

1-1-1932

# Report of the West Virginia Agricultural Experiment Station for the Biennium Ending, June 30, 1932.

F. D. Fromme

Follow this and additional works at: [https://researchrepository.wvu.edu/  
wv\\_agricultural\\_and\\_forestry\\_experiment\\_station\\_bulletins](https://researchrepository.wvu.edu/wv_agricultural_and_forestry_experiment_station_bulletins)

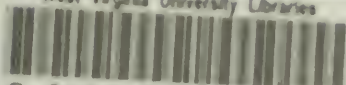
---

## Digital Commons Citation


Fromme, F. D., "Report of the West Virginia Agricultural Experiment Station for the Biennium Ending, June 30, 1932." (1932). *West Virginia Agricultural and Forestry Experiment Station Bulletins*. 254.  
[https://researchrepository.wvu.edu/wv\\_agricultural\\_and\\_forestry\\_experiment\\_station\\_bulletins/255](https://researchrepository.wvu.edu/wv_agricultural_and_forestry_experiment_station_bulletins/255)

This Bulletin is brought to you for free and open access by the Davis College of Agriculture, Natural Resources And Design at The Research Repository @ WVU. It has been accepted for inclusion in West Virginia Agricultural and Forestry Experiment Station Bulletins by an authorized administrator of The Research Repository @ WVU. For more information, please contact [ian.harmon@mail.wvu.edu](mailto:ian.harmon@mail.wvu.edu).

West Virginia University Libraries



3 0802 100521031 0



Digitized by the Internet Archive  
in 2010 with funding from  
Lyrasis Members and Sloan Foundation

*Report of the West Virginia Agricultural  
Experiment Station for the Biennium  
Ending June 30, 1932*

---

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

## TABLE OF CONTENTS

---

	PAGE
DIRECTOR'S STATEMENT .....	3
Research and Progress in Agriculture .....	3
Adapting Research to Changing Conditions .....	12
Problems Awaiting Investigation .....	13
Continuity in Research Necessary for Progress .....	15
Other Services of the Experiment Station .....	15
Location of Research Projects .....	16
REPORTS OF CURRENT RESEARCH .....	17
Agronomy and Genetics .....	17
Animal Husbandry .....	25
Chemistry (Agricultural) .....	29
Dairy Husbandry .....	30
Entomology .....	34
Farm Economics .....	38
Home Economics .....	43
Horticulture .....	44
Plant Pathology .....	50
Poultry Husbandry .....	54
STAFF LIST .....	56
Staff Changes .....	57
LIST OF CURRENT PROJECTS .....	57
PUBLICATIONS OF THE BIENNIUM .....	59
Bulletins and Circulars of the Experiment Station .....	59
Technical Bulletins Published Jointly with the U. S. Department of Agriculture .....	59
Scientific Papers of the Experiment Station .....	60

*Report of the West Virginia Agricultural  
Experiment Station for the Period from  
July 1, 1930, to June 30, 1932*

DIRECTOR'S STATEMENT

WITH THIS REPORT the Experiment Station completes 45 years of service to West Virginia agriculture. Established in 1888, it is the oldest of the several agencies maintained by the state and federal government to provide assistance to the farmer. Its period of service coincides with the period of greatest progress in the development of modern agriculture, in which the station has played an important part.

For a number of years the station was almost the sole influence in stimulating interest in the use of improved farming practices as well as in establishing the basis for such practices through experimentation and research. More recently other agencies have been created to deal with special aspects of the better-farming movement: the Cooperative Extensive Service, the State Department of Agriculture, and the Vocational Division of the State Department of Education. Since their establishment the station has been free to devote its principal activities to the purpose for which it was created — the advancement of agriculture through research — and noteworthy progress has resulted.

RESEARCH AND PROGRESS IN AGRICULTURE

It is the purpose of this report not to treat of the history of the station in any detail but rather to show the relation of its contributions to the modernization of agriculture in West Virginia. The prime purpose is to promote a better understanding by the general public of the character and value of research and experimentation in the field of agriculture. There is abundant evidence that the work is returning to the public many times its cost. Before considering the work of the current biennium, which appears in the reports of the departments, it will be worth while to review the major contributions of other years.

*Improved Methods of Soil Maintenance*

The soils of West Virginia are unusually diverse as to origin, type, and productivity. The maintenance of fertility and the economical use of land are a major concern of the orchardist, the vegetable gardener, the livestock producer, the dairyman, the general farmer,

the forester, and in fact of every one engaged in any phase of agricultural production. In the construction of roads, in the creation of parks and preserves, in the location of schools, and in other services it is the major concern of the state that the productive capacity of the soil and its ability to support a rural population be clearly and accurately determined. The importance of knowing the correct basis for the use of fertilizers and lime is shown in the fact that our annual purchase of commercial fertilizers approximates 50 thousand tons, and some 15 thousand tons of lime is used each year as a soil amendment. The annual outlay exceeds one and one-half million dollars.

The station has contributed to the knowledge of soil maintenance by:

Classifying and mapping the soils of the state in cooperation with the Bureau of Chemistry and Soils of the United States Department of Agriculture and the State Geological Survey. Many different soil types are found in the state, all differing in their level of productivity, topography, or other features. The soil type may determine the kind of crop which can be grown or the kind of farming practices that should be employed. Some soils undoubtedly are too steep for agricultural purposes and some are suited primarily to grazing, whereas others can be used to grow cultivated crops.

Determining the fertilizer and lime requirements for many of the soil types and establishing the fact that most of the soils in West Virginia are deficient in phosphorus and lime. On the other hand potash fertilizers have not given marked increases in yields except with potatoes and in some cases with alfalfa. In apple orchards some form of nitrogen fertilization is necessary, and information concerning the most economical form has been made available.

Determining the amount of organic matter in West Virginia soils and the effect of various cover crops in maintaining the organic matter and productiveness of soils. In a study of 485 soils from different sections of the state it has been found that the organic matter varied from 0.68% to 15.13%. The average content was 2.84%. These results show that some of the soils are very deficient in organic matter. The most dependable cover crop for general purposes has been found to be a mixture of rye and winter vetch. The importance of studies of the value of organic matter in maintaining the water-holding capacity of soils, particularly of orchard soils, was well shown during the drought of 1930, and further studies along this line are in progress.

Investigations in apple orchard culture have shown that permanent sods of alfalfa, of sweet clover, or of some of the grasses maintain growth and yield as well as or even better than clean cultivation with a winter cover crop, provided additional amounts of nitrogen are added. Permanent cover crops build up organic matter of the soil and help prevent erosion.



Investigating the nature of soil acidity in its relation to plant growth. It has been found that aluminum in very low concentrations may be toxic to plants. Soils from various locations in the state were studied and it was found that in general the more acid ones contained the more soluble aluminum. The use of lime on acid soils takes aluminum out of solution and therefore removes it as a source of plant injury.

Studies of pasture fertilization have shown the value of phosphorus and lime in increasing productivity and in encouraging the growth of better types of grasses and legumes. The prevailing practice of plowing and reseeded permanent pastures has been shown to have little value unless accompanied by liming and fertilization. The pasture crop is the most valuable one in West Virginia and exact knowledge of its maintenance and improvement is of great practical significance.

### *Better Crop Plants and Methods of Culture*

Almost without exception the varieties of crops in use today are of recent origin, having been developed through selection and hybridization. High yield, quality, disease resistance, soil and climatic adaptation, and other factors have been the basis for improvement. The agriculture of the state has been greatly enriched through the introduction of new crops and the use of better varieties of old crops. The station has conducted extensive varietal tests of field crops, forage crops, fruit crops, and vegetables, and has propagated and distributed the varieties having greatest value. It has under way a continuous program of plant breeding that has created a better variety of soybeans and gives promise of a smut-resistant oat, a smut-resistant corn, a disease-resistant watermelon, and a more palatable and better-adapted sweet clover. Some of the more important contributions of the station may be mentioned here.

The introduction and dissemination of the soybean has made available to the West Virginia farmer a valuable legume. Breeding activity with this crop has resulted in the development of Pekwa, a new variety, highly productive of fine-stemmed hay and one that retains its leaves better than any other variety grown in the state. This characteristic is particularly important in haymaking.

The introduction and dissemination of Gopher oats, one of the highest-yielding and stiffest-strawed varieties known.

Woodburn White dent corn was introduced into Mason county several years ago and found to outyield other varieties commonly grown in that section. From this focal point the new variety has been distributed to many farmers who are well pleased with its performance.

An investigation to determine the frequency of cutting alfalfa has shown that three cuttings in one season give best results. Fewer cuttings reduce yields and more cuttings injure the stand. In a decidedly abnormal season such as that of 1930 it may not be desirable to remove more than two crops.



The standard varieties of red raspberries do not grow successfully in West Virginia because of winter injury. The introduction and testing of Latham, which does not have this weakness, has made it possible for red raspberries to be grown successfully in this state.

One of the chief causes for failure of medium red clover has been found to be the use of unadapted seed. Clover seed produced in Ohio, Michigan, Maryland, Virginia, and Tennessee has given satisfactory results, particularly the strains resistant to anthracnose.

Investigations of the station have helped to standardize the varieties of potatoes grown in the state. At the lower altitudes Cobblers primarily are grown and at the higher altitudes Rurals give best results. Significant contributions have also been made in regard to cultural practices and the practicability of using home-grown seed.

The need of mixed plantings of varieties in orchards to insure pollination has been brought to the attention of fruit growers through the work of the station. The best varieties for such use are being determined and the information is being applied by fruit growers in their recent plantings.

The West Virginia station has been a leader in the study and development of systems of pruning for fruit trees. The moderate system that it advocates has come into general use with increased profits to growers. These studies show clearly that the established practice of severe pruning dwarfs the trees, delays fruiting, and lowers production.

Significant progress in the adoption of better varieties of vegetable crops and in the production of new crops has resulted from experimental work in the Ohio valley. The Break O'Day and Pritchard varieties of tomato and the Bender muskmelon may be mentioned among new varieties. Crops new to the section include eggplant, peppers, Chinese cabbage, and green-sprouting broccoli.

#### *More Efficient Control of Insect Pests and Plant Diseases*

The development of commercial agriculture in West Virginia, as elsewhere, has intensified the problems of parasites, both insects and plant diseases, and has made their successful control one of the most important factors in profitable production. It is freely stated by fruit growers that the development of a commercial fruit industry in West Virginia would have been impossible except for the services of the Experiment Station and allied agencies in solving the problems of disease and insect control. Nor could orcharding be maintained except for such services, since new problems are continually arising. Like conditions also apply to many of our field, garden, and forest crops. The recent virtual extermination of the chestnut tree illustrates the destructive capacity of uncontrolled diseases, and the present abundance of the Mexican bean beetle serves as a reminder to the home gardener as well as the commercial grower of the ever-present need of new remedies for new pests.

The service of the station in these particular fields has extended over a period of more than twenty years, and has been marked by particularly outstanding contributions to fundamental knowledge as well as effective relief measures for problems of an emergency character.

Among the many contributions the following are particularly noteworthy.

The effective control of apple rust was made possible by establishing definite proof of the benefits obtained from the eradication of the red cedar. The loss in one county in a single season from this disease is estimated to have exceeded \$75,000. The further prevention of serious loss in sections where the eradication of cedars is impracticable has been promoted, through a comprehensive study of the susceptibility to rust of 66 commercial varieties of apple. Some of the varieties are practically immune and may be used in sections where cedars abound without serious loss.

Established potato growing on a firm basis by solving problems of disease control through spraying and use of disease-free seed. Exhaustive series of experiments show that spraying doubles yields.

Established effective measures for protection of orchards from insects and diseases by thorough and continued study of a large number of proprietary and new spray materials and spray schedules. Demonstrated greater efficiency of liquid spraying as compared with dusting.

A new method of preparing Bordeaux mixture that saves time, reduces costs, and yields a more uniform and better spray material.

New insecticides for the Mexican bean beetle and other garden insects.

Life history studies and control measures for many serious insect pests, notably the bean beetle, pistol-case bearer, stalk borer, corn ear-worm, cabbage and radish maggots, codling moth, apple aphids, and San Jose scale.

Established the relationship between weather conditions, particularly temperature, and insect growth and activity, making possible predictions of abundance of insects and facilitating the timing of control measures. These principles have been widely applied elsewhere.

Established the principle of control for the Hessian fly by observing the "fly-free" date for sowing wheat. This practice has been followed for many years throughout the winter wheat belt and has been of great practical value.

Discovery of the cause of apple "measles", a hitherto obscure disease, with promise of effective control measures in the near future.

Discovery of a serious canker disease of black walnut with rapid progress in studies of cause and control.

Fundamental studies of the natural variation in plant parasites of special importance in the problem of breeding disease-resistant crop plants.

Contributed much original and timely knowledge concerning insect pests of forest trees.

### *Better Methods of Breeding, Feeding, and Managing Farm Animals*

Because of the adaptation of West Virginia to livestock, dairy, and poultry production the station from the time of its establishment has devoted especial attention to problems in these fields and has conducted many studies leading to the improvement of breeding, feeding, and management practices. Most of our exact knowledge of animal nutrition is the product of the work of the experiment stations and these studies have also contributed important facts to the understanding of human nutrition. The findings of station research have been carried to the farmer by means of bulletins, demonstrations, and educational campaigns and have resulted in noteworthy improvement in quality with substantial economies in production costs. Strong market preferences for West Virginia lambs, beef cattle, and eggs have been created as a result of a high level of quality and careful systems of grading. Brief mention of some phases of the station work follows.

One of the largest breeding experiments with dairy cattle, conducted at the Reymann Memorial Farms, has advanced the use of proven sires and demonstrated their possibilities.

Greater values in the use of purebred sires in the production of steers and market lambs have been clearly established, and exact data concerning their use have been recorded.

Calves sired by purebred bulls and marketed as two-year-old steers have greater value than those sired by grade or nondescript bulls. Lambs sired by purebred Shropshire and Hampshire rams are superior in weight to those sired by purebred Southdown and Cheviot rams, but the latter grade higher and dress a higher percentage. Recent studies of the use of Corriedale rams on grade Hampshire ewes show marked gains in length of staple and weight of fleeces of the yearling ewes as compared with their dams. The weight, grade, and dressing percentage of the wether lambs equalled that of lambs sired by Shropshire and Hampshire rams.

Feeding experiments with beef cattle have been directed chiefly to the problems of finishing steers for market in the belief that West Virginia farmers will profit more through the production of finished animals rather than stocker and feeder steers. Considerable data as to the value of grain supplements fed to cattle on pasture for varying periods and as to the economy of feeding in the drylot and during the wintering period have been made available to farmers and are furnishing the basis for a better and more profitable live-

stock industry. The greater potential values in the finishing and marketing of animals at an earlier age than is currently practiced in the state has also been shown.

Feeding experiments with pigs have included a variety of protein supplements to the corn ration. In particular a comparison of the values of buckwheat middlings, linseed meal, and cottonseed meal has been made. While good results were obtained with all, the most rapid gains with lowest food consumption were obtained with buckwheat middlings.

Feeding experiments with dairy cattle have included trials with different legume hays, mangels, and sunflowers as substitutes for corn silage, and extensive studies of mineral requirements. The production of soybeans in the state has been greatly stimulated as a result of the evidence that they are equal in value to alfalfa hay. Many dollars in feeding costs have been saved through the evidence that minerals need not be added to the ration for growing dairy heifers provided they receive pasture in the summer and plenty of roughage in the winter. A study of simplified, home-grown rations now in progress promises further feeding economies for the dairyman.

The value of animal protein in the poultry ration was established in early work at the station and further studies of a variety of ingredients have helped to establish the constituents of standard formulas and the basis for the feeding of home products.

Much new information has been developed concerning the relation of nutritive constituents and the rate of feeding to egg production and hatchability. Hatchability is increased by liberal feeding and by the use of sprouted oats and is not lowered by a high rate of production preceding the hatching season.

Of especial value in the improvement of breeding practices for high egg production have been the very extensive and fundamental studies of the factors affecting the weight of eggs and the relation of egg weight and volume of production to the weight and age of fowls.

Comprehensive studies of cycles in egg production show that the first egg of the cycle is laid early in the forenoon and the remainder later and later on succeeding days until late afternoon is reached. The bird then ceases to lay for a day or two and then repeats the cycle as before. The more prolific layers usually have the longest cycles.

