UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION

# WORK AND PROGRESS

*of*

# The Agricultural Experiment Station

for the Year Ending
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*In Co-operation with U. S. Department of Agriculture.

# REPORT OF THE DIRECTOR*

The past few years have been characterized in the agricultural experiment station by a gradual reorganization of the entire work of the station. The objectives have been the redirection of the projects approved for investigation to conform to the most important needs of the state and the execution of a general policy of co-operation and co-ordination.

The research specialists in the various fields of endeavor have been given opportunity to make contacts with the agricultural problems of greatest interest to farmers as a result of field trips and have brought back to the station constructive suggestions for new research undertakings. The extension division staff has co-operated in a fine way, both in utilizing the latest findings of the experiment station and in bringing to the experiment station suggestions with reference to modification of projects or needs for new projects. This policy has resulted in a gradual orientation of the entire program of the experiment staton to closely conform to needs found on the farms, in the livestock herds, and in the orchards and gardens of the state, and has resulted in greater efficiency in experiment station operation.

Both at the central station and on the substation farms, projects are under way in co-operation with various divisions of the United States Department of Agriculture. A great many of the projects carried by the various departments involve the co-operation of one or more co-ordinate divisions of the station Broad understanding of all station problems by the research workers and increased output have resulted from this method of procedure.

The increased understanding and appreciation of farmers' problems on the part of members of the staff have given the station program a state-wide character. The members of the staff are sent to those portions of the state where the need seems to be the most urgent and the station in recent years has not hesitated to establish either permanent or temporary field stations to meet the demand for experiment station service.

The public has come to have greater interest in and reliance upon the results of agricultural investigations. Many problems are brought to experiment station divisions by farmers and these requests of farmers and stockmen have been important factors in the initiation of new enterprises. Both the farm and business interests of the state have come to rely upon the experiment station to meet the problems of soil fertility; to undertake new enterprises in plant and animal breeding; to map out new policies in economic procedure; to develop and redirect farm policies with reference to nutrition; to determine methods of combating insect pests, plant and animal diseases and damage by rodents; and in general to render a wide var-

*This report was prepared for publication by Dr. C. W. Hungerford, Vice-Director of the Station.

iety of service to agriculture. The experiment station program has been popular to a marked degree. At the same time there has been no neglect of lines of work of a fundamental character. Some of the long time investigations, apparently with no immediate practical value, frequently have been found to have an important bearing upon farm progress.

The enlarged budget made possible by the increase in the Purnell fund has been utilized in developing new lines of work that could not be undertaken without this more adequate financial support. The home economics research has been strengthened by the employment of Dr. Ella Woods as Home Economist. Her major projects are concerned with vitamin studies to determine the function of certain Idaho-grown food stuffs in human nutrition.

Much effort has been put forth to develop new knowledge with reference to the dissemination and life history of the suger beet leaf-hopper. This project has been in co-operation with the Bureau of Entomology of th United States Department of Agriculture and with the Utah Agricultural Experiment Station. Reference to new projects in the pathological phases of bacteriology will be found under bacteriology. The Purnell fund has permitted the extension of the program of investigation in agricultural economics and has made possible the initiation of new projects in nearly all departments of the station.

Some improvements and repairs have been made at the central station. The agronomic field plots have been moved from the old farm to the new Reilly farm, now known as the North farm. Much needed machinery has been purchased for the Sandpoint substation and general improvements have been made there during the past year. A new building for storing grains and seeds and for housing the seed grading equipment was erected at the Aberdeen substation. The space released in the old combined seed house and office building has been made into a laboratory to be used in connection with plant breeding and plant pathological studies. This building, therefore, is now used both for the laboratories and for offices and has provided much better facilities for summer work on the part of representatives of the United States Department of Agriculture, who are co-operating in various lines of work maintained at the substation. The improvement program initiated at the Caldwell substation has been brought near to completion. A building erected for the storage of grains, has been equipped with elevators and with grinders for reducing grains to various states of fineness. This building has been of great assistance in permitting the assemblage of feeds in steer and lamb feeding and has provided the facilities for preparing feeds used in the many combinations fed to experiment lots of animals. Funds have not been available to fence the entire irrigated farm consisting of 267 acres. This

is an important obligation of the first year of the new biennium.

There have been several staff changes in the Department of Agricultural Economics. R. H. Engle resigned September 1, 1928. C. F. Wells, employed on a co-operative basis with the Bureau of Crop Estimates, United States Department of Agriculture, resigned May 1, 1928. G L. Sulerud, Assistant Economist, resigned July 1, 1928. R. B. Heflebower was appointed Assistant Economist of the station and Instructor in the School of Business Administration, effective September 1. The position of Chief Economist is now vacant but it is hoped that this position may be satisfactorily filled in the near future. The new plan contemplates the appointment of an assistant economist on a full-time basis to replace Mr. Wells who was on a half-time basis.

John D. Remsberg, Jr., instructor in agronomy, was transferred to the Southern Branch at Pocatello and advanced to the position of Assistant Professor of Agriculture, effective September 1, 1928. He has been succeeded in the agronomy department by C. A. Michels. B. L. Taylor, Assistant Professor of Veterinary Science, resigned September 1, 1928, and has been succeeded by Dr. E. M. Gildow of the New Hampshire Agricultural College, who comes as Associate Professor of Veterinary Science.

C. C. Vincent, horticulturist of the station was granted leave of absence for the academic year, effective October 1, 1928. Dr. C. W. Hungerford, Plant Pathologist of the station, who acted as Director during the leave of the Director, June 1, to December 31, 1927, was appointed Vice Director of the station January 1, 1928.

## Publications

The bulletins and circulars published during the past two years 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 follws:

**Bulletins.**

157. Apple Tree Leaf Roller in Northern Idaho. L. E. Longley.
158. The Cut-Over Lands of Northern Idaho. J. H. Christ.
159. Idaho Recommendation Chart for Plant Diseases and Insect Control. Claude Wakeland and C. W. Hungeford.
160. Work and Progress of the Agricultural Experiment Station for the Year Ended December 31, 1927. C. W. Hungeford.

161. Study of Bull Associations in Idaho. H. A. Mathiesen and F. W. Atkeson.

162. Statistics of the Price and Destinations of Idaho Apples. Clinton F. Wells.

**Circulars.**

51 The Potato Situation in Idaho for 1928. C. F. Wells.

52. The Idaho Wool Caliper and its Application in Making Density Determinations. J. E. Nordby.

**Mailing List.**

| | |
|---|---|
| Residents of Idaho | 16,735 |
| Residents of Other States | 4.776 |
| Foreign | 210 |
| Total | 21,721 |

## Active Projects

A list of active Experiment Station projects follows. All investigations carried on at the several substations are in co-operation with the various departments of the home station.

### *Agricultural Chemistry*

The iodine content of Idaho grown foods in relation to the prevalence of goitre.

Feeding experiments: (a) The comparative value of various silages for milk production; (b) Winter rations for young stock in Idaho; (c) Feeds for wintering dairy heifers under practical farm conditions in Idaho. (In co-operation with Dairy Husbandry.)

Rotation and fertility investigations at Moscow and Sandpoint. (In co-operation with Agronomy and Sandpoint Substation.)

Chemical studies of soil survey samples. (In co-operation with Agronomy.)

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

Cause of unproductiveness of recently cleared, coniferous soils, relation of toxicity thereto and corrective measures.

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

Tolerance of crops for alkali.

Slick spot investigations. (In co-operation with Agronomy.)

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

Spray residue control. To exercise proper control over the commercial shipping of sprayed fruit. (In co-operation with State Department of Agriculture.)

Arsenical Spray Residue Removal. To develop efficient removal methods under a variety of conditions. (In co-operation with Horticulture.)

### *Agricultural Economics*

Agricultural economics study of irrigated farming in selected areas of southern Idaho. (In co-operation with Bureau of Agricultural Economics, United States Department of Agriculture.)

A study of the changes that have taken place in the production of beef cattle in Idaho and the reasons for these changes.

A study of the changes that have taken place in the production of sheep and wool in Idaho and the reasons for these changes.

A study of the changes that have taken place in dairying in Idaho and the reasons for these changes.

Business analysis study of apple orcharding in systems of farming in selected areas in Idaho.

Statistical analysis of factors affecting Idaho late potato prices.

## *Agricultural Engineering*

The relation of electricity to agriculture.

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

A sub-project "Conditions governing the application of irrigation water" under Sec. I. "Soil and Irrigation Relationships" of the general project. "Factors underlying the economic use of water in irrigation."

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

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

"A study of the influence of irrigation upon soil fertility" a sub-project under the general project, "Soil and irrigation relationships." (In co-operation with Department of Agricultural Chemistry.)

A study of building requirements for poultry production in Idaho. 'In co-operation with Department of Poultry Husbandry, Department of Extension, field poultryman, and the poultrymen of Idaho.)

A study of the cost, effectiveness, and methods of pumping for drainage and supplemental irrigation. (In co-operation with Idaho Committee on Relation of Electricity to Agriculture.)

"Effect of the time of irrigation of beans upon the yield," a sub-project under the general project, "Plant and irrigation relationships."

The development of a method for structurally testing farm buildings.

## *Agronomy*

Small grain improvement. (a) Wheat; (b) oats; (c) barley; (d) rye, emmer, flax and miscellaneous grains. (In co-operation with the substations.)

Forage investigations: (a) Grasses and legumes for hay, seed, and potatoes; (b) cultural tests with alfalfa; (c) introduction and testing of miscellaneous forage crops; (d) seed production; (e) alfalfa improvement—(1) breeding, (2) hard seed study, (3) identification studies with seedlings.

Field and garden pea investigations: (a) classification studies; (b) cultural experiments; (c) breeding and improvement.

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

Weed eradication investigations.

Silage crop investigations: (a) cultural tests of corn for silage production.

Tests with commercial fertilizers.

Soil amendments: Use of sulphur, lime, gypsum and leguminous crop. (In co-operation with Agricultural Chemistry.)

Rotation and fertility investigation.

Peat soils of Idaho. (In co-operation with Agricultural Chemistry.)

Soil survey: (a) A detailed survey of a designated area each season as funds permit. (In co-operation with the United States Department of Agriculture.)

Alfalfa seed production.

