

UNIVERSITY OF IDAHO
COLLEGE OF AGRICULTURE

Experiment Station

Work and Progress
of the
Agricultural Experiment Station

for the Year Ending

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*On leave of absence.

Report of the Director

GENERAL farming, livestock raising, orcharding and gardening constitute by far the State's largest enterprise, on the average bringing each year approximately twice the increment of new wealth as compared with the combined contributions from all sources. This great business of farming, involving to some extent at least every county of the State, has been in distress; a distress not due to local causes but having its source in economic upheaval, world-wide in its ramifications. It was only natural that the people should expect the State Experiment Station, organized and maintained to search for new knowledge, to help meet the difficulties of the period and to aid in pointing the way to a better day. In so far as its facilities permitted, the Station has attempted to meet this special call for help from the farming population.

Station Work in General

In the face of low priced crops and animals, bringing only a small financial return as compared with that of two or three years ago, farmers and stockmen still desired to attain the greatest possible success in production and marketing. They wanted crop and animal production to yield well and to have such protection as science could provide against unnecessary deterioration and losses. They called upon the Experiment Station more frequently than ever before for advice on soils, information on animal feeding, for formulas upon which to base home utilization of farm products, for control measures to use in protecting crops and livestock from insect and rodent pests and from plant and animal diseases, for fundamental economic facts upon which to base the management of their farms and the orientation of their farm and home programs to better face future situations, and in many other ways, large and small, they utilized the State's agency for agricultural research.

Objectives of Agricultural Research

Along with evidence of faith in and reliance upon the findings and the general program of the Station, have come some criticism and some efforts to discredit and at least partially destroy the State's only organized and authorized official agency for conducting agricultural investigations. Some of the critics, undoubtedly with entire sincerity, have expressed doubt of the desirability and of the efficacy of spending money for research to improve farm practice when the products of the farm do not sell for enough to meet the minimum costs of production. This is to some extent a doctrine of despair; namely, "how can a public agency help me with its scientific program applied to my business when the products of my enterprise have little or no value?" Another group, which would curtail or eliminate the agricultural experiment stations, expresses a

point of view briefly summarized as follows: "Why spend money for research to produce two blades of grass when there is no adequate market for the single blade we have been growing?" In other words, those who hold this view seem to feel that gross production and constant expansion constitute the aim of the American agricultural research institutions, and that the success of these institutions in that field of endeavor has contributed materially to the present crop surpluses, the so-called over-production. The claim of futility of research, under present conditions, needs little consideration other than the assertion of fact that the farmers now are asking for and need new knowledge as never before and that science in all probability will be found effective in searching out the way to a new period of success in farming enterprises. The charge of responsibility for over-production needs analysis from two points of view. First, is there over-production, and second, if so, what, if any, responsibility must be assumed for such a situation by the agricultural experiment stations.

Those who have given careful consideration to the economic background of the present period of distress soon find themselves challenging the over-production theory. World-wide disorder has come into a former well-g geared economic machine. Where there once was active demand there now is unemployment on a vast scale, low consumer purchasing power, and price levels so far out of line with those previously maintained that they represent a condition near chaos. An agricultural productive capacity formerly well in harmony with demand, scarcely could hope to function properly in the disordered condition of world affairs briefly outlined above. Problems of distribution and consumption, incidental to world-wide economic disturbance, for the most part outside of the agricultural field, primarily are responsible for farm distress, with so-called over-production having little or no significance.

Dr. George Warren, veteran economist of Cornell University, expresses the view that world production scarcely has kept pace with consumption. Professor C. R. Arnold, of the Department of Rural Economics of Ohio State University, recently supplied the following facts dealing with production and price relationships:

"1. The volume of net agricultural production (omitting duplication of feed fed) in 1932 was 8 per cent less than in 1931; $4\frac{1}{2}$ per cent less than average of 1924 to 1928; and the lowest since 1923. This is not based on prices but the actual physical volume.

"2. Wheat production in the United States in 1932 was the lowest for seven years and second lowest for 15 years but wheat prices went to the lowest point in the history of this country.

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| Av. U. S. wheat production 1918-1920 (war period) | 907,481,000 bu. |
| Av. U. S. wheat production 1926-1928 | 874,873,000 bu. |
| Av. U. S. wheat production 1929-1931 | 854,334,000 bu. |
| Av. U. S. wheat production 1932 | 726,831,000 bu. |

"3. Federal inspected slaughter of cattle in 1932 was the lowest for 12 years.

"4. Milk production per capita in the U. S. in 1932 was lower than in 1929.

"5. Comparing the period 1920-1930 with the previous ten-year period 1910-1920, physical volume of agricultural production in Ohio increased 3 per cent while the non-farm population increased 26 per cent. This increase of 3 per cent came from 10 per cent less farms and 5 per cent less land in farms which shows greater efficiency. More efficient production of food is a direct benefit to consumers."

The real objective of the agricultural experiment stations is the securing of new knowledge to assist farmers in attaining greater efficiency and increased success in their farming operations and in marketing their products. Lower costs of production, higher quality of products, and a higher standard of rural life have been the goals toward which the American experiment stations have worked for the nearly half century of their existence. In other words, not more acres, more cows, and more hens but higher yield and lower costs per acre; more butterfat per cow, and eggs per hen; more products that bring premiums for quality, and greater convenience and comfort for the farm family have been the real and definite objectives.

Director F. B. Mumford, of the Missouri Experiment Station, in an address before the Experiment Station Section of the Association of Land Grant Colleges and Universities in annual meeting at Washington, D. C., last November, thus expressed his judgment of the value and function of the experiment station:

"Low prices are in part due to changes in the monetary standard, over-production and decreased consumption resulting from the world-wide economic depression. For none of these can the agricultural experiment stations be held responsible. The primary economic purpose of the work of experiment stations is to provide the knowledge necessary for the farmer to adapt himself to the changing conditions—economic, climatic, and industrial. It is true that the agricultural experiment stations have increased the efficiency of farmers; that is, they have pointed the way to better utilization of the factors of production for the ultimate purpose of increasing profits from the agricultural enterprise. The efficient farmers are those who are adapting themselves to the present conditions because they have available the aid of the experiment stations. It is worthy of note that the farmers of the present era who are holding their own are the farmers who are most closely following the advices and counsels of the experiment stations. It is reasonable and proper to conclude, therefore, that without the experiment stations the farmer's plight would be infinitely worse than it now is, and with the help and aid that these institutions are now organized to give the farmer's re-

covery will be more rapid and his adjustment to changed conditions will be more certainly and successfully accomplished."

Achievements

The total program of the Idaho Experiment Station has to do with approximately 160 separate projects concerned with nearly every phase of general farming, orcharding, livestock production and marketing in Idaho. In general, the projects of the Station are up to date and are very closely correlated with the most pressing needs of the agricultural industry. The Station has established a record of high efficiency in serving the agricultural interests of the State. It is possible, with the space at hand, to mention only a few of the enterprises of the Station that have been of high value.

A few years ago the bean varieties in the bean growing regions of the north-central part of Idaho deteriorated rapidly because of mosaic disease, until bean growing no longer was a successful farm enterprise. The Department of Plant Pathology of the Experiment Station, in cooperation with progressive farmers, introduced a mosaic resistant strain known as the Robust which rapidly supplanted the former varieties and resulted in the rehabilitation of the bean-raising industry. In a similar way mosaic was found to be taking heavy toll in the Great Northern fields of the Twin Falls district and of contiguous territory. Genetic studies and selections resulted in the development of a resistant strain known as Idaho No. 1. This, together with a few other disease resistant strains, is rapidly replacing the Great Northern strain found lacking in disease resistance.

Trebi barley developed and distributed from the Substation farm at Aberdeen has become the dominant feed barley for Idaho and has spread from Idaho over much of the West and into territory as far removed as the Red River valley of the Dakotas and western Canada.

The prune studies of the Department of Horticulture have been productive of a practical test to determine a satisfactory state of maturity for greatest success in marketing.

The soils tests of the central Station at Moscow and of the Substation farms and of cooperative field plots with farmers have formed the basis upon which a considerable percentage of the progressive farmers of Idaho are basing their program for the maintenance of soil fertility.

The researches with insect pests and plant diseases have been concerned with the problems most acutely effecting the success of fruit growing. The findings of the Experiment Station in these fields constitute the basis for the spray and other disease and insect control recommendations promulgated and put into practice in the State through the agents of the State Department of Agriculture.

At this time a cooperative research undertaking of representatives of the Departments of Agricultural Chemistry and Agricultural En-

gineering gives promise of a new fuel for internal combustion engines of high efficiency and possessing other advantages as compared with the use of gasoline exclusively.

Mosida wheat, a selection developed by the agronomists at the Station at Moscow, has become a leading variety, especially adaptable to the cut-over regions.

From the poultry experimental feeding pens of the central Station has come new knowledge of feed combinations best adapted to utilization by Idaho poultrymen. Especially significant is the discovery of the place that field peas can have in furnishing protein material for the ration of laying hens.

The animal feeding investigations conducted with steers and lambs at the Substation farm at Caldwell and with lambs at the Aberdeen Substation form the basis for the Station's recommendations to the livestock men of the State.

These recommendations, for steers, are based upon feeding experiments with 960 head and date from 1920 up to and including 1931-32. A wide variety of Idaho-grown grains and forage crops and by-products have been fed, in varying combinations and after the application of various treatments such as cutting and grinding, in the attempt to determine the most efficient ration for profitable feeding of Idaho steers. Some evidence of the efficient way in which this work has been conducted may be cited in the fact that of 13 lots of steers fed since 1919, 8 have been fed with distinct profit and only 5 lots have been unprofitable. The total profit above all costs, not including labor, is nearly five times the total losses shown in the careful records kept of these feeding undertakings.

Lambs have been fed with similar objectives of finding lowest costs and of determining most effective rations and methods, 8,885 lambs having been fed experimentally since 1920. Of the 16 lots into which these lambs were divided, 11 have been fed with profit and 5 have been unprofitable. All costs were taken into consideration except labor, which of course is greater with experimental undertakings and which ordinarily the farmer does not figure in considering whether or not either steer or lamb feeding is a profitable enterprise for him to carry on during the winter months. In the case of these lambs, the total amount credited to profit is approximately three and one-half times the losses that were incurred.

In the last few years the agricultural economists of the Station have been engaged in projects concerned with the problems of farm organization, of adjustment to changing economic situations, and with the very vital issues found in standardization and distribution. That this work meets a real need in the State is indicated by the pressure exerted to have the work conducted and to have the results disseminated.

In many other ways, in the field of dairying, in soils and plant production, in those phases of farming that are concerned with low

cost, with protection from loss, and with high standards and high quality, the Experiment Station has been a collaborator with the farmers of the State in meeting the issues that are vitally concerned with the success of the agricultural industries.

Emergency Work

During the past year the demand for information coming from the farming regions largely was for help with emergency problems and for suggestions that would permit them to place their obligations on a paying basis. It of course was impossible for the Experiment Station staff to make recommendations that would bring immediate solution to problems so fundamental in their origin. In so far as possible, however, the general program of the Station was oriented to meet the peculiar problems of the time. Several publications were issued, especially for the purpose of presenting reliable information upon which could be based the redirection of farm enterprises from an unprofitable to a very satisfactory and frequently a profitable basis. Examples of such publications are the Bulletins and Circulars dealing with the factors that enter into profitable dairying, the home-mixing of poultry rations, utilization of Idaho-grown grains and forage crops in feeding range steers and lambs for market, and others that might properly be classified as an individual special emergency group.

Branch Experimental Farm Policy

In adopting a policy of adequate service to the agricultural interests of the State, the Experiment Station has found it necessary to establish branch experimental farms and field stations. In a few states one or two properly located experimental farms might serve the entire state. Idaho, however, is a state of great diversity of soil and climatic conditions. The altitude ranges from a little more than 600 feet in the Lewiston valley to more than 6,000 feet in the Teton basin. Rainfall in regions where farming is practiced varies from 8 to 10 inches in the Snake River plain to more than 25 inches in certain non-irrigated farming sections. Soil ranges are from the highly organic peats to the heavy loams, with calcareous underlay, and many gradations between. Climatic conditions vary greatly from north to south and from east to west, involving wide ranges in both summer and winter temperatures, length of growing season, and adaptation to various processes of plant and animal production. Under conditions in this State, therefore, it is impossible for a single experimental farm, no matter where located, to render adequate service to the State's agriculture.

At the opening of the University in 1893, and establishment the same year of the Agricultural Experiment Station, branch experimental farms were established at Nampa, Grangeville, and Idaho Falls. The first branch stations were supported by federal funds

but a ruling of the federal authorities having supervision over the expenditure of these funds in the states, forced the discontinuation of this policy. The branch stations first established and supported by federal funds were suspended when the federal ruling became effective. After a lapse of seven years, branch stations again were opened, supported by state appropriated funds. It has been the policy of the University to maintain such branch experimental farms with support from state appropriated funds since 1907, a period of twenty-five years.

The plan now in operation provides five experimental farms, a field station, and other points of contact with special experimental problems. The central farm at Moscow conducts investigations of interest to a large farming region in the northern and central parts of the State. The branch station at Sandpoint serves the cut-over regions. The irrigated farm at Caldwell is maintained to deal with peculiar soil problems of southwestern Idaho and to provide facilities for important animal feeding and dairy cattle management studies. The irrigated crops station conducted in cooperation with the Federal Office of Cereal Crops and Diseases is located at Aberdeen, midway between the Upper Snake and the Lower Snake River farming region, and the branch station dealing with the problems of the high altitude non-irrigated farming is at Teton, in the Teton Basin, at an altitude in excess of 6,000 feet. The entomological field station is maintained at Parma, because of easy access to insect problems of both orchard and field crops. Some of the other points of experimental contact are Twin Falls, Emmett, Boise, Payette, Lewiston, and Coeur d'Alene.

Inventory value of the buildings and equipment of the four branch experimental farms, *not including value of lands*, is as follows:

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| Aberdeen Substation | \$11,751.65 |
| High Altitude Substation | 7,735.00 |
| Caldwell Substation | 27,334.00 |
| Sandpoint Substation | 19,029.55 |
| Total | \$65,850.20 |

The research specialists of the home Station at Moscow, in conference with the branch Station Superintendents, work out the projects that are deemed of most value to the farming interests of the State. For example, the general soils and crop experiments are planned by the Departments of Agronomy, Agricultural Chemistry, and others, with part of the work conducted at Aberdeen, some at Sandpoint, Teton, and Caldwell. The animal feeding studies at Caldwell and Aberdeen are under the direct general supervision of the Department of Animal Husbandry of the University.

Few Changes in Staff

The Station has been fortunate during the year in the continuity of service of the members of the staff. For the most part the research workers of the Station have been employed by it continuously for several years and are well-acquainted with conditions peculiar to the agriculture of the State. H. P. Magnuson, Acting Chemist of the Station, was on leave of absence for graduate study at the University of Wisconsin for the period September 1, 1931, to August 1, 1932. During this period of leave J. A. Shellenberger was employed as Assistant Chemist. Claude Wakeland, Station Entomologist, was granted leave of absence for one year, effective September 1, 1932.

Improvements.

A recent major improvement is the completion of the main dairy barn, constructed to replace the barn destroyed by fire in the spring of 1932. The cost of the new barn was met by insurance and many improvements in design and arrangement were made possible in the reconstruction.

General repairs, some improvements of buildings, and painting have been completed on the substation farms. The most important adjustment of Substation farm buildings was the removal of the residence, barn, and seed house of the High Altitude Substation from a site three-quarters of a mile north and west of Felt to a new location in the town of Tetonia. The new site in Tetonia is on the state highway and provides a convenient headquarters and at the same time affords ready access to the 160 acre farm used for the experimental program of the Station.