#### *More Efficient Control of Animal Diseases*

The early work of the station in this important field has consisted chiefly of the interpretation of research conducted elsewhere and the application of the findings to West Virginia conditions. It is only in recent years that original research has been included in the station program and as yet the work is limited in scope because



of inadequate funds. Nevertheless substantial progress in the solution of some of the more important problems of animal pathology has been achieved. A laboratory for the diagnosis of diseases of animals is maintained in cooperation with the State Department of Agriculture. This renders an important service to the livestock, dairy, and poultry producers of the state and is closely coordinated with and supplemental to the research service.

Recent and current research deals chiefly with two projects: the problem of infectious abortion, which is responsible for great economic losses through loss of calves, sterility, reduction in milk, and predisposition to disease in the offspring, and the problem of the control of stomach and lung worms, which is a major concern of the stockman and sheep producer.

Methods of herd management for the control of infectious abortion in dairy and beef cattle have been developed which point the way to a satisfactory solution of this important problem. The method involves the gradual elimination of diseased animals and the prevention of further spread of disease by means of complete or part-time isolation of reactors. The complete segregation of infected animals in the station herd at Wardensville has resulted in elimination of the disease. Part-time isolation, isolation during the period of calving, is rapidly achieving similar results at Morgantown. Of 73 animals in the station herd in June 1930, 20 reacted to the agglutination test. In June 1931 the number had been reduced to 12 in a total of 77 animals, and in June 1932 only 3 animals in the herd of 77 were reactors. Part-time isolation will doubtless prove the most practical method in West Virginia since most of our farms do not have facilities for complete isolation.

The need for more exact information concerning dosage in the treatment of stomach worms and for effective measures for the control of lung worms has been apparent through the excessive losses sustained and the repeated requests for advice from stockmen and farmers. The work to date has involved a considerable number of sheep at the station farm and has included a variety of materials and concentrations. Rapid progress has been made and the findings have been applied to privately-owned flocks with complete success.

#### *Better Methods of Farm Management*

The readjustment of production to meet changing market requirements and to promote the best economy in the use of capital and labor has been fostered through a series of farm management studies conducted solely by the station or in cooperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture and other agencies. In the transition from the general, self-sustaining agriculture of the earlier days to the more specialized, commercial agriculture of today, the need for accurate appraisal of the sources of profit has been especially evident and the contributions of the station have been of great value in supplying correct and time-

ly information on a variety of questions. These studies have included:

A market-garden survey of the Ohio and Kanawha valleys with the delimitation of areas suitable for the development of trucking, and recommendations for the improvement of current practices.

General studies of the organization of the farm business in typical counties with particular emphasis on the amount of labor and other costs involved in the production of the leading crops.

Studies of the management and organization of typical, specialized farms showing the relation of profits to size of farm and other factors.

Special studies of the business of orcharding, poultry farming, and wool production, together with a particular study of the construction, management, and economic efficiency of stationary spraying systems for apple orchards.

A comprehensive farm management and land-use study of Nicholas and Webster counties, from which an economic program for agriculture and forestry has been developed.

### *Better Marketing of Farm Products*

Closely allied to research in farm management are the studies of marketing organizations and marketing which have received attention in recent years.

Studies of the production of staple farm commodities in four major consuming areas of the state together with consumption data for the principal markets, Charleston, Clarksburg, Beckley, and Wheeling, have disclosed opportunities for the expansion of production along certain lines that should be advantageous to both city and country.

The marketing of apples, including market outlets, marketing costs, and methods has been the subject of a recent comprehensive study made in the eastern section of the state in cooperation with the federal Bureau of Agricultural Economics. Many facts concerning this most important aspect of fruit growing have been made available to the growers.

Studies of costs, methods, and practices in the marketing of livestock have recently been completed. They include records of sales through various county livestock shipping associations as well as a large number of private sales. They offer definite suggestions for economies in marketing and improvement in the business transactions of the cooperatives.

Further studies of the business of cooperative marketing associations, including all active agencies in West Virginia, have been completed in cooperation with the Federal Farm Board and have supplied the necessary groundwork for the future development of cooperative marketing of a regional as well as state-wide character.

## ADAPTING RESEARCH TO CHANGING CONDITIONS

During the biennium an unusual amount of attention was given to revising projects and recasting the research program to meet emergency problems in the agriculture of the state and to make adjustments to conform with reduced funds.

Each study received rigid scrutiny as to its value, timeliness, and productivity with the result that many were brought to a conclusion or completely revised. The scope of this recasting is seen by comparing the status of projects as of July 1928 with that of July 1932. Of a total of 91 projects at the beginning of the period 53 have been completed and 11 have been revised. Only 27 projects have been continued through the period and are now active. Half of these cover miscellaneous work or variety tests and rotation studies which are modified from time to time but are continuous as to the main objectives. The others are of such character that more than four years are required for their completion.

The completed projects have been replaced in part by 34 new projects, of which 18 have been adopted within the biennium. These together with the 11 revisions and the 27 continued studies make up the total of 72 projects that are now in operation.

The curtailment of work made necessary by the reduced budget has been effected with as little loss as possible. There has been no lowering of standards or tendency to reach hasty, ill-founded conclusions.

Among the new projects especial mention should be made of the farm management and land-use study of the Huntington area, comprising parts of the counties of Wayne, Cabell, Putnam, Lincoln, and Mason. The intensive study of large numbers of typical farms of this area is planned to reveal the types of farming best adapted to the area and the factors that are necessary for profitable farming. The productivity of the various soils, the quality and management of livestock, systems of cropping, market outlets, costs and incomes, and the human factor are all given consideration. The study is unique in that it enlists the cooperation of practically all departments of the Experiment Station and thus brings to a focus the knowledge and experience of the entire staff. The results will supply an effective basis for future planning in the area for land utilization, population movements, schools, roads, markets, and the like, and will be applicable in part to other areas of the state. The close cooperation of the Extension Division through the services of specialists and county agents gives assurance that the findings will receive greatest possible application.

Other recent studies have as their objectices:

The improvement of poultry management in the Parkersburg area.



The control of round worms in pigs through correct feeding.

Methods of herd management for the production of slaughter and feeder calves.

The use of green manures for maintaining soil fertility in vegetable crop rotations.

The use of simplified rations for dairy cattle with especial emphasis on the feeding of home-grown products.

The control of stomach and lung worms in sheep and cattle.

The value of deep tillage in the production of field, truck, and orchard crops.

The cause and control of the canker disease of black walnut.

Effective organization and operation of apple orchards.

#### PROBLEMS AWAITING INVESTIGATION

The current research program of the Experiment Station naturally does not include nearly all the problems that press for solution. It is necessary that a choice be made of the more urgent problems and those that the station is best equipped to solve, and that others be postponed until work in progress is completed or new personnel or facilities are made available. No exhaustive listing of problems awaiting investigation will be attempted but a few examples will serve to illustrate their character and scope.

One of the broad, major problems and the final goal of much of the research in progress lies in the proper utilization of the land resources of the state. A considerable amount of data contributing to the problem has been recorded, but these must be amplified with additional information and brought together from new viewpoints before any satisfactory attempt can be made to classify land according to future profitable use. The ground-work for a land-use program has been laid with the soil survey, which is now complete except for a single county. Information concerning productivity of soil types, farm incomes, and other economic data also exists for separate localities, notably for Nicholas and Webster counties.

A study of the Huntington area, now in progress, affords a further important contribution. With a return to normal conditions the state should undertake to finance a state-wide study of types of land utilization, so that more definite programs of public and private ownership and of agricultural, timber, and recreational uses can be formulated. The Experiment Station is devoting as large a part of its appropriations as possible to this important work and will continue to do so, but unfortunately the amounts available are such that a good many years will be required for completion. Obviously it is desirable that more rapid progress be made. To have greatest

value such a study should be completed within a short period. The costs of such work are not excessive. In New York they have averaged one cent per acre and in West Virginia, because of the uniformity of some of the large mountain areas, it is thought that even lower costs would suffice.

Closely allied to the problems of land use is the problem of soil erosion. Because of the topography of the state, erosion is particularly important in West Virginia not alone because of soil loss but also because of flood damage, which is a natural result when hill-sides are denuded of forests or other vegetation. Serious losses of soil may take place even on relatively level land. Cropping plans and cultural practices should be so designed as to minimize the permanent loss of soil. The station has long recognized the importance of this need but because of a lack of funds and equipment has given little active attention to it.

The need for more exact information concerning soil-moisture relationships has been intensified by the droughts of recent years, especially that of 1930. The value of measures tending to minimize losses to farmers and fruit growers can readily be appreciated when we consider the losses of 1930, which were variously estimated to be in the neighborhood of thirty millions of dollars for West Virginia alone. While it is known in a general way that such factors as depth of soil, its organic content, character of subsoil, tolerance of varieties, and kinds of crops are of importance in determining the degree of injury in years of drought, much additional information of more specific character should be sought. There are also possibilities of using irrigation during critical periods especially with high-cost crops such as fruits and vegetables, and the economy of such practices should be investigated.

Within the period of this report a number of requests have been received for advice concerning the dying of forest and ornamental trees. Preliminary study has been made of several cases that should be investigated more fully. Except for the black-walnut canker, now being studied, and the chestnut blight but little attention has been given in West Virginia to the diseases of forest trees.

Among recent spray materials much interest has been displayed by fruit growers in the tar oils, which appear to offer promise of certain economies. Our own work has demonstrated that some of these preparations will kill apple aphids in the egg stage and that they offer possibilities for the control of the pistol-case bearer during the dormant season. As yet there are no standards to govern the use of these materials since the tar oils themselves are variable according to source of origin, and a thorough study of the properties of limited fractions seems essential to further progress. The solution of this problem would not only benefit the fruit growers but conceivably would further the coal industry of the state through utilization of by-products.

## CONTINUITY IN RESEARCH NECESSARY FOR PROGRESS

Continuity is an important factor in the successful prosecution of research. Only rarely are agricultural projects completed within a single season. More often a period of two or more years is required and if the study deals with the testing of varieties of crops, or fertilizer applications, or food rations, or cultural practices, the period for completion is usually several years. Ten or more years are often needed to arrive at a definite goal in the development of a new crop variety through breeding. Hybridization, selection, and testing are time-consuming but essential processes. In the testing of varieties or materials the seasonal factor is an important one. Single-season results are seldom reliable guides to long-time behavior because of seasonal variations. The crop variety that is outstanding in a normal year may lodge in a wet season or fall short in a dry season. The farmer is concerned with performance over a long period and if research is to answer his requirements it must establish the facts in conformity with the seasonal variations that he encounters.

The investment in agricultural research is therefore of necessity a long-term investment. The security of the investment and the guarantee of satisfactory results are insured in large measure by the degree of continuity that is maintained. Enforced interruption or discontinuance of a study prior to completion may involve the loss of all that has gone before with waste of time, labor, and money. Because of these facts it is in the interest of economy to provide funds for research that will guarantee continuity during periods of depression as well as in times of prosperity.

The human factor is the all-important factor in research. Laboratories, equipment, land, and livestock cannot advance knowledge except as they are utilized by the trained worker. The guarantee of success for an experiment station lies, therefore, in the maintenance of a competent staff. Although salaries are not the sole factor in the building of a research staff they are quite necessary to obtain and hold competent workers, and the salary item should be the last to suffer from declining revenues and the first to be restored with increasing incomes.

### OTHER SERVICES OF THE EXPERIMENT STATION

Although its principal function is the conduct of research the Experiment Station is called upon for a variety of other services for which it is particularly qualified because of special facilities and trained personnel. All such services are rendered free to citizens of the state.

The station cooperates with the State Department of Agriculture in maintaining the following laboratory services: the testing of purity and germination in seeds, the diagnosis of diseases of poultry and farm animals, the testing of fertilizers and animal feeds, and the determination of arsenic in spray residues on apples.

Further laboratory services conducted solely by the station include: miscellaneous chemical analyses, the testing of soil samples to determine lime requirements, the testing of limes to determine their value in agricultural use, and the scoring of blackberry jam prepared by farm women for sale under the Mountain State Brand.

Other services include:

The supervision of the testing of dairy cows for the Advanced Register.

The identification of plants, varieties of fruits, and farm crops.

The identification of injurious insects and of plant diseases.

The determination of effective dates for spray-service recommendations based on studies of insect and disease development.

The supplying of technical information on a wide range of subjects in response to specific inquiries.

Advice on organizing and managing the farm unit.

Information on farm lease contracts.

Plans for construction of farm buildings.

Aid to individual farmers in the improvement of small-grain crops through selection.

The station also cooperates with various agencies such as the College of Agriculture, the Extension Division, and the farm organizations of the state in assisting with special schools, educational tours, livestock improvement campaigns, and in the conduct of public meetings.

#### LOCATION OF RESEARCH PROJECTS

Agricultural research in West Virginia is centered in the seat of the Experiment Station at Morgantown and in the three outlying branch stations: the University Experiment Farm at Kearneysville, Jefferson county; Lakin Experiment Farm, Lakin, Mason county; and Reymann Memorial Farms, Wardensville, Hardy county. Yet the program of investigation and experimentation is not confined to these centers. It reaches out to all sections of the state, so that the conditions under which crops are grown or marketed may be studied at first hand. The appended list of counties tells how this program is divided according to the general lines of investigation followed.

*Animal Husbandry\**: Greenbrier, Hardy, Monongalia, Pocahontas.

*Crops and Soils*: Grant, Hardy, Jefferson, Mason, Monongalia, Preston, Randolph.

*Fruits and Vegetables*: Berkeley, Hampshire, Jefferson, Mason, Monongalia, Morgan, Preston.

*Insect Pests*: Berkeley, Hampshire, Jefferson, Monongalia.

*Plant Diseases*: Berkeley, Hancock, Hardy, Jefferson, Mason, Monongalia, Morgan, Ohio, Putnam.

*Farm Economics*: Berkeley, Brooke, Cabell, Hampshire, Jackson, Jefferson, Lincoln, Marshall, Mason, Mineral, Monongalia, Morgan, Ohio, Putnam, Tyler, Wayne, Wetzel, Wirt, Wood.

\*Includes Dairy Husbandry and Poultry Husbandry.



## REPORTS OF CURRENT RESEARCH

The reports which follow concern the status and results of research work in the several departments of the Experiment Station for the biennium 1930-32.

### AGRONOMY AND GENETICS

The agronomic projects have been planned with a view to helping solve the problems peculiar to West Virginia that pertain to field crops and soils. There are relatively few places in the state where the production and sale of field crops is the main agricultural enterprise. The principal farm income is more likely to be derived from the sale of livestock or livestock products, or from some horticultural crop. The experimental work in agronomy is therefore supplementary to and coordinated with the experimental work which deals more directly with the chief income-producing activities on West Virginia farms.

The orchardists are confronted with the problem of soil management and cover cropping. Studies are being carried on to determine what cover crops are most effective in supplying organic matter and hence increasing the water-holding capacity of the soil. Investigations with sweet clover include a breeding project in which an attempt is being made to produce a new strain particularly adapted to West Virginia orchards. Various cultural practices with respect to height and time of cutting sweet clover are being compared with a view to determining their relative value.

One of the important problems of the livestock farmer is the production of leguminous hay. Extensive investigations are being carried on with alfalfa on several soil types to determine the fertilizer and lime requirements. Soybean breeding has resulted in the development of a new variety named Pekwa, which is particularly well adapted for hay purposes. Additional leguminous crops are being investigated with the object of determining their value for conditions in the state.

Cost accounts show that dairy products can be most economically produced when pasture is available. In cooperation with the federal Department of Agriculture and the Dairy Husbandry department of this station, extensive pasture investigations are being carried on at the Reymann Memorial Farms and at several other places in the state. Some work is also being done with annual pasture crops. It is hoped that the results from these investigations will help the West Virginia dairyman in the problem of pasture management so as to enable him materially to reduce the cost of producing dairy products.

In addition to the activities indicated above there are a number of agronomic projects which have for their aim breeding for disease resistance. Under this category the following may be mentioned: corn resistant to smut, oats resistant to smut, tobacco resistant to

rootrot, and watermelons resistant to wilt. Several new smut-resistant strains of oats which have been produced by hybridization appear promising in the variety trials.