## *Animal Husbandry*

Studies in the growth of wool.

Physiological effect 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 co-operation with Caldwell substation.)

Lamb feeding investigations. (In co-operation with Caldwell substation.)

Range livestock investigations.

Inheritance of skull defects in swine.

Whorls in the hair in swine.

Congenital epithelial defects in swine.

White spotting in Duroc Jerseys.

Black spotting in Rambouillets.

Overshot (prognathism), and undershot (brachyganathism) jaw in sheep.

Turned-in eye lids (entropion) in lambs.

## *Bacteriology*

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

Sterility in the bovine male.

Study of scours in dairy calves.—(Inactive.)

Legume culture preparation.

Survey of prevalence of infectious abortion and its economic importance. (In co-operation with Dairy Husbandry.)

Bacillary white diarrhoea.

Isolation and study of nitrifying bacteria and contaminating forms with special reference to the use of dyes as a means of isolating nitrifying organisms.

Study of udder infection in dairy cattle. (In co-operation with Dairy Husbandry.)

Coniferous timber soil investigations. Biological activities of Helm silt loan soil. (In co-operation with the Department of Agricultural Chemistry.)

## *Dairy Husbandry*

A study of the normal growth of dairy cattle.

Survey of prevalence of infectious abortion and its economic importance. (In co-operation with Bacteriology.)

Weight of dairy cattle as influenced by pregnancy, age and methods.

A study of the best methods of feeding calves while receiving milk.

The best winter ration for young dairy stock in Idaho. (In co-operation with Agricultural Chemistry.)

The comparative value of various silages for milk production. (In co-operation with Agricultural Chemistry.)

Dairy farm management: (a) To encourage the introduction of dairying as a type of farming for this area of the state; (b) To determine the crops to be grown for a dairy herd; (c) To determine the proper number of animals to be maintained on an 80-acre unit of land and their management.

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 co-operation with the Bureau of Dairy Industry, Unitel States Department of Agriculture.)

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

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

Effect of addition of skimmilk powder, gelatin and quantity of milk production. (In co-operation with Washington State College.)

Relation of physical characteristics of cow's mammary system to production. (In co-operation with Washington State College.)

Relation of feeding and management to production. (In co-operation with Washington State College.)

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

Factors effecting efficiency of cream collection by the route method in Boise Valley as measured by quality of cream and cost of collection.

Study of breeding efficiency in dairy herds.

Field study of efficiency of cream separators on Idaho farms.

## *Entomology*

Aphids, control on fruit trees and garden plants.

Codling moth: Control investigations.

Eleodes beetles: Collecting and classifying all species in the state.

Investigation of sugar beet leafhopper. (In co-operation with Federal Bureau of Entomology and Utah Station.)

Oil sprays: Investigations in preparation and use of oil sprays in the control of orchard insects and their effects upon the trees. (In co-operation with Montana, Washington, California, Oregon and with the Bureau of Entomology, United States Department of Agriculture.)

Onion thrips investigations.

Leaf hoppers of Idaho: A systematic study and collection of species.

Mineola scitulella: Life history study and control experiments.

Wireworms: Experiments in control. (In co-operation with the Bureau of Entomology, United States Department of Agriculture.)

## *Forestry*

Blister rust studies. (Germination.)

Forest management in relation to blister rust control.

Studies on the cull due to rot in standing timber.

Studies on the decay resistance of native woods.

Study of the cause and control of water core in western white pine. (Idaho White Pine.)

Studies of the rots found in wood products.

Studies on the cause and prevention of sap stain.

Utilization of native woods.

Movement of moisture in wood.

The diagnostic characteristics of the woods of the genus *Abies*.

Adequate slash disposal in northern Idaho.

The effect of release by logging on growth and form of residual species in the western white pine type of northern Idaho.

Effect of release by logging on growth of residual western red cedar in northern Idaho.

A forest survey of Benewah County, including a study of restocking on cut-over and burned-over lands.

The growth, yield and change of form of residual *Pinus Ponderosa* (Western Yellow Pine or Pondosa Pine) in Idaho.

A study of forest and shade tree windbreaks.

Experimental forest and shade tree planting on alkali soils.

Forest and shade tree planting in the higher elevations of Idaho.

## *Home Economics*

Food expenditures of farm families.

A study of the methods of vegetable storage now in use.

A study of the conditions determining successful storage of potatoes.

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

## *Horticulture*

Potato production experiments.

Experiments in the control of western yellow tomato blight by breeding and selection. (In cooperation with Plant Pathology.)

Varietal study and cultural tests in producing head lettuce.

Pruning investigations.

Orchard fertilization tests. (In co-operation with Agronomy.)

Variety testing of fruit trees, small fruits and vegetables.

Factors determining storage of Idaho prunes.

Apple breeding.

Factors influencing the cracking of sweet cherries. (In co-operation with Fruit Growers of Lewiston.)

## Plant Pathology

Comparison of various treating agents for grain smut control.

Potato seed treatment investigations.

Study of western tomato blight.

A study of mosaic and dry root rot of beans.

Virus diseases of potatoes.

A study of sclerotium disease of wheat.

Clover mildew investigations.

Study of stripe rust of grains and grasses. (In co-operation with the office of Cereal Investigations, United States Department of Agriculture.)

Investigation of a disease of wheat caused by *Typhula graminium*.

## Poultry Husbandry

A study of the blood as an index of the health and body functions of the laying hen. (In co-operation with the Department of Agricultural Chemistry and Bacteriology.)

A study of the influence of various levels and forms of alfalfa intake upon the interior quality of eggs laid.

The relation of humidity to the hatchability of hens' eggs.

A study of the inheritance of fecundity and egg characteristics in single comb white leghorns.

The inheritance of fecundity and plumage color in S. C. Rhode Island Reds and Barred Plymouth Rocks.

## Aberdeen Substation

(In co-operation with United States Department of Agriculture.)

Small grain investigations: (a) Varietal experiments with wheat, oats, barley; (b) cereal breeding and selection in nursery.

Investigations in field and garden peas and beans: (a) Varietal experiments; (b) The value of the various pea varieties as nurse crop for alfalfa; (c) Seed-bean investigations.

Breeding and selection of corn for eastern Idaho.

Potato Investigations: (a) Tuber-unit potato improvement.

Study of trees with respect to environment.

Duty of water for selected crops.

Seed production: (a) Sugar beets; (b) Potatoes; (c) Red clover and alfalfa seed.

To determine the adaptability of various ornamental trees to higher elevations of eastern Idaho for the improvement of the homestead.

Soil fertility investigations: (a) To determine effect of phosphorus on yield of alfalfa; (b) Crop rotations, designed to maintain soil fertility and crop yields.

Pure seed distribution: (a) Increase the distribution of pure seed of various crops which have been improved.

"The effect of time of irrigation on yield of potatoes" a sub-project of the general subject, "Plant and Irrigation Relationships." (In co-operation with the Department of Agricultural Engineering.)

"Effect of time of irrigation on yield, sugar content and sugar production of beets." A sub-project under the general project, "Plant and Irrigation Relationships." (In co-operation with the Department of Agricultural Engineering, Department of Agricultural Chemistry.)

Seed clover investigation selections for winter hardiness, mildew resistance and seed and forage.

Cereal smut investigation.

## Caldwell Substation

Dairy Farm Management: (a) To determine whether it is economical to feed grain to grade dairy cows where alfalfa hay is the main ration; (b) To determine the relative cost of hand and machine milking; (c) To determine the actual KWH of power used in the various operations in handling milk and cream.

Farm management: (a) To place the remainder of the farm in condition to produce crops for feed or sale; (b) To determine the cost of certain crops from the standpoint of man and horse labor expended.

Farm management: (c) To determine whether any saving can be made in the cost of production, on irrigated farms, by the use of tractors and larger machine units; (d) To determine whether the slick spots can be eliminated by the use of chemical applications to the soil; (e) To determine whether the slick spots can be eliminated by the use of deep tillage machinery; (f) To determine which pasture mixtures and what pasture management will give the best results in the Boise valley.

Livestock management: To determine which home-grown rations are the most efficient for producting grains in winter feeding of cattle and lambs.

## High Altitude Substation

Small grain investigations: (a) Variety tests with wheat, oats, barley, and miscellaneous grains under high altitude conditions; (b) Rate of planting oats.

Fallow and cultural tests with wheat.

Forage and miscellaneous crop investigations: (a) To determine the best variety of grases and legumes for the production of forage and the most successful cultural practice; (b) The introduction and testing of such crops as flax, buckwheat, sunflowers, corn, etc., for the production of grain or forage; (c) Effect of sweet clover upon crop yields.

Horticultural investigations: (a) The planting of ornamental trees and shrubs for the improvement of the homestead.

Rotation experiments, primarily to discover the value of sweet clover in soil improvement.

Rotation experiments with peas and wheat.

Field and garden pea investigations: (a) To determine the varieties best adapted to dry lands.

## Sandpoint Substation

Gain and field pea investigations: (a) Variety tests of winter wheat and barley, spring wheat, barley, oats, corn and field peas; (b) Rates of planting winter wheat; (c) Rate and date of planting field peas; (d) Effect of date of seeding corn and number of plants per hill upon yield; (e) Effect of spacing on yield of wheat.

Root crop investigations: (a) Potato variety test; (b) Potato seed treatments; (c) date of planting potatoes; (d) Spacing of potatoes; (e) Maturity of seed potatoes and effect on yield.

Sheep management: (a) Cost of production.

Forage crop investigations: (a) Legume variety test; (b) Grass variety test; (c) Annual hay crop; (d) Clover and alfalfa seed production; (e) Pasture experiments; (f) Alfalfa variety test; (g) Experiments with reed canary grass; (h) reseeding of burned-over land.

Soil investigations: (a) Rotation experiment; (b) Sweet clover and manure rotations with winter wheat; (c) Sulphur fertilizers on alfalfa; (d) Cultipacking and harrowing experiments with grain; (e) Cultivation of alfalfa.

