteurization is lower for Grade-A milk than for milk of higher bacteria content. This is explained on the basis that a fairly constant number of resistant organisms exist in milk of any grade, making the proportion surviving in milk of low initial count high as compared to milk of higher initial count. It was also found that the efficiency of pasteurization was more variable for milk of low initial counts than for those of higher counts.

The proportion of types of bacteria in the milk before and after pasteurization differs. There was a decided increase in proportion of acid-forming bacteria in the pasteurized milk over those present in the raw. These organisms were predominantly of the bacillus form. The proportion of acid-coagulating bacteria decreased because of pasteurization. In seeking the explanation it was found that the organisms producing acid-coagulation were mostly Streptococci, which were destroyed more efficiently by pasteurization than the Bacilli, which were mostly acid formers. The proportion of inert bacteria increased on pasteurization, as did the peptonizing organisms, but the alkali formers decreased.

Attempts to determine whether the apparent increase in numbers of bacteria in pasteurized milk was due to breaking of clumps failed because the milk used contained so few bacteria that microscopic counts proved impossible.

In tests of keeping quality of raw and pasteurized Grade-A milk the pasteurized milk was found to keep considerably longer than the corresponding raw milk in each of a number of trials. Coagulation of the raw milk in these trials was due to the acid which developed, but evidence indicated that coagulation of the pasteurized milk was due to a rennin-like enzyme secreted by the bacteria.

Flavor in Dairy Products

A study to determine the constituents of milk that contribute to the flavor of dairy products has been inaugurated by L. M. Thurston. A series of trials has been carried out comparing the flavors of normal whole milk with those of standardized buttermilk obtained from the same batch of milk and with standardized skimmilk from the same original source. Standardization consisted in bringing the content of the buttermilk and skimmilk to that of normal milk. The skimmilk was standardized by adding cream containing fat which was washed 10 to 15 times by dilution and reseparation and which should contain a minimum of fat-globule films. The buttermilk already rich in fat-globule films was standardized by the addition of unwashed cream. There was a perceptible graduation in rich flavor for each of the three samples in every case, in the order of standardized skimmilk, normal whole milk, and standardized buttermilk. This is in confirmation of the theory that fat-globule films do give milk some of its rich flavor.

Causes for Poor Quality Cream Shipped in less than Carlots

A study of the causes for poor quality cream shipped in less than carload lots has been started by L. M. Thurston, H. O. Henderson, and R. A. Ackerman. An especially good opportunity for this study is provided with the cream obtained from the herd at the Reymann Memorial Experimental farm which is shipped to Washington, D. C., daily. Observation is made at Wardensville as to the temperature, bacteria count, flavor, etc., and the same is obtained upon arrival of the cream at Washington about 15 hours later. Cream is shipped in different types of cans and under various conditions. The results of such a study should be of interest to the many cream shippers in West Virginia.

Manufacture of Sweet-Curd, Rennet-Coagulated Cottage Cheese

A study of the manufacture of sweet-curd, rennet-coagulated cottage cheese conducted by L. M. Thurston is yielding some very interesting results.

It was found that the acidity of the whey at the time of cutting the curd is the most important single factor concerned in the manufacturing process. Regardless of variations in other factors, a whey-acidity of 0.35 percent or more was found necessary in order to produce curd with a desirable body. When the acidity was lower a rubbery curd always developed. Acidities as high as 0.68 percent were developed, this being the upper limit for this type of cheese, as acid coagulation results independently of the action of rennin in this range. The average acidity at cutting for these batches which produced desirable curds was 0.48 percent, and the majority range as determined by the mean plus and minus the standard deviation was 0.41 to 0.54 percent.

The use of calcium chloride proved of no value in hastening coagulation by rennin or in firming the curd during "cooking".

Variations in amount of rennet extract from 1.33 to 3.33 cc. per 1000 pounds of skim milk had no apparent effect on the making process or on the character of the curd produced from skim milk pasteurized at 185° F. for 20 minutes. As these amounts were sufficient to yield a desirable curd and varied more widely than the likely limits of error in measurement under ordinary conditions, greater amounts were tried.

Knowledge gained in this work concerning factors governing the process made it possible to shorten the making time from 18 to 8 hours and thus to manufacture the curd during the day. The chief factor in speeding up the process was the quicker development of lactic acid.

Gassy curd was often encountered and if not overcome resulted in a curd of unclean flavor. The gas can be removed and its effects reduced to an unappreciable minimum by heating the curd in the whey to 150° or higher. These results were obtained from skim milk

pasteurized at 185° for 20 minutes. Similar setting and cooking methods proved unsatisfactory when applied to milk pasteurized at 145° for 30 minutes according to common practice. Studies are under way to find the reason for this difference and to develop a satisfactory method for milk pasteurized at lower temperatures, as well as for raw milk.

POULTRY HUSBANDRY

Weight of Eggs Fairly Stable for Each Layer

When Leghorns are maintained under average conditions the decrease in egg production due to increasing age is, in round numbers, 20 percent per year, according to conclusions reached by Horace Atwood and T. B. Clark after five years of research into the factors affecting the weight of hen eggs. Data include 86,000 egg-weight records, 7,800 body-weight records, and the records of mortality from a random sample of 200 single-comb White Leghorn pullets selected in 1925 on the Poultry farm and fed throughout the experiment on a standard laying ration.

The weight of eggs laid by a bird, it was found, is a relatively stable character, persisting from year to year. The heavier birds laid the heavier eggs, but there was no evidence that the birds which became materially heavier with increasing age were either better or poorer layers than their companions which remained lighter. A bird which lays a large number of eggs is as likely to lay large eggs as small ones, and a small pullet is as likely to lay a creditable number of eggs as her larger companion. The younger the pullet when beginning to lay, the better the egg production for the pullet year. This relationship did not hold true during later years. Mortality of the flock was normal. At no time was there an outbreak of an infectious disease. A full account of this project is reported in Bulletin 233.

The Time Factor in Egg Production

It seems probable that the intervals in hours from one egg to another within a cycle are so closely correlated with the process of egg formation that the average length of these intervals may be employed during the first stages of production to indicate the potential fecundity of birds for their entire period of production. In order to shed light on this question eighty pedigreed pullets were selected by T. B. Clark in 1929, to be placed in laying houses when developed. Data relating to the following items are being observed: regularity of laying within the cycle, relationship between time of laying and production, relationship between time of laying and length of cycle, inheritance of egg weight, inheritance of length of cycle and time of laying within the cycle, and hatchability as affected by length of cycle.

Egg Incubators Withstand Higher Initial Temperatures

Considerably higher temperatures may be employed with safety at the beginning of the incubating process than have been advised by manufacturers of cabinet-type incubators, according to Horace Atwood. In a study of the proper incubating temperature for the eggs of the domestic fowl in incubators of the cabinet type, begun on the Poultry farm in 1929, six carefully controlled hatches which total 2700 eggs were made in two Petersime incubators during the first year. High initial temperatures have seemed to increase the number of fertile eggs as determined by candling, but so far such temperatures have not increased hatchability. Temperature is relative, not absolute, in relation to humidity and ventilation.

CROPS AND SOILS

Pasture Improvement

Some of West Virginia's bluegrass pastures, particularly those located on soils of limestone origin, rank among the finest known. On the other hand, most of the pastures in the state are located on

Many pastures could be much improved by means of liming and top-dressing with fertilizer

less productive soil and hence are of inferior quality. As the result of a survey made several years ago it was found that on the average approximately 4 acres of pasture were required to support one cow during the grazing season, whereas not more than one-half that amount should be required in a good bluegrass pasture. In view of the extensive area of farm land in West Virginia suitable only for pasture or woodland, the question of pasture improvement is of considerable importance.

In order to study this question an experiment was begun in 1922 by T. E. Odland, C. V. Wilson, H. O. Henderson, and E. P. Dea-

trick in which the effect of certain fertilizer, cultural, and seed treatments were investigated on 44 grazed and ungrazed pasture plats located on each of two farms of the Experiment Station at Morgantown. This investigation has been completed and the results have been published in Experiment Station Bulletin 235. It was found that the use of lime and superphosphate are basic to pasture improvement. On poor, rundown pastures little, if any, benefit may be expected from the use of seed or harrowing unless soil acidity is at least partially corrected by the use of lime, and superphosphate is added to supply a plant-food nutrient deficient in practically all soils of West Virginia.

Date of Soybean Harvest Influences Yields of Wheat and Corn

When soybeans are followed by wheat the results may be unfavorable. Whether the yield of wheat is increased or decreased depends somewhat upon the interval between the soybean harvest and the seeding of wheat. The problem has been studied by D. R. Dodd and R. J. Garber in a series of plats at Morgantown in which soybeans were harvested on three separate dates, August 10, August 30, and September 25. All plats were seeded to wheat on September 28. Good yields were obtained from the plats harvested in August, four and six weeks before seeding, but the reverse was true of the plat harvested in September, three days before seeding. The explanation for the difference was found in analyses of the nitrate content of the soils. Nitrate content is lowest at the time of soybean harvest. It increases rapidly following harvest and within a month the supply is ample for the vigorous growth of wheat. Early harvest of soybeans or the application of some nitrogen fertilizer is, therefore, essential to good yields of wheat as a following crop, since this insures an ample supply of nitrogen in available form for the young wheat plants.

The experience with corn is completely reversed. Late harvest of soybeans is preferred since it provides high nitrate during late spring and summer when the need of the corn crop is greatest.

Rye and Vetch Best as Cover Crops

Rye and vetch have proved more satisfactory as winter cover crops than sweet clover or crimson clover in experiments conducted at Morgantown by R. J. Garber, T. E. Odland, and H. O. Henderson. The clovers have been almost complete failures because of winter killing, while rye and vetch, both alone and in combination, have given excellent winter cover during the nine years of the experiment. The cover crops are grown each year in a rotation of corn and soybeans, being seeded at the last cultivation of corn and following the harvest of soybeans for hay. Appreciable increases in yield of corn as silage have followed the use of the rye and vetch cover crop, but the yields of soybean hay have only been slightly increased. A combination of rye and vetch is preferred to either crop grown separately.

Early Maturing Oats Best for West Virginia

Varieties of oats that mature early yield better under West Virginia conditions than mid-season or late varieties according to tests conducted at Morgantown and Lakin by R. J. Garber, M. M. Hoover, and T. C. McIlvaine. Experimental plantings of a large number of varieties and pure-line selections have been under continuous study since 1921.