Publications

THE Bulletins and Circulars published during the past year have been written in popular style and have been in much demand by the farmers. Investigations of a more fundamental nature have been reported in technical papers and published in various scientific journals. The list of publications follows:

Bulletins

187. THE REMOVAL OF ARSENICAL RESIDUE FROM APPLES. R. S. Snyder and H. P. Magnuson.
188. PLANNING THE FARM BUSINESS FOR THE YEAR AHEAD. P. A. Eke and E. T. Benson.
189. METHODS AFFECTING THE EFFICIENCY OF CHLORATE WEED KILLERS. H. W. Hulbert, R. S. Bristol, and L. V. Benjamin.
190. TYPE IN MARKET SWINE AND ITS INFLUENCE ON QUALITY OF PORK. J. E. Nordby.
191. HOG PRICES AND THE HOG ENTERPRISE ON IDAHO FARMS. T. L. Gaston.

192. WORK AND PROGRESS OF THE AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING DECEMBER 31, 1931. E. J. Iddings.
193. EFFICIENCY OF CREAM STATIONS IN CREAM COLLECTION. C. O. Youngstrom, D. R. Theophilus, F. W. Atkeson, and Geo. N. Tucker.
194. FATTENING RANGE LAMBS IN IDAHO. E. F. Rinehart, C. W. Hickman, and R. F. Johnson.
195. A METHOD OF DETERMINING WHAT TO PRODUCE—BUDGETING THE FARM PROGRAM ON THE TWIN FALLS IRRIGATION PROJECT. Byron Hunter and Paul A. Eke.

Research Bulletins

10. CODLING MOTH LIFE HISTORY IN SOUTHWESTERN IDAHO. Claude Wakeland and Paul Rice.

Circulars

62. A REVIEW OF THE ACCURACY AND TIMELINESS OF OUTLOOK STATEMENTS. C. O. Youngstrom.
68. ELECTRIC SOIL AND HOT BED TREATING. Hobart Beresford.
69. PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

Technical Papers

83. VITAMIN A CONTENT OF PASTURE PLANTS. I. White Clover (*Trifolium repens*) and Kentucky Blue Grass (*Poa pratensis*) Under Pasturage Conditions and Fed Green. Ella Woods, A. O. Shaw, F. W. Atkeson, and R. F. Johnson.
84. IRRADIATION OF THE COW'S UDDER WITH A QUARTZ MERCURY LAMP AS A TREATMENT FOR MASTITIS. H. C. Hansen, V. A. Cherrington, E. M. Gildow, and F. W. Atkeson. Read at Dairy Science Meetings at Davis, California, 1931, but not published.
85. THE LEUCOCYTE CONTENT OF MILK AS CORRELATED WITH BACTERIAL COUNT AND HYDROGEN ION CONCENTRATION FOR THE DETECTION OF MASTITIS. *Journal of Dairy Science*. V. A. Cherrington, H. C. Hansen, and W. V. Halversen.
86. A SHORT METHOD FOR CALCULATING GAMETIC RATIOS IN RANDOM MATINGS. In Press. *Journal of Heredity*. J. E. Nordby.
87. CRYPTORCHIDISM AND ITS ECONOMIC IMPORTANCE TO THE PRODUCER OF SWINE AND PROCESSOR OF PORK PRODUCTS. In Press. *Journal of the American Veterinary Medical Association*. J. E. Nordby.
88. INFLUENCE OF DIFFERENT STARTERS ON THE QUALITY OF CHEDDAR CHEESE. *Journal of Dairy Science*. H. C. Hansen, H. A. Bendixen, and D. R. Theophilus.
89. TREATMENT FOR MASTITIS WITH ULTRA VIOLET LIGHT, FORMALIN, COLLOIDAL CARBON, AND AUTOGENOUS BAC-

TERINS. *Journal of the American Medical Association*. E. M. Gildow, H. C. Hansen, and V. A. Cherrington.

Mailing List

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| State of Idaho | 12,375 |
| States Other Than Idaho | 2,038 |
| Foreign | 237 |
| Total | 15,150 |

Active Projects

A LIST of active Experiment Station projects follows. All investigations carried on at the several Substantions are in cooperation with the various Departments of the central Station.

Agricultural Chemistry

A study of certain types of chlorosis as found in Idaho on trees, shrubs, and herbaceous plants (In cooperation with Agronomy and Plant Pathology).

The protein content, yield of wheat and nitrogen content of the soil, when cropped continuously to wheat and when cropped under a definite rotation system.

Slick spot investigations (In cooperation with Agronomy).

Blood studies, as an index to nutrition, health, and body functions of the laying hen (In cooperation with Poultry Husbandry and Bacteriology).

Drainage and reclamation of water-logged alkali and overflow lands (In cooperation with Agronomy, Agricultural Engineering, and Bureau of Public Roads, U. S. Department of Agriculture).

A study of the influence of irrigation on soil fertility (In cooperation with Agricultural Engineering).

A study of the availability of plant nutrients and the response of fertilizers in

Idaho soils (In cooperation with Agronomy and Bacteriology).

The effect of sulphur, gypsum, and lime on yield and composition of alfalfa (In cooperation with Agronomy).

Feeding experiments with dairy cattle (In cooperation with Dairy Husbandry).

Casein Studies: No. II A study of technique and physical and chemical analyses of casein made by the natural sour and graincurd methods. No. III—Influence of various phases of manufacture of casein by the natural sour method on physical and chemical tests (In cooperation with Dairy Husbandry).

Influence of kind of crop used and systems of management on the value of pastures for dairy cattle (In cooperation with Dairy Husbandry).

Analysis of feed and fertilizer samples to comply with the State law.

The effect of time of irrigation on the yield, sugar content, and sugar production of beets (In cooperation with Agricultural Engineering).

Agricultural Economics

A study of the prices, marketing, and markets of the dairy products of Idaho (In cooperation with Dairy Husbandry).

Poultry management (In cooperation with Extension Poultry Specialists).

A potato enterprise and efficiency study (In cooperation with Horticulture).

A dairy and enterprise cost and efficiency study (In cooperation with Dairy Husbandry).

Types of farming areas in Minidoka, Cassia, Jerome, Twin Falls, and Gooding counties.

Agricultural Engineering

Factors underlying the economic use of water in irrigation, Sec. III. Drainage and reclamation of water-logged, alkali and overflow lands.

A study of "Plant and irrigation relationships" under general project "Factors underlying economic use of water in irrigation."

"A study of the influence of irrigation upon soil fertility," a sub-project under the general project "Soil and irrigation rela-

tionships" (In cooperation with Agricultural Chemistry).

A study of methods, equipment, crew organization, and cost of harvesting grain with combines in northern Idaho.

A study of methods, equipment, organization and cost of seed bed preparation on University farms.

A study of the methods, equipment, crew organization and cost of harvesting and stacking hay in southern Idaho.

The relation of electricity to agriculture (In cooperation with the Idaho Committee on the Relation of Electricity to Agriculture).

A study of the cost, effectiveness, and methods of pumping for drainage and supplemental irrigation.

The efficiency of irrigation and drainage pumping plants, a sub-project (In cooperation with the Bureau of Agricultural Engineering, U. S. Department of Agriculture).

A study of the effects of radiant energy on horticultural plants (In cooperation with Horticulture).

A study of electric soil heating and floor heating for hotbeds and stable floors.

A study of the comparison of radiant energy with cod liver oil as a vitamin source

for promoting growth of chickens (In cooperation with Agricultural Chemistry and Poultry Husbandry).

The development of a method for structurally testing farm buildings.

A study of building requirements for poultry production in Idaho (In cooperation with Poultry Husbandry, Extension, Field Poultryman, and the poultrymen of Idaho).

A study of the ventilation and lighting of dairy barns (In cooperation with Dairy Husbandry).

A study of the use of petroleum alcohol blends as fuel for internal combustion engines (In cooperation with Agricultural Chemistry).

Agronomy

Field and garden pea investigations: (a) classification studies; (b) cultural experiments; (c) breeding and improvement; (d) germination studies; (e) inoculation trials.

Corn breeding and improvement: (a) cultural experiments; (b) breeding improvement.

Weed eradication investigations.

Tests with commercial fertilizers.

Soil amendments; Use of sulphur, lime, gypsum, and leguminous crop (In cooperation with Agricultural Chemistry).

Rotation and fertility investigation.

Peat soils of Idaho (In cooperation with Agricultural Chemistry).

Soil survey: (a) detailed survey of a designated area each season as funds per-

mit (In cooperation with the U. S. Department of Agriculture).

Alfalfa seed production.

Small grain improvement: (a) Wheat; (b) oats; (c) barley; (d) rye, emmer, flax, and miscellaneous grains (In cooperation with Cereal Office, U. S. Department of Agriculture).

Forage investigations: (a) Grasses and legumes for hay, seed, and pasture; (b) cultural tests with alfalfa; (c) introduction and testing of miscellaneous forage crops; (d) seed production; (e) alfalfa improvement—breeding; (f) strain test alfalfa varieties; (g) clover breeding studies; (h) pasture investigations; (i) soybean yield trials for seed, hay, and pasture.

Animal Husbandry

Studies in the growth of wool.

Physiological effects of feeding rations restricted to Canadian field peas on growth and reproduction of swine.

The effect of field pea rations on the skeleton development in swine.

Hogging-off field crops.

Protein supplements with barley and wheat for growing and finishing swine.

Steer feeding investigations (In cooperation with Caldwell Substation).

Lamb feeding investigations (In cooperation with Caldwell and Aberdeen Substations).

Farm flock investigations.

Farm and range lamb marketing studies.

Inheritance of skull defects in swine.

Whorls in the hair of swine.

Congenital epithelial defects in swine.

White spotting in Duroc Jerseys.

Black spotting in Rambouillets.

Overshot (prognathism), and under shot (brachygnathism) jaw in sheep.

Turned-in eye-lids (entropion) in lambs.

Congenital ear defects in swine.

Sex development in cryptorchid swine.

Bang abortion disease control program (In cooperation with Dairy Husbandry and Bacteriology).

Foul sheath in sheep.

Treatment of subacute and chronic mastitis (In cooperation with Dairy Husbandry and Bacteriology).

Oestrus ovis (grub in the head) of sheep.

Bacteriology

Study of the blood as an index of the health and body functions of the laying hen (In cooperation with Agricultural Chemistry and Poultry Husbandry).

Study of scours in dairy calves (Inactive).

Legume culture preparations.

Sterility in bovine male (Inactive).

Bacillary white diarrhoea studies (In cooperation with Extension Poultry Husbandry).

Study of udder infection in dairy cattle (In cooperation with Dairy Husbandry and Animal Husbandry).

Coniferous timber soil investigations. Biological activities of Helmer slit loam

soil (In cooperation with Agricultural Chemistry).

A study of the availability of plant nutrients and the response to fertilizers of Idaho soils (In cooperation with Agronomy and Agricultural Chemistry).

Eradication of Infectious Bovine abortion (Bang Disease) and accreditation of bang abortion disease-free dairy herds in the State of Idaho (In cooperation with State Department of Agriculture, Dairy Husbandry, Animal Husbandry, and Extension Division).

Dairy Husbandry

Official testing of dairy cows for advanced registry.

Continuous use of proved sires to breed dairy cattle that will be pure in their inheritance for high milk and butterfat producing capacities (In cooperation with the Bureau of Dairy Industry, U. S. Department of Agriculture).

Investigation of the use of dairy sires from ancestry of known production in co-operative bull associations.

Study of the normal growth of dairy cattle (Also being conducted at the Caldwell Substation).

Influence of pregnancy on weight of dairy cattle (Also being conducted at the Caldwell Substation).

Study of inheritance of umbilical hernia in cattle.

Inheritance of wry-tail in dairy cattle. Study of breeding efficiency in dairy herds.

Influence of kind of crops used and system of management on the value of pastures for dairy cattle (In cooperation with Caldwell Substation).

Study of the vitamin "A" content of pasture plants (In cooperation with Home Economics and Caldwell Substation).

Alfalfa seed screenings compared to linseed oil meal for milk production.

Study of the best methods of feeding calves while receiving milk.

Cost and efficiency of raising heifers on different planes of nutrition (In cooperation with Caldwell Substation).

Study of ventilation and lighting in dairy barns (In cooperation with Agricultural Engineering).

Study of udder infections (In cooperation with Bacteriology and Animal Husbandry).

Eradication of Bang's abortion disease (In cooperation with Bacteriology and Animal Husbandry).

Study of prices, marketing, and markets for dairy products in Idaho (In cooperation with Agricultural Economics and Bureau of Dairying, State Department of Agriculture).

Comparison of methods of standardizing milk for cheese making.

Cascan investigations (In cooperation with Agricultural Chemistry).

Entomology

The insects of Idaho—Assembling data considering the species of insects occurring in the State, their distribution and their economic importance.

Codling moth. Control investigations. Bee leaf-hopper investigations (In cooperation with the Bureau of Entomology, U. S. Department of Agriculture).

Oil sprays. Investigations in preparation and use of oil sprays in the control of orchard insects and their effects upon trees (In cooperation with the Experiment stations of Montana, Washington, California and Oregon, and with the Bureau of Entomology, U. S. Department of Agriculture).

The leaf-hoppers of Idaho. Investigations in control of economic species and a systematic study of the leaf-hoppers of Idaho.

Mineola scitulella. Life history studies and an investigation in methods of con-

trol.

Wireworms. Experiments in control and study of economic species (In cooperation with the Bureau of Entomology U. S. Department of Agriculture).

Pea weevil. Ecological and biological study of the insect and a study of cultural practices bearing on control (In cooperation with the Bureau of Entomology, U. S. Department of Agriculture).

Tarnished plant bug. Investigations of injury to alfalfa affecting possible seed set. Puncture injury to beans. A study of the insects that may cause it.

Comparative results from the use of oil emulsion, liquid lime-sulphur, and dry lime sulphur sprays in San Jose Scale control.

A study of the life cycle and methods of control of *Oestrus ovis* (grub in the head) of sheep (In cooperation with Animal Husbandry).

Home Economics

The effect of storage upon the Vitamin "C" content of the Russet Burbank potato of Idaho.

A study of the Vitamin "G" content of

the Idaho Russett Burbank Potato.

Vitamin "A" content of pasture grasses (In cooperation with Dairy Husbandry).

Horticulture

Apple breeding. Orchard fertilization (In cooperation with Agronomy).

Tomato experiments. Potato production experiments.

Pruning investigations. Varietal study and cultural tests in producing head lettuce.

Variety testing of fruit trees, small fruits,

and vegetables.

Factors determining storage of Idaho prunes.

Factors influencing the cracking of sweet cherries.

Factors influencing the keeping quality of sweet cherries.

A study of maturity and keeping quality of apples.

Plant Pathology

Study of virus diseases of potatoes.
 A study of a sclerotium disease of small grains.
 Control of curly-top of tomato by breeding and selection.
 Grain smut studies.
 Bean disease investigations.
 Clover mildew investigations.
 Nature and control of bacterial wilt and

the stem rot of alfalfa.

Nature and control of coryneum blight of stone fruits.

A study of the stripe rust of grains and grasses (In cooperation with the Office of Cereal Crops and Diseases, U. S. Department of Agriculture).

Plant disease survey.

Poultry Husbandry

The relation of humidity in the artificial incubation of chicken and turkey eggs.

A study of the blood as an index of health and body functions. II, mineral supplements; (a) comparative value of calcite and oyster shell in chick rations; (b) various levels of mineral supplements in chick rations (In cooperation with Agricultural Chemistry).

Comparative value of calcite and oyster shell as a source of calcium carbonate for laying hens.

A study of the efficiency of peameal as a source of vitamin "A" in poultry rations.

Alfalfa as a vitamin "A" supplement and its effect upon yolk color.

To determine the relative efficiency of various grades of cod liver oil as a vitamin "A" supplement.

The efficiency of electric brooders in insulated and non-insulated portable brooder houses as compared with coal-burning brooders.