## Agricultural Chemistry

**Alkali Soils.**

The alkali soil studies conducted in co-operation with the Bureau of Public Roads of the U. S. Department of Agriculture, and departments of agricultural engineering and agronomy of the University have been continued during the past year. Crop surveys have been made on all plots at the Helms tract and our records show a continued improvement, due to culture and special treatments. The chemical analysis shows a continued reduction of carbonates in all plots. The reduction from the normal carbonate to the bicarbonate shows the greatest correlation to crop growth. Marginal studies have been conducted on various selected places to determine the condition of the soil in the good spots, on the transition line, and in the bare spots. Numerous pH determinations, careful crop counts and water table readings were made in the field; and colloid content, further pH determinations and salt analyses were made in the laboratory. The physical and chemical constants correlate quite closely with the crop records. The continued presence of a perched water table, and slow reaction of chemical agents in reclaiming soils, indicate that the drainage is inadequate. To relieve the high water table, a suitable well and pump are necessary to control the water table for an extended period to study water movement and subsequent effect on structure and salt content of the soil. At Banida the soil is responding very rapidly to drainage, both as shown by crop yield and as shown by salt content.

**Chlorosis of Trees and Shrubs.**

The co-operative studies of methods for control of cholorosis have been continued and extended. Careful sampling was made of the soil by profile, and extensive chemical analyses made on these samples including pH and replaceable bases. In combination with deep tillage on an orchard of over 300 trees, cross-checks have been treated, using iron and manganese salts. These are placed in the trunk of the tree by making an augur hole, and placing the dry salt in this and sealing it up. This work has not progressed for enough to justify recommendations, but the use of iron has shown temporary improvement of the trees affected. The work was done on the Harvey and Decatur orchards in Twin Falls County.

**Slick Spot Investigations.**

Slick spot studies on the Caldwell Substation have been continued, and crop records taken. In addition to the chemical treatments, deep tillage has also been introduced on these plots. The laboratory studies have been continued, and are being extended in view of new apparatus recently received to study the colloid content and pH of the various profiles of this soil.

**Fertility of Coniferous Timber Soils.**

Good progress has been made during the year in the study of the biological activities of Helmer silt loam soil in co-operation with the department of bacteriology. Crops of oats, wheat, red clover, alfalfa and sweet clover were grown. In some cases the whole plant, and in others only the roots were turned back in the soil, and a second determination made of carbon dioxide production, ammonification and nitrification on these soils. Virgin soils with treatments of one ton and four tons of lime per acre, rotted manure, fresh manure, and fertile cultivated Helmer soil were run as checks. Bacterial and mold counts made on these showed that the value of the returned crops rank in the order named, alfalfa just maintaining normal activity, sweet clover showing the only increase. The lime had little effect above the carbon dioxide equivalent to complete neutralization of the calcium carbonate applied. It is being determined now if all the lime was neutralized. As was noted before, the cultivated soil was most active in carbon dioxide production and ammonification for the first few days, but the virgin soil soon passed it in daily production, and produced more in the 77 days observed. This was not true of the nitrification. Nitrification was slowly increased, however, in the virgin soil by the return of crop residues, especially sweet clover and alfalfa. Another series of crops have been grown on the same plots, and the bacterial activity will be determined after another cropping season. A report has been published on this work.

**Blood of Laying Hens.**

Preliminary work has been done on the study of the blood as an index of the health and body functions of the laying hen. Satisfactory normals were not established, due to the absence of satisfactory checks on the pens, and also due to disease among the birds. New pens have been started by the poultry husbandry department, however, with fifty birds in each, placed on high, medium high, normal and low protein rations. Analyses on these will be made periodically throughout the experiment.

**Arsenic Problem.**

The growing use of oil with arsenate of lead for the control of codling moth in apples, has lead to increased complications in the removal of spray residues. In addition to the service analysis for Lewiston and Coeur d'Alene orchardists, various washing practices have been used to take care of oil spray. These studies show that more drastic treatments than are in common use are necessary to meet the world tolerance. These apples are in cold storage now to determine the effect on their keeping qualities.

**Miscellaneous.**

A project co-operating with the Aberdeen Substation and department of agricultural engineering includes tests of various

methods of irrigation of sugar beets. Sugar analyses have been made of the beets from all these plots, in an effort to correlate sugar content with duty of water and time of irrigation.

Tolerance of beans for alkali has been continued one more crop, and the study of chemical aids to reclamation is completed, but has not been published.

Similarly, studies on the effect of field peas on the skeleton of swine and cumarin content of sweet clover should be written up within the next year.

## Agricultural Economics

Due to the fact that no permanent head for the department of agricultural economics has been appointed, no complete program was worked out. Therefore considerable time was spent in preliminary examination of four possible projects, the bean industry, the wool industry, the lamb industry and the potato industry. Available production, price and marketing facts were gathered. Relationships between these data were examined and a preliminary outline of a study of the bean industry was drawn up.

During the year, surveys of farm organizations in the Boise Valley and of the Minidoka Project have been completed. The leading types of farm organizations are presented and illustrated by actual farms. Suggestions are then made as to how the profitableness of the enterprise might be incrased by using more or less of different crops or livestock.

**Destination of Idaho Apples.**

A statistical survey of the prices and destinations of Idaho apples has been completed and published. This is part of a nation-wide survey being conducted by the United States Department of Agriculture. Approximately fifty per cent of the Idaho apples are sent to the states bordering on both sides of the Mississippi from Missouri north. The remaining percentage is scattered rather evenly over the United States except for the South Atlantic states. Over fifty per cent are shipped in baskets and hence receive a lower price than those packed in boxes.

**Price of Idaho Potatoes.**

The intentions to plant potatoes as sent out by the United States Department of Agriculture were used to predict the probable acreage. This, on the basis of an average yield production, was estimated at 422,000,000 bushels, and therefore, the 1928 price would probably be lower than that for 1927. These predictions as made in Circular No. 51 have been more than fulfilled by the estimated crop of 460,000,000 bushels and the very low prices. Work is now under way to refine and make more accurate these results in a project concerning factors affecting the price of Idaho potatoes.

The earlier study considered only a short period, 1921-1927, which is too short for reliable results. Moreaver, it dealt only

with total United States production as affecting price, whereas it is thought several other factors enter, though to a less degree. Preliminary analysis using the statewide prices gathered by Mr. J. H. Jacobsen, Agricultural Statistician, seemed to point to the following factors as being of importance: United States production, the price level, the percentage of total production in eleven far western states, the business conditions. The study has been halted temporarily because it was felt that these state-wide prices, representing both surplus and deficit areas, were not representative of what the farmers actually received. Those in deficit areas more nearly correspond to retail prices. Prices, wagon loads cash to growers of U. S. No. 1 potatoes, in terms of dollars per hundredweight, are available by weeks and by months 1921-1927. They are also available by months for most of the 1918-19 and 1919-20 seasons. However, before reliable results can be secured similar prices back to 1910 should be obtained. It is hoped that they can be obtained from dealers' books.

**Price of Range Beef.**

In co-operation with the department of animal husbandry, a survey of the range beef industry is being made. Facts as to production and management methods are being collected and problems of marketing and factors affecting the price of beef are to be presented as part of the completed project.

The prices used here are those gathered by Mr. Jacobsen, for it was felt that what few deficit areas there were in the state would affect the price but little. Also it was found that this series varied from the Portland price by an almost constant differential, except during 1918. This price probably represents the price movement, though the price of good steers may average above and that of feeders below.

Apparently the chief factor in determining the annual price of beef in Idaho is the number of beef cattle in the eleven western states on January 1, one year previous. However, hog prices and business conditions are of some importance. Probably the factor which will account for most of the remainder of the variations is whether the price is rising, remaining about constant, or falling. If the price is rising, heifers will be used as stockers and hence the total number of beef cattle will not lead to the marketing of as much beef. If the price is falling, few heifers will be kept. If the price is constant at a low level, few heifers will be kept. It is hoped that the way can be found for measuring the effect of this factor.

A very marked seasonal variation in the price is evident, ordinarily culminating in the highest price in May. But if the annual price is rising rapidly, the highest point may be in December and vice versa, it may be in January. In other words, the seasonal varies with the price cycle. This probably can be measured. This seasonal, even if effect of the cycle is elminated, will vary from year to year. Investigations are now being

conducted to determine whether these variations may not be due to variations in precipitation and hay prices. It is hoped that this study will enable beef prices to be known fairly definitely some months in advance.

## Agricultural Engineering

**Reclamation After Drainage.**

Among the irrigation and drainage problems which the department of agricultural engineering is studying on a co-operative basis are the reclamation of alkali lands after drainage and the time and amount of irrigation required for various crops. The reclamation after drainage experiment is conducted on experimental plats at Caldwell in Canyon County and at Banida in Franklin County. Repeated leaching of the sweet clover plots at Caldwell indicates that this method is effective for reclaiming certain alkali conditions and that the treatment has produced improvement in both the chemical and physical conditions of the soil. The greatest success in getting a stand of sweet clover on the alkali lands has been from winter seeding or from seeding on ground which has been treated with a layer of well decomposed manure. Although a deep open drain is located near the tract, the presence of an impervious layer of soil at depth of eighteen to thirty inches is responsible for the perched water table which forms immediately following each irrigation. This condition is also found on the plots which have received chemical treatment and is probably the cause of their lack of improvement. At Banida the soil has shown improvement where proper irrigation and cultivation has followed drainage. Due to the insufficient water supply of the district and to the low price for farm products, a considerable area of the district is not farmed. The fact that a limited amount of water is applied has been a contributing factor to the success with which the water table has been lowered by the title drains. On August 19, of this year, none of the drains were discharging water. The plats have been indifferently farmed and conclusions as to soil improvement as measured by crop growth are hardly justified.

**Application of Irrigation Water.**

In the laboratory at Moscow, fundemental research has been conducted on the rate of infiltration of water into soil and on the flow of water in thin sheets. Based upon observations of the flow of water over soil (in the laboratory) a mathematical expression for the flow of water in thin sheets has been developed. The expression is $V = KR^{0.9}S^{0.7}$ where V is the velocity, R the hydraulic radium, S the slope and K a constant depending upon the soil, etc. For the conditions of the laboratory experiments, K was found to be 1100. Application of this formula to field conditions will necessitate other values for K. Previously reported experiments upon the infiltration of irrigation water into Palouse silt loam soil in large containers has been

published in Agricultural Engineering Vol. 9 No. 5, May, 1928, as Research Paper No. 56 of the Idaho Agricultural Experiment Station.