Gopher has proved to be one of the high-yielding varieties and is particularly well adapted to West Virginia conditions, as shown also by the results of farmers' trials which have been conducted throughout the State under the supervision of the department of agronomy.

Considerable quantities of Gopher seed are now available through the Crop Improvement Association and indications are that it will soon become the dominant variety in West Virginia. The complete replacement of varieties now in use with high-quality seed of Gopher would, according to estimates based on the experimental trials, increase the production of oats by approximately 2,000,000 bushels a year with no increase in acreage.

Other varieties that have yielded well in the experiments are Iowar and Albion, but Gopher is preferred since it combines earliness, yield, and stiffness of straw.

Wheat Varieties Best Suited to West Virginia

Experimental trials of wheat varieties which have been under way at Morgantown and Lakin for a number of years have been continued during the period of this report. The yields for the entire period have been summarized and compared by M. M. Hoover and R. J. Garber. Eighteen named varieties have been grown at Morgantown for periods varying from two to nine years, and eleven varieties have been grown at Lakin for six years. As would be expected, no single variety can be named as the one best variety for West Virginia but a good choice can be made among three varieties, any one of which can be relied upon to produce better yields than varieties commonly grown in the State. The high yielding varieties are Fulhio, Reliable 80, and Trumbu'l. Fulhio and Trumbull, both selections of Fultz, are beardless varieties, while Reliable 80, a selection of Gypsy, is bearded. Fulcaster and Ashland have also produced high yields at Morgantown, and Gladden and Mammoth Red have been satisfactory at Lakin. The experiments indicate that the yielding ability of wheat varieties over a period of years is determined very large'y by their winter hardiness.

In addition to the trials of named varieties, a number of pure-line selections have been isolated and compared. All but 16 of these selections were discarded in 1929, and the four most promising of these have now been increased for testing in other sections of the State. The latter have produced higher yields than any of the named

varieties and will doubtless be brought into general use within a few years.

Crop Responses to Fertilizers

In 1930 T. C. McIlvaine, W. H. Pierre, R. J. Garber, and K. C. Westover outlined a rather comprehensive project to study the response of different crops to various fertilizers when grown on Wheeling fine sandy loam, an important soil type found along the Ohio river. The crops whose fertilizer responses are being studied are corn, wheat, red clover, soybeans, and potatoes. The relative effect on yield of the three essential plant food nutrients—nitrogen, phosphorus, and potassium—in various amounts and combinations are being determined on more than 300 1/30 acre plats located at the Lakin Experiment farm. A study is also being made of the effect on yield of different methods of placing the fertilizers with reference to the plants: i. e., broadcast, hill, and row applications, alone and in various combinations.

Field experiments such as these are useful in evaluating various fertilizers in terms of increased yields and are also of great importance in that they furnish a basis for more fundamental studies in the greenhouse and laboratory. The goal of this type of soils research is to determine from a laboratory study of soil in a given region just what it needs to grow particular crops. Much information of a fundamental character is still necessary before such a method may be used.

Alfalfa in Relation to Soil Type

A comprehensive study of the growth of alfalfa on the principal soils of West Virginia which has been inaugurated by W. H. Pierre and R. J. Friant during the past year is already yielding results of practical value, although a number of years will necessarily be required to complete a study of this character. Among the points to be determined on the different soil types are the effects of phosphorus and potash fertilization, and the effect of liming to different pH values and percentage base saturation. The effect of mowing and of cultural practices on permanency of stand is also under investigation in several sections of the State.

Early results indicate that the optimum reaction for the growth of alfalfa varies with the soil type, and that good growth of alfalfa may be obtained at pH values considerably below neutrality. All soils but one responded to phosphorus fertilization, the extent of the response varying with the soil type. In the mowing tests the stand was reduced where more than three crops were removed in a single season, the alfalfa being replaced by grass and weeds.

Cowpeas Tolerant to Soil Acidity

Soil acidity studies conducted at the Lakin Experiment farm by T. C. McIlvaine and W. H. Pierre show cowpeas to be much more tolerant of soil acidity, as determined by pH values, than soybeans. The plants were grown in the open in bins 3 feet square, in which the

soils were adjusted by means of lime and sulphuric acid to a range of pH values from 4.01 to 8.13. As will be noted in the accompanying table, cowpeas grew almost as well in the most acid soil, pH 4.01, as in the less acid soils, while the yield of soybeans was greatly reduced at pH 4.04.

TABLE 2.—*Yield of Soybeans and Cowpeas on Soil Brought to Different Degrees of Reaction by the Use of H_2SO_4 and Lime*

Series	pH value of soil	Yield of soybeans (Dry wgt. in grams)	Series	pH value of soil	Yield of cowpeas (Dry wgt. in grams)
A	4.04	183	A	4.01	1138
B	4.42	1350	B	4.40	1277
C	4.73	1517	C	4.64	1338
D	5.49	1523	D	5.49	1164
E	5.79	1441	E	6.00	1159
G	7.22	1679	G	7.17	1195
H	7.76	1889	H	7.74	1292
I	8.12	1586	I	8.13	1105

Hay Tests of Forage Plants, Alone and in Mixtures

In August, 1921, a series of 96 1/40-acre plats was established on the Agronomy farm for the purpose of determining the yields of air-dry hay of several legumes and grasses, both when grown alone and in mixtures. The experiments included varietal and pure culture tests as well as combinations of different hay crops.

In the alfalfa varietal tests Grimm, Canadian variegated, and native common varieties from Kansas, Nebraska, Utah, and other Northwest states were found superior to those from any other section of the United States or foreign countries. Seeds were obtained through the courtesy of the federal Office of Forage Crops Investigations. In a similar study of red clover, it was found that native-grown red clover is superior to seed from foreign countries, particularly from countries with a mild climate like Italy and southern Europe. The Tennessee strain, bred for resistance to Anthracnose, is well adapted to West Virginia conditions and shows no evidence of disease.

Among the pure cultures alfalfa, tall oat grass, and timothy each produced an average yield for the five years in excess of two tons per acre. Italian and perennial rye grasses, meadow fescue, and brome grass did not prove very satisfactory in this experiment.

Among the meadow mixtures, those containing tall oat grass gave the highest yields. Timothy and alfalfa also proved very satisfactory components in increasing the yields in the several mixtures in which they occurred.

Systems of Farming

A large part of the Lakin Experiment farm is located on what is known as Wheeling fine sandy loam, a type of soil that is being used to grow many kinds of field and truck crops in the Ohio river valley section. For this reason a project was outlined five years ago

by T. C. McIlvaine and R. J. Garber to study and compare in field plats different cropping systems with and without the use of lime but with all crops receiving the same amount and kind of fertilizer. There are 270 $1/30$ acre plats used in this investigation and practically all the important field crops are included in the study.

The use of lime has produced increased yields of all crops except potatoes. In general the higher yields have been obtained from the crop rotations in the "livestock system" of farming, where roughages are fed or used for bedding and the manure is returned to the soil, as compared with the "grain system" of farming, where the grains and first cutting of hay are removed and the crop residues and aftermath on the meadows are returned to the soil. Cowpea stubble turned under has resulted in somewhat greater yields in the following crop of wheat than soybean stubble. The two-year rotations have shown a tendency to produce somewhat lower yields than the three- and four-year rotations.

A Promising Soybean Selection

A selection of the Peking variety of soybeans isolated from the parent variety by R. J. Garber and M. M. Hoover has proved one of the most promising of the soybean varieties and selections tested at Morgantown and Lakin. Especially desirable characteristics of the new selection are the fineness of the stems and the fact that the leaves do not drop as early as in other varieties, thus insuring better quality of hay. Haberlandt, Wilson, and Manchu produced the highest yields of seed, while the Peking selection, Wilson, and Haberlandt led in yield of hay.

A comparison of the yield of seed of three varieties of soybeans when grown in cultivated rows and in solid drill rows showed no significant differences.

Studies relating to field technic have been published as professional papers.

Sweet Clover Breeding Studies

Strains of sweet clover especially adapted to West Virginia and of improved quality as forage and hay are being sought by R. J. Garber, M. M. Hoover, and R. B. Dustman in a recently established project. A large number of new strains have been produced by inbreeding and it is hoped that the desired types may be found among these or other strains produced in similar manner. Under natural conditions sweet clover is normally cross-pollinated and the plants, although varying in some degree, are all much of the same general type. Extreme variations occur, however, when self-pollination is practiced. The strains which have been produced by this method show a wide range of habit of growth, disease resistance, and tolerance to soil conditions. After they have become fixed through selfing for several generations they will be tested for tolerance to acid

soil conditions and for coumarin content, and if possible, strains with low coumarin content that will grow on relatively acid soils will be isolated and propagated for use on the farms of the State.

Controlling Oat Smut by Breeding

One of the diseases which annually cause considerable damage to oats grown in West Virginia is smut. Several years ago an investigation was undertaken by R. J. Garber and N. J. Giddings which had for its object the production of a high-yielding strain of oats resistant to smut. Black Mesdag, a variety known to be resistant to both covered and loose smut, but of little value in other respects, was crossed with Gopher, one of the highest-yielding varieties of oats grown in this section but moderately susceptible to smut. The descendants of this cross are now in the seventh generation. It has been shown that resistance to smut is just as definitely inherited as is color of seed or any other character. Two technical papers giving the results of this work have been published.

A few white-seeded descendants resembling somewhat the Gopher parent but resistant to smut are being increased to determine their relative yielding ability. It is hoped to obtain a variety of oats just as desirable as Gopher and in addition possessing resistance to the disease.

Smut Resistance in Corn

An especially interesting phase of the corn investigations conducted by R. J. Garber and M. M. Hoover has been a study of the susceptibility of inbred strains of corn to the smut disease. A total of 175 selfed strains were compared for smut resistance in 1929 and 120 strains were compared in 1930. Each of the strains has been fixed in its characters through several years of self-pollination, and a remarkable range of susceptibility is exhibited within the series. Some are extremely susceptible, others highly resistant, and others range between these extremes. The strains are not only strikingly different in susceptibility for the plant as a whole but they differ also with regard to the plant parts affected. Some are infected especially in the tassel, others especially in the ear, still others especially at the base of the stalk or on the leaf. An extensive analysis of the genetic behavior of resistance and susceptibility now in progress indicates that a complex condition prevails.