Practically every West Virginia farmer is confronted with problems pertaining to liming and fertilization. Approximately 700 field plats at the Lakin Experiment Farm are being used to study the fertilizer needs of the commonly-grown field crops, including potatoes. Laboratory and greenhouse studies on soil reaction have yielded some interesting results which may have an important bearing on the question of liming practice.

A service maintained by the experiment station of direct value to individual farmers is the testing of soil samples for lime requirement and in some cases for available phosphorus. On the basis of these tests advice is given as to lime and fertilizer treatments for certain crops. Another service of direct value to West Virginia farmers is the analysis of limestone for its neutralizing value when applied to the soil. During the past biennium 831 samples of soil have been examined for lime requirement and 550 samples of limestone analyzed for calcium carbonate equivalent.

In cooperation with the state department of agriculture a laboratory is being maintained for the purpose of testing seeds for germination and purity. This service helps to establish a high standard for seeds planted by West Virginia farmers.

Below are brief statements concerning the agronomic projects under way with particular emphasis on progress that has been made since the last biennial report was issued.

### *Pasture Improvement*

In 1930 a comprehensive pasture investigation was begun at the Reymann Memorial Farms and at certain other locations in the state in cooperation with the U. S. Department of Agriculture. The principal experiment at Wardensville is being carried out on a 44-acre tract with approximately 40 Ayrshire cows. Here an attempt is being made to evaluate various combinations of fertilizers in terms of pounds of milk and pasture days. Inasmuch as grazing was just begun during the season of 1932 it is not yet possible to draw even tentative conclusions from this phase of the work.

Supplementary to the main experiment there was established a series of small plats on each of the following soil types: Dekalb and Westmoreland silt loams near Morgantown, Upshur clay loam near Aurora, Huntington silt loam near Moorefield, Dekalb shale loam near Petersburg, and Monongahela fine sandy loam near Wardensville. In these experiments differences between fertilizer treatments are being measured by clipping and weighing the grass at intervals of from two to five weeks and also by noting any changes in the character of the vegetation. It has been found that pastures on different soil types give different response to the same fertilizer treatment (See Table 1). In general a complete fertilizer has stimulated

the growth of cultivated grasses and clovers and hence reduced the stand of weeds.

TABLE 1—Yield of grass per acre from different soil types

Plot No.	Treatment	Yield in pounds per acre (dry matter)			
		Morgantown		Aurora	Moorefield
		Dekalb soil	Westmoreland soil†	Upshur clay loam	Huntington silt loam
..	Check .....	894	1942	660	1780
10	L .....	1038	....	812	1704
1	P .....	1104	2187	1064	1903
2	P-L .....	1254	....	994	2013
4	P-K .....	1191	2191	1022	1968
5	P-K-L .....	1771	....	967	1998
6	N-P-K .....	1727	2543	1336	2516
7	N-P-K-L .....	2243	....	1588	2458
11	1/2N-P-K-L .....	1924	2602*	1312	2151
12	2N-P-K-L .....	2472	....	1930	3144

\*No lime applied.

†One of the highest-yielding cuttings is not available; therefore these figures represent probably 80% of the actual yield.

### Annual Pastures

In the investigations being conducted with various legumes and grasses for the purpose of determining their relative value as annual pasture crops, biennial sweet clover has proved to be one of the most desirable. It usually furnishes plenty of grazing during that part of the season when bluegrass is most likely to be short.

### Liming Pays

In the rotation experiment located on Wheeling fine sandy loam near Lakin, in which all the commonly-grown field crops are included, distinct increases in yield due to lime have been obtained with all crops except potatoes and cowpeas. Over the seven-year period the value of the increased yields due to liming is several times the cost of the lime. Liming experiments carried on elsewhere in the state in general corroborate the results obtained at Lakin.

### Acid Soils May Contain Sufficient Soluble Aluminum to be Harmful

It was found in culture solution studies that soluble aluminum is decidedly injurious to various crops in concentrations as low as one part per million. In view of these results it seemed desirable to determine the concentration of soluble aluminum found in some of the representative acid soils of the state. In all about sixty soils were studied. Most soils below pH 5.0 were found to contain some soluble aluminum and one soil with pH value of 4.2 contained 27 parts per million of soluble aluminum. The greater the acidity of the soil and the higher the salt concentration, the more aluminum was found present in solution. These and other results obtained show that one reason why liming is beneficial to the growth of plants is that it takes the aluminum out of solution and renders it non-injurious to plants.



### *Excessive Liming May be Temporarily Injurious to Crops*

In greenhouse studies with alfalfa and corn it has been found that the use of excessively large amounts of lime may result in a decided injury to the crop planted immediately after liming. This has been found to be due to the fact that the excess lime renders the phosphorus in the soil less available to the plant. Crops grown one year after liming showed little or no injury. While injury from excessive liming is not as likely to occur under field conditions, it is believed best, where large amounts (four tons or more per acre) of lime are to be added, to lime in the fall or at two different times during the rotation.

### *Wheat Yields Following Soybean vs. Cowpea Stubble*

In a comparison between two three-year rotations at Lakin that are identical except that in the one soybeans are cut for hay and the stubble turned down and in the other cowpeas are treated similarly, the succeeding wheat crop has shown a difference of 4 bushels between the average yields over a seven-year period in favor of the crop following the cowpea stubble.

### *Wheat Responds to Nitrogen Fertilization*

At the Lakin Experiment Farm the use of nitrogen fertilizer in the form of nitrate of soda has resulted in marked increases in the yield of wheat. The use of 130 pounds per acre of nitrate of soda increased the yields over 12 bushels per acre, whereas the use of twice that amount has resulted in yields more than double those where no nitrogen was applied. Detailed results are given in Table 2.

TABLE 2—*Effect of nitrogen on wheat yields in 1931 at Lakin Experiment Farm*

Treatment* in triplicated plats	Average yield (Bu.)
P - K	17.3
1/2N - P - K	24.6
N - P - K	29.7
2N - P - K	36.4
N - 2P - 2K	29.7
2N - 2P - 2K	38.1
4N - 2P - 2K	44.8

\*N = 20 pounds nitrogen or 130 pounds nitrate of soda.

P = 60 pounds  $P_2O_5$  or 300 pounds 20% superphosphate.

K = 20 pounds  $K_2O$  or 40 pounds muriate of potash.

N-P-K is equivalent of 500 pounds per acre of 4-12-4 fertilizer.

Rotation — Corn, wheat, and clover.

Corn also responded well to nitrogen fertilization. On the other hand the yields of both wheat and corn were not significantly increased on this Wheeling fine sandy loam soil from the use of phosphorus or potash fertilizers.

### *Some Nitrogen Available in Acid Soils*

The value of lime in increasing the rate at which nitrogen becomes available for plants has long been recognized. Recent studies show that nitrates are produced in some of the most acid soils in the state. The pH of some of them was found to be less than 4.0 and the soluble aluminum content very high. The amount of nitrates produced in these soils is related to the supply of available calcium, which is the principal base found in limestone.

### *Three Cuttings Best for Alfalfa*

In the frequency-of-cutting experiment with alfalfa it has been found that three cuttings give best results. The plats cut twice yielded somewhat less hay and hay of poorer quality. The plats cut four times showed greatly-reduced stands of alfalfa and a corresponding increase in weeds after the second year.

### *Phosphate Fertilization Important for Alfalfa*

In both the greenhouse and field tests alfalfa has shown a marked response to phosphatic fertilization on practically all soil types. On the other hand no marked response to potash has been obtained.

### *Alfalfa May Grow on Slightly-Acid Soils*

Studies in both greenhouse and field have been carried on to determine how much lime is required by West Virginia soils for the satisfactory growth of alfalfa. It was found that where the soil is well fertilized, good growth of alfalfa was obtained even though the soil is slightly acid — pH 6.0 to 6.5. In one experiment where lime was thoroughly mixed with the surface eight inches of soil the yields obtained from the use of 2¼ tons of hydrated lime (pH of 5.85) were only 11 percent lower than where 6 tons had been applied (pH 7.10). Where the lime was mixed with the surface 3 inches of soil the plats limed to pH 7.1 were found to give 42 percent greater yields than those limed to pH 5.85. The average amounts of ground limestone required for all the soils studied to bring them to pH 6.5 was 4 tons. To bring these same soils to pH 7.0 or neutrality required 6½ tons.

### *A Strain of Oats Resistant to Smut*

During the biennium covered by this report the early maturing varieties of oats have continued to outyield the mid-season and late varieties. One of the early varieties introduced by the station is becoming widely grown in the state under the name of Gopher. Several years ago Gopher was crossed with Black Mesdag, a variety resistant to smut but otherwise undesirable. During the last two years certain smut-resistant white-seeded descendants from this cross have been included in the variety trials with gratifying re-

sults. The yields of some of the new strains compare favorably with Gopher and a few of them have less awn development.

#### *New Variety Experiments with Wheat and Barley*

Winter wheat and winter barley are grown extensively in the Eastern Panhandle. After the establishment of the branch experimental farm near Kearneysville it was deemed advisable to locate some variety experiments at that place. Accordingly variety trials with winter barley and winter wheat were established in cooperation with the federal Department of Agriculture. The variety trials at Morgantown and Lakin, as indicated in a previous report, continue to show Fulhio, Reliable 80, and Trumbull to be among the highest-yielding varieties of winter wheat for those locations. (Bul. 244.)

#### *Inheritance of Reaction to Corn Smut*

It has been shown by a study of the progeny resulting from crosses between resistant and susceptible corn that reaction to smut is definitely inherited. Not only is smut susceptibility transmitted from parent to offspring but, what is more striking, place of infection on the plant seems also to be a heritable character. During the past two years considerable information has been collected concerning the manner of inheritance of resistance and susceptibility to this important disease. It is hoped that this information will facilitate the production of high-yielding varieties of corn adapted to West Virginia that are resistant to smut.

#### *Producing a Yellow-Seeded Woodburn White Dent*

One of the highest-yielding white-seeded varieties of corn grown in the Point Pleasant area is Woodburn White Dent, which was introduced by the Experiment Station several years ago. The main objection to this variety is that it has white seed. A cross has been made between it and a strain of corn resistant to smut isolated from the variety Reid's Yellow Dent by self-pollination. The plants resulting from this crossed seed were again crossed with Woodburn White Dent. The ears so produced bore approximately 50 percent white and 50 percent yellow seed. Plants from the yellow seeds were again back-pollinated to Woodburn White Dent. It is expected to continue the process for a period of six or seven years with the aim of finally producing a variety of corn similar to Woodburn White Dent except in seed color.

#### *Progress in Breeding Tobacco Resistant to Root Rot*

In addition to the tobacco strains descendant from the crosses — Kelley x resistant Burley, and Pepper x resistant Burley mentioned in the previous biennial report (Bul. 244) — plant selections from the Pepper and Kelley varieties have been grown in soil known to be infested with the organism producing root rot. Some of these selections appear promising both from the standpoint of desirable type and resistance to root rot.

### *Breeding Watermelons Resistant to Wilt*

A few years ago a Russian strain of watermelons resistant to wilt but not edible was crossed with Early Fordhook and with Grey Monarch. The two latter varieties are susceptible to wilt but of good edible quality. Second generation descendants from these crosses grown during the present year show a wide range of susceptibility to wilt and of edible quality. The object of this project, which is in cooperation with the department of Plant Pathology, is to produce a variety of watermelon that possesses resistance to wilt and high quality of fruit.

### *Pekwa, a New Variety of Soybean*

The descendants of a single plant selection made from the Peking variety over ten years ago have proved valuable enough to justify giving them a variety name. The name chosen is Pekwa — “Pek” as the first syllable of the parent variety, and “wa” for “West Virginia”. This new variety in addition to high yield possesses fine stems and retains its leaves unusually well during hay making.



Bundles of Pekwa (left) and Wilson (right) soybeans after flailing.  
Note superior leaf-retention on part of Pekwa

### *Concrete Soil Bins Used to Study Fertilizer Response*

It is often difficult to find an area of land sufficiently uniform to be used for fertilizer studies. To overcome this difficulty soil bins having an area of 1/1000 of an acre each have been constructed on the Agronomy farm. The various layers of soil were well mixed



before being placed in the bins. The first crop of wheat and of soybeans showed that variation in yields due to natural variation had been largely overcome. Therefore these bins seem to offer a satisfactory method of studying fertilizer response. They are used at present in a study of availability of phosphate fertilizers.

#### *Corn Sap May be Used to Determine Available Phosphate in Soil*

The need for an accurate method for determining the availability of soil phosphates has led to the study of the phosphate content of corn sap as related to phosphate response. Recent studies in the greenhouse under controlled conditions indicate that there is a positive relationship between the phosphate present in the sap of corn and the yield. The tests are being continued in the field. Such variables as stand, weeds, moisture, and availability of other nutrients have been found to influence the amount of phosphate present in the plant.

#### *New Fertilizers Prove Valuable*

A new method of adding the nitrogen to mixed fertilizers, known as "ammoniation," has raised the question as to the availability of the phosphorus present in the new fertilizers. Since this method of manufacture has become widely used during the last few years, studies were undertaken in cooperation with the U. S. Department of Agriculture to determine the availability of the phosphorus. It was found that the tri-calcium phosphate formed as a result of ammoniation was as available to crops on slightly acid soils as is the phosphorus in superphosphate. As a result of these and other tests the official method for determining the phosphorus availability of fertilizers has been tentatively changed. Further studies are being made regarding this problem with soils of different degrees of acidity.

#### *Application of Fertilizer in the Hill Better than Broadcast for Corn*

In cooperation with the Joint Committee on Fertilizer Application of the American Society of Agronomy, studies have been made to determine the best method of applying fertilizer to corn. It was found that hill fertilization if properly done was much better than broadcast applications. One hundred and twenty-five pounds of fertilizer per acre applied in the hill was more effective in increasing yields than 500 pounds of the same fertilizer applied broadcast. The best method of applying fertilizer in the hill was found to be in two parallel bands two and one-half inches apart on either side of the seed and three-fourths inch above the seed level. Other methods of applying fertilizer in the hill were also effective, but all methods of hill fertilization in which the fertilizer was in contact with or too close to the seed were found to injure the stand and reduce the yields.

### *Frequency and Height of Cutting Sweet Clover*

The question of height and frequency of cutting sweet clover is of particular interest to the orchardist. An investigation was begun recently to determine the effect of cutting sweet clover at different heights and at different stages of maturity. This work has not been in progress long enough to justify drawing conclusions at this time.

### ANIMAL HUSBANDRY

The research program of the department of Animal Husbandry is designed to answer some of the more important problems confronting the farmers interested in beef cattle, sheep, and hogs. It is recognized that there are three essential things to be considered which make for economic production of meat animals: namely, health, breeding, and feeding.

Studies are now being made in connection with parasites of sheep and hogs. Rams of various breeds of sheep are being tested from the standpoint of market lamb production and from the standpoint of building up desirable ewe flocks when mated to native ewes. Cattle of various ages are being fed grain in conjunction with pasture to determine the amount of grain and the time it should be fed during the grazing season. Cow herds are being maintained under different systems of feeding and management to determine the most economical way to produce and sell calves. The majority of projects in progress with beef cattle and sheep of necessity center around the economic utilization of pasture — the most important farm crop in the state.

In addition to parasite work, studies are being made of various protein supplements in growing and finishing hogs. Studies are also conducted as to the accuracy of feeding experimental hogs in groups as against individual feeding.

### *Grain Supplement on Grass Pays for Itself*

An investigation of beef production and quality as affected by grade of steer and by feeding grain supplement on grass was carried on for three years jointly by the Experiment Station and the Bureau of Animal Industry of the U. S. Department of Agriculture on typical bluegrass pasture land in southeastern West Virginia. Results obtained from the feeding of 40 steers of good and medium grade show that 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. Good and medium steers handled similarly during the winter feeding period and through the summer grazing period following may be expected to make similar total gains, the report states. The relative returns of each grade will therefore depend primarily upon the margins obtained.

In palatability tests it was found that the meat of the lots fed a

supplement on grass was of slightly greater tenderness. (U. S. D. A. Tech. Bul. 217.)