Agricultural Chemistry

AGRICULTURAL Chemistry deals with the composition, reactions, and uses of farm products, so that many of the projects are cooperative with other Departments. Studies have been conducted on the manufacture and analysis of casein, the management and value of pasture grasses, and the composition of various feeds in cooperation with the Dairy Department; nutrition studies with chicks in cooperation with the Poultry and Bacteriology Departments; and soil studies in cooperation with Soils, Agricultural Engineering, and Bacteriology Departments. Material progress has been made in these projects during the past year, some of the results of which are ready to be prepared for publication.

Soil Fertility

A set of three-year rotations have been run at the Idaho Station since 1914, with special reference to the relation of protein content and yield of wheat to the nitrogen content of soil. These rotations contain comparisons of the summer fallow practice with that of using various crops in place of the fallow. In all cases there has been a loss of nitrogen in the period considered, but this depletion has been slower where legumes have been used in the rotation than with non-leguminous crops. The summer fallow system has proved to be the most wasteful of the nitrogen of the soil. Potatoes and peas have been effective in the rotation in maintaining both yield and protein content of the wheat, and in maintaining the nitrogen content of the soil. In the rotations receiving an application of 20 tons of manure per acre every three years, there was usually an increase in yield and protein content of wheat, and higher organic matter in the soil than on the corresponding unmanured rotations. Even with

these manure applications every three years there has been a continuous loss of soil nitrogen in the case of fallow one year in three.

Plots at Winchester were in alfalfa and were fertilized with different applications of sulphur and gypsum. Soil samples were obtained from the same spot from which hay samples were taken. Analyses of the alfalfa hay showed higher protein content on the sulphur and gypsum plots than on the check. The nitrogen content of the soils was higher from those plots on which the high-protein hay was produced. The average of a number of plots gives a protein content of 13.39 per cent for the check, 14.62 per cent for gypsum, and 14.72 per cent for sulphur plots. The nitrogen content of the soil was .141 per cent for the check, compared with .164 per cent for the gypsum, and .167 per cent for the sulphur plots. The use of gypsum and sulphur thus gives higher protein production by increasing both the nitrogen content and the yield of hay, as well as further enriching the soil.

During recent years phosphorus has been found to be a limiting factor in many sections. A survey of the State to determine the degree of this deficiency has been carried on in cooperation with the county agents. The crop response to phosphorus applications in the field is used as the background for these studies. A chemical method has been developed which gives certain information about the available phosphorus content of the soils. The soils are extracted with Truog's .002 N sulphuric acid solution, and the soluble phosphorus determined by Zinzadse's colorimetric method. In the calcareous soils of southern Idaho this is not a true measure of the availability. The carbonate content of the soil has material influence on the crop response that can be expected from application of superphosphates. High calcium carbonate content of the soil and high pH of the soil extract are associated with low availability. This type of estimation is not entirely exact as to phosphorus content but will serve as a means of comparative classification when backed by sufficient field data on the crop response to phosphorus application.

Alkali Soil Reclamation

A study of the reclamation of alkali lands has been carried on for a period of five years, using a variety of chemical and physical aids to the reclamation by drainage. Analyses of soil samples taken this year show a general decrease in soluble salts where there was adequate downward drainage. Where drainage was impaired by an impervious layer near the surface, the alkali content was not materially reduced.

The chemical treatments with high applications of sulphur, gypsum, and sulphuric acid showed material improvement over the check plots. The cost of these treatments, however, has been shown to be too high for the results obtained, even though improvement is apparent. One series, in which grasses were sown in the native

vegetation and watered without leveling, showed very satisfactory results at low cost. A comprehensive progress report for the five-year period is being prepared.

The analyses of water samples from various places in the Snake River valley have been completed, and are being correlated as to fertility and salt content. The drainage wells usually have a good quality of water.

In certain areas of the State large spots have a slick, shiny appearance when wet, bake badly when dry, and take water slowly when irrigated. These spots produce poor crops, and are hard to cultivate. Pot studies in the greenhouse show that these soils require as high as three times the amount of water to produce a pound of dry matter as do normal soils. Laboratory studies on this soil show a high ratio of sodium to calcium in the replacable bases, ranging from about a 30 per cent sodium saturation in the slick to a 1.5 per cent in the normal soil. In making clay determinations on these soils it was found that the fraction below 2 microns and that between 2 and 5 microns are both higher in the slick than the normal soil. These two factors tend to explain the physical condition of these soils, and account for their water absorbing capacities. The method of Puri for determining the dispersion factor seems to offer a useful constant in evaluating these soils, but the dispersion coefficient does not hold true for the slick soils.

Casein Studies

Comparison of approved methods of analyzing casein showed considerable variation in results, and indicated the necessity of knowing the specific method used in the analysis when comparing results from different sources. A paper is being prepared comparing various methods and making recommendations for certain changes. The pH and conductivity determinations were found useful in estimating the quality of a casein sample. A study is now in progress on the influence of various phases of manufacture of casein by the natural sour method on physical and chemical tests. Factors being studied are, temperature, washing, drying, and acidity.

Nutrition Studies

A project in which oyster shell was compared with native calcites as a source of calcium for growing chicks, shows calcite to compare favorably, if of good quality. This was borne out by growth curves and by analyses of the blood and bone of the chicks. Different levels of calcium and phosphorus failed to show appreciable differences in the blood and bone content of these elements.

This experiment is being repeated with laying hens. Present results indicate the high value of calcite as measured by egg production and shell quality. When both are given *ab lib.* the hens eat about three times as much oyster shell as calcite. Solubility tests are being made on these products.

Different levels of calcium and phosphorus used do not seem to affect the blood or bone composition so long as sufficient vitamin D is supplied. It seems that 5 per cent of calcium carbonate and 5 per cent of calcium phosphate constitute a higher mineral content of the ration than is necessary. High ratio of phosphorus did not produce slipped tendons or enlarged hocks.

Studies of pasture grasses have been carried out on nine species of grasses, taken at two-week intervals for 20 weeks. Analyses show material variation in protein between species, as well as great seasonal variations. Comparison of analyses to be comparable must be made from samples taken at the same stage of growth. Analyses of waste products have shown them to have considerable feeding value.

Alcohol-Gasoline Blend

Work has been carried out on the use of alcohol which could be made from waste and low grade farm products as a motor fuel blend. A mixture of gasoline and alcohol has been found that permits higher compression ratios, reduces deposition of carbon, and increases engine efficiency.

In connection with these studies, special methods have been necessary for the particular needs met with in the investigation. Modifications have been made in the sodium, calcium, and magnesium determinations on plant materials, using Puri's method for replaceable bases, and Truog's available P method as applied to carbonate soils.

Agricultural Economics

Price Outlook Information

RESEARCH of the Department of Agricultural Economics has been directed toward a solution of the farmers' problems of organizing, planning, and managing farms in such a manner as to enable them to realize the highest net income from their labor and for the use of their land and capital. The depression has made this service doubly important because of the confusion arising from the precipitous and uneven falling of prices, the lag in the drop in costs, and the large fixed charges under which the industry is struggling. Farmers in Idaho have cast about in search of some adjustments which would better their condition. To meet this state-wide problem, price and production outlook information has been furnished the Extension Service, through which it has been made available to the farmers in the monthly mimeographed circular, *The Idaho Agricultural Situation*.

Articles on the agricultural outlook have been published in the *News Letter* and in farm journals and newspapers. The Extension

Specialists have carried the message to all parts of the State. Several radio talks have been given on the subject of outlook. The more thoughtful farmers have taken advantage of this information to increase or decrease their acreage or breedings to conform with the price outlook. A good example of this response to the price outlook was the increased acreage planted to sugar beets in 1932. This crop has, as was expected, turned out to be a fairly profitable crop in this year of generally low returns. To increase confidence in outlook information, a publication, Experiment Station Circular No. 62, *A Review of the Accuracy and Timeliness of Outlook Statements*, has been issued. It shows that the trend of potato prices has been accurately foretold each year for the past seven years. No doubt Idaho could have increased the income from potatoes by millions of dollars by acting upon this information. For the other important crops and livestock the future trend of prices has been told accurately five to six years out of seven years.

Planning the Farm Business

To meet another state-wide farm problem, Experiment Station Bulletin No. 188, *Planning the Farm Business for the Year Ahead*, has been published. This Bulletin outlines a scientific method of using the latest information in planning a farm and ranch program. Through the use of this method a farm program can be outlined which will have the best chance of succeeding during the year and years ahead. Custom, guesses, and "hunches" may be set aside for systematic planning.

To assist the Extension Service and Experiment Station in meeting more of the specific needs of certain farm areas, detailed information on all phases of the farm management problem have been collected for the Twin Falls project, the Idaho Falls area, and the Minidoka project. Mimeographed reports have been made of the first two areas and manuscripts now are ready for publication. In these manuscripts farm budgeting has been carried to the point where several of the more profitable crops and livestock combinations have been discovered and pointed out. Yields per acre, production of livestock and its costs in physical terms, and other subsidiary information have been assembled to enable the Extension Service to advise farmers in these areas how to direct their efforts along profitable lines even though prices and costs in terms of money may change. A more detailed manuscript will be published on the Minidoka project, where the productive possibilities of eight important soil types will be given.

With this information available, it is hoped that expert farm management service can be made available to the farmers of a community as a group and also directly to individual farmers in these areas upon request. Farm records and accounts will be a part of this service. That this full and complete service is needed has been

demonstrated the past three years by the fact that some farmers have been able to pay all expenses and interest and have made a fair living in spite of the depression. Others failed to make a farm pay even in good years such as 1929. Many farms now in the hands of finance companies are in great need of equitable leasing arrangements and scientific management.

Special Studies

A detailed budget study of hog production has been made for the Upper Snake River valley and a similar sheep study has been made for the Twin Falls project. These studies are of value to the Extension Service in approaching the hog and sheep enterprises with the profit motive foremost. They are in manuscript form.

Two other special studies have been completed. The first is published in Bulletin No. 191, *Hog Prices and the Hog Enterprise on Idaho Farms*. This Bulletin gives an analysis and a history of hog prices in the Pacific Northwest. It discusses the profitableness of using wheat as the basic feed for hogs in Idaho.

Of special interest to the dairy industry is Station Bulletin No. 193, *Efficiency of Cream Stations in Cream Collection*.

Agricultural Engineering

EXPERIMENT Station projects in Agricultural Engineering consist of applied engineering in the fields of reclamation, power and machinery, rural electrification, and farm structures. This work is largely cooperative with other Departments of the Station, with the Bureau of Agricultural Engineering, United States Department of Agriculture, and with State Departments and organizations.

Reclamation, Irrigation, and Drainage

The work on reclamation, irrigation, and drainage has included a study of "The Efficiency of Irrigation Drainage Pumping Plants" in cooperation with the Bureau of Agricultural Engineering, United States Department of Agriculture. The work on this project is of interest to most of the irrigated sections of the State, as drainage pumping offers a means of control of a rapidly rising water table. This is imperative in many of our irrigated districts. During seasons of water shortage the pumped water is in demand and in many seasons has been a means of saving or increasing crop yields that otherwise would have faced a severe reduction or failure due to a limited water supply.

The influence of irrigation on soil fertility has been studied in cooperation with the Department of Agricultural Chemistry and the results of its analyses of samples of irrigation and drainage water taken from seeps, ditches, drains, and drainage pumping plants have indicated that with correct practice most of the drainage water in the State can be re-used for irrigation purposes.

The reclamation of alkali land has been studied in cooperation with the Department of Agricultural Chemistry and the Bureau of Agricultural Engineering, United States Department of Agriculture. Drainage has continued to be of major importance in combatting the formation of and effecting the reclamation of alkali land.

The time and amount of irrigation required for major crops was halted temporarily by the prevalence of the beet leafhopper at the Experiment Substation farm at Aberdeen where work on sugar beets was in progress. The irrigation studies on potatoes have been continued in cooperation with this Substation and indicate that the control of the intervals between the irrigations has more effect on the quality of the potatoes than does the total amount of water used during the growth of the plants. In cooperation with the Department of Plant Pathology studies have been continued on the effect of the time of irrigation upon the yield of beans. A maximum yield of 49.3 bushels per acre was obtained from the plots planted in sheltered locations, indicating that protection from cold winds influenced the yield more than did the variations in the irrigation practice.

Farm Power and Machinery

The direct harvesting of field peas with the combine has been included in the study of harvesting methods and equipment. This work has been reported in Extension Bulletin No. 85, *Harvesting Field Peas with the Combine*, published in March, 1932. During 1932 a new type of combine reel was built in the agricultural engineering shops with the assistance of Mr. Ted Nelson. The new reel, which is essentially a cam-operated, side-delivery rake mechanism replacing the regular slat-type combine reel, proved very efficient in reducing shatter and in lifting the vines from the cutter bar to the header platform.

Methods of harvesting hay have been studied at the Substation farm at Caldwell, where chopping the hay as it is brought from the field has been practiced for the past two years. The second cutting of alfalfa was handled from the field hay cocks to the chopped rick by a ten-man crew and four teams. Three men pitched in the field and three men worked in the stack yard feeding the cutter, unloading, and stacking. The hay was handled at the rate of 2.5 tons per hour, requiring 3.58 man hours per ton with a labor and machine cost of \$1.88 per ton. This method of handling hay offers a material saving in labor over the stacking and chopping practice. However, there is grave danger of spontaneous combustion taking place in the chopped rick unless the hay is allowed to cure thoroughly in the field.

The investigation of tillage problems has been continued with a study of the duty and cost of tillage equipment. The combined-group tillage operations required for growing wheat in the northern

part of the State saved from 20 to 30 per cent of the tillage costs as compared with similar individual tillage operations. Automatic records have been made of the machines' operation and dynamometer studies of the draft of several tillage implements. Cooperating with the Extension Soils Specialist, work has been continued on the development of deep-tillage equipment and the adaptation of the standard mold-board plow to the chisel type of implement. Data obtained from these studies have been used as a basis for Extension Circular No. 41, *Chisel Attachment for the Mold-Board Plow*, published in May, 1932.

This Department cooperated with representatives of the Oregon State Agricultural College and the State College of Washington in a study of the operation of the first Diesel tractor sold in the north-west. This machine was located at Arlington, Oregon, and was used during the months of March and April for plowing 6,880 acres of land, which it did at the rate of 6.52 acres per hour or a total of 1,055 hours of operating time. Dynamometer tests showed the tractor to be developing 59.84 horsepower when operating in high gear, traveling at the rate of 3.59 miles per hour, and pulling twelve 16-inch hold-board plows at an average depth of 5.5 inches. The records of the costs for fuel, repairs, and lubricating oil for the entire acreage averaged \$0.0778 per acre.

A study of the uses for stellite in agricultural machinery has included the application of this material to plowshares, chisel points, chain sprockets, cylinder and concave teeth, feed grinder hammers, and harrow teeth.

Rural Electrification

The cooperative studies in rural electrification have been reported in the annual rural electrification progress report made to the Idaho Committee on the Relation of Electricity to Agriculture.

The blower elevator on the hammer-type feed mill has been adapted to elevating and mixing grain independent of the grinding unit. Also a magnet tray has been devised for the removal of metal scraps from the grain being ground or elevated.

The use of ultra-violet light in agricultural production has been studied in cooperation with the Departments of Poultry Husbandry, Agricultural Chemistry, and Animal Husbandry. A preliminary report of the progress of this work may be found in Rural Electrification Progress Report No. 8. Results indicate that irradiation with ultra-violet materially improves the condition of the blood upon which the protection and recovery from disease depends.

The housing requirements for and the management of electric brooders under northern Idaho conditions have been studied in cooperation with the Department of Poultry Husbandry. Planer shavings used for insulation in a portable-type brooder house have been compared with no insulation in a house of similar construction. Also

electric brooders have been compared with coal brooders under the housing conditions noted.