As is generally known, inbred strains of corn are usually inferior in growth and yield to cross-bred strains, and the strains developed in the work at Morgantown are no exception to the rule. None of the immune strains has sufficient vigor and yielding ability to recommend it from this standpoint. Their sole merit lies in their smut resistance. They must be re-invigorated if they are to find a useful place in corn production. In theory this should be possible of accomplishment by means of cross pollination between resistant strains, and attempts to do so are now under way.

Breeding Tobacco for Resistance to Rootrot

Rootrot (*Thielavia*) is a problem of considerable importance among tobacco growers and although it has been partially solved through the development of resistant varieties, the latter do not yield as well under West Virginia conditions as the non-resistant varieties. R. J. Garber and T. C. McIlvaine, in cooperation with the Office of Tobacco Investigations of the U. S. Department of Agriculture, have attempted to correct the low yield of resistant varieties by breeding with a high-yielding variety. They have crossed Maryland Mammoth, a high-yielding susceptible variety, with two strains of resistant Burley and have secured hybrid strains that combine high yield and resistance. Unfortunately, however, all the hybrids were of poor quality, their market value being only about one-half that of the Burley strains. Although unfortunate in final outcome, the experiments indicate the possibilities of the methods employed and point the way to further trials which are now in progress. In the new experiments Kelly and Pepper, two high-yielding varieties of good quality, well adapted to the Huntington area, have been crossed with the resistant Burleys. It is hoped that strains of the desired characteristics may be isolated from the progeny of these crosses.

FRUITS AND VEGETABLES

Varieties of Fruits Adapted to West Virginia

About 250 varieties of apples, peaches, cherries, pears, plums, nuts, and small fruits are being tested as to their value under West Virginia conditions at Morgantown and at the branch stations at Lakin and Kearneysville by members of the Horticulture department. An interesting phase of the study is the testing of the new color sports of the apple that have lately been introduced. These include three color sports of Delicious, several of Rome and Stayman, and one each of Winesap, Jonathan, and Oldenburg.

Results of these studies up to date have been published in Bulletin 222. It serves as a valuable guide to fruit growers in planning new plantings.

Most Varieties of Apples Self-sterile

In tests on self-sterility of varieties of apples conducted by H. E. Knowlton in the important producing sections of the State practically all have been found to set little fruit when self-pollinated. York seems to be the only variety so far tested that sets sufficiently for a commercial crop when planted by itself. Varieties of the Winesap group will not set any fruit when self-pollinated, because of the impotent pollen produced. These varieties are also cross-sterile from this abortive pollen. Other varieties producing normal pollen are therefore necessary for adequate setting of fruit. De-

sirable combinations of the standard commercial sorts which will insure sufficient fruit setting have also been determined, as for example Jonathan and Delicious or Grimes; York and Rome; and Northwestern and Delicious. Any of the above varieties will fertilize Stayman and Winesap.

Growers are seeing the practical value of these investigations and when making new plantings are no longer setting large blocks of single varieties but are mixing them with the idea of getting adequate cross-pollination.

Better Rootstocks for Apples and Sour Cherries

Propagation of all apple and sour-cherry trees in America is upon seedling rootstocks. These roots vary in vigor, hardiness, resistance to insects and diseases, and soil adaptability, as well as in other factors. These variable roots used as stocks produce trees which differ in size, productivity, length of life, etc. Studies now under way by Leif Verner, in cooperation with the U. S. Department of Agriculture, are aimed at a solution of the problem. The work involves the following method of attack: first, a study of species and types of roots now available for the propagation of apple and sour cherry trees; second, a search for new species, seedlings, and strains that show promise as stocks; third, testing these stocks for insect and disease resistance, congeniality with the various varieties grown commercially, and ease of propagation asexually; and fourth, a study in the orchard of the most promising root stocks when propagated upon the important commercial varieties. Three test orchards for apple stocks have already been planted and a fourth of about 25 acres is to be set out on the University Experiment farm at Kearneysville. This experiment will be one of the most complete and elaborate of any in the United States on this particular problem. In it a dozen or more of the most promising apple stocks (clone and seedling) will be budded this summer to our most important commercial varieties. These trees will be ready to plant out in the spring of 1933. Montmorency cherry on five selections of Mazzard and Mahaleb roots have also been planted on the University Experiment farm.

Potato Seedstock Studies

Studies were made over a period of four years by K. C. Westover and E. N. McCubbin, to determine the effect on yield of the storing of cut potato seedstock. Stored lots cut at two-week intervals during the storage season were compared. The results obtained indicated that only a relatively short time (three weeks at the most) should intervene between the cutting of the seed and the planting operation.

Comparisons of the vigor of the bud and stem ends of the same seed tuber were carried on in 1929 and 1930. Tubers selected from several bags of high-grade seedstock graded to meet U. S. No. 1 grade were sorted according to weight into three groups: (1) 6 to 8

ounces; (2) 8 to 10 ounces, and (3) over 10 ounces in weight. Just before planting time, cylindrical plugs of the same length were cut from the bud and the stem ends of each tuber and planted in hills in this sequence. The growth and yield data taken do not indicate a real difference in vigor between the bud and stem ends of the tuber, although there was a tendency for the bud end to produce more stalks per hill.

Trials run during three seasons to determine the effect of green-sprouting Rural potato seed tubers on earliness and yield failed to indicate any marked benefit from this practice.

Experiments to determine the influence on yield of the removal of sprouts from improperly stored seed potato tubers were run for two years. Lots of tubers were compared from which the sprouts had been removed from one to six times during the storage period. The results show quite conclusively that the practice of removing sprouts from improperly stored seed tubers results in greater losses in storage from decay, reduces stand of plants in the field, lowers their vigor, and decreases the yields of No. 1 tubers and the total yields. Tubers which have had the sprouts "rubbed" from them more than once are of questionable value as seedstock.

Strains of Earliana Tomato Earliest at Lakin

In tests conducted at the Lakin Experiment farm in 1929 by K. C. Westover and F. W. Craig, strains of the Earliana tomato were the best-yielding during the early season (to July 25). Burbank was also good. In total yields for the whole season, Bonny Best was highest. World Beater pepper and New York Improved eggplant were outstanding in variety tests of these vegetables.

Preliminary trials were also made in 1930 with early sweet corn, carrots, beets, and early cabbage. The data obtained are, however, considered of little value because of the abnormal weather conditions which existed.

Nitrogen Fertilizers and the Keeping Quality of Apples

Many commercial apple growers claim that fruit from orchards heavily fertilized with quickly available nitrogen fertilizers is being discriminated against by the buyer because of alleged poor keeping quality. In experiments conducted in 1928 and 1929 on Black Twig and Stayman apples by H. E. Knowlton and M. B. Hoffman, apples from nitrated trees kept as well as fruit from trees not so fertilized. Fruit from nitrated trees was poorer in color and somewhat softer in texture, however.

It is believed that the poor reputation of apples on the market from heavily nitrated trees is due principally to three reasons: (1) They have scalded badly in storage because of their poor color. While the value of shredded oil paper in preventing scald has been known for a number of years it has not been used extensively in the East until the last two or three years. (2) In many instances fruit

has been left on the trees until overripe in order to get better color. As a result it has kept poorly in storage. (3) Poorly-colored fruit is lower in dessert quality than well-colored fruit. This is especially true of such varieties as Delicious and Jonathan.

Sulphate of Ammonia Cheapest Nitrogen Fertilizer for Apple Trees

In experiments conducted for the past five years in Jefferson and Pleasants Counties by H. E. Knowlton and M. B. Hoffman, sulphate of ammonia gave as good results as nitrate of soda on apple trees as measured by growth and yield when both were applied several weeks before bloom. When applied at blossoming time nitrate of soda was much superior.

Since sulphate of ammonia is cheaper per unit of nitrogen than other quickly available nitrogenous fertilizers, its use will mean a large financial saving to the apple orchardists of the State. It should be emphasized, however, that this fertilizer gives an acid reaction to the soil; consequently its continued use may be detrimental to leguminous cover crops unless the acidity is corrected by the addition of lime.

Cultural Practises Affect Peach Bud Hardiness

According to studies conducted at Morgantown by H. L. Crane, greater hardiness of peach buds results when trees have stored a large amount of food reserves the summer before. To get this food storage a large and healthy leaf surface should be maintained late in the fall. Moderate dormant pruning, cultivation, applications of nitrogenous fertilizer in the spring, and control of insects and diseases will accomplish this. Fruit thinning should be practiced to prevent overbearing, which depletes the tree's food reserves. Nitrogen content analyses have been made by the department of agricultural chemistry.

These studies are of practical importance to the fruit grower because of the great losses that occur almost annually to peaches, plums, and cherries from low winter temperatures.

Light Pruning Best for Young Fruit Trees

Light pruning of apples, peaches, plums, and cherries for the first few years after planting produces larger trees which come into bearing earlier than trees more heavily pruned, according to experiments conducted by H. L. Crane of the department of Horticulture on the University farm at Morgantown. This light pruning should be continued with sour cherries after the trees come into bearing, but apples and peaches should be pruned more severely if size and color of fruit are to be maintained.

Pruning of Greenhouse Tomatoes

Double-stem tomato plants with the stems tied apart on separate strings yield more than plants with single stems or plants with double

stems tied together, according to studies carried on by A. P. Dye. The single stem plants averaged 11 pounds, the double stem tied together 14 pounds, and the double stem tied apart 18 pounds per plant. Another year's data will be obtained before definite conclusions are drawn. These results will be of interest to greenhouse men since training to a single stem is the common practice.

Results with Paper Mulches on Vegetables Depend on Kind of Crop and Soil

Experiments conducted by K. C. Westover, F. W. Craig, and E. N. McCubbin on paper mulches at Morgantown and at the Lakin Experiment farm have given strikingly different results. On a clay loam soil at Morgantown the paper mulch produced significant differences in growth and yield of tomatoes, peppers, eggplant, string beans, and beets in 1929 as compared with clean cultivation. With peppers, eggplant, and string beans yields were more than doubled.

On a fine sandy loam at Lakin small increases were made, but it is doubtful if the increased yields would pay for the paper. Since these results are only for one year, definite conclusions are not being drawn until further data have been obtained.

Time of Thinning of Elberta Peaches

Late thinning of Elberta peaches (four weeks before harvest) gives as good results when measured by fruit size as thinning done soon after the June drop, according to tests conducted by H. E. Knowlton and M. B. Hoffman.