### *Finishing Calves for the Market*

There is a place in West Virginia for the production of more good beef calves. Adjoining states offer a good market for our surplus feeder calves and it is not so speculative a phase of beef production as is the finishing of heavy steers.



A typical lot of steer calves used in the experiment

In a six-year experiment with good, grade, native Hereford and Aberdeen-Angus steer calves it was found that calves fed and marketed as baby beefs proved to have a greater potential value than calves fed and marketed either as 2-year-old or 3-year-old steers, and calves fed and marketed as 2-year-old steers had a greater potential value than calves fed and marketed as three-year-old steers. A short grain-feeding period for 2-year-old steers is less expensive and produces a more valuable slaughter animal than carrying them another year and marketing them as grass-fat three-year-old steers. Besides, the two-year-old steers so fed are more desirable for slaughter and for the market.

Grass alone, it was found, will not produce sufficient finish on two-year-old steers for slaughter. (Bul. 251.)

### *Herd Management for the Production and Slaughter of Feeder Calves*

Does it pay to graze beef cows on land suitable for both tillage and pasture, or should beef herds be grazed only on strictly pasture land?

Sixty head of high-grade and purebred Hereford cows were divided into two equal lots late in 1931. One lot was wintered on the home farm of the Tuckwiller brothers, Greenbrier county, on a ration of corn silage, wheat straw, and cottonseed meal. The other lot was kept on mountain pasture nearby on a ration of mixed hay. In spring, 1932, cows and calves were turned on their respective pastures. A purebred Hereford bull was turned with each lot for a period of 2½ months.



Additional objects of the 5-year experiment are to study the cost of maintaining herds under the two systems; determining the necessary replacements of breeding animals as well as the percentage of calf crop raised; obtaining data concerning the net profit or loss per cow; and comparing grain rations fed to nursing calves on pasture that are to be finished for slaughter.

### *Finishing Two-Year-Old Steers on Grass and Grain*

To determine the most economical period of feeding grain and at the same time to utilize pasture for the full grazing season, 30 yearling steers were wintered in 1930 on a daily ration composed of 20 pounds corn silage, 3 pounds mixed hay, 3 pounds oat straw, and 1½ pounds cottonseed meal. The average gain in weight per steer was from 652.5 pounds to 713 pounds, an average winter gain of 61.5 pounds. On April 17, 1931, the steers were turned on grass after separating into 3 equal lots of 10 each.

Lot I was started on 5 pounds grain (6 pounds cracked corn and 1 pound cottonseed meal) after the first 56 days on grass; Lot II, 7½ pounds of the same grain mixture after the first 84 days on grass; and Lot III, no grain on grass.

On September 4, or at the end of 140 days' grazing, all lots were fed a full grain ration for 56 days. Lots I and II were fed in bunks and remained on pasture while Lot III was removed from the pasture and fed in drylot.

These steers were sold on the Pittsburgh market at the end of the 56-day full-feed period and while they actually sold at different prices, the dressing percentages and carcass grades did not justify the spread in prices paid by the purchaser. The dressing percentages and the carcass grades indicated that all lots should have sold at approximately the same price. Net returns were in favor of Lot III.

This study is being repeated with 30 head of yearling steers.

### *Corriedale Topcross Increases Wool Yield*

A study was begun in 1930 with 120 grade Hampshire ewes concerning the effect of a top-cross of Corriedale rams on the resulting crop of wool and mutton. The female progeny in turn were mated in the fall of 1932 to Corriedale rams and this procedure will continue for three or more generations. The wether lambs are sent to the laboratories of the Bureau of Animal Industry, U. S. Department of Agriculture, at Beltsville, Maryland, for the study of slaughter and carcass grades and weights as well as of quantity, quality, and palatability of meat.

Analysis of the data to date shows that the yearling ewes sired by Corriedale rams sheared approximately 80% heavier fleeces in the grease than their dams had as yearlings. These dams had sheared an average of 4 pounds, while their daughters averaged 7.23

pounds of wool. Likewise a decided increase in length of staple was noted in the case of the daughters, whose fleeces averaged 3.92 inches in length as compared to 3.16 inches for their dams. The daughters also averaged about 16 pounds or 23% heavier than their dams at the same age. The difference in weight is considered due largely to growth rather than fatness or condition. These yearling daughters are to be mated to Corriedale rams in the fall of 1932.

### *Control of Stomach and Lung Worms in Sheep*

Stockmen and farmers in increasing numbers are requesting information concerning relief measures for stomach and lung worms. These diseases have not been fully investigated in either cattle, sheep, or swine, and remedial measures can be advised only empirically. As a calf and lamb-producing state West Virginia is in need of accurate information leading to the lessening of this important source of loss of farm livestock.

The department in 1929 undertook a detailed study of different drugs in their effect on several hundred lambs which were quartered in a specially constructed parasite barn with which was connected a securely fenced lot. Systematic treatment of sheep has been accomplished with the use of nicotine sulphate; nicotine sulphate and copper sulphate mixture; copper sulphate 1%; copper sulphate 1½%; colloidal iodine; tetrachlorethylene; and a mixture of equal parts of santonin, calomel, and aloin, for the removal of stomach and intestinal parasites.

A privately-owned farm flock of sheep, used in this experiment and numbering 23 ewes and their 29 lambs, was treated satisfactorily with copper sulphate.

A 1½% solution of this drug has given the highest percentage of efficiency in the control of stomach worms and other gastro-intestinal parasites.

### *Protein Supplements for Finishing Swine in Drylot*

Four lots of 10 fall pigs each were fed from January to June 1932 on equal amounts of yellow corn and various combinations of tankage, linseed oilmeal, alfalfa meal, cottonseed meal, fish meal, and buckwheat middlings.

Lots I and II, comparing tankage and fish meal, gained at almost exactly the same rate, and the feed required per 100 pounds gain was almost the same for the two lots. In Lots I and III, comparing linseed oilmeal and cottonseed meal, Lot I gained more rapidly and more economically. This was also true of the comparison of linseed oilmeal and buckwheat middlings as between Lots I and IV.

The results of this trial indicate that tankage and fish meal are nearly equal in value, but that linseed oilmeal is superior to cottonseed meal when used as a part of the protein supplement to corn for growing pigs. Although the results of this trial indicate that

linseed oilmeal is slightly superior to buckwheat middlings, in five out of seven previous trials buckwheat middlings gave more satisfactory results than the oilmeal.

TABLE 3—*Summary of feeding trials with protein supplements for pigs*

Protein supplement	No. of lots	Ave. pigs per lot	Total pig days	Average daily gain (lbs.)	Ave. dry matter per 100 lbs. gain
Tankage .....	17	9.88	15294.2	1.26	360.14
Wheat middlings .....	4	9.75	2622.8	1.13	351.63
Buckwheat middlings .....	4	9.75	3285.8	1.32	348.48
Linseed oilmeal .....	5	10.00	5630.0	1.26	358.59

#### CHEMISTRY (AGRICULTURAL)

The work of the department of Agricultural Chemistry is two-fold: analytical service for the so-called production departments of the Experiment Station, and research of an original character.

In the course of many experiments with both plants and animals the point eventually is reached where further research is independent upon accurate knowledge concerning the organic and inorganic constitution of plant or animal matter. Even insect and disease control, to be adequate, must resolve itself into the determination of spray materials of known chemical composition. Thus in multifarious ways chemistry finds itself concerned with plants and animals, their life processes, and their products. Rather than require each department to perform its own analyses of this nature, it has been incumbent upon one division of the station to perform such service on behalf of all departments concerned. The work of the department of agricultural chemistry therefore has included analyses of grains, grasses, silage, feedstuffs, spray materials, fruit buds, fruits, blood, bones, and miscellaneous materials.

The chemistry of bone composition is a case in point. It is known that the proportionate amounts of moisture, ether extract, non-fat organic material, and ash or mineral vary with the type of animal, the kind of bone within the body, the age of the animal, and the condition of nutrition. The extent of this variation is a matter of conjecture. For that reason extensive experiments were begun several years ago to determine the amounts of these ingredients in the bones of hogs, of dairy animals, and of chickens on normal and deficient rations. Later rat bones were included in the study. Six representative bones of hogs — the ulna-radius, vertebra, rib, tibia-fibula, humerus, and femur — were studied. The corresponding bones and the cannon-bone of dairy animals were included, as were also the corresponding bones and the breastbone of the chicken. For the rat the same bones were employed as for the hog. To insure accuracy of results, whole bones were analyzed for moisture, ether extract, and ash content. Calcium, phosphorus, and magnesium determinations were made on certain of these bones.

To date it has been found that the ulna-radius is the least variable of these bones in moisture content and also in ash. A pairing of bones within the same body also is evident. Analyses of many samples show that the humerus and femur, the ulna-radius and the tibia-fibula, and the rib and vertebra tend to pair as far as composition is concerned.

The final aim in this experiment is to reduce, if possible, the rather exhaustive amount of analytical work necessary by learning which part of the skeleton is best adapted for mineral deficiency determinations, and also by determining whether such deficiency may be ascertained from organic symptoms of disease in the animal body, or by other measures, without resorting to the necessity of extensive chemical investigations.

An interesting phase of the function of chemistry in farm crop analysis has come to light in studies with sweet clover. Coumarin is a bitter element which renders this legume objectionable to cows and other forms of livestock. Breeding trials are under way by the department of agronomy and genetics seeking to develop a strain of this clover possessing a low coumarin content. The Obermayer method of extraction with solvents, generally employed for coumarin determinations of this character, proved time-consuming and ill suited to the work in this experiment. Investigations in the department have established a simple technique for coumarin removal through steam distillation, which has proved considerably more rapid and at the same time more accurate.

The intricate process by which apples color as they ripen is the burden of an independent study carried on by the department. The physiological conditions and changes accompanying and affecting pigmentation and ripening are included in this study, the practical application of which, it is hoped, will be to ascertain the actual chemical composition of the coloring matter in apples and the various factors and processes contributing to its formation in the ripening fruit.

A carefully conducted pruning experiment in the department of horticulture, carried on from 1916 to 1930, has afforded opportunity to study certain chemical factors related to kind of pruning (corrective and heavy dormant and early summer pruning), blossom-bud formation, and fruiting. The object has been a study not so much of progressive changes but rather of the apparent relation of certain groups of nutritive substances, including carbohydrates and nitrogen, to kind of pruning, leaf and blossom-bud formation, and fruit bearing.

#### DAIRY HUSBANDRY

The research program in the department of Dairy Husbandry has necessarily been divided into two fields: that pertaining to the production of milk, and that pertaining to the processed and manufactured products.



In the production field the aim has been to attack the problems in dairy cattle feeding and management that are most important to the West Virginia dairyman. The projects have dealt with problems in nutrition, breeding, and disease control.

In the nutrition of dairy animals it has been felt that one of the largest problems is the lack of sufficient roughage. Each year many tons of hay are shipped into the state, much of which could be saved if crops suitable to West Virginia conditions were grown and their use, with proper supplements, were demonstrated. Many of the projects in the department have been in this field.

Milk can be produced cheaper on pasture than by any other method of feeding. The department has started extensive pasture experiments at the Reymann Memorial Farms. It is hoped that the results obtained from these studies will help the dairyman materially to decrease the cost of milk production.

How best to handle the disease of infectious abortion has been one of the biggest problems in the state. An attempt has been made to develop a method of isolation which can be recommended to the dairymen of the state. One of the largest breeding experiments on the continued use of proven sires is being carried on at the Reymann Memorial Farms.

In the manufacturing field some of the problems confronting dairy plant operators have been attempted. Such problems as the best method of manufacturing rennet-coagulated sweet-curd cottage cheese have been investigated, while studies continue on the bacterial flora of high-grade pasteurized milk, the shipping of cream, and the cause of various flavors in milk and cream.

#### *Part-time Isolation Gives Effective Abortion Control*

The method used under this project to control infectious abortion is the isolation of reactors for a period of two weeks before calving and to the end of six weeks after calving.

Testing once each month was accomplished on all animals six months of age or older.

The first isolation was accomplished in June, 1930. At the beginning of the experiment there were 20 reactors in the herd. Reactors have been eliminated from the herd as their economic usefulness ended. Two reactors remain. The size of the herd has been maintained without the purchase of additions on account of infectious abortion.

Only three new cases developed during the progress of the project.

#### *Simplified Rations for Dairy Cows*

An experiment seeking to provide the West Virginia dairyman with a simple, economical home-grown ration with which to lower his milk production cost was begun in the spring of 1932 with 14 dairy heifers. A ration consisting of yellow cornmeal, alfalfa hay,

and salt is being compared to a ration consisting of timothy hay and a concentrate mixture of yellow cornmeal, corn gluten, and salt. Check animals of each group are kept in the barn throughout the year, while other animals receive pasture in season. The animals will be carried on through growth, reproduction, and lactation. Various other rations will be studied in this project.

### *Effect of Low-Mineral Rations on Dairy Animals*

Four of the 16 female animals involved in this study have come into milk. One of these belonged to the group receiving a normal-calcium: phosphorus ration; two to the normal-calcium: low-phosphorus group; and one to the low-calcium: low-phosphorus group. Although no significant difference in milk production can be claimed when all factors are considered, yet there has been a noticeable difference in the physical condition of the animals on the abnormal rations as compared to the physical condition of the animals on the normal rations. These animals are being bred again, and will be carried on the experiment until they give birth to the second calf. Each of these cows has given birth to a normal living calf.

### *Dry Beet Pulp as Good as Wet*

In a reversal experiment, the relative feeding value of wet and dry beet pulp for milk and butterfat production is being determined.

Results so far available, would indicate that when dairy cows are given free access to water there is no appreciable difference in the feeding value of wet and dry beet pulp as to the amount of milk or butter-fat produced, palatability, the maintenance of body weight, and the amount of water consumed. It requires considerable more labor to prepare and feed the pulp wet than it does to feed it dry.

### *Varieties of Pasture for Milk Production*

In this study of sweet clover, Sudan grass, oats and Canada field peas, and blue grass as a pasture for dairy cows, certain indications have been observed.

Sweet clover supplied considerably more nutrients than did the other pastures studied. The first year it can be pastured beginning about August 1, even if oats and peas are seeded with it and pastured much earlier. During the second year, very little pasture can be expected from it after August 1. It would seem then that with two fields sown on alternate years, sweet clover would furnish pasture throughout the season. The Sudan grass did fairly well during the first year, but thereafter poor stands resulted, although good stands were obtained on other plots near at hand. This indicates that it may not be advisable to follow Sudan grass with another crop of Sudan.

### *Flavor in Dairy Products*

Buttermilk has a richer flavor than skimmilk and whole milk of equal fat content. The added richness of buttermilk appears to be due to the presence of fat-globule films, a large portion of which becomes disengaged from the fat globules when they coalesce in churning and are left in the buttermilk. The compound in the fat-globule film which seems to contribute largely, if not entirely, to the increased richness of flavor is lecithin. Results of nine controlled trials also indicate that lecithin, which is readily oxidized when purified, oxidizes rapidly in buttermilk also under the conditions obtaining in these experiments, for a "cappy" flavor became evident in nearly all the buttermilks when stored 12 to 24 hours at low temperature. In spite of this cappy flavor an increase in richness of flavor was noted, which indicates conclusively that lecithin in milk and buttermilk contributes to its rich or fat flavor.

### *Type of Can Affects Cream in Shipment*

This study so far has involved methods of shipping cream in less than carload lots. The data collected indicate that the insulated cans are superior to plain, jacketed cans of equal capacity for preventing warming of the cream in transit. Little difference in this respect was found between 5- and 10-gallon cans of similar construction.

In general, bacterial-count increases during shipment were proportional to temperature increases. Mold counts did not change significantly during shipment in any case, but a slight tendency was found for yeast counts to increase when temperature rises were greatest. Acidity and flavor did not change noticeably in any case.

### *Improvement in Cottage-Cheese Manufacture*

Earlier observations that whey acidity at time of cutting the curd is the most important single factor in controlling the manufacture of sweet-curd, rennet-coagulated cottage cheese, have been confirmed in recent studies. Setting temperature, temperature at which skimmilk is pasteurized, amount and strength of rennet extract, and temperature to which curd is heated in the whey, are other factors each of which has a direct bearing upon the production of a clean, firm, palatable cottage cheese.