The use of electricity for soil and hotbed heating is reported in Experiment Station Circular No. 68, *Electric Soil and Hotbed Heating*, published in October, 1932. This report deals with the application of a newly-developed soil-heating wire to hotbeds, cutting benches, and soil plots. Under northern Idaho conditions an average of two to three kilowatt hours per 3x6-foot sash may be expected where temperatures are maintained at 65° to 75° F. The electric heat permits a permanent installation of the hotbed and maintains the temperature regulated automatically to the needs of any particular plant. The use of the soil-heating wire for floor heating in brooder houses is reported in Vol. 15 No. 9 of the *Agricultural Engineering Journal*, issued in September, 1932.

The operation and management of electrically operated ventilating systems are being studied in cooperation with the Department of Dairy Husbandry.

Farm Buildings and Equipment

In the development of farm building plans for Idaho the structural testing of scale models and framing joints has been made possible through the courtesy of the Department of Civil Engineering and its testing laboratory. Plans were developed for several of the Substation farm buildings and for the restoration of the dairy barn at the University Farm. Also, plans have been made available from the Bureau of Agricultural Engineering, United States Department of Agriculture, from which blue print copies may be secured through the county agents or upon application direct to the Department. The complete catalog of these plans is available in Extension Mimeograph No. 4, *Farm Buildings and Equipment Plans*. The insulation and ventilation of farm buildings is being studied in conjunction with the rural electrification work and in cooperation with the Departments of Poultry Husbandry and Animal Husbandry.

The study of ventilation and lighting requirements for calf shelters conducted on the new calf barn in cooperation with the Dairy Husbandry Department included such factors as temperature, humidity, air changes, and light intensities. A commercial gravity-type ventilating system was shown to be an aid in maintaining desirable animal living conditions in a shelter where animal heat was low. During the five-month period, December to April, temperatures within the barn ranged from 29° to 61° F. with an average of 40° to 50° F. The humidity range was from 75 to 85 per cent. The ventilating system supplied 350 cubic feet of air per hour per calf when 30 calves were in the barn. At the higher outside temperatures it was desirable to supplement the ventilating system by opening windows. Light intensities in the pens ranged from 16 to 60 lumens depending upon conditions. Roof windows made possible higher

light intensities in the barn than were obtainable from wall windows. Roof windows were subject to frosting and snow coverage which reduce window efficiency.

Utilization of Surplus and Waste Products

In cooperation with the Department of Agricultural Chemistry, a method has been devised for blending alcohol with gasoline for use as a motor fuel. A mixture of 20 per cent alcohol and 80 per cent gasoline permits the use of higher compression ratios and apparently prevents the deposition of carbon and increases the efficiency of the engine from 15 to 20 per cent, as shown by block and road tests.

The calorific value of wheat when used as a fuel has been shown by laboratory tests to be about 8,000 B. T. U. per pound as compared with about 12,000 B. T. U. per pound of the average soft coal. Methods of burning wheat are being studied as a result of the inquiries received from localities where a surplus of wheat and a shortage of fuel exists.

Agronomy

THE 1932 growing season was preceded by one of heaviest snowfalls recorded at the Idaho Experiment Station in 40 years. This snowfall, combined with heavy precipitation in early spring, filled the soil with much-needed moisture to a depth of six to seven feet. Soil moisture determinations made in January showed 22 per cent of moisture in the fourth foot.

Investigations with Cereals

Winter wheat yields were reduced approximately 15 per cent below normal. This was due, undoubtedly, to a weakening of the vitality of the wheat plants caused by smothering from the heavy snowfall which remained on the ground for several months. Besides, some winter-killing in a few of the winter wheat varieties occurred in isolated areas. Marquis and Federation seeded in early September almost completely winter-killed. Jenkin seeded at the same time showed a slight loss of stand. However, spring varieties seeded in October survived with quite satisfactory stands. Jenkin was the high-yielding variety in the plot trials.

The season was favorable for the production of seeded small grains. Onas, a white kernalled variety, was the high yielding spring variety. Over a period of years, Federation, Jenkin, and Red Bobs are the outstanding varieties.

Banner was the leading oat variety from the standpoint of yield. Wasa, Victory, and Abundance, midseason white kernalled varieties, produced high yields. Markton, a smut-resistant variety, is the leading variety over a period of years.

Peruvian, White Smyrna, and Hannchen outyielded the other spring seeded barley varieties. Trebi is the outstanding variety from the yield standpoint over a 13-year period. Winter Club is the recommended variety for fall seeding.

A uniform winter wheat smut nursery containing 35 of the most important resistant and susceptible varieties was grown this season. The varieties selected were smutted heavily with spores from a bunt collection obtained from fields in the Palouse area. None of the varieties tested showed complete resistance to the disease. The percentage of infection in Redit was 25.8; in Oro, 31.6; in Albit, 32.0; and in Hybrid 128, 94.2. Unsmutted, clean seed of each variety was grown to check soil infection. In this trial the percentage of smut varied from 4.9 to 17.1, with no variety completely resistant.

Golden, a selection from Fortyfold made at the Sherman County Branch Experiment Station, Moro, Oregon, was distributed to farmers for fall planting. This variety is a valuable one in all sections where Fortyfold is adapted. Golden resembles the Fortyfold variety but is non-shattering and higher yielding.

White Top Controlled by Tillage or Chlorates

The investigational work pertaining to the eradication of perennial weeds was greatly increased. Two seasons' results have been secured upon the eradication of White Top (*Lepidium draba*) in the Boise valley. Five pounds of sodium chlorate per square rod, applied in two doses of one and four pounds respectively at a two-weeks interval, produced 100 per cent kills. Cultivation is effective for large areas if frequent enough to keep down all green top growth. The two-year tillage program carried on in the Boise valley has been effected at a total cost of \$36 per acre. This cost has been computed by using 30 cents an hour for man labor and 10 cents per horse-hour. Effective tillage should include early spring plowing followed by a blade at frequent intervals. Six acres of alfalfa sod badly infested with White Top were used in the experiment. Replacing the second season's cultivation with thickly seeded smother crops of soybeans, millet, sorghum, hemp, and corn was not successful in holding down the weed.

Soil applications of sodium and commercial calcium chlorates made in September were more effective in the control of Bindweed (*Convolvulus arvensis*) than plant applications. Numerous additional soil applications on a number of weed species have been made this season. In addition, ammonium sulphocyanate, calcium chloron, monochloronaphthelene, and numerous combinations of chlorates with zinc salts have been applied to the various serious perennial weed species.

Soy Beans Adapted to Warmer Areas

Sixty new varieties of soy beans recently introduced from the colder sections of the Orient were added to the yield and adaptation

trials located at Summit. The results of these tests and extensive trials by numerous farmers have demonstrated the value of this crop for pasture during the summer drought period. A few farmers have used the crop effectively as a soiling crop for dairy cows. Minsoy, Manchu, Elton, Mandarin, and Chestnut are the better varieties for Idaho conditions. These varieties will ripen anywhere in Idaho where navy beans or corn mature satisfactorily. Acre plots of the Minsoy variety have yielded from 2,000 to 2,400 pounds of seed per acre under irrigation in southern Idaho. Soy beans make an excellent annual hay crop in the warmer irrigated areas.

New Crop Possibilities

The purple seeded strain of sweet clover with a crown like alfalfa produced seed this season. Many of the individual plants selected from this strain show promising vegetative characteristics and additional selection of the better types will continue. Stem and root heterosis was shown in first generation hybrid white sweet clover plants. It is believed that this is the first time that root heterosis has been called to the attention of agronomists. Late blooming plants of white sweet clover, producing large numbers of fine, leafy, sterile stems and non-shattering seed habits, have been isolated. The sterile stems were still growing vigorously in September.

A number of plants of red clover homozygous for seed color have been developed. All of these plants show a high resistance to powdery mildew. Studies upon the resistance of red clover to powdery mildew were begun in 1930. Lack of resistance in many of the progeny of highly resistant strains is due to the lack of heterozygosity for disease resistance in the original parents. Selfing is now used to develop homozygous types for disease resistance.

Mahogany colored blooms, purple seeds, high forage production, and winter hardiness are the important characteristics of the new Lardino clover strain. Sufficient seed of this strain is now available for plot trials in 1933. Additional study will be made of the progeny of some of the more outstanding plants.

Other active plant-breeding projects include work with alfalfa, sunflowers, slender wheat grass, corn, and beans

Crop Rotation Work Valuable.

Crop rotations at the University farm, Moscow, show that good crop yields can be obtained without summer fallow. Peas are an excellent substitute for fallow. Potatoes appear to be the best cultivated crop in the rotation. Alfalfa and sweet clover are suited for use in the longer rotations. The yields of subsequent crops are increased for two or three years following these legumes. Manure applied every third year is effective in increasing crop yields.

Pot experiments with "slick spot" soils indicate that greatly increased yields are obtained by the use of phosphorus. Apparently

the poor physical condition together with the phosphorus deficiency are the causes of the unproductiveness in these soils.

Deep tillage in place of fall plowing assists greatly in reducing soil erosion. In some instances the moisture penetration was greater in the deep tilled areas. This was especially noticeable two or three years after the soil had been deep tilled.

The soil survey work was continued in Bonner county. Another season will be necessary to complete the field work in this county because of the numerous soil types and the rough character of many parts of the area. Aerial photographs have assisted to a considerable extent in mapping the rougher areas.

Animal Husbandry

ACTIVE projects in Animal Husbandry are: studies comparing Idaho-grown feeds, including various by-products, for fattening steers and lambs for market; studies to increase the value of sweet clover pasture; studies with various feed combinations for growing and fattening swine; animal breeding studies having to do with variations and abnormalities affecting swine and sheep; and animal diseases.

Steer and Lamb Feeding

Feeding investigations have been conducted at the Caldwell and the Aberdeen Substations to determine the best use of home-grown feeds for fattening steers and lambs for market. Extensive use has been made of the various by-products available in the State to determine their value when fed with alfalfa hay and barley for fattening lambs and steers. The by-products that have been fed experimentally included cull beans, cull peas, alfalfa seed screenings, cull potatoes, beet pulp, beet syrup, alfalfa chaff, and clover chaff. A portion of the experimental work with lambs was conducted at the Aberdeen Substation because of easy access there to some of the by-products, especially those of the sugar beet industry.

This program of experimental feeding has as its objective the permanent establishment of the feeding industry in Idaho. This will provide a home market for range livestock that does not carry sufficient finish to justify shipping it for slaughter. During the feeding period upon the farms in the irrigated valleys, these animals consume grains, forage crops, and by-products and serve as an effective market outlet for such products.

Further reference to results of steer and lamb feeding investigations will be found in the section of this report devoted to the Caldwell Substation and to the Aberdeen Substation.

Pastures

As a result of pasture management studies in connection with sweet clover, it has been found that the efficiency of sweet clover

pasture can be increased by approximately 25 per cent when one-half to two-thirds bushel of a hardy, profusely growing variety of wheat or rye has been seeded into the first-year sweet clover in September or October. The increased value is due in part to increased tonnage, but more largely to the fact that the wheat or rye makes it possible to have green feed from two to four weeks earlier in the spring. Tests are under way to determine the practicability of similar methods of improving alfalfa forage for swine inasmuch as alfalfa is rather slow growing in cool spring weather.

Swine Feeding

Feeding trials with swine show that alfalfa hay or leaves may be used very satisfactorily, not only as a supplement in feeding pigs for the market but also for making a cheaper and more efficient ration for brood sows in the winter. Trials further show that rations are made more efficient by the use of an animal protein, such as skimmilk or tankage. It has been found in repeated trials that ground wheat is worth about 5 per cent more than corn and from 12 to 15 per cent more than ground barley for fattening swine.

Experimental studies at this Station, combined with a survey made in cooperation with the Meat Inspection Service of the United States Bureau of Animal Industry covering nearly 800,000 hogs, reveal that only a small percentage of hogs that have retained testicles (cryptorchids) are condemned when slaughtered as the sex odor does not seem to develop to any marked extent before the pigs are six months of age.

Animal Breeding

Short ears, and often a total absence of ears, in swine is associated with incomplete development of the bony structure of the inner ear which renders the victims of such defects deaf. Pigs have been born with this defect in a number of herds in the State.

In a number of herds sows have been found with "blind" teats. Such teats are inverted and do not yield milk. In some cases one-half of the teats have been defective, rendering the sow only 50 per cent efficient. By experimental matings it has been found that this defect is inherited.

Large moles (Melanotic tumors) have cropped out in some herds. These may be found up to two inches in diameter on the back, sides or hams, and must be removed before the cuts are merchantable, and hence lower the value of these cuts. This defect has also been found to be heritable in experimental matings.

This department has previously reported that the overshot or undershot jaw defect in sheep is inherited, and that it is likewise a significant disturbance in many of the flocks in the State.

The inherited defects that are listed above are of considerable annoyance to the livestock breeders of the State and must be elim-

inated by carefully avoiding the use of defective animals or animals that have been known to produce defective animals.

Animal Diseases

Studies have been carried on in cooperation with the Bacteriology, Poultry Husbandry, and Dairy Husbandry Departments, and the State Department of Agriculture, on diseases of cattle, sheep and poultry.

Mastitis has been conservatively estimated to be responsible for as great loss to the dairymen as any single disease affecting cattle. The use of formalin per orum, autogenous vaccines subcutaneously, colloidal carbon intravenously, and ultra-violet light applied directly to the udder have been tried. None of the treatments eliminated the infection. However, ultra-violet light relieved the clinical symptoms of the disease and restored the milk to normal appearance.

Bang's-abortion disease infected cows have been shown to produce 28 per cent less milk than similar cows free from the disease. A flexible program has been worked out for the control of Bang's-abortion disease which has for its ultimate aim the elimination of positive reactors from the herd. The plan of eradication selected by Idaho dairymen depends, first, upon the status of the disease in the herd as shown by the number of abortions and by the blood test and, second, by the adaptability of the equipment and resources at hand. Temporary isolation of reactors at calving time, complete segregation of reactors, or the beefing of reactors, are examples of programs adopted.

Foul sheath infection of rams is responsible for the rejection of approximately 25 per cent of the rams inspected yearly for ram sales in Idaho. A study of this condition shows that the disease is infectious. Best results in control consist in segregation and treatment of affected rams. It was found that the application of pure powdered copper sulphate to the cleaned area two to three times weekly will readily eliminate the infection in mild to moderately severe cases.

The grub of the gad fly of sheep is responsible for the majority of cases of nasal discharge in sheep. Practically all farm sheep are affected with this condition. The purely range sheep, however, are relatively free. No practical method of prevention seems to be satisfactory, although the use of carbon disulphide when correctly administered is very efficient in killing the grubs when they are present in the sinuses of the sheep's head.

Reliable worm remedies are in great demand in the State, since intestinal parasites of poultry are responsible for enormous losses to poultrymen. Approximately one-third of the birds autopsied in the laboratory during the past year were heavily infested with parasites.

Three widely advocated tapeworm remedies were tested. It was found that Kamala at the rate of one gram for four-pound pullets administered after an 18 to 20 hour fast was practically 100 per cent effective in eliminating tapeworms and the most satisfactory treatment tested.

Bacteriology

Bacillary White Diarrhea Studies

THE poultry accreditation program suffered a severe setback during the past year, due to the low market value of poultry products. In cooperation with the Poultry Husbandry Extension Service, 6,402 samples of blood, representing 15 commercial flocks, have been tested. In order to determine the efficiency of a single test for eradicating this disease from breeding flocks, it was decided to make two retests on as many of these flocks as were practicable. The first retest was made on 4,268 blood samples, representing 10 flocks. The second retest has not yet been made. The first test showed an infection incidence of 7.23 per cent. Though the data from the retests are not yet complete, it is very reassuring to find that few reactors were found which were not apprehended in the first test.