From the practical standpoint there are many advantages in late thinning. First, less fruit will be removed in late thinning because of the more or less constant dropping that occurs in the interim between the time that fruit is normally thinned and the time of the late thinning (four weeks before ripening). Second, there is opportunity in the late thinning to remove blemished fruits—fruits injured by curculio, hail, limb rubs, etc. Third, if late thinning is as effective as earlier thinning the grower can spread the operation over a longer period, performing it with the regular help without going to the necessity of hiring additional help. Or on the other hand, he may postpone this rather expensive operation until the middle of July, hire more labor, and finish in a few days. This would be an exceptionally good plan to follow in sections where partial or total loss of crop from hail storms in mid-summer is of fairly common occurrence. Thinning done later (three weeks before harvest) may not be as good as earlier thinning, particularly if August is dry.

Lawn Grass Studies

Tests conducted by A. P. Dye for the past three years on kinds and mixtures of grass seeds most suitable for lawns show that the bent grasses and mixtures containing Kentucky bluegrass, redtop, and white Dutch clover are best under conditions at Morgantown. Among

the grasses tested were Velvet, South German, and Rhode Island bent, Kentucky and Canadian bluegrass, New Zealand, fine-leaved, hard, creeping, and sheep's fescue, timothy, wood meadow, crested dogstail, perennial rye grass, redbud, and white Dutch clover. The fescues are difficult to cut, tend to bunch and are unattractive in appearance. The bents stand adverse conditions better than bluegrass but do not make as attractive a lawn.

Greenhouse Carnation Experiments

In handling carnations the common greenhouse practice is to make cuttings in January and February. When rooted they are transplanted to the field until July or August, when they are put in their permanent planting in the greenhouse. A. P. Dye is carrying on experiments to find out if this is the best procedure. Three varieties are being used—White Matchless, Spectrum, and Betty Lou. Cuttings will be made on the first day of December, January, and February. A representative number of each will be planted in their permanent beds in the greenhouse about the middle of May after being in coldframes since April 1, following rooting. Another similar lot will be set in the field until August and then planted in the greenhouse. Records will be kept on quantity and quality of bloom, season of heaviest productivity, and prices obtained throughout the season.

INSECT PESTS

Pistol-Case Bearer a New Problem

The value of research to fruit growing is well illustrated by the work of Edwin Gould and L. M. Peairs with the pistol-case bearer. The insect gets its name from the appearance of its protective case, which resembles a pistol. It feeds on the buds, leaves, and fruit of apple trees. Within the past few years it has developed into a pest of the first magnitude in certain orchards in the eastern section of West Virginia. The entomology staff in the spring of 1929 began a thorough study of the feeding habits and life history of the insect and tested its susceptibility to all the known poisons under a variety of conditions.

The life-history studies finally gave the clue that pointed the way to control. They showed that in hatching, the worm does not expose itself to stomach poisons. It eats directly through the bottom of the egg into the leaf, feeds there a while, and then emerges on the opposite side with its protective case already formed. The only possible hope lay in gassing the worm during the hatching period. Contact insecticides were therefore tested and in numerous trials nicotine proved fully effective. It was found that the efficiency of the nicotine could be increased and the cost lowered when penetrol was added.

Studies continue looking toward discovery of a poison which may be incorporated into the regular spray program, obviating thereby the need of a special spray application.

Orchard Insects

Work on orchard insects has been carried on primarily at Inwood and Kearneysville. The codling moth has received most attention. Studies by L. M. Pairs on a spray program which would eliminate the second brood spray have resulted in a modification of the spray program so that the latest spray may be applied not much later than July 1—about six to seven weeks after the petal-fall spray.

Tests of insecticides to replace arsenate of lead were made. The materials tested included other arsenates, calcium and magnesium, and sodium and calcium fluosilicates, as well as barium carbonate. Best results followed the use of magnesium arsenate, but satisfactory control, not equal, however, to the arsenates, was obtained from the fluosilicates.

Life history studies aiming to establish spraying dates have been continued on codling moth. Apple red-bugs, leaf-roller, bagworm, San Jose scale, flea beetles, and other minor insects have been studied to some extent, mainly as to the degree of control secured by the orchard spray program.

Dusts and Sprays for the Control of Garden Insects

In the control of Mexican bean beetle, now occurring throughout the state, many insecticides have been employed. L. M. Pairs reports that lead arsenate, calcium arsenate, and magnesium arsenate, each one used with lime alone as a carrier, were applied in dust form, and the same materials were applied as sprays. Calcium fluosilicate and sodium fluosilicate were used as dusts, either without dilutions or with the addition of lime or with lime and copper dust. Contact insecticides employed were nicotine, derris, and pyrethrum at various dilutions and with soap as a spreader or with penetrol. Results showed a decided advantage from the use of pyrethrum extract, either alone or with penetrol. This is considered particularly true of "Red Arrow," the great value of this material being to reduce quickly heavy infestations of larvae where early spraying with other materials has been neglected. While it kills larvae most readily, it has a decided killing effect on eggs, pupae, and adults as well. The dilutions permissible with the penetrol activator should make it sufficiently economical to use especially in small plantings.

Biology and Control of the Apple Aphids

At both Inwood and Morgantown it has been found by L. M. Pairs and Edwin Gould that apple aphids, mainly the green aphids, can be killed in the early season with dilutions of nicotine as great as one part to 4000 parts of water, if along with it Penetrol is used

at 1/2% strength. Midsummer tests at Morgantown gave 95-100% kill with one part nicotine to 6000 parts water, and 85-95% with 7500 parts water. Other tests showed similar kill with 4000 parts water and 3/4% Penetrol. Penetrol alone showed little kill.

Strengths less than 1-4000 were ineffective in spring but effective in late June at temperatures of 75° to 90° F. during the period of the tests, indicating that the critical dilution depends somewhat on temperature.

Kill of wholly dormant eggs has been strongly indicated with a pyrethrum—white oil combination. Kill of active forms with very dilute solutions of nicotine—penetrol was secured. With pyrethrum—white oil—penetrol mixtures even greater dilutions—1 to 5000—were effective in a few cases. An accurate measure, however, of the strength of pyrethrum extract was not available.

Relation of Temperature to Insect Life

Soil temperature records from January to May have been kept for several years in the belief that many plant phenomena can be shown to be dependent primarily on soil temperatures rather than on air temperatures. Studies by L. M. Peairs point to the conclusion that soil temperatures alone do not initiate development in the aerial parts of plants, but that, when the air temperatures reach a certain point, the previous soil temperatures have a definite effect on the time required for development. Soil temperatures apparently have a similar effect in the emergence of insects. Temperature in the soil determines the completion of development of forms which winter as pupae. When metamorphosis takes place, some of the insects emerge almost regardless of air temperatures. Many of these do not survive.

The killing power of contact insecticides as influenced by temperature has also been investigated. Different contact sprays act in different ways. For those whose action is dependent upon the absorption of the material by the insect, temperature has a very direct effect on the time factor at least. For those whose action is purely corrosive there seems to be little effect from variations in temperature above the point of freezing of the liquid used. The materials tested were nicotine extracts and two brands of pyrethrum extract.

Miscellaneous Insect Studies

Since concentrated outbreaks of hitherto unimportant insects cannot be foretold, this study has included insects which in some seasons are unusually abundant, as well as insects which have not previously been reported as pests. The work, begun by L. M. Peairs in 1923, has been carried on in various parts of the State.

Two tests using poisoned potatoes as bait in the soil for mole-crickets indicate that the insect will eat and be killed by potatoes poisoned with arsenic and likely by those poisoned with strychnine.

But there is indication that the crickets avoid the strychnine, preferring the unpoisoned potatoes where available. No such avoidance was noted with arsenic-poisoned potatoes.

In the control of the squash vine-borer, four treatments of lower portions of the stems of the vines with nicotine—lead arsenate spray, five to seven days apart, have given good control.

Control of the cucumber beetle was obtained by spraying the entire plant twice with Bordeaux and lead arsenate—once while it was still bushy and once after it had started to run freely. A third spray was applied two or three weeks later.

In gardens in one locality the giant ragweed has been found to harbor 85 percent of the common stalk borer. Destruction of this plant late in June, and burning or feeding it to hogs to obviate survival of the larvae, is recommended.

Magnesium arsenate, with dust or liquid carrier, has proved the best control for blister beetles. The stronger grades of calcium cyanide for dusting purposes have been found unsafe for use on the foliage of most truck crops.

PLANT DISEASES

Apple Varieties Resistant to Cedar Rust

The results of seven years' observations in an experimental orchard of 66 varieties of 8 trees each at Wardensville show that the following eleven varieties are practically immune to cedar-rust infection occurring naturally in that vicinity: Arkansas Black, Delicious, Fameuse, Gravenstein, King David, Kinnard McIntosh, Mann, Northwestern Greening, Starking, and Wolf River. Only occasional "flecks" were found on any of the above varieties.

Thirteen varieties were classed as very highly resistant—Baldwin, Chicago, Dominie, Duchess, Early Harvest, Grimes Golden, Ingram, Martha, Paragon, Mammoth Black Twig, Sweet Bough, Seek-No-Further, and Winesap. Any of the varieties in these two classes could apparently be planted with the assurance that they would be uninjured by cedar rust *GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE* in the middle Atlantic States, according to C. R. Orton and Anthony Berg, under conditions which are favorable for heavy infections upon Benoni, Rome Beauty, and York Imperial.

Rust-resistant Red Cedars

cedar,

A field study of the red ~~cedar~~ *JUNIPERUS VIRGINIANA*, by Anthony Berg and C. R. Orton, has disclosed its variability with respect to its resistance to *GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE* in the Shenandoah Valley. In a large natural stand of red cedars some 100 trees have been tagged and notes taken annually for the occurrence of rust galls. Over a period of several years certain trees have shown little or no infection, whereas other trees standing beside them have borne heavy crops of galls annually. The propagation of these resistant types is in progress.

Late Planting of Corn Reduces Rootrot

Studies by L. H. Leonian of the conditions surrounding the infection and development of corn rootrot caused by *Fusarium moniliforme* have shown that the disease is relatively unimportant in West Virginia when infected seed is planted in June, after the soil has become warm and rapid growth of seedlings takes place. The same seed planted in early May produced a poor stand with a higher percentage of infected stalks. The results were approximately the same when healthy seed was planted and the inoculum was introduced into the soil about the roots when the plants were about six inches in height. If warmer temperatures prevail, infected seedlings recover, and no apparent injury can be seen.