At the Aberdeen Substation valuable data have been secured on the effect of the time of irrigation upon the yield and sugar content of sugar beets, maximum production of sugar being obtained where the plants were never allowed to suffer for water. Studies of the time of irrigation of potatoes were initiated this year. The best yield of potatoes was from the plots irrigated before the buds started forming, followed by succeeding irrigations each seven days during the growing season.

**Pumping For Irrigation and Drainage.**

A preliminary study of the results obtained thus far by pumping for drainage and irrigation is in progress. Drainage by pumping from wells is creating a great deal of interest in the Boise Valley, and further applications throughout the irrigated sections of the state are being considered.

**Combine Studies.**

Co-operating with farmers near Moscow the agricultural engineering department has studied the costs of operating combines during the 1927 and 1928 harvesting seasons. The comparison of the horse and tractor drawn outfits has revealed that the managerial ability of the operator is a very important factor and that the tractor outfits have averaged $0.67 per acre less than the horse drawn machines under similar conditions. During 1928 the study of bulk handling methods was added to the investigation. The data obtained thus far indicate a saving of .0118 per bushel and show that the bulk handling of grain in the Palouse region is practical provided suitable equipment is selected and proper methods used for carrying on the work. The results obtained from both years' study indicate that with slight alterations the combine may be used successfully for the field harvesting and threshing of peas. During the past season one machine combined 100 acres yielding 2070 bushels at a cost of $0.1525 per bushel. The use of horses and tractor on the same combine has resulted in the development of a combination tractor and horse hitch. The use of the tractor and horses for meeting the peak load improves the seasonal load factor and furnishes the reserve power required for the operation of the combine in the hilly sections.

**Seed Bed Preparation.**

At the Caldwell Substation the work in seed bed preparation includes methods, equipment and organization. New tillage machines and tractors have been secured from manufacturers interested in the development of new methods of tillage.

**Hay Harvesting.**

The study of hay harvesting methods shows that the use

of slings for handling hay in place of the commonly used Jackson fork saves one-half of the time required for unloading. When a large amount of hay is stacked the motor driven mechanical hoist has the advantage over animal power by its faster return and more accurate control. For short hauls the use of one sling per load gave the best distribution of labor for field and stacking crews. The tests made indicate the need of new developments in haying equipment.

**Relation of Electricity to Agriculture.**

The results of research work in rural electrification have been published in the progress reports of the Idaho committee on the relation of electricity to agriculture. These reports on the electrification of the Caldwell Substation farm and on the cost of electrical service on rural lines in Idaho, also include the use of electric motors for silo filling, hay hoisting and feed preparation. A comparison of the relative cost of hatching eggs by means of oil heated and electrically heated incubators has been conducted in co-operation with the poultry husbandry department and poultrymen of the state. The electrical investigation and demonstration work at Caldwell combine the study of the use of electricity in the household and on the farm. This work has been carried on in accordance with the Agricultural Experiment Station practice. The third progress report of the Idaho committee includes in addition to the work started in 1927, time studies for the labor distribution for operating the experimental dairy unit, and a comparison of the completely electrified conditions with the manual operation under similar conditions. The mechanical equipment was found to save 53.5 man hours of the labor required per year for milking each cow. The use of electricity as an aid to poultry production has been expanded to include heating of the drinking water, lighting the poultry house for influencing the egg producing period of the hen, and the use of electrical energy for the artificial brooding of chicks. Mechanical refrigeration has been applied to the dairy unit in the form of a deep setting tank for milk cooling and a cold storage box for general farm use. Energy consumption and condensing water requirements have averaged 75.2 K.W.H. per month for the past year. Three household refrigerators are being operated under the domestic conditions found on the farm and electric cooking, water heating, laundry equipment, and mechanical household aids are included in the labor, time and cost studies. The 1929 report of the project director to the Idaho committee on the relation of electricity to agriculture will include additional information on the progress of the work at Caldwell.

## Agronomy

Climatic conditions for the production of spring seeded crops in 1928 were rather unfavorable. A wet winter and cool,

wet spring followed by rapid clearing of the weather and sudden increases in temperature caused a rapid drying out of the soil. Such a condition made rapid preparation of seed beds and hurried seeding essential. The result was thin and spotted stands of all spring seeded crops under actual farm conditions in northern Idaho. Undoubtedly such stands which prevailed were the cause of the somewhat lower than normal yields. Winter grains did not suffer greatly, because they had the advantage of cool, wet weather in early spring and became well established before dry weather began. However, the yields of winter grain were somewhat lower than usual.

Little trouble was experienced on the station in securing satisfactory stands of spring seeded crops because all of the plantings were made within a three or four day period. Some difficulties were experienced in the cereal nursery work because the seeding had to be extended over too long a period of time and upon spring plowed land.

**Cereal Investigations.**

Enlarged co-operation with the Sandpoint Substation is essential to fully determine the winter hardiness of the many varieties on trial. This work at Sandpoint was increased sufficiently to secure winter hardiness data on all of the varieties now grown in the Moscow winter nursery.

**Wheats.**

Mosida and Triplet have proven to be the high yielding winter wheats over a period of years. A cross between Fortyfold and Federation is also showing much promise but is not yet ready for distribution. Albit, a new variety, distributed by the Washington station, has been slightly poorer in yield than Hybrid 128, which ranks twenty-first among about thirty-five varieties. Like many of the other smut resistent varieties this wheat is not resistent to all of the strains of bunt or stinking smut that are prevalent in the Pacific Northwest.

During the past three years a new means of determining the value of our present wheat varieties to the farmer has been undertaken. Wheat nurseries in co-operation with county agents have been established in many sections of Idaho. In these nurseries the better wheat varieties have been grown and yields secured under actual farm conditions. Already from this work a new variety, Sherman, has proven to be outstanding for the dry farm areas of southeastern Idaho, especially for the vicinity of American Falls. The new variety is not only high yielding but is quite highly smut resistent and is higher in protein than the Turkey generally known.

Jenkin and Federation were the high yielding spring wheats in 1928. These varieties together with Red Bobs have been the high yielding ones over a period of years. Garnet, a spring variety highly advertised for the last two years in farm papers throughout the United States, yielded 18 bushels less than Jenkin. Burbank's Quality, likewise a very highly advertised

variety, has always been low in yield and was seventeen bushels below Jenkin this season.

**Barley.**

Trebi barley outyielded its nearest competitor by eleven bushels. Winter Club barley was the high yielding winter variety. However, Trebi, spring seeded, outyielded the Winter Club variety twenty bushels to the acre.

**Oats.**

Markton oats, a smut resistent variety, again demonstrated its high yielding ability by outyielding the next highest variety, Victory, by six bushels. Considerable seed of Markton is now available for distribution and many farmers will take advantage of it by planting their oat acreage with this variety. Either of these varieties are superior to Idamine, the previously recommended variety.

**Forage Crop Investigations.**

The Pasture studies carried on at Moscow, Caldwell and Aberdeen are showing satisfactory progress. Considerable information has been secured upon the growth habits of the grasses studied at the three stations. In this connection, strawberry clover was tried out for the first time upon alkali spots at Caldwell. Apparently this species is quite resistant to this condition, although further studies of its value are necessary before definite recommendations can be made.

Three hundred and twenty-five pounds of red clover seed per acre was secured at Moscow from the first cutting. This is an exceptionally high yield for this section. For the fourth consecutive year satisfactory yields of alfalfa seed in the Palouse area have depended upon thin stands—not more than one plant to a square foot, and utilization of the first growth.

Rate and date of seeding trials with alfalfa have shown early seeding at eight to ten pounds per acre to be the most satisfactory. Good stands of alfalfa can best be secured when no nurse crop is used. However, early varieties of peas made a more desirable nurse crop than any of the small grains.

A new strain of Ladino clover having a solid pink flower has been isolated and shows considerable promise. The alfalfa breeding work began in 1924 is showing satisfactory progress. A new nursery has been established in which the plants are all progeny of mother plants showing definite seed color.

Bluebell, number 8257, a selection made at the station was the high yielding variety in the pea variety test. This was selected from Bluebell a number of years ago and is outstanding both in yield and quality. Other high yielding varieties were Kaiser, Everbearing and White Canada. Kaiser and White Canada are satisfactory varieties for hogging off or mixing with the small grains for hay. Bluebells should be seeded at nine pecks per acre for maximum yields.

**Weed Eradication.**

Chlorates have proven to be the most satisfactory weed

eradicators. These chemicals have been effective in the control of all weeds with running root stalks. Sodium chlorate has been largely used commercially in Idaho. This chemical is applied in the form of a spray to the weeds any time after they have come into bloom. A ten per cent solution is generally used; this is made by dissolving four pounds of the chemical in five gallons of water. K-M-G (kills morning glory) which at first appeared promising has not proven satisfactory. Carbon bisulphide is effective for small patches when the moisture content of the soil can be controlled.

**Soils Investigations.**

The application of an 8-4-2 fertilizer to potatoes in the St. Joe River bottoms gave profitable returns in 1928. A 5-8-10 fertilizer was not as satisfactory showing that nitrogen and phosphorus were the limiting factors. Lime proved to be the most promising treatment for the reclamation of the overflow lands along the Coeur d'Alene river. This confirms the similar results secured for 1926 and 1927 inclusive.

Gypsum and sulphur have given equally satisfactory results when applied to legumes at Winchester. The results there indicate that 200 pounds of gypsum should be added to alfalfa every three or four years for best results. Sulphur and lime gave no increased yield over sulphur alone. Lime alone gave no increase over the check plots which received no treatment.

Iron sulphate for the treatment of chlorosis has proven disappointing. New work, including special tillage methods and the use of manganese, has been started. Tillage work, including the substitution of the chisel for the plow upon slick spots in dry farm areas of Cassia County, has been begun.

The annual soil survey conducted in Idaho in co-operation with the U. S. Bureau of Soils and Chemistry, was carried on in Gooding County. The work is nearly finished, requiring but a month's field work for completion.

## Animal Husbandry

The investigational work of the animal husbandry department is conducted at Moscow and at the substation farms at Caldwell and Aberdeen. The following subjects are being studied: Practical rations composed of Idaho grown feeds for fattening steers and lambs for market; various combinations of feeds for growing and fattening swine; animal breeding studies having to do with variations and abnormalities affecting swine; growth of wool studies with three breeds of sheep, and control methods for internal parasites of sheep and infectious abortion of cattle.