It is found that the true function of rennin in this type of cheese lies in preventing the matting of curd flakes, while its coagulating properties are of secondary importance. Matted flakes must be broken — a process which results in unsightly, irregular-shaped flakes prone to be rubbery and unpalatable.

To produce the most desirable curd the proper balance must obtain between rennin action and acid development. As much rennet-extract as possible should be used in order to reduce matting to a minimum. The amount to be used will be determined by the



strength of the extract and the cutting acidity selected, and is the amount just below that which causes curd disintegration on stirring.

The temperature to which the curd is heated in the whey governs the firmness and character of the curd resulting from each set of setting and cutting conditions. For skimmilks pasteurized at 145°F. and set at 90°F., desirable firmness is attained usually at from 120-135°F.

A setting temperature of 90°F. was found preferable to one of 70°, since rennin and acid-producing bacteria act faster at the higher degree, and so permit of a shorter making time. Pasteurizing temperatures of 165° and 185°F. yielded a softer curd more prone to shatter and break on stirring, and less easily firmed, than that from skim milk pasteurized at 145°F.

#### *Effect of Pasteurization on Bacteria in Grade-A Milk*

Since the previous report on this project a second study of the efficiency of pasteurization for 74 samples has been made in which a greater efficiency was shown for low-count raw milks than was found in the previous trial. This result was attributed largely to the fact that the packing of the vat agitator which was slightly leaky during the first trial was in good condition during the second trial. It was found possible to destroy by pasteurization at 145°F. for 30 minutes more than 99 percent of the bacteria in the 74 deliveries of low-count milk produced by the station dairy herd under controlled conditions.

Results previously obtained, showing a decided increase in the proportion of acid-forming and a decrease in acid-coagulating organisms, were confirmed.

In further tests of the keeping qualities of high-grade milks before and after pasteurization a tendency was found for the proportions of peptonizing organisms to decrease during a four-day storage period at temperatures ranging from 36° to 56°F. Neither the raw nor pasteurized milks showed marked changes of percentage of acid-coagulating organisms on storage at any of the temperatures used, whereas the percentages of acid-forming bacteria were more variable though exhibiting no definite general trend.

#### ENTOMOLOGY

With the limited staff available for research, work in the field of entomology is necessarily restricted. Projects in progress are of two general types: studies which may have more or less immediate practical value and studies which are of a more fundamental nature and which may be expected to develop practical applications only after more protracted periods. In the latter class must be included the departmental project dealing with the effect of climatic factors on insects. One of the important ultimate objectives in this project

is to determine how to foretell, through knowledge of the development of insects and their natural enemies under different climatic conditions, the probable abundance of injurious species. Long-time studies of hibernation, behavior of insects under different conditions of drouth, excessive moisture, extremes of temperature, and normal conditions may furnish the desired information.

Determination of the most effective time for the application of spray and other treatments for insect control is already accomplished, at least in part, by the utilization of facts obtained through the studies of the temperature relations of insects, and progress seems certain along this particular line.

Projects of a more immediately practical nature are those dealing with the life history and biology of pests attacking the crops of the state. Such a study has been that of the pistol-case bearer and of other orchard insects as well as pests of other crops such as the Mexican bean beetle.

Insect control practices are constantly being modified and improved, either by the development of new methods or by the use of new materials. Studies, particularly of new insecticides which may be of value for our pests, are imperative since local practices and conditions often determine whether materials are suitable or not. Investigations of materials such as the various fluosilicates, pyrethrum products, tar-oil derivatives, and several less important products take up a considerable portion of the time available. The application of insecticides, methods, and accessory materials as adhesives must be considered along with the work on insecticides themselves and is receiving attention. Related work has to do with arsenical residues and with tree-banding materials.

Minor insect outbreaks and means for preventing damage from them must be considered from year to year. Problems of insect distribution, especially that of potentially important species, are correlated with the experimental work.

#### *Adherence and Distribution of Arsenical Residues*

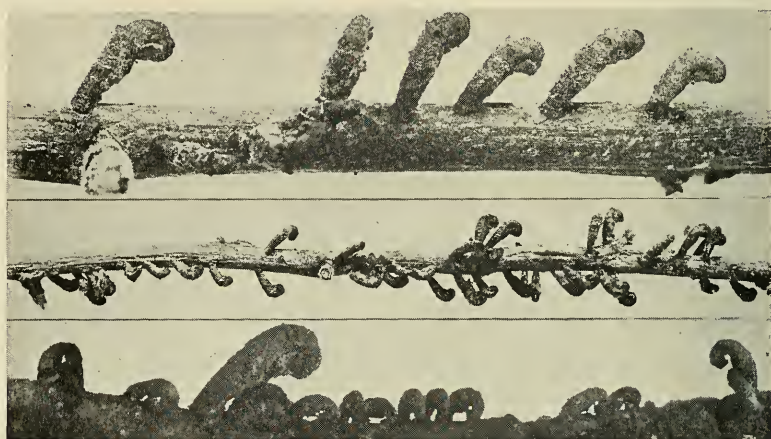
Weather and rainfall have surprisingly little effect on the amount of arsenical residue on fruit in work done at the University Experiment Farm at Kearneysville. Any reduction in the amount of residue per pound of fruit is found to be due to the growth of the apple rather than to loss of arsenic. In the process of growth a certain amount of residue becomes detached and lost, independently of weather conditions, for sheltered fruits show nearly as much loss as those exposed.

Arsenate of lead alone adheres to fruit better than does the same material mixed with bordeaux, lime, "glutrin," "goulac," or "ferro-skim." The only adhesive which increased the residue was fish-oil. Fruit from the lower limbs showed 66% more residue than that from the upper branches.

A definite correlation is seen between the amount of residue in different parts of trees and the infestation of codling moth in those parts.

#### *Pistol-Case Bearer Control*

The pistol-case bearer is an insect which has increased in abundance during recent years to such an extent in certain orchards in the Eastern Panhandle that it may be said to rival the codling moth in potential destructiveness. It has been found very difficult of control; so far the usual spray program, even with modifications of the materials used, has failed.



Various enlargements of a group of cocoons on a twig

A degree of control which at least prevents the increase of the insect in abundance has been obtained by the use of a combination of nicotine sulphate at one part to 800 parts of water with one-half percent penetrol, applied just after the hatching of the eggs in July. The utmost thoroughness in the application of this material is necessary if a satisfactory degree of control is to be obtained. Some of the new tar-oil sprays seem to promise winter control.

It is recommended that special sprays to keep down the numbers of the insects be applied in orchards where it seems to be increasing, even though not yet present in destructive numbers.

Further work in the development of new control methods and materials is in progress. (Bul. 246.)

#### *Control of the Apple Aphids*

Studies looking toward control of the apple aphids, which must be considered among the most important insect pests of this fruit, have dealt with coal-tar products. These have included emulsions of tar-oil distillates prepared by commercial firms, and similar emulsions prepared for the tests with various emulsifying materials, as

well as several coal-tar derivatives. Results indicate that the tar oils, and especially certain fractions thereof, will kill aphid eggs during their dormant season and may thus afford the apple grower a more satisfactory means of control than has hitherto been available. Cresylic acid preparations seem to be the best materials so far developed. However, the higher strengths of the tar-oil emulsions, according to laboratory tests, may retard bud development and even kill the buds. Recommendations must therefore be made with considerable caution.

Laboratory and field tests of the fractions of tar oil show considerable variation in killing power and in their effect on the trees, especially on the developing buds.

Results with the San Jose scale were much less definite than results with aphid studies. It is possible that a combination spray may be required if both insects are to be controlled at one operation.

### *The Weather Factor in Insect Control*

The department for a number of years has carried on investigations concerning the effect of temperature and other climatic factors on the development and behavior of orchard insects. The following new facts have been recorded:

The bean beetle has no fixed hibernating habit, studies made over a period of years would indicate. The insect spreads in search of food and becomes inactive with the advent of cold weather. Extremely cold spring weather following an otherwise mild winter in 1931-1932 maintained beetle mortality around the usual 90% mark.

Rosy aphid may at times remain semi-active on plantain until February or March, when late migration to apple may occur and result in unexpectedly high orchard infestation. Exceedingly high mortality of San Jose scale resulted from severe March freezes in 1932.

Many apple aphids perished from lack of available food at hatching time during erratic weather in early spring of 1932.

Studies of the hibernation of the codling moth lead to the conclusion that temperature records may furnish an index for spraying operations which will be just as reliable as the observations of emergence of moths in cages and at much less trouble and expense.

An unusual outbreak, in the spring of 1932, of the grass webworms of several species is correlated with the high minimum soil temperatures recorded for the preceding winter and suggests that warnings based on soil temperatures of similar range, furnished to the farmers, may be of distinct service in the future.

### *Control Measures for Garden Insects*

Practical control of the Mexican bean beetle seems now to be a problem of education rather than of experiment, since definite measures of control have been developed which are at once effective and economical.



Barium fluosilicate is a valuable addition to the list of poisons as it is slightly quicker in its action than the other fluosilicates. This material and the other fluosilicates used are comparatively non-toxic to man and should replace arsenical sprays when the beans have formed on the vines.

With certain restrictions, pyrethrum is entirely satisfactory. This insecticide is comparatively high in cost, and the fact that it is a contact poison reduces its value where neighboring gardens are left unsprayed.

Three species of common native ladybugs, two stinkbugs, and one assassin bug have been studied in field and laboratory. Indications are that all these may become effective aids in the control of the bean beetle.

### FARM ECONOMICS

The work of the department of Farm Economics is designed to point out weaknesses in organization, management, and marketing as related to agricultural production, with the object of formulating recommendations for changes which will result in greater efficiency and economy.

The investigations of the department during the biennium have consisted chiefly of studies of orchard management, livestock production and marketing, wool and egg production, land utilization, and orchard spraying. Two of the projects are being carried on cooperatively with other states and the U. S. Department of Agriculture. Of these projects only the study of land utilization was begun during the biennium. The adjustment of use of land to climate, soil, and economic conditions in the Huntington area has been undertaken in cooperation with several of the departments of the Experiment Station. Particular attention is being given by this department to returns from farming as practised in the region. The solution of land utilization problems in this area seems to lie in a change in the type of agriculture and farm organization.

West Virginia is essentially a livestock state. Cost data and methods of marketing form the basis of the selection and combination of livestock and crop production. Through cost studies farmers learn how to produce more economically and market more efficiently. An analysis of cost of production and prices received by farmers for livestock grown and marketed in different ways has pointed out the weak and strong points in the handling of livestock. The study of farms on which fine-wool sheep and poultry are important enterprises tends to show the place and outlook for these products on West Virginia farms.

Studies of factors governing the production and marketing of apples in the Eastern Panhandle have been completed. The study in orchard management covering a period of three years which is almost finished will complete the work on the orchard project.

Closely related to this is the study of hydrant spray systems which has been in progress for three years.

#### *Trends in Fine-Wool Sheep Production*

The field work of this project, concerning the status, trends, place, and outlook of the fine-wool sheep industry in the northern part of West Virginia, begun three years ago in cooperation with Pennsylvania, Ohio, and the U. S. Department of Agriculture, should be completed in the fall of 1932. Results of the past two years' records would indicate that fine-wool sheep production has not been very profitable from 1929 to 1932. The low price of wool has materially changed the method of managing the flocks of 38 cooperators. This change is from wethers to more ewes and, in a large number of cases, the raising of cross-bred lambs. This system gives the sheep producer two sources of income — wool and lambs. It increases expenses for feed, but incomes are increased in a much greater proportion.

Flocks having a high weight of fleece, medium amount of grain and roughage, and good management in the way of shelter and treatment, are found the most profitable. Lack of adequate control over stray dogs and lax enforcement of the dog-license tax have resulted in heavy sheep losses and small returns in some flocks. Complete results of the study with recommendations will be published in 1933.

#### *Profits in Poultry Management*

This project was started with 40 poultrymen in the Parkersburg area in February, 1931, with the assistance of the Agricultural Extension Division and the Poultry Producers' Cooperative Association. Results indicate that poultry was one of the most profitable enterprises on these farms in 1931. Improved management methods and better-producing hens have resulted from the marketing and record work being done in this area. Poultry clubs have been organized in two counties. Continued work on records and flock management should help increase poultry flocks and profits.

#### *Land Utilization in the Huntington Area*

A comprehensive investigation of the diversified agriculture of a large section of the state was instituted in the spring of 1932. The Huntington area, comprising the counties of Wayne, Cabell, Putnam, Lincoln, and Mason, was chosen. Five factors were involved in this study, in which practically all departments of the Experiment Station were engaged, as well as the Agricultural Extension Division. These include the physical factor, the organization of the farm as a factor in the return of profits, the status of marketing and of markets, and the human or management factor. About 225 farmers, representing the predominating ten types of farming in the area, are cooperating with the fieldman in keeping

cost account records. In addition, labor income records were obtained from 453 farms.

### *Economic and Social Problems of the Highland Area*

In a comprehensive economic and social study of the Southern Appalachian highland area, begun in 1931, the Experiment Station is cooperating with the U. S. Department of Agriculture and the U. S. Department of the Interior in so far as the highland sections of this state are concerned. Available geographical, statistical, and descriptive material is being utilized to determine the major facts concerning the nature, extent, and importance of the economic and social problems of the West Virginia highland area. The study indicates that a large number of families living in the mountainous area of the state are making very small incomes. Social conditions are anything but good. The question of what can be done to improve both social and economic conditions among these people is receiving careful consideration.

### *Land-Utilization Study of Nicholas and Webster Counties*

The most economic utilization of the land resources of a mountainous state such as West Virginia is one of the major problems confronting the agricultural program of a commonwealth. An investigation was carried out in cooperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture in Nicholas and Webster counties, typical of a large area of the state. One objective was to show which type of land should be used for agriculture and which for forestry, and to point out the conditions which might determine whether land not easily classified as farm land or forest land should be employed for another type of farming or for a different combination of agriculture and forestry. A second objective was to suggest avenues of improvement in the utilization of both farm and forest lands, and the relation of such changes in utilization to the social institutions of the area, particularly the schools and roads. The study with its recommendations is reported in Technical Bulletin 303 of the federal Department.

### *Orchard Management Studies*

A study of orchard management and of the place of orchards in the farm organization in the apple section of eastern West Virginia has revealed that entirely too many varieties of apples are grown in this region and points to several leading varieties which are very promising and from which growers are making good returns. Spraying is being done reasonably well on most orchards and is showing results where properly applied.

There are real possibilities for improving the work in general by proper distribution of labor, eliminating unprofitable varieties, spraying at the proper time, marketing the product soon after harvesting, and by the use of proper equipment for all orchard work.

Orchards can be divided as units, and equipment provided to fit each unit. Methods of financing orchards are not satisfactory. A number of growers are learning the value of economy in performing the various operations at the proper time. A definite operating statement is being worked out for each individual orchard.

### *Grading and Packing Hold Key to Profits*

Many production problems in the apple-growing region of the Cumberland-Shenandoah valleys are still unsolved. A study of one of the more pronounced of these problems, that of marketability, was undertaken during the years 1924-27 by the experiment stations of Pennsylvania, Virginia, and West Virginia in cooperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. It was found that the marketing problem in this region resolves itself into a consideration of the national status of apple production as well as of the most advantageous methods of merchandising the crops grown locally.

There is need for close attention to those points of orchard practice which result in a high percentage of unblemished fruit. Strict and uniform grading and packing are imperative if eastern growers would successfully meet the competition of western apples, which are sold in this region in attractive containers. Storage is recommended as a means of extending the marketing season and so of enhancing the possible returns to the grower. (U. S. D. A. Tech. Bul. 234.)

### *Deep Tillage for Field Crops and Orchards*

Work on a project to determine the value of deep tillage for field and orchard crops, begun in the fall of 1931, is being carried out on the University Experiment Farm at Kearneysville in cooperation with the departments of horticulture, agronomy, and the University Experiment Farm.

Paired plots are being used in the study with potatoes, corn, and alfalfa in a four-year rotation. All plots are in quadruplicate. The effect of deep tillage is being measured by yields and by moisture determinations, the latter being taken at regular intervals throughout the season.