Variability in the Corn Rootrot Organism

FUSARIUM MONILIFORME, which causes rootrot, is an extremely variable fungus in pure culture under laboratory conditions. Certain strains isolated from diseased corn plants have dissociated into many variants which differ with respect to sporulation, color, mycelial development, sensitivity to toxic substances, and in pathogenicity. It has been shown by L. H. Leonian that these variants are themselves not permanent and in turn may dissociate into still different forms or may revert to the original type. There is evidence that similar dissociations take place under natural environments and are not to be interpreted as the result of artificial conditions. It is also evident that all such variants or dissociants must be included in our concept of what constitutes the species.

The failure of attempts to synthesize particular variants by mixing together various strains and dissociants indicate the unlikelihood that new variants might arise through such a process.

Russian Watermelon Proves Immune to Wilt

Many strains of watermelon have been tested by E. C. Sherwood for their reaction to the wilt-producing fungus *FUSARIUM NIVEUM* in heavily infested soil. A Russian variety which possesses the desirable color and shape but is inedible is the only one which has been found to be highly resistant. This was crossed in 1930 with the best commercial varieties grown in the Ohio Valley in an attempt to combine the resistance of the Russian melon with the quality of the commercial varieties.

Two Types of Apple "Measles"

Continued studies by Anthony Berg have led to the conclusion that there are two distinct types of the disease which has heretofore currently passed under the name "measles." One of these types termed *PUSTULAR MEASLES* exhibits the highest degree of virulence upon Red Astrachan but is also severe upon Maiden Blush, Rome Beauty, and Grimes Golden after infection is established. It has been proved that this type is infectious since the pustules occur only on unprotected twigs of healthy young trees planted under large infected trees. Portions of the stem protected from infection by cellu-

loid cylinders remained free from pustules throughout the season while the same trees showed heavy infections both above and below the cylinders. No infection of new twigs arising from such infected parts takes place in the greenhouse, clearly indicating that this type is not systemic and further that there is some factor absent in the greenhouse which is important in bringing about infection.

BLISTER MEASLES is a disease which is typical on Starks Delicious variety and is already established in several localities in Northeastern West Virginia. Histological studies show that this disease originates in the primordia of the buds in the region of the pericycle. Grafting experiments have not met with success apparently because of the very low vitality of infected wood.

Bordeaux Mixture More Effective than Copper—Lime Dust in Increasing Potato Yield

Spraying potatoes with Bordeaux mixture seven times at the rate of 200-250 gallons per acre resulted in an increase of more than 100 percent in yield when compared with check plots. Dusted plots showed 35 percent increase over the check. It is evident that copper is more effective in liquid than in dust form in preventing hopper burn, which was the chief malady present in the plots.

Physiological Studies on Phytophthoras

Studies on heterothallism in *Phytophthora* have been concluded and are now ready to be assembled for publication. Some 85 cultures were mated and 40 of these were found to be heterothallic, 22 representing one sex and 18 the other. Of the remaining 45, some were homothallic, and some showed no sexual reaction in any combination. Thus, one species may consist of strains some of which are homothallic, some heterothallic, and others neutral.

FARM ECONOMICS AND RURAL SOCIOLOGY

Orchard Management in the Eastern Panhandle

A threefold study by A. J. Dadisman of the economics of the apple industry in the Cumberland-Shenandoah region was begun early in 1929 in cooperation with the Pennsylvania and Virginia stations and the Bureau of Agricultural Economics of the U. S. Department of Agriculture. The first part, a survey of the place of apple orcharding in the farm organization of the Eastern Panhandle and surrounding territory, has been reported fully in Technical Bulletin No. 54 of the federal Department, entitled, "Factors influencing the yield of apples in the Cumberland-Shenandoah region of Pennsylvania, Virginia, and West Virginia." The second phase, dealing with markets, costs, and methods of marketing apples, also has been completed and is reported in Technical Bulletin No. 234 of the Department, entitled, "Marketing apples grown in the Cumberland-Shenandoah region of Pennsylvania, Virginia, and West Virginia."

For part III of the study, dealing with the organization and

management of orchards, C. H. Bruce has been employed cooperatively between West Virginia and Pennsylvania, with West Virginia headquarters at Martinsburg. Twenty orchardists in each of these states are visited monthly, and a careful study is being made of such factors as the use of spray machinery, packing, use of fertilizers, and size of business. As a result growers are beginning to study their business from the analysis presented them and are finding ways of reducing costs and increasing returns.

The aim in this piece of research is to unify like studies in three states in which the same practices and problems of orchard management obtain. As more data become available for tabulation and the drawing of conclusions, and through the experience gained by the field workers, each state becomes the beneficiary of similar studies in adjoining commonwealths.

Advantage of Production for Home Consumption Varies with Locality

While nearness to market might be considered of strategic value in the production of staple farm commodities for local consumption, studies by W. W. Armentrout in four major consuming centers of the State point rather in other directions. Inventories of the receipts and shipments of agricultural products in the Charleston, Clarksburg, Beckley, and Wheeling areas were made to determine consumption, along with a survey of the methods of production and distribution of farm products in these areas. The studies cover the period 1923 to 1926, inclusive.

The production of high-quality farm commodities, both perishable and non-perishable, is encouraged in the Charleston area. Soil and climatic conditions are adapted to the production of the usual perishable food commodities, and industrial stability assures a steady demand for such staples as potatoes, milk products, truck crops, fruit, poultry, and meats. It is recommended that the production of quality early potatoes, truck crops, and fruits be increased. Representatives of the Bureau of Agricultural Economics, U. S. D. A., cooperated in the Charleston study. (Bul. 188.)

Farmers in Harrison and nearby counties have a ready home market for practically all their produce, especially potatoes. The present system of distribution of farm produce in Clarksburg is markedly inefficient and unsatisfactory both to farmer and distributor. (Bul. 212.)

Because areas of good farm land in the section are inadequate to produce sufficient farm products to meet local market needs, Beckley and other coal towns in the southern West Virginia coal fields must expect to continue to receive much of their food commodities from distant points. The opening of good roads to the Greenbrier Valley farming section would provide a ready market to the farmers of Summers, Monroe, and Greenbrier counties. The supply of market milk is inadequate for the demand in Beckley, and there would be room for expansion in many types of farm production in the area if suitable land were available. (Bul. 226.)

Farmers in the Wheeling area have an advantage in transportation costs because of nearness to market. Yet it is possible that high production costs cancel this advantage for many commodities. A negligible quantity of potatoes is grown locally, and truck farming appears to be losing in favor. Poultry production for the local trade could be expanded. The growing of apples, grapes, and small fruits is recommended in the area. (Bul. 228.)

Cost, Methods, and Practices of Marketing Livestock

Records of the business transactions of the various county livestock shipping associations in West Virginia for each year of their operation have been collected by W. W. Armentrout. Analysis of the data, including costs of marketing and prices received for various classes of livestock marketed through the associations, freight records of shipments to out-of-state markets, and records of livestock prices received by some 2000 farmers in private sale during 1928 and 1929, is in process.

Systems of Livestock Farming in West Virginia and Southwestern Virginia

In 1928 W. W. Armentrout, in cooperation with field workers from Virginia Polytechnic Institute and the Bureaus of Agricultural Economics and Animal Industry of the U. S. Department of Agriculture, obtained records on the organization and operation of 150 livestock farms in the state. The Department of Agriculture is tabulating and analyzing the data.

The Fine-Wool Sheep Industry

In October, 1929, Pennsylvania, Ohio, West Virginia, and the U. S. Department of Agriculture began a study of the cost of producing fine-wool sheep in the three states. Sixty-five cooperators were obtained by R. O. Stelzer in Brooke, Ohio, Wetzell, Tyler, and Marion counties. Each of these farmers was visited three times during the year. These visits included taking an inventory of sheep, equipment, and feed; bringing the sheep, feed, and pasture records up to date; and making up the lamb, wool, feed, and labor record. The object of the study, which is pursued by the department of farm economics and the Agricultural Extension Division, is to determine for the territory involved the cost of production, returns, methods of handling, trends in production, the place, and the outlook for fine-wool sheep on northern West Virginia farms.

Hydrant Spray Systems

A project begun by F. D. Cornell, Jr., in 1927 and now pursued in cooperation with the department of plant pathology has as its object a detailed study of the stationary spraying systems in the State, including installation details and costs, costs of operation, mechanical efficiency of equipment, friction losses in pipe lines, pressures, etc., as well as comparison of costs and efficiency of stationary systems with the common methods of tank spraying under simi-

lar conditions. A detailed survey has been made of all stationary spray systems in the State, and complete cost records have been obtained for most of these. In addition cost data and other comparable information were obtained on 20 orchards using the portable system of spraying during the same seasons. Results of the study are in process of publication.

Methods used in piping orchards

A stationary spray system also has been installed on the University Experiment farm at Kearneysville. This plant will furnish opportunity for further study of the mechanical efficiency of this type of spray equipment. The entire study continues with emphasis on mechanical tests and measurements with the view to adding useful information to the available knowledge concerning the stationary plant for spraying operations.

Practical Farm Building Plans for West Virginia

In order to develop a series of workable plans of the essential buildings and equipment for farms under West Virginia conditions, a project was begun by F. D. Cornell, Jr., in 1926 in the hope that greater interest in better farm buildings could be stimulated and that marked improvement would eventually be brought about in the arrangement, construction, and equipment of new structures. Many requests for such information had been received by the Station for help concerning the planning, erecting, and equipping of farm buildings.

The first publication in the series, "Buildings and equipment for the dairy farm," appeared in January, 1928; the second, "Buildings and equipment for the livestock farm," was published in November, 1928. Since then work has been undertaken for a publication on storage buildings for the farm. Data have been assembled on common storage of apples under West Virginia conditions, and text material on potato and machinery storage also has been prepared.

The Status of 4-H Work

In order to determine the types of existing young people's organizations in the rural sections of West Virginia, along with their objectives, activities, and accomplishments, as well as to determine the value of these groups in developing a satisfactory rural life and in promoting a permanent and effective agriculture, a state-wide study was inaugurated in 1926 by T. L. Harris, rural sociologist, in cooperation with the Division of Farm Population and Rural Life of the Bureau of Agricultural Economics, U. S. D. A.