**Lamb Feeding Investigations.**

The lamb feeding investigations conducted at the Aberdeen substation showed that recleaned alfalfa seed screenings, when fed in limited quantities, can be used successfully as a part of

the basal ration of barley and alfalfa hay. Alfalfa seed screenings reduced the barley and hay requirements and increased the gains thereby reducing the cost of gains. Wet beet pulp added to the basal ration of barley and alfalfa hay gave very satisfactory results for fattening lambs. It reduced the barley and hay requirements and thus reduced the cost of gains. Cull beans, when fed in limited quantities together with barley and alfalfa hay, reduced the barley and hay requirements but were not as palatable as many other feeds used in this experiment. Cull beans have a lower feeding value than barley.

The lamb feeding investigations conducted at the Caldwell Substation showed that chopping and grinding alfalfa hay materially reduces the proportion of waste hay. The lambs receiving the ground, chopped and long hay wasted the following percentages respectively: None, 5.1 per cent, and 28.2 per cent. The barley and hay requirements were reduced with the preparation of the hay. The cost of gains were lower for chopped and ground hay due to the lower feeding requirements. The lambs fed chopped hay made slightly cheaper gains. There was little difference between chopping and grinding alfalfa hay for fattening lambs when fed with barley. Corn silage did not materially lower the feed requirements and did not increase the gains, consequently corn silage did not prove economical in a ration of barley and alfalfa hay with prevailing feed prces.

**Steer Feeding Investigations.**

The steer feeding investigations conducted at the Caldwell Substation showed that the addition of grain, corn silage, or both, to the alfalfa hay ration had an advantage over hay alone. On an average the increased selling price was more than enough to compensate for the increased cost of grains where barley, silage or both were added. The chopping and grinding of alfalfa hay reduced the percentage of waste hay and the hay requirements. Chopping or grinding of alfalfa increase the grains and finish of the steers. Ground hay was somewhat more efficient than chopped hay for two year old steers. Yearling steers made slightly more economical gains than two year old steers, but required a longer feeding period to secure a satisfactory finish. Yearling steers required less roughage but slightly more grain to produce 100 pounds gain. There was little advantage in adding corn silage to the ration of alfalfa hay and barley for either yearling or two-year-old steers in this experiment with prevailing feed prices.

**Skeletal Defects in Swine.**

There has been discovered in five herds of swine a heritable defect manifest in pigs at birth in the form of a brain hernia on the fore part of the skull. This is due to the failure of the skull bones to fuse in the region of the forehead thus allowing the outer brain layers, and consequently brain fluid to escape (Mennegocoele); and in some cases all of the brain layers

and some brain tissue have actually escaped into the abnormal development (Proencephalus). A very small percentage of pigs thus affected live. Records are available covering a period of four years involving matings especially designed to bring out the method of inheritance which characterizes this type of defect. It is found to be definitely inherited. The problem is being developed to include embryological consideration with the hope of securing more specific information relative to its hereditary behavior, as some of the pigs die in utero at a rather premature age.

**Whorls in the Hair of Swine.**

Breeders of purebred swine discriminate seriously against whorls in the hair especially along the backline in swine. For a number of years systematic matings have been under way with a view of studying the inheritance of the defect. It has been found that the defect is decidedly heritable. It appears that the particular type of inheritance involved is not simple, rather scattered variations occur. Whorls have been found to vary in size in the mature specimen from two to eight inches; to be left or right, and also to have either posterior or anterior to them and contiguous "feathering" of the hair which ends in a crest where it meets the opposite hair stream. Whorls appear for the most part in the region of the neck, withers, loin and rump.

**Spotting in Duroc Jerseys.**

White markings in Duroc Jersey swine occasionally appear on the extremity of one foot, as a rule. It may be found on two or even more extremities. The Duroc Jersey breed associations and the breeders discriminate against this rather exceptional occurrence of spotting in this breed which is, in the main, red. In systematic matings covering a period of five years, specimens have been obtained with every marked spotting on all four legs, the tip of the tail, and in the form of a belt completely surrounding the body. The belts occurring so far have been just back of the shoulders. Progress is being made in an effort to make a genetic analysis of the spotting tendency.

**Parrot Mouth in Sheep.**

It appears from the result of controlled matings that prognathism, commonly known as "parrot mouth", in sheep is inherited. The upper jaw or maxillae is abnormally long and proects one-half inch or more beyond the lower jaw, a situation which interferes with the specimen's ability to graze where the feed is short. The opposite condition, brachygnathism, commonly known as an "undershot' jaw, also appears to be hereditary. Specific information on the genetic behavior of these defects is becoming available in systematic matings.

**Infectious Abortion in Cattle.**

Work has been started on the development of a program

to eliminate infectious abortion in badly infected herds by a gradual removal of reacting animals. The object of this project is to determine the possibility of eventually establishing an infectious abortion free herd from one heavily infected by exercising sanitary precautions and gradual elimination of infected animals where the general herd is handled as a unit. If successful it will help the farmer who has infectious abortion in his herd and has not sufficient equipment to segregate the infected animals nor ample funds to eliminate them at once.

**Internal Parasites of Sheep.**

A program has been planned to gain some additional information regarding the detrimental effects of Oestous Ovis "grub in the head" of sheep, its prevalence, relationship to the muco prevalent nasal discharge of sheep and more satisfactory metods of control.

**Toxic Effect on Sheep of Chemicals Used in Weed Control.**

It has been found that a total of three ounces of sodium chlorate or calcium chlorate given in two equal doses four hours apart is sufficient to kill yearling wethers weighing approximately 100 pounds each. When fed on cut alfalfa hay at the rate of one to one and one-half or two ounces per pound of hay it greatly reduced the palatability of the feed. At the two ounce per pound of feed level it produced symtoms of chlorate poisoning that were evident in poor health and lack of fleshing for more than a month following the poisoning. Whether sufficient chlorate to produce ill effects could or would be taken in on pastures recently treated has not been determined.

## Bacteriology

**Study of Udder Infections.**

The work on this project, in co-operation with the department of dairy husbandry, has consisted of immunizing rabbits with known streptococci, and isolating streptococci from cows' udders. In this connection, methods of growing streptococci successfully and of keeping stock cultures have been studied. It is planned to make a serological study of the newly isolated strains, using the sera of the immunized rabbits as a means of identifying the serological groups occurring in udder infections. Part of a quantitative bacteriological study has also been made to establish a norm for each animal in the dairy herd. Counts have been made of the strippings of forty-one animals, most of which were counted on four different occasions. Comparisons of the counts from the fore milk, middle milk and the strippings are being made for the purpose of deciding which portion of the milkngs will give the most representative samples of the udder flora. In line with the results of previous studies at other stations the fore milk has thus far given uniformly higher counts than any

other portion of the milkings. The work on the strippings has shown that there is a norm for each animal provided the animal is still young and healthy. A cow with a history of udder troubles is more apt to give higher counts even after the lapse of considerable periods of time after the trouble is over. Some of he data gathered have indicated that frequently the strippings yield too few colonies on the plates to give a truly representative sample of the udder flora. The opinion seems to be warranted that a more representaive sample can be obtained from the middle milk.

**Isolation and Study of the Nitrifying Bacteria.**

In this work special emphasis has been placed on the isolation of nitrate oxidizing organism. The well known fact that certain dyes exhibit a selective action toward various organisms suggested their use in this study as a means of freeing cultures of the nitrite oxidizing organism from bacteria that persist when other methods are used. Rosaniline hydrochloride, a tri-phenyl methane derivative, was found to be an effective agent in eliminating the two most objectionable contaminating forms from cultures of the nitrite organism. When impure cultures were exposed to the action of this dye in 1.0 per cent concentrations for periods of time varying from five to thirty minutes these forms did not appear in the resulting cultures. Washed agar plate cultures made from such cultures were found to contain a third contaminating form. The nitrite oxidizing organism can be separated from this form by picking colonies from the surface of the washed agar plate cultures. Detailed studies of the nitrite oxidizing organism and the contaminating forms were made. The nitrifying organism isolated in this study is referred to by the term "the nitrite oxidizing organism" rather than by the term Nitrobacter or the nomenclature suggested in Bergey's Manual of Determinative Bacteriology. Additional studies are in progress on these organisms.

**Helmer Silt Loan Soil.**

The work on this project in co-operation with the department of agricultural chemistry, has for its object an explanation and remedy for the slow rate of decomposition of various organic manures and the consequent poor yield of crops on newly cleared cut-over timber soils. Ammonification and nitrification and carbon dioxide evolution studies were made on virgin timber soil after additions of barnyard manure, gypsum, ammonium sulphate, sodium nitrate, both alone and in combination with lime. The virgin soil in the various treatments showed a greater production of carbon dioxide and a greater ammonifying power than did a cultivated soil of the same type. All of the samples of virgin soil showed a very low nitrifying power.

Pots of virgin soil with the above soil amendments were cropped to sweet clover, red clover, alfalfa, wheat and oats. After the removal of the crop, ammonification, nitrification

and carbon dioxide evolution determinations were made on samples of these soils to which had been returned portions of the crop as a green manure. These additions of crop residues tend to cause a decrease in the accumulation of ammonium compounds. Additions of sweet clover residues stimulated carbon dioxide production whereas other crop residues appeared to retard carbon dioxide production to a slight extent. A further study is being made on this problem.

**Chicken Disease Studies.**

Immunization experiments against fowl pox were conducted on four commercial flocks. This infection had been endemic for several years on these premises and had resulted in heavy mortality and exceedingly low production in successive years. The vaccination resulted in the production of an active immunity in the pullets so that the infection did not appear. While there was a delay of thirty days in the vaccinated birds coming into production due to the immunization infection, the value of such protective vaccination was clearly established, as the birds rapidly attained a high production level which was held persistently throughout the winter season and there was a singular freedom from losses from intercurrent infections.

Comparative trials of various modified serologic antigens for the diagnosis of *Salmonella pullorum* infection in fowls to eliminate interference in diagnostic accurary because of non-specific precipitations show the superiority of antigens containing respectively 0.04 per cent sodium hydroxide and 1.8 per cent sodium chloride over non-phenolized and formolized antigens.