Objectives of the study are to determine the value of deep tillage as it affects crop yields and to ascertain the effect of deep tillage upon the water-holding capacity of the soil.

### *Stationary Spray Systems*

A three-year study of the stationary system of orchard spraying in comparison with the portable system in common use has now been completed, and final data have been assembled for publication. A number of plants operating in West Virginia have been studied to determine the advantage of such factors as capacity of pump, sizes and kinds of pipe, length of lead hose, number in spray crew,

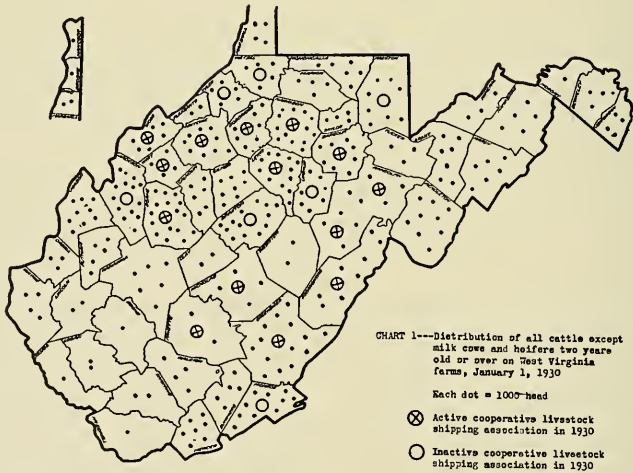


and the like. Detailed costs of power, materials, and labor have been recorded. Because of the wide range of conditions and of management obtaining in the different orchards no general recommendations can be made, but the fruit grower who considers the installation of a stationary system can determine its advantages, costs, and the best management practices from a study of the data. Observations covering two years of the study were published in Bulletin 239 of the Experiment Station, and complete data on recent studies will be available in the near future.

In comparing disease and insect control the stationary system is found to be very efficient in trees from 15 to 20 feet high, but ineffective spraying, especially where codling-moth infestation is severe, may result in the upper parts of taller trees.

### *Cooperative Marketing of Livestock*

To examine the efficiency of cooperative shipping associations in West Virginia as livestock marketing agencies, to evaluate their accomplishments, and to locate factors of inefficiency, the elimination of which would make such associations more effective agencies for marketing livestock, a study was undertaken by the department of such associations in the state operated within the years 1924-29. This study embraced a view of the history of the movement in West Virginia, the plan of organization, the aims, the costs of marketing livestock cooperatively, and a comparison of independent dealers' and cooperative prices. These data are set forth in Bulletin 249 of the Experiment Station.



It is concluded that the marketing costs of the shipping associations were greater than necessary for maximum efficiency. The key to lowering these costs is larger volume and better management. The cooperative has an incentive, not felt by the independent deal-

er, to improve the quality of livestock, for with costs as they are the price received by the producer is dependent upon the terminal market price. The work of the cooperatives in the improvement of this quality is perhaps their greatest achievement. Yet the work, just begun, cannot become fully effective until a larger part of the producers patronize these associations which pay according to quality.

## HOME ECONOMICS

### *The Protective Function of Vitamin A in Infection*

Vitamin A, the anti-infection vitamin, can be present in the diet in considerable amounts without preventing middle-ear infection. Infections of the sublingual gland, however, seem to occur only on diets entirely lacking in vitamin A, according to experiments with white rats.

In the infections characteristic of vitamin-A deficiency the adrenal glands of rats show changes in their content of water and cholesterol which may prove of significance in immunity.

Syrup of ferrous iodide has been found to have no substituting value for vitamin A in preventing loss of weight, xerophthalmia, middle-ear infections, or death in rats on vitamin-A free diets.

### *Histology of Bone Growth in Vitamin Deficiency*

Evidence derived from studies with 20 rats would seem to indicate that the enlargement of the joints generally reported as occurring in rickets may prove to be apparent rather than actual and due to failure of certain phases of normal bone growth. Significant changes are brought about in the bones by additions of even minute traces of vitamin D in the form of irradiated ergosterol which will help to clarify the method by which rickets is healed.

Studies of blood chemistry of a limited number of human subjects indicate that there may be an adult need for vitamin D as important as that necessary to prevent rickets in children, the need to improve calcium-phosphorus metabolism.

### *Uses for Surplus Food Products*

Studies in the economic utilization of surplus food products on the farm have resulted in: I. Determination of the cause of spoilage of vegetables canned by farm women as a sale product in gallon tin cans; II. The working out of an economical and satisfactory method of making blackberry jam for sale through the Home Industries shops of the state and for home use. This investigation has brought out the following practical points for improving the quality of the product and preventing loss through poor results:

1. A simple test for pectin content has been put in the hands of housewives and made to show the correct amount of sugar to be added to blackberry jelly or jam for maximum yield and best consistency without waste.

2. The commercial practice of cooking jelly and jam by weight has been adapted to home use for blackberries, and a table of weights has been worked out for the ordinary quantities used. This has proved simpler to use and more uniform in result than cooking jelly or jam to temperature as first recommended.

III. Improvement in the method of making cherry preserves along lines similar to those used under No. II (above).

#### HORTICULTURE

Research with horticultural crops at the Experiment Station has a twofold aim: first, the testing of new crops, new varieties, and variety strains of fruits and vegetables to determine their adaptability to the diverse conditions of soil and climate found in West Virginia. Among the new fruit crops being studied are pecans and Persian walnuts, among the vegetables broccoli and Chinese cabbage. Hundreds of new varieties of fruits and vegetables also are being tested. Variety strains among such vegetables as tomatoes, cabbage, and potatoes are often more distinct than the varieties themselves, especially as regards earliness, quality, and productivity. Many are being grown at the Lakin Experiment Farm to find out which are best for that trucking region. Much attention is being given to color sports of our standard varieties of apples, as they seem destined to supplant the varieties from which they have sprung.



An apple orchard in bloom

The second aim of research in this department is the determination of the cultural and fertilizer requirements of the various horticultural crops to the end that a quality product be produced as economically as possible. A few of the important investigations along this line may be mentioned. Various nitrogen fertilizers are being studied to determine which is the best and most economical for the orchardist to use, and their effect on the keeping quality of the fruit



produced. The building up and maintenance of fertility in the orchard and truck garden is of great importance particularly on the shale soils of the Eastern Panhandle and on the sandy bottoms of the Ohio river. In the study of this problem the crop rotations most adapted to the region are being investigated as well as different kinds of cover crops, all with and without different types and amounts of fertilizer. The thinning of fruits markedly affects their quality. With the growing demand for a high-quality product come problems such as time and severity of thinning for the standard commercial varieties of apple and peach. Studies are being pursued to throw light on these questions.

#### *Pollenizers for Northwestern and Rome*

In a continuation of apple pollination studies the varieties Northwestern and Rome were found to be practically self-sterile. Pollen from Starking, Red Rome, Lowry, York, Jonathan, and Delicious gave good sets on Northwestern, while King David, Northwestern, Golden Delicious, Jonathan, Starking, and Lowry proved to be good pollenizers for Rome. Red Rome also gave a poor set on Rome.

#### *Apple Storage as Affected by Nitrate and Maturity*

Data obtained in Eastern Panhandle orchards indicate that the increase in the amount of scald from nitrogen fertilization probably is due largely to delayed maturity of the nitrated fruit rather than to the presence of more nitrogen in the apple. Yorks picked on Oct. 6, about a week before the peak of commercial harvest, scalded severely regardless of whether the trees had been nitrated or not. Fruit picked a week later (October 14) showed very much less scald, although it was still high in the fruit from nitrated trees. In fruit picked October 21 (a week later than the peak of commercial harvest) there was still further decrease in scald, the fruit picked from nitrated trees at this time developing less scald than fruit from check trees picked two weeks earlier, although the nitrated fruit was still rather green in color. It is important, therefore, that harvesting of scald susceptible varieties such as York, Grimes, Black Twig, etc., be delayed as long as possible, and especially so in nitrated trees.

TABLE 4—Scald development of apples in storage experiment, 1931-32, with York Imperial (5 trees in each treatment)

Treatment	Date picked	Total no. apples	No. sound	No. scalded	Percent scalded
Check—without oiled paper	Oct. 6	562	98	464	83
Nitrated—without oiled paper	Oct. 6	494	75	419	85
Check—without oiled paper	Oct. 14	564	262	302	54
Nitrated—without oiled paper	Oct. 14	397	111	286	72
Check—without oiled paper	Oct. 21	341	230	111	33
Nitrated—without oiled paper	Oct. 21	680	322	358	53
Check—with oiled paper	Oct. 14	739	611	128	17
Nitrated—with oiled paper	Oct. 14	658	513	145	22

The data, taken eight months after the fruit was picked, are given in Table 4. The marked reduction in scald as a result of using



shredded oil paper — from 54% to 17% in fruit from check trees without nitrogen, and from 72% to 22% in fruit from the fertilized trees, may also be noted.

#### *Nitrogen Sources for Apple Trees*

Four fertilizer experiments comparing nitrate of soda and sulphate of ammonia with apple trees were conducted between 1922 and 1927 in different apple-growing sections of the state. In Pleasants county early applications of both fertilizers on 32-year-old Rome trees were found superior to those made at bloom. Nitrate excelled sulphate when both were applied at bloom. Nitrate also proved superior in both growth and fruitfulness on 9-year-old Jonathan trees in Berkeley county fertilized at bloom. In Jefferson county in a 25-year-old Black Twig orchard no differences in growth of trees were observed between the two fertilizers when applied two to three weeks before bloom, but significant differences in yield were obtained in favor of sulphate of ammonia.

It is concluded that the choice between the two fertilizers should be determined by their relative cost in terms of nitrogen units. To insure full value from sulphate of ammonia it should be applied at least two weeks before bloom and should be worked into the soil where early cultivation is being practiced. It should be borne in mind also that eventually lime must be applied to correct the acidity of sulphate particularly if legume cover crops are grown. (Bul. 252.)

#### *Cover Crops for Apple Orchards*

Tests were begun in 1927 in a commercial apple orchard at Paw Paw of clean cultivation, alfalfa, sweet clover, and mixed-grass sod. Additional nitrogen has been added to trees in all plots. Results to date as measured by growth and yield indicate that sweet clover and alfalfa are best.

#### *Good Culture Prevents Winter Injury in Peach*

Great losses result annually by freezing injury to the fruit buds of peach, plum, apple, cherry, and other fruit trees. The peach is particularly subject to damage by freezing and it is not uncommon to lose a season's crop because of death of the fruit buds by low temperatures. Besides, the floral organs may be killed by freezing temperatures when the trees are in flower.

The killing of fruit buds during the dormant period varies with the variety. Experiments were conducted over a three-year period on the influences of cultural practices and other treatments on the hardiness of two varieties of peach tree — Salwey and Greensboro. The results of these studies suggest some procedures that should be followed in peach-orchard management in order to obtain the maximum resistance of the buds to winter injury. Since the greatest degree of hardiness was found in cases with the greatest storage of food reserves, it follows that a large and healthy leaf area should be maintained late into the fall. This can

be accomplished by judicious cultivation, pruning, applications of nitrogen, and the adequate control of insects and disease.

Cultivation or the application of nitrogen-carrying fertilizers should be made early in the spring to stimulate a quick growth of the trees and to produce a thrifty leaf area. The trees should be pruned in the dormant season and this should be of such moderate severity as to regulate the bearing area without producing a vegetative condition of the trees. Over-bearing of the trees should be avoided by proper thinning of the fruit. (Bul. 236.)



A view of the sour-cherry pruning block

#### *Moderate Pruning for Early Growth and Yield of Cherries*

In recent years considerable interest has been taken in the production of sour cherries for canning purposes in the Eastern Panhandle. In order to study the relations of pruning to the growth and yield of sour-cherry trees an experiment was undertaken at Morgantown in which varying degrees of dormant and summer pruning were employed. (Bul. 240.)

The conclusions derived from the experiment show clearly the severe dwarfing effect of summer pruning and heavier-than-corrective dormant pruning on tree growth. Such reduction in tree growth as well as in yield of fruit following summer pruning apparently is due to the removal of the leaves before they have made their contribution to the food supply of the tree. The circumstance would emphasize the great importance of maintaining during the summer and early fall the maximum area of leaves capable of functioning photosynthetically.

Young correctively pruned sour-cherry trees make more shoot growth and larger gains in trunk diameter, come into bearing earlier, and produce heavier crops than similar trees more severely pruned.

A new series of treatments of Montmorency cherry trees, involving four degrees of severity in pruning young trees, has been begun on the University Experiment Farm at Kearneysville.

A training experiment on newly-planted trees of four varieties of apples has for its object a comparison of debudding with standard practices of starting the young tree.

## *Seed Potatoes Can be Grown in West Virginia*

In order to determine the feasibility of seed-potato production in certain of the upland areas of West Virginia, seventeen trials were carried on during three years at four altitudes in the state and at two latitudes outside the state — at the Kentucky and Minnesota Experiment Stations — in which the yields of two native strains of Smooth Rural seed potatoes and a recommended strain of the same variety from the North were compared. (Bul. 242.)

The native strains equaled or bettered the northern strain in yield in the plantings made in West Virginia. The altitude at which the trials were run usually determined which of the native strains proved superior. Usually the high-altitude and northern-grown stock gave higher yields at the higher altitudes, even as did the low-altitude strain in trials at the lower altitudes.

It is concluded that it is feasible to produce seed potatoes in the medium and probably the high altitudes of the state.

### *Normal Storage Best for Potato Seed*

No difference has been discerned in respiration studies of Rural seed with normally-stored stock and stock greened in the fall, but plantings at Reedsville have shown the normally-stored tubers to be superior as seedstock to either fall-greened or sun-sprouted stocks. Experiments with Cobblers show that warming the seed gives quicker come-up and more vigorous young plants, but results in no differences in yield.

### *Better Varieties of Vegetables*

A series of field trials with several vegetables at the Lakin Experiment Farm shows, among early varieties of sweet corn, Vanguard as a vigorous, heavy yielder with large, white, well-filled ears of good quality. It is moderately early and perhaps more resistant to bacterial wilt of corn than any other variety tried. Whipples Early Yellow, Whipples Early White, and Extra Early Bantam are other high-yielding and early varieties.

John Baer, Penn State Earliana, Bonny Best, and President proved to be desirable varieties of early tomatoes. Break-O-Day, a new variety, shows every advantage except susceptibility to sunscald, a result of its branching habit of growth.

Among early beet varieties the following proved superior: Early Wonder, Crosby's Egyptian, Extra Early Egyptian, Improved Early Egyptian, Eclipse, and Detroit Dark Red. Early Wonder is particularly of value for canning because of solid red color and earliness. These strains were high in quality and of uniform appearance.

Early cabbage strains of particular promise are Golden Acre, Copenhagen Market, New Early Krop, and Early Market.

Particularly adapted for early bunching purposes among carrots are Danvers Half Long, Early Chantenay, Red-Cored Chantenay, Orange Danvers, and Oxheart.

Among eggplants Black Beauty, New York, and Excelsior compared closely, and Ruby King and California Wonder varieties of pepper seemed to do best. Bender's Surprise proved superior in many respects to Tip Top, a standard muskmelon variety.

#### *Paper Mulch Has Decided Limitations*

At Morgantown mulching as compared with clean culture has resulted in earlier yields of eggplant, greater suckering of sweet corn, greater yields of marketable beets and carrots, and greater number and total yield of tomatoes, peppers, and eggplants. These increases, however, were so markedly reduced by the increased occurrence of sunscald, soft rots, blossom-end rots, etc., that no marked influence was noted on the number and weights of marketable fruits. With nearly all vegetables used, mulch paper gave greater plant growth.

The comparison of black and white papers with the pepper showed no significant differences, although white paper appeared to be more beneficial. Black paper treatment resulted in more sunscald and tissue breakdown.

Soil moisture studies showed the amount of water to be greatest under the mulch at nearly all times during the season.

Hydrogen-ion concentration and the amount of nitrate nitrogen in the soil were apparently not influenced by the mulch paper.

Temperatures were higher under the mulch; there was a considerable time lag as compared with the air temperatures. The temperatures were higher by a few degrees under the black paper than under the white.