The scope of the study includes an analysis of the structure, functions, and influences of 341 clubs in 39 counties; case-studies of a county in which 4-H work has made steady progress, a county in which the work has declined, and a single club which is in some respects outstanding, in other respects average or below; an analysis of the effects of club experience in the socializing of personal character; appraisals of club work by supervisors and by parents; and an estimate of the strength and weakness of the movement as found in the State. A published report of the study, completed in 1929, is pending.

HOME ECONOMICS

Standardization of Preserves and Jelly

Fruit obtained in the vicinity of Morgantown within a few hours after picking was used by Hazel Cameron and Ruth B. Burns in tests to determine a satisfactory method for cherry and blackberry preserves and blackberry jelly, and to utilize a surplus of fruit in certain parts of the State where a satisfactory market was not available for the fresh fruit. Determinations, reported in Bulletin 234,

included the sugar-to-fruit ratio, optimum final temperatures, cooking jelly to weight, effect of adding pectin solution, consistency and yield of jelly made with the addition of various amounts of unripe berries, and tests of color, syrup, flavor, and texture of the final product.

Under-nourished Rats May Provide Clue to Cause of Common Cold in Humans

Investigation of some of the chemical factors which underlie respiratory infections occurring in rats kept on diets lacking in vitamin A has been undertaken as a nutrition problem by Hazel Cameron. Large numbers of albino rats are being raised on Vitamin-A free diets, with control animals on the same diet plus Vitamin A. The aim is to determine whether or not there is any relation between the common cold in human beings and the respiratory infections of rats as described, since good results in preventing colds have been reported from the use of codliver oil, which is known to protect rats from respiratory infections.

The sterol cholesterol is being studied in this experiment to see if it is increased in the blood before or after the onset of infection; or whether it is increased in the adrenal gland, which is normally a storehouse for this substance. Changes in the weight and the water content of this gland are also being investigated as having a possible bearing on the apparent sterol content. Cholesterol determinations have been made by the department of agricultural chemistry.

Residence and buildings on University Experiment Farm, Kearneysville

AGRICULTURAL EXPERIMENT STATION STAFF

JOHN R. TURNER, Ph. D., LL. D., President of the University
 F. D. FROMME, Ph. D. Dean and Director
 GERALD JENNY, M. S., Agricultural Editor JOHN C. JOHNSTON, Chief Clerk

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 M. M. Hoover, M. S.
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 Veterinary Science

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†In charge of the Reymann Memorial Farms, Wardensville, W. Va.

††In charge of the University Experiment Farm, Kearneysville, W. Va.

STAFF CHANGES

Appointments

F. D. Fromme, dean and director; R. A. Ackerman, assistant in dairy husbandry; C. H. Bruce, assistant in farm economics; F. W. Craig, assistant horticulturist; I. J. Duncan, assistant in agricultural chemistry; R. S. Glasscock, assistant in animal husbandry; Edwin Gould, assistant in entomology; Gerald Jenny, agricultural editor; E. N. McCubbin, assistant in horticulture; K. S. Morrow, assistant dairy husbandman; C. R. Orton, plant pathologist; W. H. Pierre, associate agronomist; F. J. Schneiderhan, associate plant pathologist; R. O. Stelzer, assistant in farm economics; L. M. Thurston, assistant dairy husbandman.

Resignations

E. L. Anthony, dairy husbandman; H. L. Crane, associate horticulturist; L. E. Dills, assistant in entomology; D. R. Dodd, assistant agronomist; P. A. Eke, assistant farm economist; N. J. Giddings, plant pathologist; H. F. A. North, assistant in agronomy and genetics; T. E. Odland, associate agronomist; L. C. Shriver, assistant in agricultural chemistry; G. M. Trout, assistant dairy husbandman.

PUBLICATIONS

ABSTRACTS OF BULLETINS

- Bul. 221. Cooperative Buying in West Virginia. Paul A. Eke. General. 56 pp. March, 1929. This publication comprises detailed recommendations concerning the organization, management, business policies, financing, and accounting of cooperative purchasing associations. A complete copy of the West Virginia Cooperative Marketing Act of 1923 is included.
- Bul. 222. Varieties of Fruits for West Virginia. H. E. Knowlton. General. 40 pp. March, 1929. The origin of varieties of the commoner tree fruits grown in West Virginia is given along with descriptions of the characteristics of fruit and tree. Fruits discussed include the apple, crab apple, peach, sweet, sour, and Duke cherries, pear, and plum. How to avoid sterility in planting is also indicated.
- Bul. 223. A Study of the Time Factor in Egg Production. Horace Atwood. Technical. 12 pp. October, 1929. Statistical interpretation as to mean length of intervals between successive egg-layings, and standard deviation of intervals in cycles of varying numbers of eggs, is given for 172 White Leghorns trapped hourly for one month during their first laying year.
- Bul. 224. The Cost of Raising Dairy Cows in West Virginia. Paul A. Eke. General. 12 pp. November, 1929. An investigation was made of the costs incurred in raising heifers for herd replacements among 128 dairy-men owning purebred, grade, or native stock in ten dairy sections of the State. Total costs are analyzed into their various items. Differences are noted in costs between typical dairy sections such as large city fluid milk, small city milk and cream, and creamery sections, as well as between spring and fall calves and between purebred, grade, and native heifers.

- Bul. 225. The Relative Value of High-Grade and Low-Grade Calves Marketed as Two-Year-Old Steers. E. A. Livesay. General. 12 pp. November, 1929. Twenty-four steer calves, twelve of them high-grade calves of Hereford breeding, the other twelve of nondescript breeding, were carried through two winter feeding and two summer feeding periods. Further division was made into four lots of six each. One lot of good to choice and one lot of common calves received linseed oilmeal in their rations; the other lots (one good to choice and one common) received cottonseed meal. Costs were kept of feeds and pasture, and upon slaughter the carcasses were compared for evidences of superiority of well-bred over low-grade stock.
- Bul. 226. Adjusting Agricultural Production and Distribution in the Beckley Area to Meet Home Market Demands. W. W. Armentrout. General. 20 pp. January, 1930. This bulletin is the third of a series of reports dealing with the consumption of food commodities in West Virginia cities and with the production of these commodities in adjacent farming territory. Other areas previously studied were the Charleston and Clarksburg areas.
- Bul. 227. Soybeans for Silage and for Hay. T. E. Odland. General. 24 pp. February, 1930. No farm crop introduced into West Virginia has become of such importance in so short a time as have soybeans. This bulletin presents the results of experiments in which corn and soybeans were grown alone in various ways and in several combinations for silage purposes. Soybeans also were grown alone and in combination with other crops for hay. Tests also were conducted with soybeans sown at various rates and at different dates for hay.
- Bul. 228. Adjusting Agricultural Production and Distribution in the Wheeling Area to Meet Home Market Demands. W. W. Armentrout. General. 28 pp. February, 1930. A record of the quantity of certain food commodities which passed through the Wheeling market, of the sections of the country from which the commodities came, and of the transportation charges is given in this, the fourth of a series of studies of consumption of farm products in the larger cities of West Virginia and of production in the agricultural sections surrounding them.
- Bul. 229. Cream Line Studies of Market Milk. G. Malcolm Trout. Technical. 20 pp. March, 1930. The growing importance of the market milk industry in West Virginia, together with the introduction of much modern machinery, prompted a study of the effect of agitation and pumping on the creaming ability of market milk. Determinations also were made of the critical temperatures at which pumping had the most harmful effect upon the depth of cream layer appearing at the top of the bottle of milk.
- Bul. 230. Growth Studies with Swine. J. H. Longwell, H. O. Henderson, and W. M. Insko, Jr. Technical. 24 pp. March, 1930. Experiments are described seeking to determine the effects of feeding butterfat, margarine fats and oils, and a basal ration free from the known sources of the fat-soluble, growth-promoting vitamin upon the growth and development of pigs.

- Bul. 231. The Effect of Feeding Different Amounts of Calcium and Phosphorus upon the Growth and Development of Dairy Animals. H. O. Henderson and C. E. Weakley, Jr. Technical. 56 pp. March, 1930. Thirty-two grade Holstein heifer calves were divided into four groups of eight calves each. Each group was fed a ration as similar to the other rations in its digestible crude protein and total nutrient content as it was practical to obtain. The chief difference between the rations fed was in the calcium and phosphorus content. The effects of the ration were studied by weighing and measuring the animals at weekly intervals and by analyzing the blood for inorganic phosphorus and calcium, the bones for moisture, extractable material, and ash, and the ash for calcium and phosphorus.
- Bul. 232. Wintering Dairy Heifers by Means of the Self-Feeder. H. O. Henderson and E. L. Anthony. General. 20 pp. April, 1930. Two groups of dairy heifers were used during each of three trials. One group was fed during the winter months a ration as near its requirements as was practicable, while the animals in the other group were fed all the roughage they would consume and were given access to a hopper which was kept filled with cornmeal, wheat bran, and linseed oilmeal. All were turned on pasture in season, and returned to the stable late in November. Each group was weighed and height at withers was measured every two weeks during the winter months and at monthly intervals during the summer months. A record was kept of the amount of feed consumed by each group.
- Bul. 233. The Relationship between the Number and Weight of Eggs and Body Weight of Leghorn Fowls During the First Three Years of Production. Horace Atwood and T. B. Clark. Technical. 20 pp. April, 1930. Investigation into the normal variation in the fecundity of fowls at different ages, and of the changes taking place in the weight of the eggs and in the weight of the fowls from year to year, is reported on the basis of records made by 178 birds during the first and second years and by 165 birds which remained at the end of the third year of the experiment.
- Bul. 234. Standardization of Cherry and Blackberry Preserves and Blackberry Jelly. Hazel Cameron and Ruth B. Burns. Technical. 24 pp. June, 1930. Investigation was undertaken to determine a satisfactory method for making cherry and blackberry preserves and blackberry jelly, with the aim of utilizing a surplus of fruit existing in certain parts of the State where a satisfactory market was not available for the fresh fruit.
- Bul. 235. Pasture Experiments. T. E. Odland, C. V. Wilson, H. O. Henderson, and E. P. Deatruck. General. 32 pp. June, 1930. The pasture crop is the most important crop in the State. Experiments were planned to obtain information on the improvement of permanent pastures of the type that is too steep to plow. Treatments on the dairy and the livestock farms of the University at Morgantown consisted of manure, manure and superphosphate, superphosphate, and nitrate of soda. A lime strip extended across one-half of all plots. Three seed mixtures also were compared, and disking was contrasted to no-cultivation.