An investigation of an epiornithic due to *Pasteurella avicida* among turkeys on range showed that irrigation ditches are important channels for the rapid dissemination of this infection.

**Cattle Disease Studies.**

Representative herds of dairy cattle from various parts of the state were tested by means of the agglutination test for infectious abortion. Of 955 animals tested, 213 or twenty-three per cent reacted positively to the test. In conjunction with this testing work, information has been gathered on the individual cows on the regularity of estrum, shy breeding, length of gestation period (abortion or premature deliveries), dystocia, normal delivery or retention of the fetal membranes, post-parturient disorders, and prevalence of garget on calves, on the occurrence of scours and mortality in early life on bulls, a determination of potency, and freedom from genital infection by examination of the seminal fluid. The information thus secured will be correlated with the serological diagnosis of infection with *Brucella abortus*.

**Miscellaneous Activities.**

Besides the results on the research projects outlined above

the department prepared and distributed to farmers either directly or through the agency of seed companies and county agricultural agents, 1,961 bottles containing cultures for legumes. This was enough culture to inoculate 5,883 acres of leguminous crops. Most of the cultures were for alfalfa. Over 100 samples of water were analyzed during the year. Of these, 28 were condemned as unfit for drinking purposes. Other work of a routine nature, no record of which is kept, consisted of examinations of various pathological materials for physicians, daily bacteriological examinations of milk for the dairy husbandry department and monthly examinations for the city of Moscow.

Autopsy records on poultry speciments submitted for diagnosis show that over fifty per cent of the infections or infestations were soil-borne. These findings indicate the need for improvement in methods of sanitation.

Classification studies on the most commonly found tapeworms infesting poultry in the state show the prevalence of *Raillietina (S) cesticillus, Hymenolepis carioca, Davainea proglottina,* and *Choanotaenia infundibulum.* The latter organism has thus far been found most frequently.

In the 1928 season, 197 flocks comprising 50,000 birds, were tested for bacillary white diarrhea infection by the agglutination test. Thirty-three flocks contained no reactors to the test. In the remaining 164 flocks, 2,150 reactors were found which is four per cent of the total number of birds tested.

## Dairy Husbandry

During the past year the dairy herd, comprising an average of 32.5 animals, made an average per cow of 12,265.9 pounds of milk and 456.2 pounds of fat, or an average test of 3.8 per cent. Twenty-two official tests have been completed during the current year, the highest being 754.34 pounds of butterfat.

**Use of Proved Sires.**

In co-operation with the Bureau of Dairy Industry of the United States Department of Agriculture, a study of the continuous use of proved dairy sires in an attempt to breed dairy cattle pure in their inheritance for high milk and fat production was continued. Of the 75 females used in this experiment, 48 are still in the herd. Complete data, however, were obtained on many of those that have been removed since 43 of the 75 have made yearly records. Eight bulls have been used in this experiment, four of which have been tested for transmitting powers through the proved production of their daughters compared with their dams.

Normal growth studies on the Holstein and Jersey breeds have been in progress for about eleven years. This study will be continued until sufficient material is available for publication.

A new project started during the past year is a study of breeding efficiency in dairy herds.

**Calf Feeding Investigations.**

One group of four Holstein calves was fed on semi-solid buttermilk as a substitute for skim milk. Some difficulty was experienced in changing the calves to this feed from sweet milk and the calves did not appear as thrifty as those that were being fed on skim milk. Some difficulty with scours was experienced until the calves were old enough to eat considerable quantities of hay and grain. The average gain was 16.3 pounds above Eckle's Standard. The feed cost of raising the calves to six months of age was $32.17. The study indicates that semi-solid buttermilk is not very desirable as a substitute for skim milk.

**Feeding Dairy Calves.**

Three groups, composed of three grade Holstein calves each, were fed as follows: Group 1, skim milk and alfalfa hay; group II and group III skim milk, alfalfa hay and ground barley. Group I was thinner in flesh, had a longer hair coat, and lacked the freshness of the other two groups. Group I had an average daily gain of from one-quarter to one-half pounds less than group III and group II respectively. Group I had a feed cost of per calf for the six months' period of from $1.00 to $3.00 less than for group III and group II respectively. These results indicate that satisfactory calves can be raised under either system of management.

**Wintering Dairy Heifers.**

Three groups were fed as follows: Group I, alfalfa hay alone; group II, alfalfa hay and barley; and group III, alfalfa hay and silage. Group 1 failed to make the norml rate of growth as indicated by Eckle's Standard. Group II made a normal growth in heighth and weight, making more than normal growth in weight; group III made more than normal growth in both heighth and weight. The total feed cost for 182 days per animal was: Group I, $16.09; group II, $19.32; and group III, $22.37.

**Potatoes Compared With Corn Silage.**

Checking on previous year's results in the direct comparison pound for pound in a double reversal system of feeding, results indicate that the use of raw potatoes for feed is satisfactory from the standpoint of palatability, milk production and the maintenance of body weight.

**Relation of Feeding and Management to Production.**

This study was conducted in co-operation with the Washington State College. The system studied represented cows milked twice a day, cows milked three times a day and cows milked four times a day. Three cows completed records on all three systems and indicated a production of 60 per cent when milked under the system of twice a day; 75 per cent when milked under the three-times a day system, and 100 per cent when milked four times a day. Thirteen cows completing rec-

ords under both the three and four milkings daily indicated that one-fourth greater yields were obtained from the cows when milked four times daily. The peak of production from the cows milked twice a day was reached before the end of the third week after calving, while those under the more intensive systems of feeding and management usually did not reach the peak until the end of the sixth week. Maximum production was reached about seven years of age. The study indicated that the two-year-old records were reliable measures upon which to cull the herd.

**Irrigated Pasture Management For Dairy Cows.**

This is the second year's study on this project with the same treatment and the same plots as reported last year. The results are similar except this year there was a pasture season of 169 days instead of 120 days as in last year's report. This year's report gives even more striking results in the benefit to be derived from additional irrigation and no benefit to be derived from cultivation. The addition of manure gave an increase in carrying capacity and total income per acre, but it would appear from the study of the second year's work that the second year's application of manure did not give as big returns as the first year.

**Addition of Skim Milk Powder, Gelatin and Agar to Cheddar Cheese.**

A study was made of the effect of skim milk powder, gelatin or agar on the quality of cheddar cheese. Results indicate that an addition of agar or gelatin to the milk had no beneficial effect on either the yield or the quality of the resulting cheese. When milk was standardized from 9½ per cent to 10 per cent of serum solids by the addition of skim milk powder, there was a slight decrease in the flavor score but no decrease in the body or texture score. Skim milk powder caused an increase in yield of cheese. The limited data seemed to indicate the importance of more study on the use of skim milk powder.

**Cream Gathering in the Boise Valley.**

The system studied represented the gathering of cream by trucks through the route system. Considering all factors the cost of gathering cream amounted to 13 cents per mile traveled or $.0154 per pound of butterfat. The combined covered trucks were more efficient than wet burlap alone, and wet burlap was more efficient than the covered truck alone. The lack of proper cooling and lack of stirring were outstanding reasons for sour cream. The position the patron had on the route had little influence on the quality of cream produced.

**Farm Sterilizers.**

In the work as it has thus far progressed, three electric sterilizers have been added. All three proved to be very efficient for sterilizing dairy utensils. They were easy to operate, required little attention while operating under ordinary conditions, and the entire sterilization process could be completed in one hour.

**Service Work.**

During the past year a grand total of 295 days in testing supervisors' time was made on official testing work. The number of monthly tests increased from 142 tests in the previous year to 154. An average of 17 to 18 breeders were served each month.

During the past year 1,127 packages containing 11,770 pieces of glassware were checked for accuracy. Of this number twenty pieces were broken and only thirty-nine were found to be inaccurate.

**Bull Association Investigations.**

In co-operation with the Bureau of Dairy Industry, United States Department of Agriculture, an investigation of the results obtained in breeding up farm herds through co-operative dairy bull associations has been continued. Three and one-half years' results have been compiled on this project and a summary of the first three years' results was published by the Experiment Station in Bulletin No. 161, entitled "A Study of Bull Associations in Idaho" by H. A. Mathiesen and F. W. Atkeson. This study is being continued.

## Entomology

**Alfalfa Weevil.**

The alfalfa weevil was present in all the alfalfa districts of southern Idaho during the season but artificial control was not necessary excepting in the upper Snake River valley where about 200 acres of alfalfa were sprayed.

**Beet Leaf Hopper.**

A detailed study was continued in the lower Snake River valley to determine areas of high populations, ascertain seasonal importance of different host plants, obtain additional information on life history and habits of the insect, determine effects of parasitisim and weather conditions, etc. Mass selection of beets showing resistance to curly-top were continued and a quantity of seed from selected stock obtained. Beets from seed from selected plants showed marked increase in yield over commercial beets without impairment of other desirable qualities. Study of curly-top of beans was continued. Test plots of several varieties were maintained to determine susceptibility to the disease and degrees of resistance. The project includes tests of screening pigments, affects of dates of planting, etc. Work on the beet leaf hopper is conducted in co-operation with the U. S. Bureau of Entomology.

**Codling Moth.**

A three-year study of the life cycle of the codling moth in southwestern Idaho was competed in 1928. All data are assembled and ready to be prepared for publication. Studies in control of the codling moth have been under way for two seasons. These include the use of lead arsenate, substitutes and

supplements. In general, substitutes or supplements did not add to control sufficiently to justify their use instead of lead arsenate.

**Colorado Potato Beetle.**

Examinations of fields in Canyon county where erradication of the Colorado potato beetle was undertaken in 1927, indicated that erradication had been successful.

**Destructive Prune Worm.**

*Mineola scitulella* is widely distributed as evidenced by adults being collected at Boise, Emmett, Nampa, Parma and Crystal, but it has been of economic importance in prune orchards only near Boise and Emmett. It was collected from apricots also in one orchard near Emmett in 1928. Fruit growers commonly are mistaking the peach twig borer for this insect. Control experiments have proven negative to date and unless satisfactory measurers for checking it are developed it will be the worst insect enemy of prunes in Idaho when it becomes generally abundant.