Studies in Udder Infections

This project has been pursued for several years in cooperation with the Dairy and Animal Husbandry Departments. The project has had two distinct aspects. The first is the laboratory aspect, where the causative organisms have been isolated and where tests have been conducted with the hope of finding some reliable means of detecting milk from infected udders. This phase of the project has been puzzling because of the discovery of the occurrence of wide degrees of infection. The livestock owner usually recognizes the acute case of mastitis, where the udder is swollen and the animal is in distress, but he usually fails to recognize the far more common type of mastitis where the animal shows no signs of discomfort and where often the udder and even the milk appear quite normal. Because of the wide variation in the visible symptoms it becomes quite necessary to establish some laboratory technique or procedure for detecting milk from these subclinical cases. Many tests have been made on samples of milk from the individual quarters of dairy cows with the hope of finding some method that would prove a reliable indicator of udder infection. The following tests have been run simultaneously on the same samples of milk: numbers of bacteria per cubic centimeter on plain and blood agar; leucocytes per cubic centimeter; catalase; H-ion concentration; chloride content; titrable acidity; formaldehyde; cured tension; and type of organism causing infection.

During the course of these studies samples of milk from the entire herd of dairy cows of the University have been tested several times. The conclusion has been reached that no single method is reliable for detecting the mild subclinical cases. The leucocyte content and the bacterial count on blood agar containing 1 per cent dextrose of aseptically drawn samples seem to be the most reliable indicators of udder infection. These have been taken as a basis for the segregation of the animals into infected and infection-free herds.

The second phase of these studies has dealt with the value of autogenous vaccines, ultra-violet light, colloidal carbon, formalin, dyes, and other chemicals for curing mastitis.

The limited data show that none of the treatments used was effective in eliminating the causative organisms from the udders or even in regularly reducing the numbers of organisms or associated leucocytes. Of ten cows treated with two or more of these methods, only one showed a permanent recovery as indicated by a return to a normal bacterial and leucocyte count in milk.

The technical papers embodying some of the results of these investigations now are in the process of publication.

Availability of Plant Nutrients and Response to Fertilizers of Idaho Soils

Chemical, biological, and field aspects of this problem have been studied through the cooperation of the Departments of Agronomy, Agricultural Chemistry, and Bacteriology.

Many samples of soil from all parts of the State have been tested to determine their need of phosphorus and other nutrients.

Eradication of Infectious Abortion

A survey of several cow testing associations located in different sections of the State revealed the fact that 13 per cent of the cattle reacted positively to the agglutination test. This high incidence of the disease led to a demand for a State program for eradicating the disease from the infected herds, and for giving recognition to those herds which were free from the disease. Through the cooperation of the State Department of Agriculture, Extension Dairy Specialist, County Agents, and the Animal Husbandry, Dairy Husbandry, and Bacteriology Departments of the Idaho Agricultural Experiment Station a statewide program has been carried on.

The results of this program can be judged from the fact that 30 certificates of accreditation have been issued by the State Department of Agriculture in recognition of abortion-free herds. During the year up to November 15, 18,735 samples of blood had been tested. The data secured from these tests show that of the 960 herds tested 539 had no reactors, and 421 contained infected animals. These non-reacting herds will be eligible to accreditation after they have passed three clean tests during a single calendar year, provided all

mature animals have been tested. A total of 1,820 reacting animals were found, which makes an infection incidence of 9.7 per cent.

Miscellaneous Services

Legume Inoculation. Cultures of root nodule bacteria for the legumes are prepared and sold to the farmers of Idaho at cost.

Public Health Work. A limited amount of bacteriological work is done in connection with city milk supplies and farm and municipal water supplies in northern Idaho.

Dairy Husbandry

The Dairy Herd

AVERAGE production per cow during the past year was 13,951.1 pounds of milk and 49.3 pounds of butterfat. The monthly average number of cows in milk was 45.2. Twenty-six official production records of 10 months or a year were completed. Inventory showed 65 Holstein females and 39 Jersey females, totaling 104 females. The fourth consecutive certificate as an accredited Bang's abortion free herd has been received. The herd is also accredited as free from tuberculosis.

Continuous Use of Proved Sires

The continuous use of proved sires, pure in their inheritance for high milk and butterfat production, is a project carried for the past 12 years in cooperation with the Bureau of Dairy Industry, United States Department of Agriculture. One hundred ten female offspring have been obtained from the original 14 foundation cows. The number in each generation is 25 F¹, 31 F², 30 F³, 22 F⁴, and 2 F⁵. Seventy-three have completed yearly records and 62 of the 110 are still in the herd. Ten bulls have been used, seven of which have been proved by dam and daughter comparisons in this herd.

Bull Association Studies

For four years, up to July 1, 1929, this was a cooperative project with the Bureau of Dairy Industry, United States Department of Agriculture. Since 1929 it has been continued as a state project. Two bulletins have been published on results from this project. At present in Idaho there are 17 cooperative bull associations, representing 392 members, 70 bulls, 397 purebred cows, and 1863 grade cows, making a total of 2260 breeding females. Four associations have operated for 10 years, 2 for 9, 2 for 8, 1 for 7, 2 for 6, and 6 for 5 or less years.

Growth Studies

Normal growth studies on both the Holstein and Jersey herds have been in progress for 14 years. Data on the effect of pregnancy on body weight have been collected for the same period of time.

Breeding Efficiency

A field study is under way on about 50 dairy herds to determine the variations in breeding efficiency with respect to such factors as calf crop, abortion tests, production records, feeding and management, etc. The local Station herd is being studied more in detail by monthly veterinary examinations and careful daily records. During the past year the breeding efficiency of the Holstein herd was 79.1 per cent, while the Jersey herd averaged 81.4 per cent. The two herds combined averaged 80 per cent on the basis of one calf per cow each 12 months (Subject to correction). This project is being carried in cooperation with the Station Veterinarian, the Station Bacteriologist, and with field agencies.

Inheritance of Wry Tails in Jersey Cattle

Appearance of a number of calves having tails set off to the left called attention to this problem. Study of records justifies the conclusion that this is a heritable character and is of interest as another known heritable character of cattle.

Calf Feeding Investigations (Minimum Milk Plan)

Group I consisted of four Holstein calves and Group II three Jersey calves. Whole milk was fed for 70 days. Hay and grain were given as early as the calves would take them. At six months of age Group I averaged 89 per cent normal in weight and 89 per cent in height, while Group II averaged 81 per cent normal in weight and 86 per cent in height. Cost of raising to six months of age was \$22.67 per calf in Group I and \$14.54 in Group II. Results indicate calves can be raised fairly well under this system and its merit depends on prices of competitive feeds.

Ventilation and Lighting of Calf Barns

Detailed study was made of the efficiency of the roof lighting system and a modern gravity ventilating system in a new calf barn of the sunlit type. This project is in cooperation with the Department of Agricultural Engineering and further details will be found under the report of that Department.

Studies of Udder Infections

The detection and treatment of mastitis has received attention for three years. During the past year two papers have been prepared and were published in January, 1933. "The Leucocyte Content of Milk as Correlated with Bacterial Count and Hydrogen Ion Concentration for the Detection of Mastitis" was published in the Journal

of Dairy Science, and "Treatment for Mastitis with Ultra-Violet Light, Formalin, Colloidal Carbon, and Autogenous Bacterins" will appear in the Journal of the American Veterinary Medical Association. This project is in cooperation with the Departments of Bacteriology and Animal Husbandry.

Cream Buying Stations

Study of the efficiency of this agency has been completed, and the report published as Experiment Station Bulletin No. 193, "*Efficiency of Cream Stations in Cream Collection.*" This project is in cooperation with the Department of Agricultural Economics.

Standardizing Milk for the Manufacture of Cheddar Cheese

Results indicate that liquid skim milk and spray process skim milk powder are the most satisfactory standardizing media and that standardizing ratios of fat alone and one part of fat to 2.6 parts of solids-not-fat give the best results. Vacuum and roller process skim milk powders cannot be used successfully because of illegal composition of the cheese, high fat losses in the whey, and poor body and texture of the cheese.

Influence of Starters on the Quality of Cheddar Cheese

A study was made of the influence of an Ericsson starter, Ames starter No. 122, and pure and mixed cultures of *Streptococcus citrovorus* (Hammer), *Streptococcus paracitrovorus* (Hammer), and a strain of *Streptococcus lactis* on the quality of cheddar cheese. The results have been accepted for publication in the Journal of Dairy Science in the spring of 1933 as Research Paper No. 88 of the Idaho Agricultural Experiment Station.

Casein Investigations

A study of the influence of washing upon the ash content of both grain curd and natural sour casein was made. The results indicate that casein with a lower ash content, lower moisture content, and total acidity could be produced by increasing the number of washings with either cold or warm water. Warm water at a temperature of 94° F. was more efficient than cold water at 54° F. Work in progress consists of the effect of the various phases in manufacture of natural sour casein on its physical and chemical properties.

Comparison has been made of the methods of chemical analysis of casein. A uniform method has been evolved and the results prepared for publication. This project is in cooperation with the Department of Agricultural Chemistry.

Butter Improvement Program

Butter from 22 Idaho creameries was analyzed at weekly intervals over a period of five months. The analyses represented tests for moisture, fat, salt, curd, and yeast and mold content. Results showed the composition of the butter to be quite uniform both as a whole

and within individual creameries. Butter from only one creamery had a fat content consistently below 80 per cent, while two had a curd content above 1 per cent. With one exception all creameries had a uniformly low yeast and mold count, which indicates that good control measures are generally practiced in Idaho creameries.

Results of the microscopic examination of 326 samples of Idaho butter indicated a correlation between the bacterial content and the flavor score, since with a decrease in the bacterial content there was a trend toward a higher flavor score.

Service

Official testing of herds for production required a grand total of 245.5 days of supervisors' time. An average of 100.5 cows was tested each month, and about 12 breeders were served each month. The glassware calibration laboratory received 6216 pieces, of which 6206 were found accurate and etched "S. G. I." (Standard Glassware Idaho), eight were inaccurate and two broken. Analyses of dairy products included 240 samples of milk, 16 of cream, and 2 of ice cream tested for fat; 344 samples of butter analyzed for fat, moisture, salt, and curd; 326 samples of butter analyzed for yeast and mold content and direct microscopic examination.

Cooperative Projects With the Caldwell Substation

Reports on projects carried in cooperation with the Caldwell Substation will be found under the section in this report devoted to the annual report of the Substation. Projects reported are vitamin "A" content of pasture plants, alfalfa seed screenings compared to linseed oil meal for milk production, and milking machine investigations.

Entomology

Insect Punctures in Beans

EXPERIMENTAL work carried on during the summers of 1930 and 1931 show that two species of insects of the genus *Lygus* are responsible for puncturing of beans in Idaho. Experimental work with these two species was continued throughout the summer of 1932.

The life history of one species, *Lygus elisus*, was only partially described by previous workers; the other, *Lygus hesperus*, has not been described before. The eggs of both species were found to be oviposited in the tissues of host plants, and to require nine days for incubation. There are five nymphal instars in each species; the first was four days; the second three days; the third three days; the fourth three days; the fifth five days. The entire period from egg to adult was 28 days in both species.

Apparently both species cause puncture injury to beans, but since the largest population on beans are *Lygus hesperus*, undoubtedly this species causes the greatest damage.

Punctures were studied in commercial beans as in the two previous seasons. The greatest amount of injury occurred in the Twin Falls area. The highest average for any district was 1.69 per cent of punctured beans. Host plants were studied and many weeds were found to be host of both species. The population studies showed that populations of insects were higher in 1932 than in 1930 and 1931. Two parasites, one in *Lygus* eggs and the other in *Lygus* nymphs, were found. They apparently are not exceptionally efficient as parasites of *Lygus*.

Attempts were made to control the *Lygus* insects with pyrethrum and sulphur, but neither appeared to be efficient. The insects can probably be controlled in beans by changing of the cutting dates for the second crop of alfalfa.

Western Cooperative Oil Spray Project

Experimental work was continued in connection with the Western Cooperative Oil Spray Project. The extensive codling moth control experiments were brought to a close in 1931. One control experiment was made, using oil and pyrethrum in place of lead arsenate. The strength of the pyrethrum extract was increased from 1 part in 2600 of water as previously tested, to 1 in 400 and 1 in 800 parts. Oil was used at the usual 0.8 per cent strength. A low degree of control was obtained, there being 58.7 per cent clean fruit for the Delicious variety, and 45.9 per cent clean for Romes.

The tests of injury from summer type oil on apple trees were continued, completing the fifth year of the tests on the same trees. No injury to tree growth, foliage, or fruit was observed.

The codling moth bait traps were operated as in former years. The information obtained is always in much demand by local orchardists in setting the proper time for spraying. The records are not only of value to the apple growers, but to the Station since the data are used in formulating the codling moth spray recommendations issued each year.

Oil was used in experimental spray tests for the destructive prune worm. A combination spray was tested that showed promise as an effective dormant spray for San Jose scale as well as giving commercial control of the prune worm. This spray is dormant oil at 3.5 per cent with pyrethrum extract at 1 to 400 strength.

The Colorado Potato Beetle

The State Department of Agriculture cooperated with the potato growers in conducting a potato beetle control campaign in the infested territory of southwestern Idaho. The Parma Field Station had entomological supervision of the control work. The years' devel-

opment showed some increase in the intensity of infestation in Canyon county. The only new territory known to be infested during the year was a small locality near Marsing in Owyhee county. First steps were taken toward introducing a parasite of this pest from Iowa.

The Destructive Prune Worm

Experimental spray tests were made in an effort to develop a satisfactory control for this insect. Promising results were obtained with sprays containing pyrethrum. A kerosene-soap emulsion spray with pyrethrum extract at 1 to 400 strength gave a kill of 93 per cent. A dormant oil (scale spray) with the same strength of pyrethrum gave a kill of 71 per cent. Observations indicated that actual mortality was higher than percentages given, due to the activating effect of the pyrethrum on the larvae and resultant escape of sprayed larvae that missed the counts. Lime sulphur sprays gave little, if any promise, and nicotine sprays gave very low kills. No satisfactory data were obtained from summer sprays.

Aromatic bait traps were tried out, using the aromatic oils terpinyl acetate and ethyl cinnamate, and the standard codling moth bait, dimalt syrup. More moths were captured throughout the summer in the dimalt bait traps than in either of the other traps.

Fruit counts in the infested orchard near Parma showed an increase in worm injury from 5 per cent in 1931 to 9.5 per cent in 1932.

Leafhoppers of the Apple and Prune

There are two species of leafhoppers that are important pests of the apple in southwestern Idaho, *Empoasca maligna* Walsh, and *Typhlocyba pomaria* McAtee. The latter is also a pest of the prune. The studies were a continuation of those started in 1931. Experiments in control were also conducted.

The winter is passed by both species in the egg stage under the bark of the twigs and branches. *E. maligna* is a green leafhopper, occurring only on the apple and having but one generation a year. *T. pomaria* is white or straw-colored, is found on both apple and prune, and has two generations a year.

Injury to the tree is caused by the removal of the leaf juices by the insect, lowering the vitality of the tree, and reducing the quality of the fruit. Unsightly spotting of the fruit results from heavy infestations.

Control experiments showed that the standard contact insecticides will give good control if applied while the insects are in the nymphal stage, or about June 1. The insecticide used may be combined with lead arsenate in one of the early codling moth sprays on apple, or applied alone on prune. Oil at 0.8 per cent strength gave a high degree of control. The materials tested and found satisfactory were

oil, nicotine sulphate, "Cubor" (pyrethrum and rotenone), pyrethrum extract, and "Soluble Palustrex A" (pine oil and free nicotine with oil).