LIST OF CIRCULARS

- Cir. 50. Crop Rotations for West Virginia. D. R. Dodd, R. J. Garber, and T. E. Odland. 24 pp. September, 1928.
- Cir. 51. Better Seed Corn—Growing, Selecting, Storing, Testing. R. J. Garber and M. M. Hoover. 16 pp. August, 1929.
- Cir. 52. Raising Dairy Calves and Heifers. James V. Hopkins and H. O. Henderson. 24 pp. October, 1928.
- Cir. 53. Buildings and Equipment for the Livestock Farm. F. D. Cornell, Jr. 56 pp. November, 1928.
- Cir. 54. Orchard Spraying in West Virginia. E. C. Sherwood and L. M. Peairs. 32 pp. March, 1929.
- Cir. 55. Blackberry Jelly, Blackberry Jam, and Cherry Preserves. Hazel Cameron. 12 pp. May, 1930.

ABSTRACTS OF SCIENTIFIC PAPERS

- No. 30: F. E. Chidester and W. M. Insko, Jr. Influence of thyroid extract and iodine on growth and development. I. With a standard basic diet. *Am. Nat.* 62: 554-558. 1928. Rats and rabbits were placed on a standard basic diet, and certain lots were given glucose, KI, and thyroid extract, respectively. Glucose retarded weight decrease otherwise occurring under heavy iodine feeding. Fat deficiency in the diet was evident, even in the presence of sufficient minerals, and the vitamins. Iodine influence on metabolism was demonstrated.
- No. 31: F. E. Chidester, A. G. Eaton, and W. M. Insko, Jr. Influence of desiccated thyroid and iodine on growth. II. With a standard acid diet. *Am. Nat.* 63: 239-247. 1929. Twenty-eight rats and six rabbits were used in experiments on the influence on growth of thyroid extract and iodine with a standard acid diet. In the rabbits, glucose apparently protected the animals somewhat from the usual iodine effects. In the rats, low dosage of thyroid favored pregnancies in all cases and did not cause resorption of the young. Minute doses of thyroid induced growth of bones and increased weights. Glucose, administered with the iodine, accelerated this gain.
- No. 46: T. E. Odland. The inheritance of a quantitative character, length of rachilla, in an oat cross. *W. V. U. Scient. Asso.* 2(3): 57-64. Oct. 1928. The factor determining the inheritance of pubescence of rachilla is believed to be in the same linkage group as one or more of the factors determining the length of rachilla.
- No. 55: E. P. Deatrck. Watering potted soil kept under microbiologically controlled conditions. *Science* 68: 114-115. Aug. 1928. When soil in large pots is to be used, some method must be found to cover the soil with a cotton seal which will not be wetted by the moist soil. This has been accomplished by placing an inch mulch of very coarse gravel over the soil.
- No. 56: L. H. Leonian. Studies on the variability and dissociations in the genus *Fusarium*. *Phytopath.* 19: 753-868. Sept. 1929. A certain specific line of behavior persists throughout all of the strains and variants of a given fungus species. The path of the species may run in a zigzag line, but it does not exceed the specific orbit.

- No. 57: R. J. Garber and M. M. Hoover. The relation of smut infection to yield in maize. *Jour. Am. Soc. Agron.* 20: 735-746. July 1928. Selfed lines of maize may be isolated which differ sharply with respect to resistance to smut. Corn plants infected with smut in the tassel only yielded on the average more than did plants of similar genetic constitution but free from smut.
- No. 58: H. E. Knowlton. Factors affecting fruit setting in the apple. *W. V. U. Scient. Asso.* 2(3): 46-56. Oct. 1928. A variety of apple is "born" with a certain genetic complex, upon which the various environmental factors play.
- No. 59: E. P. Deatrick. Reduction of soil nitrates during the growth of soybeans. *Jour. Am. Soc. Agron.* 20: 947-958. Sept. 1928. In following soybeans with winter wheat it is advisable to plant soybeans of shorter growing period so as to allow for longer intervals for nitrification in the soil before the planting of wheat. Nitrates in soils under maturing soybeans are very low.
- No. 60: R. J. Garber. The nature and significance of mutations in present-day breeding methods. *Sci. Agr.* 9: 133-143. Nov. 1928. Among field crops mutations of economic value appear so rarely that one would hardly be justified in basing a system of breeding upon their chance occurrence.
- No. 61: R. J. Garber, N. J. Giddings, and M. M. Hoover. Breeding for disease resistance with particular reference to smut of oats. *Sci. Agr.* 9: 103-115. Oct. 1928. Breeding plants for resistance to disease offers one of the most satisfactory means of controlling numerous plant diseases.
- No. 62: Horace Atwood. Observations concerning the time factor in egg production. *Poult. Sci.* 8: 137-140. Mar. 1929. The longer the cycle the shorter are the intervals between the laying of successive eggs. The intervals between egg-layings about the middle of the cycles are shorter than the intervals at either extremity. The shorter average intervals are usually associated with the more prolific layers.
- No. 63: M. M. Hoover. Wheat-rye hybrids. *Jour. Hered.* 20: No. 4. April 1929. Fultz 7 wheat was the seed parent, and Rosen rye No. 3 the pollen parent. The hybrid plants resembled wheat rather closely, although they were intermediate in most plant characters.
- No. 64: E. P. Deatrick and Clarence Dorman. Determination of the fineness of marl. *Soil Sci.* 27: 121-122. Feb. 1929. Determinations made according to the standard method—that of calculating the percentages of material of certain finenesses from the weights of the thoroughly dried material held on the screens after thorough shaking—are inaccurate.
- No. 65: Horace Atwood. The variation in the weight and number of eggs and the weight of White Leghorn fowls during the first two years of production. *Poult. Sci.* 8: 51-55. Nov. 1928. Decreases from first to second year were 20.1 percent for number of eggs and 14.4 percent for weight of eggs. Increase in average weight of eggs the second year was 7.36 percent, and increase in weight of birds during second year was 15.3 percent compared to weight during first year.

- No. 66: Horace Atwood and Thomas Clark. Further studies on factors influencing the weight of eggs. *Poult. Sci.* 8: 193-197. May 1929. Kamala should not be given while birds are in full production, since undesirable effects may result in at least some cases.
- No. 67: A. G. Eaton, W. M. Insko, Jr., G. P. Thompson, and F. E. Chidester. The influence of suprarenal cortex and medulla on the growth and maturity of young (White Leghorn) chicks. *Am. Jour. Phys.* 38: 187-190. March 1929. Fifty White Leghorn chicks when twelve days old were divided into three groups and placed under experiment for eleven weeks to determine the influence of feeding desiccated suprarenal medulla and cortex, in addition to a standard or balanced ration. Males receiving desiccated suprarenal cortex matured more rapidly, as indicated by the weights of the testes. Their body weights, like those of the females in the cortex group, nearly equalled the controls. Chicks fed suprarenal medulla grew less rapidly than the controls or the cortex group, and the weight of the testes fell far below controls and cortex group.
- No. 68: F. E. Chidester and A. G. Eaton. The influence of arsenic, ferrous sulphate, and copper sulphate on rats furnished a Vitamin A-free diet with iron added. *Proc. Soc. Exp. Biol.* 26: 141-142. 1928. Arsenic, iron, and copper in minute doses seem less effective than the combination of iron and iodine previously shown by the writers to be of benefit in vitamin-A deficiency.
- No. 69: F. E. Chidester, A. G. Eaton, and G. P. Thompson. The influence of a modified Fowler's solution of arsenic on rats receiving vitamin A-free diet with iron iodide added. *Proc. Soc. Exp. Biol.* 26: 143-144. 1928. Fowler's solution of arsenic in doses of 0.379 mgm. daily was used in combination with iodide of iron in an experiment to determine their effect on vitamin-A deficient rats. Rapid declination in weight indicated the probable digestive disturbance due to arsenic in the presence of iron.
- No. 70: T. E. Odland and R. J. Garber. Tests of native and foreign clover strains in West Virginia. *Jour. Am. Soc. Agron.* 21: 355-360. March 1929. Clover strains of Italian origin were worthless for West Virginia conditions, and from other European countries and Chile, generally un dependable. Uniformly good results were obtained with strains from Ohio, Wisconsin, Michigan, Idaho, and Tennessee.
- No. 71: R. J. Garber and M. M. Hoover. Natural crossing between plants of hybrid origin in oats. *Jour. Agr. Res.* 38: 647-648. June 1929. Among 15 black-seeded plants growing among forms supposed to be homozygous for white seed, 14 segregated for seed color in the next generation, showing conclusively their hybrid origin. One of the plants bred true for black seed, and therefore it probably was the only one of this group whose presence was due to an accidental mixture.
- No. 72: R. J. Garber, N. J. Giddings, M. M. Hoover. Transgressive segregation for susceptibility to smut in an oat cross. *Jour. Agr. Res.* 39: 953-962. Dec. 1929. Gopher, moderately susceptible, was crossed with a highly resistant if not immune Black Mesdag. Resistance to smut is apparently dominant and controlled by a single main factor difference. There is

- apparently a linkage between the black-color gene and a modifying factor which brings about transgressive segregation for susceptibility.
- No. 73: K. C. Westover. The effect on yield of sprout removal from potato seed tubers. *Proc. Am. Soc. Hort. Sci.* 25: 53-57. 1928. The practice of removing sprouts from improperly stored potato seedstock increases the loss in storage from decay, reduces the stand of plants in the field and lowers their vigor, and decreases the yield of prime tubers and the total yield.
- No. 74: Hazel C. Cameron. Thyroid feeding and high room temperature. *Science* 69: 576. May 1929. A temperature of 96° F. was sufficient to cause death in normal rats as well as in those suffering from vitamin-A deficiency.
- No. 76: F. E. Chidester, A. G. Eaton, and G. P. Thompson. The influence of desiccated suprarenal cortex and medulla on the growth and maturity of young rats. *Am. Jour. Phys.* 88: 191-194. 1929. Desiccated suprarenal cortex induces earlier sexual maturity in young female rats than does suprarenal medulla.
- No. 77: L. H. Leonian and H. L. Geer. Comparative value of the size of *Phytophthora* sporangia obtained under standardized conditions. *Jour. Agr. Res.* 39: 293-311. Aug. 1929. The size factor cannot be of primary importance in taxonomy. Hartley's organisms Nos. 8, 36, and 121 are sufficiently different from all others to merit further study in their native habitat to determine whether they should be described as new species.
- No. 78: N. J. Giddings, H. A. Allard, and B. H. Hite. Inactivation of the tobacco mosaic virus by high pressures. *Phytopath.* 19: 749-750. Aug. 1929. High pressures were effective in destroying or inactivating the virus of tobacco mosaic.
- No. 79: Paul A. Eke. Results of a regional replanning study in the mountains of West Virginia as illustrative of the scope, methods, and practical results of such studies: The community as a unit in land utilization. *Jour. Farm Econ.* 11: 412-421. July 1929. Forest areas should be located by state authority in non-agricultural areas. Public guidance should be provided in relocating the residents. Forest areas should be purchased by county, state, or federal government wherever private or corporate ownership fails to provide economic forest management.
- No. 80: R. B. Dustman and L. C. Shriver. The chemical composition of *Andropogon virginicus* and *Danthonia spicata* at successive growth stages. *Jour. Am. Soc. Agron.* 21: 561-567. May 1929. The early growth of both grasses shows high protein and low fiber content compared to the later growth stages. Reasonably early, close, and continuous grazing during the spring and early summer months is advisable.
- No. 81: H. E. Knowlton. Some recent results in apple sterility studies. *Proc. Am. Soc. Hort. Sci.* 26: 62-64. 1929. Stayman will not fertilize Delicious, but York, Grimes, and Golden Delicious are good fertilizers for it. Stayman, Winesap, and Mammoth Black Twig are not only self-sterile but of little value as pollenizers for other varieties because of the impotent pollen they produce.