At Lakin the mulch had little effect on beets, proved detrimental to early cabbage and eggplant, and slightly increased the yields of marketable peppers and staked tomatoes, although it significantly increased the number of fruits affected with blossom-end rot. Mulch produced more suckering on sweet corn.

White paper proved to be better than black paper on peppers, although the differences were slight. Black paper resulted in a small increase in the amount of sunscald. These results are in line with those obtained at Morgantown, although the differences are less marked.

The results indicate that there is some doubt as to the practicability in the use of mulch paper for any of the crops used in these studies under West Virginia conditions.

#### *Deep Tillage and Explosives for Orchard Soils*

The possibilities of making orchard soils more productive by dynamiting the subsoil are being investigated at Morgantown and on a commercial orchard at Romney. Small charges of dynamite are placed 2 to 3 feet below the soil surface, a few feet from the base of the apple trees, and exploded to loosen the subsoil. In other orchards the subsoil is broken up by means of a subsoiler,



which bears a long tooth capable of breaking up the soil to a depth of 18 to 20 inches.

Trees on thin soils suffer severely in periods of drought because their roots cannot penetrate deeply enough to reach the moisture. The value of deep tillage will be determined by measuring comparative results on the basis of trunk circumference growth as well as twig growth and by yield and size of fruit of treated and untreated trees. A phase of the experiment concerns the effect of deep tillage on a rotation of alfalfa, corn, and potatoes.

#### PLANT PATHOLOGY

As agriculture becomes more intensive the diseases of plants and animals become more important. Fruit and vegetables were grown successfully without spraying or other protection a few generations ago, but today apples must be sprayed systematically and thoroughly in order to obtain any high-grade fruit. The diseases of potatoes have become so serious that at this time they are the most important single factor in potato production. This situation is developing with other crops of the field, garden, and forest to such an extent that it has been predicted that the most serious problem of the future agriculturist is that of controlling parasites.

The aims of the department of Plant Pathology are twofold: to study the diseases of West Virginia crops and plants, and to make public the information thus gained as well as pertinent information received from investigators in other institutions within our borders or in other states and countries.

The department is well equipped and supplied for all phases of investigations in which it is now engaged. The chief problems now engaging the staff are those dealing with the diseases of apples, truck and field crops, and tree diseases. These investigations have been assisted materially by facilities provided at the University Experiment Farm, Kearneysville, Reymann Memorial Farms, Wardensville, Lakin Experiment Farm, and in numerous private orchards throughout the state.

Some nineteen bulletins of the Experiment Station dealing with plant diseases have been published in full or in part by members of the staff. In addition nine circulars of the station and two circulars of the Extension Division have been issued as well as 20 technical articles in scientific periodicals.

#### *Studies of the Watermelon-Wilt Fungus*

The breeding phases of this problem are being conducted in cooperation with the department of Agronomy and Genetics. Extensive field tests are being made with crosses between the resistant Russian and two commercial varieties of watermelon grown in the Ohio valley.

The pathogenicity of the 23 isolants of *Fusarium niveum* from different localities of the United States varied with the resistance

of the suscept, but all of the varieties and hybrids tested were found to be somewhat susceptible to the most virulent isolants of the wilt organism.

From wilted plants growing in separate boxes of soil infested with individual isolants, dissociants were recovered which in two cases (isolants #11 and #16) were identical with dissociants obtained in petri-dish cultures of these same isolants. Dissociation therefore can take place in the soil and presumably is a common phenomenon with this organism in nature.

Cuttings of melon seedlings placed in a filtrate of *F. niveum* wilted in eight hours under laboratory conditions, but when such cuttings in the filtrate were placed under a bell jar no wilting occurred in 72 hours. This indicates that the wilting effect probably is not caused by a toxin of the parasite.

TABLE 5—*The pathogenicity of various isolants of Fusarium niveum\**

Isolant	Number of plants	Number of plants wilted	Percentage of plants wilted
1	396	353	89
2	311	143	46
3	287	276	96
4	392	345	88
5	330	122	37
6	307	273	89
7	274	127	45
8	309	272	88
9	272	62	23
10	335	7	2
11	297	291	98
12	278	8	3
13	328	0	0
14	322	0	0
15	321	0	0
16	320	266	83
17	315	3	1
18	302	0	0
19	326	0	0
20	331	331	100
21	297	0	0
22	320	0	0
23	321	247	77
Check	315	0	0

\*Plants approximately 21 days old and grown in infected flats in greenhouse.

### *Spray Materials for Apple Disease Control*

Striking differences in the quality of the finish of apple fruit were noted from the application of different fungicides to be used as substitutes for lime sulphur, which under certain weather conditions causes severe burning of both leaf and fruit. In the order of excellence of finish the fungicides tested ranked as follows: dry-lime sulphur, calmosul, flotation sulphur, lime sulphur.

Suspension tests of 30 formulae indicate that instant Bordeaux prepared from superfine chemical hydrate and pulverized copper sulphate, properly combined, gives a higher suspension than Bordeaux prepared from the finest grade of pebble lime obtainable. Concentrations lower than 2-4-50, the formula in general orchard use, have been found toxic to bitter-rot spores.

## *Fruit Spots of the Apple*

In 1930 an investigation was begun on Brooks Fruit Spot and similar diseases of the apple. An examination of overwintered apple leaves in several orchards revealed an abundance of *Mycosphaerella pomi*, the perfect stage of *Cylindrosporium pomi*. No evidence was found that the perfect stage is present on the fallen leaves of any unrelated genera and species of trees.

A series of inoculations was made on mature fruits of 12 varieties during the fall of 1931. Grimes varieties were found most susceptible to infection by two species of *Penicillium* and an *Alternaria*, with Delicious, Golden Delicious, McIntosh, Wealthy, and Jonathan next in susceptibility. York, Stayman, Winesap, and Baldwin were the most resistant.

## *The Cause of Apple Measles*

Discovery of the cause of the papular type of apple measles has definitely been verified. Successful artificial inoculations have been obtained on young Red Astrachan trees in the greenhouse during the winter of 1930-31, and the fungus was readily reisolated from the lesions produced. The fungus has been identified as a Hyphomycete showing affiliation with the genus *Endophragmia*, which bears cup-like membranes at the nodes of the conidiophores.

A survey of the important apple-growing sections of the state has disclosed that a second type of measles known as the "blister type" and peculiar to the Delicious and related varieties is becoming more important each year and is causing considerable concern to growers who have planted these varieties. Young plantings have shown a higher percentage of infected trees than old plantings. A third type of measles, characterized by producing very numerous pimples, smaller than those in either of the other two types, has been found to be fairly common on York, Jonathan, and Rome.

## *Collar Rot of Apple Trees*

In an investigation of the Grimes collar rot and similar diseases of the trunk, collar, and roots of apple trees, grafting work has been completed with Grimes scions on three different stocks: French crab, Vermont crab, and Grimes stocks. These trees will be used this coming year for experiments with low temperatures under controlled conditions.

The other phase of the problem has to do with survey and isolations from diseased roots and crowns. A number of cases of *Xylaria* root rot have been found in the eastern part of the state and half a dozen cultures of these obtained. Every culture from different sources is different in appearance. All produce fructifications but without maturing perithecia in culture.

Several basidiomycetes have also been isolated, one of which, an agaric, produces very small sporocarps in pure culture. It is planned

to use all of these organisms for inoculation studies beginning in the fall of 1932.

### *Apple Rust*

Much time has been devoted to grafting scions from resistant and susceptible red cedars on red-cedar and Biota seedling stocks. It appears that Biota is preferable to red cedar because it develops callus tissue rapidly, and consequently the graft union is more likely to succeed. More than 100 such grafts of both resistant and susceptible red cedars will be exposed for rust infection to determine their susceptibility or resistance.

The phase of the study that dealt with the susceptibility of apple varieties to rust has been concluded. Sixty-six commercial varieties were included in the test orchard, and data on rust infection have been recorded for a number of years. Marked differences exist, some of the varieties being practically immune and hence suitable for planting in localities where cedar removal is impracticable.

### *Black-Walnut Canker*

It has been established by survey methods that black-walnut canker, a disease of recent discovery, is present in 28 counties in West Virginia. It has also been found in Pennsylvania, Rhode Island, North Carolina, Ohio, Tennessee, Virginia, Wisconsin, and Ontario.

Inoculation experiments have established the causal organism as a *Nectria*, closely related to *N. galligena* Pres. as delineated by Wollenweber. A similar canker has been found on butternut, but the *Nectria* causing this disease does not infect black walnut but does infect certain exotic species of *Juglans*. Neither does the *Nectria* from black walnut infect butternut or black oak, which is another host for a very similar *Nectria* canker.

### *Miscellaneous Disease Studies*

Typical catface  
caused by canker

A considerable number of attempts to isolate the organism primarily concerned with "frog-eye" leaf spot of apple resulted in obtaining a number of bacteria and fungi, among which *Sphaeropsis malorum* was most commonly found. Repeated attempts to infect leaves of young apple trees in the greenhouse resulted in failures in every case but one, in which typical small tan spots resulted from inoculation with *Sphaeropsis*.

Studies on internal therapy with plants have involved the use of one inorganic and three organic mercury compounds in attempts to inactivate the virus of mosaic of tobacco in the expressed juice of



diseased plants. Critical amounts which inactivated the virus were determined for uspulun, resorcin mercury, and nitro-phenol mercury, all organic compounds, as well as for inorganic mercuric chloride. Injections of organic mercury compounds into healthy plants before inoculation with mosaic virus increased the incubation period about twice that for normal plants not injected.

A high degree of variation in susceptibility to soft rot caused by *Bacillus carotovorus* and related organisms has been found among different varieties and between individuals of the same variety in a number of vegetables, notably cabbage, carrots, parsnips, and turnips. Serological and physiological studies have been instituted to aid in demonstrating the relationship between the various strains of soft-rot bacteria as well as certain organisms of the colon group.

Physiological investigations have also been continued with the genus *Phytophthora*, looking toward evolving a true species concept among the many "species" of this genus.

#### POULTRY HUSBANDRY

The program of Poultry Research in the past has covered a varied field, beginning about 35 years ago. At first the work was devoted largely to economic problems bearing on management of the flock and principally on feeding problems. In later years work relating more to scientific problems has been undertaken. At present the research department is devoting its tasks to three main projects. First, a continuation of the project investigating the factors affecting egg production, with the aim to determine whether the factors which determine the number of eggs laid are correlated with the fluctuations in egg weight. Second, a study of the regularity of laying within the cycle during the pullet year. It seems probable that the time intervals in laying from one egg to another within the cycles are so closely correlated with the processes of egg formation that the average length of these intervals may be used as a more convenient and shorter method of determining the potential fecundity of a laying flock. The third project is an investigation of the best temperature to use in incubating hen eggs in incubators of the cabinet type, in which the air is maintained by electric fans at a uniform temperature throughout the incubating chamber.

#### *Factors Affecting the Weight of Hen Eggs*

The sixth year was completed with 109 birds surviving out of the original 200, 21 birds having died during the year. The fifth and sixth years have shown the highest mortality rate, being 15 percent and 14 percent, respectively.

The average egg production decreased from 76 eggs in the fifth year to 59 in the sixth. This decrease, due to senescence, was 22 percent, a figure comparable with the decrease during the first three years of production.

No reduction was observed in the average egg weight as com-

pared with the former year, the weight remaining at 54.4 grams. Little change has been observed in the egg weight since the third year, at which time the maximum was reached.

From the fifth to the sixth year the total weight of eggs laid showed a decrease of 35 percent, an increased reduction of four percent as compared with the decrease between the fourth and fifth year.

Coinciding with decreased egg production was the decrease in average annual feed consumption per bird from 61 lbs. to 58 lbs.

A slight increase in average body for the flock was shown. This characteristic has deviated very little in the past three years.

Egg production apparently has no effect on mortality.

### *Interval as an Index of Annual Production*

For estimating annual production the time interval within the cycle, even when short periods are used, has been found more reliable than winter production.

The variability in egg production has been reduced 20 percent in two years and the egg size has been materially increased, as compared with the parent stock. The rate of mortality has been unusually low. Line breeding is being used to produce a more homozygous flock of birds in respect to fecundity.

The relationship between the four months' winter production and annual production has been determined, revealing a significant positive correlation of  $+.60 \pm .05$ . From this value, 36 percent of the variability in annual production can be accounted for by winter production. A slightly lower value was obtained when winter production for three months was correlated with annual production. A negative correlation of  $-.67 \pm .04$  between the mean time interval within the cycle for March and April and annual production accounted for 45 percent of the variability in annual production.

TABLE 6—*Weight of embryos under different frequencies of turning*

Times turned daily	Weight of embryos in grams					
	4th Day	7th Day	10th Day	13th Day	16th Day	19th Day
Turned 6 times	.0743	.8445	2.8295	7.8192	17.5373	29.8743
Turned 2 times	.0507	.7035	2.6246	7.6330	16.7288	27.7255
Difference	.0236	.1410	.2049	.1862	.8085	2.1488
Odds	0:1	262:1	525:1	2.75:1	6.24:1	17.8:1

### *Frequency of Turning Eggs during Hatching*

This project has been reorganized to include studies on the effect of frequency of turning eggs during hatching. As shown in Table 6, a consistent difference is revealed between the average weight of nine embryos which had been turned six times daily and the average weight of nine embryos turned twice daily. However, the odds are significant for only the 7th and 10th days. These trials are being continued.

## 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

### AGRONOMY AND GENETICS

- R. J. Garber, Ph. D.  
Agronomist and Geneticist
- W. H. Pierre, Ph. D.  
Associate Agronomist
- M. M. Hoover, Ph. D.  
Associate Agronomist
- T. C. McIlvaine, Ph. D.\*†  
Assistant Agronomist
- G. G. Pohlman, Ph. D.  
Assistant Agronomist
- H. K. Rowley, M. S. Agr.\*\*  
Seed Analyst
- L. S. Bennett, M. S.  
Graduate Assistant
- A. D. Stuart, B. S.  
Graduate Assistant
- R. R. Robinson, B. S.  
Graduate Assistant
- M. H. Snyder, B. S.  
Graduate Assistant

### ANIMAL HUSBANDRY

- E. A. Livesay, D. Sc.  
Animal Husbandman
- C. V. Wilson, M. S.  
Assistant Animal Husbandman
- J. H. Longwell, M. A.  
Assistant Animal Husbandman
- R. H. Tuckwiller, B. S. Agr.\*  
Assistant Animal Husbandman
- J. H. Rietz, D. V. M.\*\*  
Associate Veterinarian
- E. N. Moore, D. V. M.\*\*  
Assistant Veterinarian
- J. A. Beall, M. S.  
Graduate Assistant

### CHEMISTRY

- R. B. Dustman, Ph. D.  
Agricultural Chemist
- C. E. Weakley, Jr., M. A.  
Assistant Chemist
- T. B. Leith, M. S.\*\*  
Assistant Chemist
- I. J. Duncan, B. S.  
Assistant
- A. H. Van Landingham, M. S.  
Assistant

### DAIRY HUSBANDRY

- H. O. Henderson, Ph. D.  
Dairy Husbandman
- L. M. Thurston, Ph. D.  
Associate Dairy Husbandman
- G. A. Bowling, M. S.  
Assistant Dairy Husbandman
- R. A. Ackerman, M. S.‡  
Assistant Dairy Husbandman

- J. L. Barnhart, M. S.  
Graduate Assistant
  - C. E. Teague, M. S.  
Graduate Assistant
- ### ENTOMOLOGY
- L. M. Peairs, Ph. D.  
Entomologist
  - W. E. Rumsey, B. S.\*\*  
State Entomologist
  - Edwin Gould, B. S. Agr.  
Assistant

### FARM ECONOMICS

- A. J. Dadisman, Ph. D.  
Farm Economist
- W. W. Armentrout, Ph. D.  
Associate Farm Economist
- F. D. Cornell, Jr., M. S.  
Assistant Farm Mechanician
- R. O. Stelzer, M. S.  
Assistant

### HOME ECONOMICS

- Rachel H. Colwell, M. A.  
Home Economist
- Hazel C. Cameron, M. A.  
Research Specialist in Nutrition

### HORTICULTURE

- H. E. Knowlton, Ph. D.  
Horticulturist
- K. C. Westover, M. S.  
Assistant Horticulturist
- Leif Verner, M. S.  
Assistant Horticulturist
- E. N. McCubbin, M. A.  
Assistant
- A. P. Dye, M. S. Agr.  
Assistant

- W. H. Childs, M. S.  
Assistant

- A. L. Keller, B. S.  
Graduate Assistant

### PLANT PATHOLOGY

- C. R. Orton, Ph. D.  
Plant Pathologist
- Anthony Berg, M. S.  
Associate Plant Pathologist
- L. H. Leonian, Ph. D.  
Associate Plant Pathologist
- F. J. Schneiderhan, M. S.††  
Associate Plant Pathologist
- A. R. Stanley, M. S.  
Graduate Assistant
- W. D. Henry, M. S.  
Graduate Assistant

### POULTRY HUSBANDRY

- T. B. Clark, B. S. Agr.  
Assistant

\*In cooperation with the U. S. Department of Agriculture, Washington, D. C.