The Beet Leafhopper

Field data on the beet leafhopper were gathered in southwestern Idaho in cooperation with the Bureau of Entomology, United States Department of Agriculture. Spring collections showed an extreme scarcity of the leafhoppers on the breeding areas. The spring host plant conditions were very favorable for the insect, with mustard common throughout the area. The principal summer host, Russian thistle, was very general, though sparse, and provided favorable host plant conditions until the end of the season over about 26,000 acres scattered throughout the territory under observation from Ontario, Oregon, to Bruneau, Idaho. The unit populations in July of 1931 were the lowest in the six year period, 1927-1932, and the unit populations of a year later were but slightly more. Due, however, to the tremendously increased host plant acreage in 1932, as well as favorable host plant growth, the fall populations of the leafhoppers in the aggregate are undoubtedly far greater than in the fall of 1931. A mild winter with a low mortality of the over-wintering females may result in the presence of sufficient numbers of leafhoppers in the spring of 1933 to cause some degree of damage to sugar beets within the range of the breeding areas of southwestern Idaho.

Development of Sugar Beets Resistant to Curly-top

Breeding by the mass selection method is being carried on with two strains started in 1925 and 1926. Yield tests were made in 1931 and selections made of seed beets. These beets were planted in 1932 for the production of the seed crop. Although the seed beets showed marked symptoms of curly-top, the disease was not severe and did not materially affect the production of seed. Seed from the same lot tested in 1931 was planted again in 1932 for seasonal observations on the disease. The scarcity of leafhoppers during the season resulted in little damage to the crop, although nearly half the beets showed disease symptoms.

The Silver Mite on Prune

Silver mite injury to prune was reported from many prune orchards of southwestern Idaho during the season. The mite first came to the attention of the Station in 1930, and seems to be increasing in importance. The mite feeds on the leaf surface to such an extent that the quality and size of the fruit is seriously impaired. The mite infests the leaves during May and June, disappearing about July 1. Summer oil sprays seem to afford control, but must be applied in May or early June to prevent injury. Little is known of the life history and habits of this mite in Idaho, and it is planned to make a study of the pest during the coming season.

Bacterial Wilt of Alfalfa

Studies started in 1930 on the varietal resistance of alfalfa to the bacterial wilt disease were continued in cooperation with the Department of Plant Pathology and the Aberdeen Substation.

Pea Weevil

The pea weevil investigation, in cooperation with the Bureau of Entomology, United States Department of Agriculture, was conducted on a smaller scale than during the previous two years of the project. Investigations were limited to a study of flight and hibernation in areas remote from pea fields and to observations on life history that had an immediate bearing on these two phases of study.

Frequent observations on weevils in hibernation under pine bark were made. Weevils were found to be more numerous in hibernation than they were the two years preceding. A few weevils were found in hibernation as late as the latter part of August, the time when new weevils were emerging. From these results, it would seem entirely possible that a few weevils will pass through a second winter before becoming active.

A series of nine two-way flight traps and eight weather-vane flight traps were operated from the middle of April until the latter part of October. There was no pronounced increase in the numbers of weevils collected in traps during the first part of June to correspond with the greatly increased numbers of weevil obtained by sweeping peas at that time. The height in number of weevils collected in flight came on September 23. Data obtained do not indicate that there is any pronounced flight toward distant wooded areas for hibernation. On the contrary, the flight seems to be in every direction.

Sweeping records were obtained from both volunteer and planted peas. Small numbers of weevils were present in volunteer fields as soon as sweeping was started on May 17. A very heavy increase in numbers of weevils occurred during the first part of June. Weevils appeared in small numbers in one of the planted fields before blossoms developed. Sweeping records showed that there was a migration of weevil from an early planted field to an adjacent late planted field when the latter came into blossom. Sweeping records in one field showed heavy weevil populations at one edge of the field next to a brushy fence while only a small number of weevil were present elsewhere in the field.

Well formed eggs were found in the ovaries of a female on May 31. The first deposited egg was found on June 8, and the first egg was found to have hatched on June 18.

Development of weevil within peas in one volunteer field and one late-planted field was studied by splitting open 500 peas from each field at four-day intervals. In the planted field, the first pupae were found on July 29, the first adult on August 7, and the first adult was

found to have emerged on August 15. The studies in this field showed that the pupal stage was approximately 12 days. Splitting in the late-planted field resulted in finding the first pupae on August 18, the first adults on August 30, and the first emerged adult on September 19. The approximate length of pupal stage in this field was 16 days.

This year's work concludes active participation by the Idaho Experiment Station in the pea weevil project.

San Jose Scale

Field work on San Jose scale was conducted in the Lewiston orchards and supplementary laboratory work in the Moscow laboratory. Control experiments, transfer experiments, and life history observations were the phases of investigation carried on.

Five different sprays were applied to plots of scale-infested apple trees. Dry lime-sulphur at the varying rates of 15 pounds, 20 pounds, and 33 pounds to 50 gallons of water; liquid lime-sulphur of 5° test; and commercial oil emulsion at the rate of four gallons of emulsion to 96 gallons of water, were the sprays applied. The degree of control was much better in June than it was in May on all lime-sulphur plots, as was evident at these times from counts under a microscope of live and dead scales. The liquid lime-sulphur plot and the oil emulsion plot were the only ones on which good control was produced. Many females on lime-sulphur sprayed bark did not produce young.

San Jose scales in the crawler stage, when transferred to sprayed and unsprayed bark, seemed to be able to maintain themselves nearly as well on one as the other. Transfers were made to branches on test trees by tying to them twigs from other trees heavily covered with crawlers. The transferring was done three months after sprays had been applied.

The development of the scale insects was closely observed throughout the season by means of field and laboratory examinations. Measurements of scales were made at different times. Male scales were found in the pupal stage on May 14 and on May 19 an adult male was found. A large per cent of the males had emerged prior to May 28.

Crawlers first appeared in the laboratory on June 16 and in the field on June 27. Production of crawlers continued over a period of more than a month since overwintering females that were still producing young were found as late as August 5.

Home Economics

INASMUCH as this year is the fifth report in which investigations into the nutritive value of foods have been carried on by the Home Economics Department of the Idaho Experiment Station it seems

fitting in making this one not only to review the progress of these investigations but to point out how this work may be related to any program for betterment of rural life and the advancement of positive health for the people of the State.

The problem of the best use of food is an economic as well as a physiological one. Not only should the available food supply serve the highest need of the individual for health and efficiency but it should be so used that the same high standard may be available to the greatest possible number.

The advances made in the science of nutrition during the last few years have shown that freely-chosen dietaries which superficially appear to meet the desire and need for food may prove to be most inadequate in some mineral element or vitamin. So much evidence, both from laboratory experiments and from clinical observations, has accumulated that the idea of an adequate diet has already changed from one which merely avoids deficiencies to one which promotes positive health and increases longevity. Viewed in this light the best use of food can only be made when values and deficiencies of the individual foods, as they are eaten, are known. It is to further this knowledge of food values that the investigations of Idaho food materials are conducted at the Experiment Station.

Vitamin C in Potatoes

The first study to be undertaken was that of the vitamin C value of the Idaho Russett Burbank potato, commonly called the Netted Gem. This potato is of considerable economic importance and is available everywhere in the State as a staple article of food.

With a better understanding of the functions of vitamin C in the body it is now known that this vitamin not only protects from scurvy but assists in the normal healing of bone wounds, is a factor in the prevention of tooth defects, and is necessary for general good health and vigor. It is important, therefore, that as much information as possible concerning the occurrence of this nutritive factor in individual foods should be collected. Practical experience has shown that the potato is of very great value in preventing scurvy but the reports of experimental work are somewhat contradictory and very little has been known about variety or the effects of storage.

Crops of four different years of the Netted Gem have now been studied and while a more complete report will soon be ready for publication, there are several facts which should be noted here.

Boiled potatoes do protect animals from scurvy and permit good growth over long periods of time. Two guinea pigs were kept for more than a year in the Home Economics laboratory on a diet in which the sole source of vitamin C was a feeding of boiled potatoes six times a week. These animals grew to normal adult size and when the test was ended and post mortem examinations made, signs of

only very mild scurvy could be found. However, they had not always been free from symptoms of this disease, indicating that the potatoes had not been uniform in antiscorbutic properties all through the year.

Tests with smaller doses of potato for shorter periods have given evidence of the following facts:

1. Boiled immature tubers of this variety of potato have the highest vitamin C content.

2. The fresh mature tuber when boiled permits good growth but scurvy develops earlier than with the immature ones and therefore the tissue changes due to scurvy are more pronounced.

When the mature tuber, which appears dormant but which has been in storage at 40° F. for about four months, is boiled and fed, scurvy develops in the experimental animals at about the same time as when the animals are fed the mature tuber before storage. The changes in the tissues, as indicated by the post mortem score, are also of about the same degree but the size of the animal maintained in this condition is much less than when the newly harvested potato is fed.

The combined results of tests with the four crops when four grams were fed six times a week are summarized below and indicate the kind of evidence upon which conclusions of this kind are based.

| Season | Number of Animals | Average Total Gain Gms. | Onset of Scurvy Symptoms Days | Post Mortem Scurvy Score (Possible 24) |
|-------------------|-------------------|-------------------------|-------------------------------|--|
| Summer (Immature) | 11 | 117.8 | 48.0 | 8.7 |
| Fall (Mature) | 9 | 118.3 | 22.1 | 14.4 |
| Winter (Storage) | 9 | -48.1 | 20.9 | 16.0 |

There is evidence also to indicate that the stored potatoes may be so handled that the vitamin C value may change.

When dormant potatoes were taken from four months' storage at a temperature of about 40° F. and placed in a temperature of 72° F. for ten days or two weeks they began to sprout and when fed as a source of vitamin C gave better protection than those of the same lot continued at the low temperature.

If, however, in late spring, tubers that had already developed good sized sprouts were placed in a cold chamber (40° F.) for ten days or two weeks before feeding they afforded better protection to the animals than those that were permitted to continue at the high temperature. These facts are brought out in the following summary of results of feeding tests.

| Season | Number of Animals | Average Total Gain Gms. | Onset of Scurvy Symptoms Days | Post Mortem Scurvy Score (Possible 24) | Temperature |
|------------|-------------------|-------------------------|-------------------------------|--|-------------|
| Mid-Winter | 5 | 38.8 | 24.0 | 13.8 | 72° F. |
| | 5 | -40.6 | 19.8 | 16.0 | 40° F. |
| Spring | 8 | -4.1 | 19.1 | 14.4 | 72° F. |
| | 8 | 33.0 | 18.0 | 15.2 | 40° F. |

These facts may help to explain some of the contradictory reports which have appeared concerning vitamin C content of potatoes and may effect recommended methods of handling crops. Further study of this seemingly unusual behavior is being planned.

Perhaps it is also worth noting that in the experience of this laboratory, potatoes under any of the conditions reported afford better protection from scurvy than does an equal weight of head lettuce purchased in the open market.

Vitamin G in Potatoes

Another vitamin which is of very great importance in general health and which is a factor in the prevention of the deficiency disease known as pellagra is vitamin G.

This year studies have been conducted on the content of this vitamin in potatoes and the results so far obtained indicate that they contain about seven Bourquin units per ounce. This work is still under investigation.

Investigations in Cooperation with Department of Dairy Husbandry

A third vitamin which has a very important effect on health is vitamin A in that it strengthens the mucous membranes and helps in the resistance to infection. One of the main sources of this vitamin in human food is dairy products and the maintenance of the supply of this vitamin in milk and butter depends upon the amount supplied in the ration of the cow.

It is known that green feed effects very markedly this factor in the milk supply but very little is known concerning the effect of various pasture plants in regard to their relative values in this factor.

This laboratory, in cooperation with the Department of Dairy Husbandry, has been investigating the vitamin A value of pasture plants under the normal conditions of pasturage.

A report on the relative values in this vitamin of white clover and blue grass has been published in the *Journal of Dairy Science*, Volume 15, page 475.

Seven plants have now been studied for one season each and with data available rank thus: brome, white clover, alfalfa, sweet clover, blue grass, meadow fescue, and orchard grass, as sources of vitamin A under pasturage conditions.

Horticulture

Apple Breeding

RESULTS of the apple breeding project have been summarized in Research Bulletin No. 8, *Apple Breeding in Idaho*. Of the approximately 11,000 new apple varieties produced during the period of study, several were found to be of very good quality and to show excellent commercial promise. These are ready for adaptability tests in irrigated commercial apple sections of the State.

Cracking of Sweet Cherries

The tendency of various sweet cherry varieties to crack was compared in 1932. Bing, Oxheart, Black Tartarian, Royal Ann, Lambert, Oregon Black, Republican, and Eagle were tested and found to be susceptible in the order listed. The Republican, though slightly more susceptible to cracking than Eagle, contained the highest percentage of sugar of any variety tested. It cracked the least of any variety at any given sugar content. For practical commercial purposes at Lewiston, it does not crack. It is one parent of the Bing variety and is very promising as a parent for developing a low-cracking variety for this section.

Cherry Doubling

During 1932 double or "twin" cherries were very numerous in the cherry-producing sections of the state. The North Idaho Horticultural Society has requested that a study be made of the double cherry problem. Bing, Lambert, and Royal Ann varieties show similar susceptibility to the production of double flowers. This season in Lewiston Orchards approximately one-third of their flowers were double. Of these three commercial varieties, the Lambert produced fewer culls from this cause, due to its ability to abort many of the non fertilized non-developing flowers of one of the twins.

Orchard Fertilization

Commercial fertilizers have been applied to bearing apple trees at Dalton Gardens, Payette, and Emmett. Ammonium sulphate, treble super-phosphate, and sulphate of potash were applied alone and in various combinations. This year no commercial fertilizer has shown dependable increases in apple yields on any of the plots.

Apple Maturity and Storage

Results in general confirm the previous year's studies given in the 1931 annual report. Most of the apple trees recently planted in Idaho have been red bud sports of the commercial varieties. On the old varieties color was the limiting marketing factor and therefore the principal standard for harvest. Since with the red bud sports this is not necessarily the case, requests have been made for a method of determining the proper time to harvest these fruits. This year

maturity changes of the Starking strain were compared with the Delicious. The Starking developed red color earlier but tests as to firmness, ground color, and sugar content paralleled the old Delicious. Similar studies on other bud sports are needed and planned.

Prune Maturity and Storage

Idaho Bulletin No. 196, *Prune Maturity and Storage*, summarizes the results of this work. This study has shown that firm fruits with high sugar content kept better than softer fruits with the same percentage sugar and that of two lots of prunes with the same firmness, those higher in sugar kept better.

Grape Pruning

A comparison is being made in the Heitfeld vineyard at Lewiston Orchards between the "long cane" and "spur" types of pruning Concord and Worden grapes. This season's yields were heaviest on the vines where long canes were left and trained according to the Kniffin system. This increase was due mainly to larger clusters.

Small Fruits and Vegetables

With the depression, requests are increasing from those who plan to produce small fruits and vegetables for home use. Studies have been carried on for several years as to varieties adaptable, distances, time of planting, and storage of the various products, and this information may be obtained by writing to the Horticultural Department, Moscow, Idaho.

Plant Pathology

PLANT disease problems in Idaho vary with the type of farming and the climatic and other conditions found in various parts of the State. It, therefore, always has been the policy of the Department of Plant Pathology to carry investigational work into the field and as much as possible conduct such work in regions where the diseases in question are most severe. After necessary laboratory, greenhouse, and plot work have been done at Moscow, field tests are conducted at the various Substation farms or at other points where these tests can be conducted advantageously. During the last year field tests have been located at Sandpoint, Aberdeen, and Tetonia on the Substation farms, at Twin Falls on a temporary field station, and in Jerome, Cassia, Minidoka, Gooding, Elmore, Canyon, Caribou, Madison, Fremont, Twin Falls, and Nez Perce counties, in cooperation with county agricultural agents and farmers in these counties.