- No. 82: M. B. Hoffman. The use of performance records in laying out a raspberry fertilizer experiment. *Proc. Am. Soc. Hort. Sci.* 26: 203-207. 1929. Trustworthy results may be expected from the use of a 30-foot single-row plot.
- No. 83: K. C. Westover. The relative vigor of the bud and the stem ends of the same potato seed tuber. *Proc. Potato Asso. Amer.* 16th Ann. Meet.: 101-105. Dec. 1929. There seems to be no real difference in vigor between the bud and the stem ends of the same seed potato.

LIST OF OTHER TECHNICAL PAPERS

- F. E. Chidester, A. G. Eaton, and G. P. Thompson. The influence of minute doses of iodine and iron on growth of rats furnished a vitamin-A free diet. *Science*: 68 (1766): 432. November 2, 1928.
- F. D. Cornell, Jr., and H. L. Crane. Stationary spray systems in West Virginia orchards. *Agric. Eng.* 10, No. 5. May, 1929.
- A. J. Dadisman. Factors influencing the yield of apples. *W. Va. Acad. Sci.* 2. Aug. 1928.
- H. E. Knowlton and M. B. Hoffman. Size of peaches as affected by time of thinning. (Prel. Rept.) *Proc. Am. Soc. Hort. Sci.* 25: 277-279. 1928.
- E. A. Livesay. An experimental study of hybrid vigor or heterosis in rats. *Genetics* 15: 17-54. January, 1930.
- J. H. Longwell. Buckwheat middlings as a protein supplement for growing and fattening swine. *Proc. Amer. Soc. An. Prod.* 1928: 98-100.

LIST OF CURRENT PROJECTS

CURRENT EXPENSE FUND

NUMBER	TITLE	DEPARTMENT
CE-5	Miscellaneous Chemical Investigations	Chemistry
CE-6	Oat Investigations	Agronomy
CE-7	Soybean Investigations	Agronomy
CE-8	Oat Smut	Agronomy and Plant Pathology
CE-9	Cover Crop Experiments	Agronomy and Dairy
CE-10	Pasture Fertilization Studies	Agronomy, Dairy, and Office of Forage Crops Investigations, U. S. D. A.
CE-11	Crop Rotation Experiments	Agronomy
CE-13	Effect of Soybeans on Crop That Follows	Agronomy
CE-14	Comparison of the Production of Baby Beef, Two-Year-Old and Three-Year-Old Steers	Animal Husbandry
CE-15	Forage Crops and Winter Rations for Swine	Animal Husbandry
CE-16	Line Breeding vs. Outcrossing	Dairy Husbandry
CE-17	A Study of Roots as a Feed for Dairy Cows	Dairy Husbandry
CE-18	A Study of the Different Varieties of Pastures for Milk Production	Dairy Husbandry
CE-20	Cost of Raising Dairy Heifers in West Virginia	Dairy Husbandry
CE-21	A Growth Study with Ayrshire Cattle	Dairy Husbandry
CE-22	A Comparative Study of the Microflora of Raw and Pasteurized Grade-A Milk	Dairy Husbandry
CE-23	The Control of Infectious Abortion (Brucella Abortus Infection) in Cows by Herd Management and Testing	Animal Husbandry and Dairy Husbandry
CE-24	Miscellaneous Entomological Investigations	Entomology
CE-25	Orchard Insects	Entomology
CE-26	Supply, Methods of Marketing, and Consumption of Food in West Virginia Cities, and Agricultural Production in Nearby Territory	Farm Economics
CE-27	Practical Farm Building Plans for West Virginia	Farm Economics

NUMBER	TITLE	DEPARTMENT
CE-29	The Status, Trends, Place, and Outlook of the Fine-Wool Sheep Industry in the Northern Part of West Virginia	Farm Economics and Extension Division
CE-30	Physiological Effect of Pruning Fruit Trees	Horticulture
CE-31	Potato Investigations	Horticulture
CE-32	Project Covering Miscellaneous Work	Horticulture
CE-35	The Physiology of Phytophthoras	Plant Pathology
CE-37	A Study of the Proper Incubating Temperature for the Eggs of the Domestic Fowl in Incubators of the Cabinet Type	Poultry Research
CE-38	Alfalfa Investigations	Agronomy
CE-39	A Study of the Manufacture of Sweet-Curd, Rennet-Coagulated Cottage Cheese	Dairy Husbandry
CE-40	Sweet Clover Investigations	Agronomy and Agricultural Chemistry
CE-41	A Study of the Water Consumption of Dairy Animals	Dairy Husbandry
CE-43	A Study of the Value of Oats as a Preventive of Vitamin A and D Deficiencies in Pigs	Animal Husbandry and Agricultural Chemistry
CE-44	Crop Responses to Various Fertilizers	Agronomy and Horticulture
CE-98	A Comparison of the Milk-Producing Qualities of Soybean Hay and Alfalfa Hay	Dairy Husbandry
CE-100	Steer Feeding	Animal Husbandry

SALES FUND

NUMBER	TITLE	DEPARTMENT
S-1	Line Breeding vs. Outcrossing	Reymann Memorial Farms, Dairy Husbandry, and Bureau of Dairy Industry, U. S. D. A.
S-2	Hay Tests of Forage Plants, Alone and in Mixtures	Agronomy

ADAMS FUND

NUMBER	TITLE	DEPARTMENT
A-1	Relation of Temperature to Insect Life	Entomology
A-2	Sterility Studies with the Apple	Horticulture

NUMBER	TITLE	DEPARTMENT
A-4	Hardiness Studies of the Fruit Buds of the Peach	Horticulture and Chemistry
A-5	Apple Rust	Plant Pathology
A-6	The Relation between Fusarium Moniliforme and the Corn Plant	Plant Pathology
A-7	Factors Affecting the Weight of Hen Eggs	Poultry Research
A-8	The Time Factor in Egg Production	Poultry Research

HATCH FUND

NUMBER	TITLE	DEPARTMENT
H-1	Wheat Investigations	Agronomy
H-2	Corn Investigations	Agronomy
H-3	Dusts and Sprays for the Control of Garden Insects	Entomology
H-4	Variety Tests of Fruit Trees	Horticulture
H-5	Cultural Treatments and Fertilizers for Fruits	Horticulture
H-7	Dusting and Spraying for the Control of Diseases	Plant Pathology
H-8	Variety and Strain Studies of Vegetables	Horticulture

PURNELL FUND

NUMBER	TITLE	DEPARTMENT
P-1	Breeding Tobacco for Resistance to Root-Rot and High Yield	Agronomy and the Office of Tobacco Investigations, U. S. D. A.
P-2	Soil Acidity and Plant Growth	Agronomy, Agricultural Chemistry Coop. in part
P-4	Growth Studies with Young Pigs	Animal Husbandry
P-5	The Effect of Breed of Sire on the Production and Quality of Lamb	Animal Husbandry and Bureau of Animal Industry, U. S. D. A.
P-7	Fattening Two-year-old Steers on Grass with and without a Grain Supplement	Animal Husbandry, and Bureau of Animal Industry, U. S. D. A.
P-8	The Effects of Low-Calcium and Low-Phosphorus Rations on Growing Dairy Heifers	Dairy Husbandry and Agricultural Chemistry
P-9	Biology and Control of the Apple-Infesting Aphids	Entomology
P-10	The Biology and Control of the Pistol Case Bearer	Entomology
P-11	Cost, Methods, and Practices of Marketing Livestock	Farm Economics and U. S. D. A.

NUMBER	TITLE	DEPARTMENT
P-12	A Study of Orchard Management and of the Place of Orchards in the Farm Organization of the Apple Section of Eastern West Virginia	Farm Economics, U. S. D. A., Virginia, and Pennsylvania
P-13	A Study of the Costs, Efficiency, and Management of Hydrant Orchard Spraying Systems in West Virginia	Farm Economics and Plant Pathology
P-14	The Economic Utilization of Surplus Food Products with Special Reference to the Problems of the Home	Home Economics
P-15	A Study of the Relation of the Lipoids, particularly Cholesterol, to the Incidence of Respiratory and Middle-Ear Infections Occurring on Vitamin A Deficient Diets	Home Economics
P-16	The Improvement of Root Stocks for Apple Trees	Horticulture
P-17	Studies on the Storage Qualities of Fruits of the Apple as Affected by the Culture and by the Fertilizer Treatments Given the Orchard	Horticulture
P-18	Fusarium Wilt of Watermelon	Plant Pathology and Agronomy (Genetics)
P-19	A Study of Apple "Measles"	Plant Pathology
P-20	A Study of Variability in Composition of Different Skeletal Parts of Experimental Animals	Agricultural Chemistry
P-22	Paper Mulches vs. Clean Culture for Vegetable Crops	Horticulture
P-23	Constituents of Milk that Contribute to the Flavor of Dairy Products	Dairy Husbandry
P-24	Causes for Poor Quality of Cream Transported in Less Than Carlots	Dairy Husbandry
P-159	Young People's Organizations as a Factor in West Virginia Rural Life	Rural Sociology

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