\*\*In cooperation with the State Department of Agriculture, Charleston, W. Va.

†In charge of the Lakin Experiment Farm, Lakin, W. Va.

‡In charge of the Reymann Memorial Farms, Wardsenville, W. Va.

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

## STAFF CHANGES

New appointments to the research staff during the biennium include the following: G. A. Bowling, assistant dairy husbandman; W. H. Childs, assistant in horticulture; E. N. Moore, assistant veterinarian; G. G. Pohlman, assistant agronomist; A. H. Van Landingham, assistant in agricultural chemistry; and Leif Verner, assistant horticulturist.

Resignations during the same period include the following: Horace Atwood (retired as professor emeritus of poultry husbandry); C. H. Bruce, assistant in farm economics; R. S. Glasscock, assistant in veterinary science; L. P. Hansen, assistant agricultural chemist; M. B. Hoffman, assistant in horticulture; K. S. Morrow, assistant dairy husbandman; and L. F. Sutton, assistant dairy husbandman.

## LIST OF CURRENT PROJECTS

### AGRONOMY AND GENETICS

Oat investigations (CE 6)  
Soybean investigations (CE 7)  
Oat smut (CE 8; coop. Plant Pathology)  
Cover crop experiments (CE 9; coop. Dairy Husbandry)  
Pasture fertilization studies (CE 10; coop. Dairy Husb. and U. S. D. A.)  
Crop rotation experiments (CE 11)  
The availability of phosphorus compounds (CE 12)  
Effect of soybeans on crops that follow (CE 13)  
Alfalfa investigations (CE 38)  
Sweet clover investigations (CE 40; coop. Agricultural Chemistry)  
Crop responses to various fertilizers (CE 44; coop. Horticulture)  
Breeding tobacco for resistance to root rot and high yield (P 1; coop. U. S. D. A.)  
Soil acidity and plant growth (P 2; coop. Agricultural Chemistry)  
Wheat investigations (H 1)  
Corn investigations (H 2)

### ANIMAL HUSBANDRY

Methods of finishing two-year-old steers on grass and grain (CE 14)  
Forage crops and winter rations for swine (CE 15)  
The control of infectious abortion (*Brucella abortus* infection) in cows by herd management and testing (CE 23; coop. Dairy Husbandry)  
A study of the factors involved in individual vs. group feeding of growing, fattening pigs (CE 42)

Relation of round worm (*Ascaris lumbricoides*) infestation and vitamin-A deficiency in pigs (P 4)  
Breed as a factor in sheep production and quality of products produced (P 5; coop. U. S. D. A.)  
Investigations concerning treatment for stomach and lung worms in sheep and cattle (P 6)  
Herd management for the production of slaughter and feeder calves (P 7; coop. U. S. D. A.)

### CHEMISTRY (AGRICULTURAL)

Miscellaneous chemical investigations (CE 5)  
A study of variability in composition of different skeletal parts of experimental animals (CE 20)  
A study of the pigmentation and ripening of fruits (A 3)

### DAIRY HUSBANDRY

The continued use of proven sires (CE 16; coop. U. S. D. A.)  
A study of the different varieties of pasture for milk production (CE 18; coop. Agronomy)  
Cost of raising dairy heifers in West Virginia (CE 20)  
A growth study with Ayshire cattle (CE 21)  
A comparative study of the microflora of raw and pasteurized grade-A milk (CE 22)  
A study of the manufacture of sweet-curd, rennet-coagulated cottage cheese (CE 39)



- A study of the water consumption of dairy animals (CE 41)
- The effect of low-calcium and low-phosphorus rations on growing dairy heifers (P 8; coop. Agricultural Chemistry)
- Constituents of milk that contribute to flavor of dairy products (P 23)
- Causes for poor quality of cream transported in less than carlots (P 24)
- A comparison of alfalfa and timothy hay with and without corn silage for dairy cattle (P 25)

### ENTOMOLOGY

- Miscellaneous entomological investigations (CE 24)
- Orchard insects (CE 25)
- The biology and control of the apple-infesting aphids (P 9)
- The biology and control of the pistachio case bearer (P 10)
- Dusts and sprays for the control of garden insects (H 3)
- Relation of temperature to insect life (A 1)

### FARM ECONOMICS

- Deep tillage studies with field, truck, and orchard crops (CE 19; coop. Agronomy, Horticulture, and University Experiment Farm)
- Practical farm building plans for West Virginia (CE 27)
- Poultry as a farm enterprise (CE 28)
- The status, trends, place, and outlook of the fine-wool sheep industry in the northern part of West Virginia (CE 29; coop. Extension Division)
- A study of the economic and social problems and conditions of the West Virginia highland area (P 3; coop. U. S. D. A. & U. S. Dept. of Interior)
- Costs, methods, and practices of marketing livestock (P 11; coop. U. S. D. A.)
- A study of orchard management and of the place of orchards in the farm organization of the apple section of eastern West Virginia (P 12; coop. U. S. D. A., Pennsylvania, and Virginia)
- A study of the costs, efficiency, and management of hydrant orchard spraying systems in West Virginia (P 13; coop. Plant Pathology)

### HOME ECONOMICS

- 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 (P 15; coop. Agricultural Chemistry)
- Histology and bone growth in vitamin-deficient animals (P 26)

### HORTICULTURE

- Training and pruning of fruit trees (CE 30)
- Potato investigations (CE 31)
- Miscellaneous horticultural investigations (CE 32)
- The improvement of root stocks for apple trees (P 16)
- Studies on the storage qualities of fruits of the apple as affected by culture and the fertilizer treatment given the orchard (P 17)
- Paper mulches vs. clean culture for vegetable crops (P 22)
- Variety tests of fruit trees (H 4)
- Cultural treatments and fertilizers for fruits (H 5)
- Variety and strain studies of vegetables (H 8)
- Sterility studies with the apple (A 2)
- Hardiness studies of the fruit buds of peach (A 4; coop. Agricultural Chemistry)

### PLANT PATHOLOGY

- Black-walnut canker (CE 33)
- Miscellaneous plant pathology investigations (CE 34)
- Fruit spots of the apple (P 14)
- Fusarium wilt of watermelon (P 18; coop. Agronomy and Genetics)
- A study of apple "measles" (P 19)
- Collor rot of apple trees (P 21)
- Dusting and spraying for the control of diseases (H 7)
- Apple Rust (A 5)
- The effect of environment upon morphology and parasitism in fungi (A 6)

### POULTRY HUSBANDRY

- A study of the proper incubating temperature for eggs of the domestic fowl in incubators of the cabinet type (CE 37)
- Factors affecting the weight of hen eggs (A 7)
- Time factor in egg production (A 8)

## PUBLICATIONS OF THE BIENNIUM, 1930-32

### BULLETINS AND CIRCULARS OF THE EXPERIMENT STATION

- Bul. 236. Physiological investigations on the resistance of fruit buds to freezing temperatures. H. L. Crane. Technical. 80 pp. Aug. 1930. (Out of print.)
- Bul. 237. Varietal experiments with wheat, oats, barley, rye, and buckwheat. M. M. Hoover and R. J. Garber. General. 12 pp. Oct. 1930.
- Bul. 238. The West Virginia community packing house at Inwood as a state service to apple growing. F. J. Schneiderhan. General. 24 pp. Nov. 1930. (Out of print.)
- Bul. 239. Stationary spray systems in West Virginia. F. D. Cornell. General. 28 pages. Jan. 1931.
- Bul. 240. Effects of pruning on growth and yield of cherry trees. H. L. Crane. Technical. 20 pp. Mar. 1931.
- Bul. 241. Four-H clubwork in West Virginia. T. L. Harris. General. 36 pp. April, 1931.
- Bul. 242. Northern and native-grown potato seedstock. K. C. Westover. Technical. 20 pp. June, 1931. (Out of print.)
- Bul. 243. Soybean culture and varieties. M. M. Hoover, T. C. McIlvaine, and R. J. Garber. General. 16 pp. Sept. 1931.
- Bul. 244. Report of the West Virginia Agricultural Experiment Station for the biennium ending June 30, 1930. F. D. Fromme. General. 60 pp. Nov. 1931.
- Bul. 245. Seed-borne parasites—a bibliography. C. R. Orton. Technical. 48 pp. Dec. 1931.
- Bul. 246. The pistol-case bearer. Edwin Gould. General. 12 pp. Dec. 1931.
- Bul. 247. Pekwa—a new soybean. R. J. Garber and M. M. Hoover. General. 8 pp. Jan. 1932.
- Bul. 248. The pathogenicity and the variability of *Fusarium moniliforme* from corn. L. H. Leonian. Technical. 16 pp. Mar. 1932.
- Bul. 249. Efficiency of cooperative livestock shipping associations in West Virginia. W. W. Armentrout. General. 92 pp. May 1932.
- Bul. 250. Varietal experiments with red clover and alfalfa, and field tests with meadow mixtures. R. J. Garber and T. E. Odland. General. 16 pp. June 1932.
- Bul. 251. Finishing calves for the market as baby heaves, two-year-old, and three-year-old steers. E. A. Livesay. General. 12 pp. June 1932.
- Bul. 252. The fertilization of apple orchards. III: A comparison of nitrate of soda and sulphate of ammonia. H. E. Knowlton and M. B. Hoffman. General. 12 pp. June 1932.

- Cir. 56. Feeding dairy cows. H. O. Henderson and J. V. Hopkins. 20 pp. Sept. 1930.
- Cir. 57. Topworking the apple tree. M. B. Hoffman. 32 pp. Nov. 1930.
- Cir. 58. Save black walnut from canker. C. R. Orton and J. M. Ashcroft. 4 pp. Dec. 1930.
- Cir. 59. West Virginia weeds. H. K. Rowley. 36 pp. July 1931.
- Cir. 60. Instant bordeaux. F. J. Schneiderhan. 8 pp. Mar. 1932.

### TECHNICAL BULLETINS PUBLISHED JOINTLY WITH THE U. S. D. A.

- Tech. Bul. No. 217. Beef production and quality as affected by grade of steer and feeding of grain supplement on grass. W. H. Black, K. F. Warner, and C. V. WILSON. 44 pp. Jan. 1931.
- Tech. Bul. No. 234. Marketing apples grown in the Cumberland-Shenandoah region of Pennsylvania, Virginia, and West Virginia. C. R. Swinson, J. J. Vernon, F. F. Lininger, F. P. Weaver, and A. J. DADISMAN. 52 pp. Mar. 1931.
- Tech. Bul. No. 303. Economic utilization of marginal lands in Nicholas and Webster counties, W. Va. Millard Peck, Bernard Frank, and P. A. EKE. 64 pp. May 1932.

SCIENTIFIC PAPERS OF THE EXPERIMENT STATION

- No. 84. E. P. Deatrick. Computation of fertilizer mixtures from extra-high analysis fertilizers. *Jour. Am. Soc. Agron.* 22,8: 725-738. Aug. 1930.
- No. 85. L. H. Leonian. Differential growth of *Phytophthoras* under the action of malachite green. *Am. Jour. Bot.* 17: 671-677. July 1930.
- No. 86. R. B. Dustman and A. H. VanLandingham. The chemical composition of consecutive cuttings of *Andropogon virginicus* and *Danthonia spicata*. *Jour. Am. Soc. Agron.* 22,8: 719-724. Aug. 1930.
- No. 87. L. H. Leonian. Attempt to induce mixochimaera in *Fusarium moniliforme*. *Phytopath.* 21,11: 895-901. Nov. 1930. (Presented at Dec. 1929 meeting of Am. Phytopath. Soc., Des Moines, Iowa.)
- No. 88. R. J. Garber and M. M. Hoover. Persistence of soil differences with respect to productivity. *Jour. Am. Soc. Agron.* 22,10: 883-890. Oct. 1930.
- No. 89. E. P. Deatrick. Solving "mixed-acid" problems by use of determinants. *Jour. Ind. and Eng. Chem.* 23: 34. Jan. 1931.
- No. 90. T. B. Clark. The relationship between annual egg production and mean egg weight in White Leghorn fowls. *Poult. Sci., Proc.* 1930 meeting.
- No. 91. H. E. Knowlton and M. B. Hoffman. Nitrogen fertilization and the keeping quality of apples. *Am. Soc. Hort. Sci., 1930 Proc.* Presented at the annual meeting of the Society at Cleveland, O., Dec. 1930.
- No. 92. K. C. Westover. The effect of green sprouting potato seed tubers on earliness and yield. *Potato Assoc. of Am., Proc.* 1930: 12-13. Dec. 1930. Presented at the annual meeting of the Potato Association of America at Cleveland, O., Dec. 1930.
- No. 93. R. B. Dustman and L. C. Shriver. The chemical composition of *Ambrosia trifida* at successive growth stages. *Jour. Am. Soc. Agron.* 23,3: 190-194. Mar. 1930.
- No. 94. H. K. Rowley. When to treat quackgrass most effectively with chlorates. *Jour. Am. Soc. Agron.* 23, 1: 41-42. Jan. 1931.
- No. 95. R. J. Garber, T. C. McIlvaine, and M. M. Hoover. A method of laying out experiment plats. *Jour. Am. Soc. Agron.* 23,4: 286-298. April 1931. Presented at Nov. 1930 meeting of the Society at Washington, D. C.
- No. 96. R. J. Garber. Inbreeding with particular reference to maize. *Jour. Amer. Soc. Agron.* 23,7: 534-548. July 1931.
- No. 97. Anthony Berg. The causative organism of a popular type of apple measles. *Sci. n.s.* 74, 1924: 485-486. Nov. 13, 1931.
- No. 98. L. H. Leonian. Heterothallism in *Phytophthora*. *Phytopath.* 21, 10: 941-955. Oct. 1931.
- No. 99. J. M. Asheroft. Black-walnut canker caused by a *Nectria*. *Phytopath.* 22, 3: 268-269. Mar. 1932. Presented at annual meeting of the Am. Phytopath. Soc. at New Orleans, La., Dec. 1931.
- No. 100. R. J. Garber. The relative yield of a first-generation cross between two varieties of corn before and after selection. *Jour. Am. Soc. Agron.* 23, 8: 647-651. Aug. 1931.
- No. 101. H. O. Henderson, K. S. Morrow, and R. B. Dustman. Changes in the chemical composition of mangels and rutabagas during storage. *Jour. Agr. Res.* 43, 10: 919-930. Nov. 15, 1931.
- No. 102. W. H. Pierre. The effect of nitrogenous fertilizers on soil acidity. *Jour. Ind. and Eng. Chem.* 23: 1440. Dec. 1931. Presented at the Sept. 1931 meeting of the Amer. Chem. Soc. at Buffalo, N. Y.
- No. 103. L. H. Leonian. The effect of position of the inoculum upon growth of some *Trichophytons* in the presence of dyes. *Arch. Dermatology and Syphilology.* 25: 1016-1020. June 1932.
- No. 108. H. E. Knowlton. Pollination studies with some newer apple varieties. *Am. Soc. Hort. Sci.* 28: 71-73. Proc. 1931. Presented by title at the annual meeting of the Society at New Orleans, La., in Dec. 1931.
- No. 109. Leif Verner. Notes on the 1930 drought in West Virginia orchards. *Am. Soc. Hort. Sci.* 28: 646-653. Proc. 1931. Presented by title at the annual meeting of the Society at New Orleans, La., in Dec. 1931.