Problems under investigation are those which were apparently justified by their importance and by the constant demand for assistance on the part of growers in the state. A study of the virus diseases of potatoes was undertaken a number of years ago, due to the

fact that this group of little understood diseases was taking each year a serious and increasing toll of one of Idaho's major crops. Bean disease investigations have been carried on for several years in the heart of the bean growing region in southern Idaho as a result of insistent demands for assistance from bean growers in this region. A similar demand for aid on the part of pea growers in the Upper Snake River valley and an increase in the damage from pea diseases have led to a survey and plans for investigations in that field. Serious losses from alfalfa wilt in the south-central and south-western parts of the State and a material increase in the amount of smut in wheat shipped from southeastern Idaho led to investigations in each of these respective fields which have produced tangible results.

Potato Virus Diseases

The potato virus disease problem has been attacked from a slightly different angle during the past year. More stress has been placed on the freeing by tuber indexing, of the various certified seed lots of the state from the various virus disease. This has been made possible through the cooperation of the Idaho Certified Seed Improvement Association.

It has been determined that indexing tubers reduced to a minimum the demonstrable virus diseases of any given seed lot. Also, that when such indexed tubers were planted in an isolated location by the tuber unit system, such a virus disease content could be kept at a minimum. With this idea in view, 7,453 individual tubers were indexed for the growers throughout the state. Preliminary tests indicate that different strains within the same variety of potatoes respond differently in yielding ability when the virus disease content of the various lots is at a minimum. The results of two years' trials, placed four strains of *Netted Gems* in the same order both years, as to their respective yielding abilities.

Bean Diseases

U. of I. No. 1, a selection of the *Great Northern* variety of beans made for its resistance to mosaic and high yielding ability, has continued to give favorable results. Other selections within the same variety and for the same purpose, possessing, in addition to resistance and high yielding qualities, a more typical *Great Northern* type of seed or shorter growing season, have been distributed. Upon request, some of these selections were sent to several other western states and to New South Wales and to Canada for testing.

In view of the fact that it has been impossible to successfully select for resistance to curly top in any variety of beans or for resistance to mosaic in the garden varieties, crossings were made. No homozygous segregants possessing desirable characteristics have been made as yet. This is because of the fact that there must be several

generations following the original cross before such segregants appear in the population.

Bacterial Wilt of Alfalfa

Bacterial wilt of alfalfa is a serious menace to successful growing of alfalfa for hay in certain sections of southern Idaho. Seven different varieties of alfalfa are being grown in three widely separated localities where wilt infection has been severe. This is the third year that these varieties have been grown, and the disease has become quite general in all three series of plantings. There has been this year a marked difference in the different varieties in their yielding ability and resistance to wilt. Common alfalfa has given the largest yields and has been most free from wilt infection at all three locations. Cossack and Ladak have been next in order, while Grimm and Hardigan have given the lowest yields and have been most susceptible to wilt.

These tests are being continued, and other promising selections and varieties also will be tested. This project is in cooperation with the Aberdeen Substation and with farmers and county agents in the several counties.

Powdery Mildew of Clover

The life history of the fungus causing powdery mildew of clover has been carefully studied, and the results have shown that the fungus from alsike may infect common red clover and vice versa. The perfect stage of the fungus is formed in abundance upon alsike but not on red clover. It was not possible to produce the perfect stage on red clover by the use of ultra violet light.

Snow Scald of Cereals and Grasses

Snow scald of wheat and barley caused by a sclerotium-forming fungus has for a number of years caused serious losses in certain regions of high altitude where the snowfall has been excessive and when the snow has remained on the ground late in the spring. The fungus will grow in nature and in artificial cultures only at comparatively low temperatures. Cultures of a fungus, identified as *Typhula graminum* Karst, which is apparently identical in growth characters with one isolated from barley at Sandpoint, was secured from Japan. It has not yet been possible to secure sporulation in any of the available cultures of sclerotic-forming fungi. Until such sporulation is secured, it is impossible to classify these fungi. The pathogenicity of several of these cultures has been definitely established by both laboratory and plot trials. There is a difference in varietal susceptibility to this disease in both wheats and barleys. Further studies of this disease will be carried on in cooperation with the Sandpoint Substation.

Other projects under investigation include a study of physiologic forms of the organism causing smut of wheat, investigation of the

cause and control of coryneum blight of stone fruits, the adaptation of certain potato seed treatments to Idaho conditions, and a study of stripe rust of grains and grasses. The last named project is in cooperation with the office of Cereal Crops and Diseases of the United States Department of Agriculture.

Poultry Husbandry

Peameal as a Vitamin A Supplement to Poultry Rations

CULL peas have been used in poultry rations as a protein supplement. During the past year experimental work has demonstrated that this legume has the additional value of supplying vitamin A. This phase of feeding is particularly important in winter rations because of the fact that wheat, oats, and barley are all deficient in this vitamin. Chicks fed basal rations in which the grain supplement consisted of wheat, or wheat in combination with oats or barley, with no vitamin A supplement, were all dead by nine weeks of age. On such basal rations the chicks exhibited typical vitamin A deficiency lesions including enlarged and congested ureters, urate deposits in the kidneys, enlarged gall and proventriculus, and white pustules in the throat.

When the ration was supplemented with 15 or 20 per cent peameal of good quality and of the green variety the chicks grew at a normal rate and exhibited no vitamin A deficiency lesions. The work conducted thus far indicates that green peas contain more vitamin A than the yellow varieties. Peameal made from shriveled and small immature peas was found to be more potent in vitamin A than meal made from peas badly infested with weevil. The vitamin is present in the kernel rather than the hull; therefore, when hulls are added to produce a blended meal the product becomes less potent. Ground peas used in combination with alfalfa as a source of vitamin A produced very satisfactory growth.

A Study of the Blood as an Index of Health and Body Functions

The second phase of this project has been concerned with the study of calcite as a source of calcium carbonate in poultry rations as indicated by the calcium and phosphorus levels of the blood and bone.

Effects of various levels of calcium and phosphorus in the ration was also included. The results secured by both chemical analysis and rate of growth furnished the basis for the following conclusion: The calcite used (93 to 98 per cent calcium carbonate and less than 2 per cent magnesium carbonate) compares very favorably with oyster shell as a source of calcium carbonate in rations for growing chicks. The addition of 10 per cent of minerals, including 5 per cent of either oyster shell or calcite and 5 per cent of chick

size granulated bone, is more than is necessary for maintaining normal growth. The various levels of calcium and phosphorus used in the ration did not materially alter the levels of calcium and phosphorus in the blood stream or the bone. Neither was the total ash content of bone appreciably changed.

A comparative study of the blood of birds reared in confinement with those reared on range constitutes the third phase of this project. Sufficient results have not been secured to make a report at this time. This work has been done in cooperation with the Department of Agricultural Chemistry.

Calcite as a Substitute for Oyster Shell in Laying Rations

Calcite has proved to be a satisfactory substitute for oyster shell in the second feeding trial with laying hens as measured by the number of eggs produced, soundness of egg shell, hatchability of eggs, and the physical condition of the birds. In those cases where birds had free access to both products a preference for oyster shell was exhibited. No satisfactory explanation is offered as yet for such preference unless it may be a matter of solubility. In as much as there is considerable variation in the various products used as a source of calcium carbonate, this may be a factor in determining the relative value. Work on this phase is being continued.

Alfalfa as a Vitamin Supplement and its Effect Upon Yolk Color

Alfalfa leaf meal from ordinary sun-cured alfalfa may be used in the mash to the extent of 5 per cent, or alfalfa leaves may be fed constantly without seriously affecting yolk color; however, when 10 per cent or more is used a large percentage of the eggs have dark yolks. This latter level also reduces palatability which results in a lower feed consumption.

Alfalfa leaf meal at the rate of 5 per cent of the mash, in combination with 12 per cent ground yellow corn and 1 per cent cod liver oil, did not entirely prevent the preliminary lesions of nutritional roup.

Artificial Incubation of Turkey Eggs

The continuation of the study of the moisture requirements in the artificial incubation of turkey eggs has given results which concur with those reported a year ago. Humidity conditions should be such that eggs will lose approximately .6 per cent daily due to evaporation or approximately $3\frac{1}{2}$ per cent for each 6-day period, resulting in a total loss of weight from $13\frac{1}{2}$ to $14\frac{1}{2}$ per cent by the 24th day. A high moisture condition in the incubator is essential during the final hatching period.

Sanitation and Disease Control

This work has consisted largely of initiating and proving the efficiency of practices to be recommended to growers. Such practices

as rotation of brooding and rearing fields, the use of wire-bottomed sunyards for permanently located houses, separate fields for turkeys and chickens, and various other sanitary measures, have proved effective in reducing losses. This work has been carried on in cooperation with the Station Veterinarian.

Comparison of Conditions Provided by Electric and Coal Brooders

Very little difference was observed in the average weight and mortality of chicks brooded with electric and coal burning brooders. Dampness in those houses in which electric hovers were used was the chief difficulty encountered. Some difficulty was also experienced in maintaining satisfactory room temperature during cold weather. Houses should be tightly constructed and well insulated to insure satisfactory results with electric hovers. This project was carried on in cooperation with the Department of Agricultural Engineering.

Maintaining the Quality of Summer Eggs

The extreme heat and dryness of summer weather prevailing in this state offers a serious handicap in maintaining quality of eggs. Observations secured with a home-made humidifier at the University Poultry Farm demonstrated that a moisture condition of 70 to 75 per cent relative humidity could be maintained in such a cabinet even when the atmosphere outside the cabinet was as low as 18 and 20 per cent relative humidity. Evaporation from eggs kept in this home-made humidifier was only $\frac{1}{4}$ to $\frac{1}{2}$ that of eggs kept under ordinary atmospheric conditions.

Pure Seed

IDAHO'S activities in the interest of the production and marketing of high quality seed are under the general supervision of a Seed Commissioner, who is appointed by the Director of the Experimental Station. Pure seed work includes maintenance of a State laboratory in Boise, annual inspection of seed merchandising concerns, and educational efforts in the direction of improved practices and high quality.

Aberdeen Substation

THE branch experimental farm at Aberdeen is maintained to deal with the problems peculiar to irrigated agriculture. It is devoted to exhaustive tests of cereal varieties and to work in selecting and crossing of strains to bring into existence new creations of economic importance to farmers in the southern Idaho counties. It affords facilities for experiments on problems associated with the application of water to crops. Fertilizer trials are conducted to determine the feasibility of improving crop yields by the addition of commer-

cial, mineral, and other soil amendments. Feeding experiments are carried on to determine the value of irrigated farm by-products in the finishing of Idaho lambs for market.

This Substation has had another important function in serving as the port of entry for Idaho for new and rare varieties of grains brought from remote regions of the earth by the explorers of the United States Department of Agriculture. It has made exhaustive tests of new crops introduced from far and near with the hope that they might bring new wealth to the farmers of Idaho. It has been a center of scientific interest in agricultural problems for a large region, lending encouragement to the application of progressive practices to irrigated agriculture.

Major Contributions to Agricultural Progress

From the Aberdeen Substation have come contributions of new knowledge, new plant strains, and new farm policies of inestimable value to our State. It has helped forward-looking farmers in their successful efforts to build up the Grimm alfalfa seed growing and marketing industries. It has recommended, based upon experimental findings, reliable methods for potato production. It has distributed Trebi barley, Idamine oats, Federation wheat, and other crop varieties that have become standard upon Idaho farms. Some of the Aberdeen Substation varieties have gone far beyond the confines of Idaho and contribute to the agricultural wealth of other regions. Trebi barley, for example, is widely grown as far east as the Red River valley of the Dakotas and a large acreage now is grown in Canada. Dr. H. V. Harlan, principal agronomist in charge of barley investigations for the United States Department of Agriculture, recently made this statement regarding the value to agriculture of Trebi barley: "The increased yield due to the use of this variety in Idaho represents a revenue many times the annual expenses of the Station (Aberdeen). The returns from outside of Idaho in a single year would pay the entire federal budget on barley studies for one hundred years."

The efforts necessary for the development and distribution of new and better plant types may well be illustrated by reference again to barley. In the barley investigational work at the Aberdeen Substation during the past twenty years, more than four thousand barleys have been tested for yield. Some of them are the results of crosses made at the Station. Others have been introduced from far distant lands.

Study of Grasses

There has been a valuable contribution from Aberdeen experimental work to knowledge on pasture grasses. A considerable number of grass varieties were grown in nursery for a sufficient length of time to determine their forage yield, drouth-resisting qualities,

and palatability. Based upon information secured in this way, a formula was developed now known as the Idaho pasture mixture. This mixture has been tested in various parts of the State and has been found very well adapted to meeting pasture needs for various classes of livestock.

Soil Fertility, Irrigation, and Crop Studies

In the experimental trials with crop rotations and fertilizers, outstanding results have been secured by the use of barnyard manure and other fertilizer material and by the proper use of legume crops in the rotation. The rotations are carried on a long-time basis and the information from them becomes increasingly valuable with the passage of time. Phosphate applications have been especially effective the past year on stands of clover and alfalfa. In one alfalfa field, treated with superphosphate, the yield was increased nearly 50 per cent as compared with a tract where no fertilizer was applied. This work is in its initial stages and will be given added emphasis in the next few years.

Irrigation experiments have dealt with the time of applying water, amounts most effective at each application, width apart of corrugations, and other data of practical value in growing crops under irrigated conditions. The major portion of the irrigation trials have been carried on with beets and potatoes.

The cereal studies include close attention to wheats and oats as well as to barleys. Experiments are under way to develop strains of red clover better adapted to Idaho conditions.

Lamb Feeding and Flock Maintenance

Each year approximately 500 head of lambs are fed at the Aberdeen Substation, consuming the surplus products of the Station, together with supplemental feeds purchased from the surrounding country, and supplying each year valuable manure for the experimental fields. These lamb experiments are closely correlated with the feeding experiments at the Caldwell Substation. The general conclusions drawn from lamb feeding experiments will be found in the section of this report devoted to the Caldwell Substation.

A flock of crossbred ewes is maintained at the Substation for use in experimental work and as a means of consuming the forage on the ditch banks. Experiments in flock management of interest to farm flock owners are a part of the sheep program.

Some improvements, including painting, have been made on the buildings during the biennium. The reputation of the Station for outstanding accomplishment in agronomic research, the opportunity it offers to study soil and crop experiments under growing conditions, and the attractive appearance of buildings and grounds bring many visitors during the summer season.

Caldwell Substation

THE Caldwell Substation consists of 267 acres of irrigated land located three and one-half miles south of the city of Caldwell. It is maintained primarily as a desirable location for carrying on experimental work in the finishing of lambs and steers for market. In addition, however, a dairy herd of grade Holstein cattle has been maintained on the farm for a number of years for experimental work with the feeding and management of cattle under conditions typical of southwestern Idaho. Other experimental undertakings include soil fertility, utilization of modern machinery in farm operations, and application of electricity to farm and home enterprises.

Increased Productivity of the Land

The feeding work of the Station results in the accumulation each year from steers, lambs, and dairy cattle, of a vast amount of barnyard manure. This has been applied to the fields devoted to the growing of such crops as alfalfa, corn, barley, oats, and pasture. In the years that the Station has been operated there has been a marked increase in the productive capacity of the land as a result of this fertilization program.

Lamb and Steer Feeding

Four years of experimental data show that heavy re-cleaned alfalfa seed screenings compare favorably with cottonseed cake for fattening lambs when the screenings replace one third of the barley and cottonseed cake replaces 10 per cent of the barley. Two years' data show that cull peas compare favorably with cottonseed cake for fattening lambs when the peas replace 20 per cent of the barley and cottonseed cake replaces 10 per cent of the barley. Data secured through a period of six years show that cull beans can replace approximately 20 per cent of the barley for fattening both steers and lambs. Cull potatoes fed in limited amounts with alfalfa hay and barley to fattening steers are practical and economical.

The lamb feeding experiments show that the relative values of barley, corn, and wheat are not materially different. Wheat is a more satisfactory ration when improved by the addition of barley. Cottonseed cake and linseed oil meal fed with barley and alfalfa hay increased the rate of gain, lowered the feed requirements, and increased the market value of the lambs.