The experiment station has been studying the pest for three years during which time the life history has been determined and much data assembled, including numerous illustrations. One point in the life cycle was discovered that it is believed will lead to the establishment of successful control measures before the time when the pest becomes of wide-spread importance. One parasite of the summer larva was discovered. The insect has not been reported of economic importance elsewhere in the United States.

**Fruit Tree Leaf Roller.**

Numerous experiments were conducted against the fruit tree leaf roller in the Twin Falls area in 1927 and the results showed that four per cent oil strength killed an average of 95.80 per cent of the eggs and that very good commercial control was obtained. Heretofore seven per cent oil has been recommended by the Idaho Agricultural Experiment Station but its use has often resulted in marked injury to the trees. Four per cent oil failed to give satisfactory control in 1928 in the same district and further information is needed. Results were about equal where Cresoap emulsifiier or calcium caseinate were used.

**Onion Thrips.**

Studies on control of the onion thrips have been in progress for three seasons. The general conclusions to date are that dusts are much more effective than sprays and more practicable to apply. Nicotine dusts are the most effective of the materials tested and in these experimnts even inert dusts gave better control than nicotine sulfate spray. Also, arsenical sprays gave better control than nicotine sulfate spray. Most of the materials tested are extremely costly and their practicability doubtful. Studies are in progress concerning the species of thrips infesting onions and all nearby plants.

**San Jose Scale.**

Oil sprays were tested against San Jose scale and results were identical with those of the past four years. Where thorough application is made, three per cent oil kills 100 per cent of these insects in southern Idaho. Lime-sulfur at four and five degrees Baume strengths gave entirely satisfactory control.

**Western Oil Spray Co-operative Project.**

With other states of the Northwest and British Columbia, Idaho is co-operating in a general test of oil sprays for the control of insects. The work is planned and carried out co-operatively by all members of the organization and tests are directed against the insects concerned in their respective states. The work comprises the use of various oils and emulsifying agents as well as a study of the effect of such oils against insects and of the injury they may cause to vegetation. The insects in Idaho that come under the work of this project are the fruit tree leaf roller, the codling moth, the pear leaf blister mite, San Jose scale, spider mites, aphids, and leaf hoppers.

## Farm Forestry

**Windbreak Study.**

A study to determine the influence of windbreaks on the growth and yield of field and orchard crops has been carried on the field seasons of 1927 and 1928 in the Twin Falls irrigated tract of southern Idaho. It is expected to complete gathering the data the field season of 1929 and compile results for an average. So far the data indicate that windbreaks have both a beneficial and detrimental effect on field and orchard crops. The detrimental effect is chiefly confined to the zone of windbreak competition in which the trees of the windbreak are competing with the field and orchard crops for soil nourishment, moisture and light. This area is parallel to the trees and of a width on both sides equal to about the height of the trees composing the windbreak. The extent of the loss of field and orchard crop depends not only upon the species of trees composing the windbreak and their handling but upon the crops grown adjacent to them. A ditch established on the crop side of the windbreak of depth sufficient to prevent the tree roots from spreading excessively out in the field will go a long way toward reducing this crop loss. Where windbreaks parallel a road or highway, loss of crop is felt only on one side.

The beneficial effect extends from the zone of windbreak competition a distance on the leeward side equal to about 20 times the height of the trees and is called the zone of windbreak protection. The benefit comes to the field and orchard crops through decreased wind movement and consequently less evaporation from the soil and plants. In the case of a severe wind at the time the crops are ready for harvest, windbreaks

are of special benefit since they prevent the crops from being scattered and damaged. Orchard spraying can be carried on at any time under the protection of a suitable windbreak.

**Economic Value.**

Over and above any protective influence the trees might have come the returns in the way of forest products, such as fence posts, poles, props, fuelwood, bridge timbers, wagon tongues, etc., especially if black locust or Russian olive are the windbreak trees. Actual harvests and cruises of windbreaks show that often as much revenue can be realized from a black locust or Russian olive windbreak as from field or orchard crops grown on the same area as that taken up by the trees over a period of years. The aesthetic value of a farm windbreak is also of more or less importance.

Since the prevailing winds in the Twin Falls tract are from the west during the growing seasons, only north and south windbreaks have any great influence on crop protection. An east and west row of trees cannot be expected to exert much protective influence except for livestock but is valuable aesthetically as a roadside planting and for the revenue it might produce in the way of forest products.

The economic importance of this study can be appreciated when it is realized that approximately three acres of land are lost for crop production for every mile of windbreak where the trees are not properly handled. The concentration of crop loss on this narrow strip parallel to the trees often has been the cause assigned for removal of windbreaks resulting in the loss of a three-fold asset: protection for field and orchard crops, forest products, and the aesthetic value of the windbreaks.

## Home Economics

**Vegetable Storage.**

During 1928 additional returns were received on the questionnaires sent out in connection with the study of the methods of vegetable storage now in use. These results have not yet been tabulated but will be at an early date. It seems doubtful, however, that anything radically different from the present accepted methods of vegetable storage will be revealed through this study. With the co-operation of the Department of Horticulture a study has been undertaken of the best methods of storage of certain vegetables. Potatoes, carrots, cabbage and cauliflower were put in storage in the storage house of the department of horticulture in the fall of 1927. Thermograph records were kept during the greater portion of the time the vegetables were in storage. Temperature was found to be remarkably constant at about 40 degrees F. No records of humidity were kept. Potatoes were in good condition on June 1, 1928, and were usable for some two weeks longer. It was difficult by superficial examination to discover any difference

in the condition of carrots kept in sand in the storage house and of those kept on shelves. These were in good condition on May 1, 1928. Cabbage did not keep so well under conditions of this storage house and the cauliflower failed to keep either when wrapped or when left on a shelf without wrapping. No cauliflower were put in storage in the fall of 1928 but the other three vegetables were.

**Vitamin C in Idaho Potatoes.**

Progress has been made in the study of the effect of storage upon the Vitamin C content of the Russett Burbank potato of Idaho. During 1928 a small laboratory was equipped to care for guinea pigs in the study of this problem. Space and equipment were acquired to care for twenty-four test animals in individual cages. A preliminary group of animals were run in the spring of 1928 to test the equipment and two series were run late in the year. For the first series young growing tubers were used and for the second series potatoes at the time of digging and just following digging were used as the test material. A slight modification of Sherman and Le Mur's technique was used. While results cannot be announced at this time, the new potatoes appear to be somewhat richer than the mature potatoes in Vitamin C. Further tests will be run on these potatoes after three to six months' storage.

## Horticulture

**Storage of Prunes.**

Prune storage studies in the Boise valley have shown that with proper care in picking and handling, storage of the Italian prune at 32 degrees can be relied upon as a satisfactory means of holding the fruit for long enough periods to equalize shipments throughout the season and to relieve an occasional over-production by slightly extending the normal shipping period. As in 1927, the pressure resistance of the fruit determined by the modified Murneek pressure tester served as the most dependable and the most convenient measure of proper picking time and of storage possibilities of the fruit. The medium early to the mid-season pickings, ranging in pressure from 9.5 to 7.5 pounds gave the best storage results this year. Fruit from these pickings held up well for from three to four weeks after mid-season. Except for shriveling they would have been marketable one to three weeks later. Shriveling constituted by far the most extensive form of deterioration in storage. Irregularity in the rate of ripening of the fruit on individual trees also proved an important factor in this work, particularly in connection with the mid-season and later pickings. A certain percentage of the fruit going into the pack at that time passed the stage of best keeping quality; and the storage life of the pack as a whole was, of course, largely determined by the storage life of the ripest fruit contained in it.

Prunes picked very early hold up well in storage but do not develop prime quality. Late picking shortens storage life. Rapid ripening and subsequent deterioration of the fruit takes place upon removal from cold storage to a display window at room temperature, emphasizing the importance of early disposal of such fruit after it reaches the hands of the retailer.

**Cracking of Sweet Cherries.**

Growers of sweet cherries in the Lewiston district occasionally experience a loss of fifty or more per cent of the commercial crop through injury to the fruit by cracking. Losses somewhat less than that are quite common. A study during the summer of 1928 of factors influencing the extent and severity of this injury, brought out a number of interesting points for further investigation. The type of cracking injury common to the Lewiston district was found to be, for the most part, the direct result of wetting of the fruit by rain at a time when the fruit is mature or nearly so. An osmotic intake of water through the skin of the cherry at this time results in a volume increase under the pressure of which the cherry finally bursts. Soil moisture conditions seemed to have little or no direct bearing upon this type of injury. There are, however, a number of other factors which materially influence the extent and severity of the cracking when weather conditions are such as to bring it about. Much depends upon the stage of maturity that has been reached by the fruit. The amount of cracking, both as to the number of fruits involved and the severity of the injury on each, increases with increasing maturity. With Lambert cherries a considerable variation was found in the time of ripening of the fruit among individual trees, suggesting the possibility of reducing the danger of severe cracking by harvesting first from the trees which are in the most advanced stages and hence most susceptible to cracking injury. Of the three leading commercial varieties grown at Lewiston, the Bing proved most susceptible to cracking and the Royal Ann least, with Lambert intermediate between the two. These varietal differences appear to be due in part to differences in the normal sugar contents of the three at maturity, and in part to differences in the capacities of the skins of the three varieties for expanding and so taking care of the increased volume which otherwise would result in cracking. The Royal Ann suffered 64 per cent of cracking with a volume increase of 9.8 per cent, while in the Bing 100 per cent of cracked fruit resulted with only 5.4 per cent volume increase.

**Apple Breeding.**

Work on the apple breeding project, started by the Experiment station in 1909, continues to show an extremely wide range in size, form, color, per cent of acidity, and keeping qualities among the offspring of the various crosses. Most of the seedlings having Ben Davis as one parent have shown remarkable keeping qualities, even under common storage con-

ditions, but only a small percentage of these are sufficiently high in other qualities to be considered as promising new varieties. A number of the more promising seedlings so far developed have been grafted in the commercial orchard to hasten their bearing under normal orchard conditions. A few others propagated in the nursery row will be sent out to commercial growers in the state for further trial.