Feeder lambs may vary in size and weight. The pewee (small) lambs are as economical to feed as average size feeder lambs, provided they are fed apart from the larger lambs.

The steer feeding investigations conducted at the Caldwell Substation have been continued along the lines previously reported and new lines of work added. The feeding of calves and yearlings is of increasing interest in the State. Yearlings have been compared

with two-year-old steers. The yearling steers make more economical gains than two-year-olds. Yearling steers require a longer feeding period and a larger proportion of grain for fattening. Yearling steers have been compared with steer calves. The steer calves make more economical gains than the yearlings. The calves require a longer feeding period and a larger proportion of grain for fattening.

Vitamin "A" Content of Pasture Plants

A biological study was made of the vitamin "A" content of white clover and Kentucky blue grass. Approximately 220 rat units were indicated for the white clover and half this amount for the blue grass. This was published in the October, 1932, issue of the *Journal of Dairy Science* as Research Paper No. 83 of the Idaho Agricultural Experiment Station. Preliminary work has been done on brome grass, orchard grass, meadow fescue, sweet clover, alfalfa and three different cuttings of alfalfa hay. This project was made possible through the cooperation and leadership of the Departments of Home Economics and Dairy Husbandry of the Agricultural Experiment Station.

Alfalfa Seed Screenings Compared With Linseed Oil Meal

This feeding trial was conducted simultaneously with the University herd at Moscow and with the herd at the Caldwell Substation. Two pounds of alfalfa seed screenings were substituted for one pound of linseed oil meal in a grain mixture. Practically equal results were obtained from the two rations when measured by milk and butterfat production and increase in body weight. Alfalfa seed screenings are a low priced by-product feed which should be utilized for livestock feeding. Over one million pounds are available in Idaho each year.

Milking Machine Investigations

Total man hours required for milking 14 cows twice daily for five days was 13 hours and 27 minutes for the entire period, using two double units; 16 hours and 42 minutes, using one double unit; 14 hours and 57 minutes, using four single units; 16 hours and 38 minutes, using two single units; and 22 hours and 12 minutes, using one single unit. Considerable variation was found in efficiency of attendants in stripping. This project was conducted in cooperation with the Departments of Dairy Husbandry and Agricultural Engineering.

Harvesting Hay

Methods of harvesting hay have been studied in cooperation with the Department of Agricultural Engineering. For the past two years the major portion of the hay crop of the Substation farm has been chopped when brought from the field. The second cutting of alfalfa was handled from the field haystacks to the chopped rick by

a ten-man crew and four teams. Three men pitched in the field and three worked in the stackyard feeding the cutter, unloading, and stacking. The hay was handled at the rate of 2.5 tons per hour, requiring 3.58 hours per ton, with a labor and machinery cost of \$1.79 per ton. This method of handling hay offers a material saving in labor over the chopping and stacking practice. There is grave danger, however, in spontaneous combustion in the chopped rick unless the hay is allowed to cure thoroughly in the field.

Other Experimental Work

Space does not permit further detail with reference to the experimental program at Caldwell. Suffice it to say the other lines of experimental work are conducted with the same objective as the animal feeding, namely, that of contributing new knowledge that can be applied to the solution of the problems of farming and home-making.

Minor improvements have been made during the biennium, including repairs and painting of buildings and addition of minor items of equipment.

High Altitude Substation

THE High Altitude Substation near Tetonia serves the needs of the State for research with the problems of farming under conditions of limited rainfall and at high elevations. Ordinarily the rainfall in the Teton Basin and the length of the growing season are sufficient to permit satisfactory maturity of grains and forage crops. Experimental tree planting has shown that several of the hardier varieties are well adapted to this elevation of the eastern part of the State.

Land and Other Facilities

The experimental tract consists of 160 acres of land leased from the State on a long time basis, located approximately 10 miles from the town of Tetonia. Prior to 1932 the headquarters for the Station was on 20 acres of land owned by the Board of Regents, three-quarters of a mile north and west of the town of Felt. In order to place the headquarters on a State highway and to obtain communication facilities such as railroad station and telegraph, the buildings, including the residence of the superintendent, the barn, and the seed house, were moved during the summer of 1932 to a new site in the town of Tetonia. This new location, purchased by the Board of Regents for this purpose, consists of one-half acre of land facing the State highway and quite near the railroad station and the business establishments of Tetonia.

Principal Lines of Work

The investigational work has had to do with variety testing, cultural and rotation experiments, the introduction of new crops, and

other undertakings of interest and value to the region in which the experimental farm is located.

Spread of Influence

Several new varieties of grains and forage crops have been distributed after a successful test on the experimental farm. The most effective date for seeding wheat in the Teton Basin region was determined under experimental conditions and the information distributed for the use of farmers. The cultural methods found most satisfactory in handling the soil under the so-called dry farming conditions of the Teton Basin have been a distinct contribution to farm practice. Alfalfa and sweet clover have yielded well in the experimental plots and these crops, as a result of Station recommendation, are being grown in neighboring territory.

New Projects with Furrow Drill and Potatoes

New experimental projects have been with the furrow drill and with potatoes. For this purpose a combination drill adapted both to the furrow and to the usual method of seeding was purchased for the Substation and plot trials have been under way for the past two years to determine the advantage that can be gained by the furrow method in the planting of fall grain. A considerable area of the high altitude country in eastern Idaho is devoted to the growing of seed potatoes. The experimental work with potatoes at the Substation has been concerned with the value of potatoes in rotation and with strain tests, the latter in cooperation with the Department of Plant Pathology of the Moscow Station. The present plan contemplates tuber indexing in the greenhouse at Moscow in the Winter and the planting of the seedstock the next spring at the High Altitude Substation. It is hoped that from this procedure there may be found superior disease-free seedstock for distribution to growers as foundation stock.

From time to time the program of the High Altitude Substation is re-directed to meet new needs that develop in the section of the State in which it is located.

Improvements.

In addition to the moving of the buildings to the new headquarters in Tetonia, a combination barn and machine shed was constructed on the tract of land used as the experimental farm; three of the buildings were painted, and fencing and other improvements have been made.

Sandpoint Substation

SIX OF the counties of northern Idaho have considerable areas of the land from which the original timber has been removed, leaving it in what is known as the cut-over condition. The most of this land is located in the four northern counties, Benewah, Kootenai,

Bonner, and Boundary. The importance of an experimental farm strategically located for work with the problems of cut-over lands was seen 22 years ago when some experimental work was initiated on a piece of land provided for the purpose in Bonner county by Mr. Paul Clagstone.

Origin and Early Work of the Station

The present cut-over land experimental Substation, known as the Sandpoint Substation, was started in 1912 on land donated for the purpose by the Humbird Lumber Company. The Substation consists of approximately 100 acres of land well adapted to investigational work and quite representative of the average timber soils of the northern counties.

The first experimental undertakings on the experimental farm at Sandpoint were with the problems of the soil. It was found in the early years of investigations that gypsum as a soil amendment and certain cultural practices that were discovered experimentally, were the keys to success in crop production on the cut-over lands. The results as secured from the application of these new cultural practices for timber land were so striking on the farm at Sandpoint that they were readily adopted by the farmers, especially when demonstrated by private individuals under the supervision of county extension agents.

Grain and Forage Projects

Accompanying the early work with soils, and constituting the second step in the program of research, were extensive trials with grains and forage crops to determine their adaptation to the region. A number of varieties have been found, not necessarily successful elsewhere in the state but well adapted to the cut-over lands. As such varieties and strains are determined they are distributed. Recently a two-rowed spring barley, Charlottetown, has been found to be outstanding from the point of view of yield and has been quite widely distributed to farmers. The results of these farm trials have further demonstrated its adaptation. It promises to replace many of the present spring barley varieties.

Reeds' Canary Grass

As a result of rather extensive trials of many kinds of forage plants, a vigorous growing grass, known as Reeds' Canary, was found a valuable pasture plant for low, wet land. It grows vigorously, with abundant leaf surface; will stand flooding; and is rapidly coming into favor in the northern counties, almost entirely as a result of the findings of the Sandpoint Substation. Tests have shown that the most satisfactory seeding rate for Reeds' Canary grass is 10 pounds per acre. Special non-shattering selections are being developed. This will facilitate harvesting and result in cheap-

er seed for those who desire to use this grass for pasture or forage purposes.

Alfalfa

Alfalfa was one of the earliest forages given attention in the attempt to develop legumes that would be advantageous in rotations. Alfalfa, when treated with gypsum and seeded according to the methods developed at the Station, has given high annual yields comparable with yields in some of the irrigated regions. The alfalfa trials have shown conclusively that hardy strains are essential if the crop is to be grown most successfully.

Snow Blight

Considerable attention has been given the past two years to a disease upon cereals known as snow blight. In recent years it has been found to be of considerable importance in the cut-over areas. Some of the wheats being grown at Sandpoint are quite highly resistant. All winter barleys have been quite seriously effected, especially during the winter of 1931-32.

Service to Neighboring Territory

A considerable number of miscellaneous, comparatively new crops, are under trial to determine whether they have a place in Bonner and adjoining counties.

The Superintendent of the Station has had general charge of a cooperative crop experimental tract in the Kootenai Valley near Bonners Ferry. Trials are being made on this land to determine the adaptability of various forage and cereal crops to the peculiar soil conditions characteristic of the Kootenai Valley region. Results so far obtained indicate that winter wheat out-yields the spring seeded varieties. Alfalfa, red colver, Alsike clover, Ladino clover, and several grass species so far have given good results.

Station's Achievements Recognized

The Sandpoint Substation has acquired a prestige among the farmers of the cut-over regions quite comparable with the highest expectations at the time the experimental program was initiated. Each year the popularity of the Substation program and of its management is indicated by a large attendance at the Annual Field Day, many who attend coming from long distances for this particular occasion.

Financial Statement

DETAIL OF EXPENDITURE OF FEDERAL APPROPRIATIONS IDAHO EXPERIMENT STATION

July 1, 1931 to June 30, 1932

| | Abstract | Hatch | Adams | Purnell |
|--------------------------------------|----------|--------------------|--------------------|--------------------|
| Salaries | 1 | \$ 8,799.12 | \$12,191.61 | \$42,706.62 |
| Labor | 2 | 3,138.45 | 1,363.27 | 5,700.58 |
| Stationery and Office Supplies | 3 | 423.01 | | 262.24 |
| Scientific Supplies | 4 | 17.48 | 235.52 | 1,356.35 |
| Feeding Stuffs | 5 | 155.20 | | 856.36 |
| Sundry Supplies | 6 | 164.21 | 197.36 | 573.92 |
| Fertilizer | 7 | 18.15 | | |
| Communication | 8 | 113.44 | 3.37 | 108.00 |
| Travel Expense | 9 | 780.65 | 171.55 | 3,866.65 |
| Transportation of Things | 10 | 31.69 | 5.02 | 177.21 |
| Publications | 11 | 936.76 | | 998.53 |
| Heat, Light, Water and Power | 12 | 7.26 | | 349.36 |
| Furniture and Fixtures | 13 | 55.06 | 288.15 | 645.34 |
| Library | 14 | | | 147.01 |
| Scientific Equipment | 15 | 50.50 | 353.52 | 554.18 |
| Livestock | 16 | 60.00 | 107.00 | 39.50 |
| Tools and Machinery | 17 | 245.17 | 68.83 | 437.00 |
| Buildings and Land | 18 | 1.90 | | 1,192.20 |
| Contingent Expenses | 19 | 1.95 | 14.80 | 28.95 |
| TOTAL | | \$15,060.00 | \$15,000.00 | \$60,000.00 |

SUBSTATION DISBURSEMENTS

(For Jan. 1 to Dec. 31, 1932 Report)

| | Aberdeen | Caldwell | High Alt. | Sandpoint | Total |
|----------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Salaries | \$ 3,770.04 | \$ 4,300.00 | \$ 2,277.50 | \$ 3,380.01 | \$13,727.55 |
| Help | 1,015.03 | 969.23 | 327.06 | 1,128.85 | 3,440.17 |
| Expense and Supplies | 2,742.72 | 4,383.02 | 1,035.56 | 1,694.76 | 9,856.06 |
| Equipment | 254.13 | 247.39 | 1,936.58 | 132.30 | 2,570.40 |
| TOTAL | \$ 7,781.92 | \$ 9,899.64 | \$ 5,576.70 | \$ 6,355.92 | \$29,594.18 |

Disbursements by Departments

DETAIL OF EXPEDITURES OF STATE APPROPRIATIONS*
IDAHO EXPERIMENT STATION
Jan. 1 to Dec. 31, 1931—Home Station

| | Admin. | Ag. Chem. | Ag. Econ. | Ag. Engr. | Agronomy | An. Husb. | Bacteriology | Dairy |
|-------------------------|------------|-----------|-----------|-----------|------------|-----------|--------------|-----------|
| Salaries | \$ 110.00 | \$ 333.32 | \$ | \$ | \$ 618.39 | \$ | \$ 400.00 | |
| Help | 162.90 | 9.03 | 234.43 | 123.37 | 341.06 | 111.01 | 647.02 | 130.04 |
| Travel | 39.82 | | 38.11 | 3.40 | 61.78 | 24.30 | | |
| Freight & Miscellaneous | 180.64 | 5.72 | | 6.35 | 19.06 | 64.00 | 88.00 | |
| Printing & Advertising | 1,281.17 | 6.69 | 2.27 | 3.58 | 1.05 | 4.09 | 4.09 | |
| Office Supplies | 292.25 | 117.02 | | 25.19 | 43.18 | 10.40 | 199.25 | |
| Laboratory Supplies | | | | | | | | |
| Feed Stuffs | | | | | | | | |
| Repairs to Equipment | 1.75 | | | | | | | |
| Membership & Leases | 90.00 | | | | | | | |
| Equipment | | 20.82 | | 87.59 | 11.65 | | 134.50 | |
| TOTAL | \$2,158.53 | \$ 492.60 | \$ 294.81 | \$ 245.90 | \$1,131.85 | \$ 209.71 | \$1,861.02 | \$ 918.40 |

| | Entom. | Home Ec. | Hort. | Legume | Plant Path. | Poultry | Soil Survey | Total |
|-------------------------|------------|----------|-----------|------------|-------------|------------|-------------|--------------|
| Salaries | | \$ 52.73 | \$ 63.68 | \$1,200.00 | \$ 812.76 | \$ 645.00 | \$ | \$ 4,119.47 |
| Help | 821.71 | | 11.25 | 281.30 | 82.20 | 1,110.35 | 754.30 | 4,925.13 |
| Travel | 221.04 | | 4.00 | | 55.60 | 31.80 | 393.61 | 900.71 |
| Freight & Miscellaneous | 114.21 | | 120.04 | 36.05 | 1.30 | 31.91 | 45.02 | 525.91 |
| Printing & Advertising | 5.00 | | | 68.30 | 20.06 | 21.18 | 131.80 | 1,718.95 |
| Office Supplies | 14.35 | | | 23.00 | | 1.98 | | 348.81 |
| Laboratory Supplies | 449.95 | 5.50 | 3.01 | 168.25 | | 171.61 | 45.11 | 1,238.47 |
| Feed Stuffs | | 24.58 | | | | 1,042.66 | | 1,067.24 |
| Repairs to Equipment | 23.98 | | .55 | 3.00 | 2.60 | 3.75 | 4.05 | 185.83 |
| Membership & Leases | 203.00 | | 18.01 | 3.05 | | | | 293.00 |
| Equipment | 254.79 | | | | 23.83 | 247.36 | | 1,864.07 |
| TOTAL | \$2,108.03 | \$ 82.81 | \$ 220.54 | \$1,783.55 | \$ 998.35 | \$3,307.60 | \$1,373.89 | \$ 17,187.59 |

*Includes General Appropriation and Institutional Funds.