**Orchard Fertilization.**

Fertilizer experiments in Jonathan apple orchards at Coeur d'Alene and Moscow, which in the past showed no significant gains due to any of the treatments, continued to show negative results during the past year. In a test of ammonium sulphate fertilizer in an orchard of Jonathan, Rome Beauty and Winesap apples near Wilder, in southern Idaho, considerable yield differences resulted under the various treatments; but due to a high variability among individual trees in the experiment at the beginning, as shown by trunk circumference measurements, no conclusions were drawn. A similar experiment with ammonium sulphate in an Italian prune orchard near Boise showed a 45 per cent increase in yield over the check plots from the application of one pound ammonium sulphate per tree. In view of the number of trees involved in the test (38 in each treatment), and their uniformity, this gain is considered significant. Heavier applications of ammonium sulphate, up to six pounds per tree, gave no significant increases over the one pound treatment.

**Other Projects.**

Due to unusual drouth and hot weather during 1928 experiments with the fertilization of vegetables gave such variable results that no conclusions were reached. The same was true of the potato experiments. In the cherry pruning experiment at Lewiston unfavorable weather conditions at the time of blossoming so influenced the crop by its effect on pollination as to over-shadow any possible influence of the pruning treatments on yields.

## Plant Pathology

The research work of the Department of Plant Pathology has dealt with a number of plant diseases of great importance to the development of agriculture in Idaho. Investigations have been carried on in the localities of the state where these diseases are of most importance.

**Virus Diseases of Potatoes.**

Four virus diseases of potatoes have been primarily considered in connection with this project. These are rugose mosaic, mild mosaic, leaf roll, and spindle tuber. Tests carried on in various parts of the state have shown that an isolated and carefully rogued seed plot is an effective means of practically eliminating traces of rugose mosaic, leaf roll and advenced spindle

tuber in the better seed growing sections. These diseases have been practically eliminated from the better lots of certified seed in the state.

Mild mosaic is, however, much more difficult to eradicate under field conditions due to the fact that it is many times impossible to distinguish on the field. Greenhouse indexing has been resorted to and some lots of seed which appeared to be free from infection in the field developed large percentages of the mild mosaic disease when grown under greenhouse conditions. More greenhouse space is necessary in order not only to check upon the prevalence of this disease in various lots of seed but also to establish the basis for disease free lots of seed for future use.

**Control of Potato Scab by Seed Treatment.**

Tests of various disinfectants for the control of common scab of potatoes, has again shown that hot formalin, is more efficient in control than corrosive sublimate, Semesan Bel, either as a dip or dust, Dipdust or Bayer Compound 190. Complete control was obtained with hot formalin while the amount of disease in other treated plots approached the amount of disease in the checks.

**Clover Mildew.**

It has not been possible to do any large amount of work on the clover mildew project this year. Testing of a large clover nursery at the Aberdeen Substation for resistance to the disease has given some fairly promising results. Spraying and dusting tests carried on in co-operation with farmers in several sections have shown that the disease may be held in check with sulphur dust applied at the rate of 10-20 pounds per acre when the disease begins to appear and again as necessary. Plans are being made to carry on some life history studies of the causal organism during the coming year.

**Sclerotium Disease of Wheat.**

This disease has caused considerable damage in Teton county several years and has been previously reported. The study of the disease has been approved as an Adams project and will be intensified this year. The causal organism, (*Typhula graminum* Karst), has been cultured from diseased wheat plants and a similar, if not identical, organism has been secured from sclerotia produced on lawn grass at Moscow. The disease was not prevalent in Teton county during 1928.

**Grain Smut Control.**

The results of several years' experiment with various disinfectants for the control of bunt in wheat have been summarized and will be published soon. The tests carried on during the past year have confirmed the previous conclusions that the Idaho modification of the formalin spray treatment, one part formalin to ten parts water, for oat smut control is the most effective and the most economical treatment tested. A num-

ber of the new organic mercury dusts were tested and although several gave satisfactory smut control, they are more expensive, more difficult to apply and in general not so satisfactory as the modified formalin spray treatment.

**Curley Top on Tomatoes.**

Since the discovery that this disease (Western Yellow Blight) is transmitted by the sugar beet leaf hopper (*Eutettex tenellus* Baker) the work dealing with selection for resistance has been intensified and expanded both at Lewiston and at Twin Falls. Several selections which have shown promises in the past, were again comparatively resistent when subjected to inoculation by means of viruliferous leaf hoppers under field conditions.

**Bean Diseases.**

Several methods of seed treatment were again tested at Moscow and at Twin Falls for their effect upon stand, disease, and yield of field beans. Copper carbonate, Semesan, Dipdust, Bayer Dust and several other organic mercury compounds were tested. No appreciable advantage in stand, disease control, or yield was noted as a result of any of these treatments.

During the past season a careful study has been made of the symptoms which develop upon beans as a result of infection by the beet curly-top virus in order to distinguish this disease from other diseases known to the present and due to other causes of a parasitic and non-parasitic nature. As a reult of this study the conclusion has been drawn that although curly-top is doubtless present in bean fields in southern Idaho, especially in sections bordering leaf hopper breeding areas, there is no evidence that it is the cause of all and probably not of the majority of the losses often attributed to it. The situation is complicated by the occurrence of unfavorable soil conditions, root rots, mosaic, and perhaps other factors.

For the most part the work on the bean disease project has dealt with bean mosaic investigations as this disease is by far the most important bean disease in the state. In the fall of 1927 a total of 124 healthy plants of the Great Northern variety were selected for mosaic resistance in fields which were very severely infected with mosaic. These were tested for mosaic resistance at Twin Falls the past season. The plant two row method of testing was used. Six of these selections remained free of mosaic the entire season. The possibility of obtaining mosaic resistent strains of beans by selection furnished incentive for expansion of this phase of the problem. A number of selections were again made in the Great Northern variety and a large number also made in the wax and green podded varieties for testing next season.

Greenhouse studies have been carried on with respect to seed transmission of bean mosaic. The seed from individual pods from mosiac infected plants have been indexed. Great Northern bean seed produced by plants which had become infected during their vegetative development averaged 33 per

cent mosaic infection. Plants grown from infected seed produced seed which averaged 48.6 per cent mosaic infection. The size of pod, whether containing few or many seeds did not seem to be correlated with the percentage of mosaic seed carried in either type of mosaic infected plants. Results have again confirmed the previous observation that bean mosaic symptoms are much more marked under high temperature conditions both in the greenhouse and in the field.

**Stripe Rust Investigations.**

In co-operation with the U. S. Department of Agriculture, studies of the physiology of the organism causing stripe rust, *(Puccinia glumarium* (Schm) E. & H.) have been emphasized. Tests of the longevity of urediniospores of stripe rust, leaf rust, and stem rust of grains and grasses in different degrees of temperature and humidity were repeated. The results obtained were comparable to those secured in 1927. Urediniospores kept in a temperature of 10 degrees C in a humidity of 49 per cent remained viable for a longer period of time than did any of the urediniospores kept in other temperatures and humidities.

Investigations with teliospores showed that by freezing the spores from three to five days the percentage of germination was greatly increased. This method of stimulation produced the highest percentage of teliospore germination ever secured.

Four hundred and nine wheat varieties and crosses received from Germany, Oregon Agricultural College, and Kansas State Agricultural College were tested in the field for their relative susceptibility to stripe rust. This test will be repeated in 1929 to secure a check on this year's results. Also, a number of barley varieties were tested in the greenhouse for their susceptibility to stripe rust.

## Poultry Husbandry

**Vitamin Supplements to the Laying Ration.**

The study of vitamin supplements to the laying ration has, for the most part, had to do with a study of sources of vitamin supplements rather than the specific effect of any particular vitamin. Continued investigation in this study has substantiated previous work in demonstrating beneficial results by the use of cod liver oil, dried alfalfa leaves, and dried lawn clippings as vitamin supplements in giving increased egg production, increased hatchability of eggs, and a more healthful condition of the hens.

The irradiation of wheat, by subjecting it to ultra violet rays of a mercury vapor lamp for fifteen minutes at a distance of one foot proved ineffective in promoting normal body functions. The birds receiving irradiated wheat gave a low egg production, low per cent of hatchability, suffered an extremely high mortality, and exhibited an extremely rachitic condition.

**Value of Mineral Supplements.**

The detrimental effects resulting from mineral deficient rations were demonstrated during a one year trial. A dolomitic limestone grit analyzing 53.9 per cent calcium carbonate and 45.7 per cent magnesium carbonate proved to be an inadequate source of calcium for normal calcium metabolism as compared to oyster shell. Hens receiving the limestone grit gave a reduced egg production compared to those receiving oyster shell, reduced hatchability of eggs, and laid a large number of thin shelled eggs.

An examination of skeletons of birds receiving limestone grit revealed a rachitic condition of both the keel bone and ribs. The keel bones were extremely twisted and crooked, and the ribs were badly enlarged and buckled inward at the middle joints. The hens receiving oyster shell were normal with respect to the above conditions. Both the limestone grit and oyster shell were fed in open hoppers available at all times to hens of the respective groups.

In several pens the intake of various minerals, namely: ground limestone, bone meal, and ground gypsum were restricted to 4 per cent of the mash mixture. In each case the same detrimental effects noted above occurred but to a more marked degree. Although the skeletons of the birds in these groups exhibited an advanced stage of rickets, there was no paralysis exhibited by the birds.

**Relation of Humidity to Hatchability.**

During the past year the department reorganized the study of the project dealing with the relation of humidity to hatchability. The data obtained during the past season indicates that the measurement of humidity in terms of relative humidity may be very misleading unless a uniform temperature is maintained. During two successive hatching periods, the average per cent relative humidity of the room averaged one tenth of one degree higher during the second hatch than during the first. The room temperature averaged four degrees higher the second hatch. The data on the actual humidity contained in the atmosphere indicated 13.34 per cent more actual moisture than the second hatch. The two best hatches were obtained with an average relative humidity of incubator chambers (small still air machines) as follows: (1) A hatch of 50.54 per cent of fertile eggs with an average relative humidity of 34.87 per cent; (2) A hatch of 65.56 per cent of fertile eggs with an average relative humidity of 37.8 per cent. The poorest hatch in the low range of humidity was a hatch of 41.9 per cent of fertile eggs with an average relative humidity of 21.9 per cent. The poorest hatch in the high range of humidity was a hatch of 30.0 per cent of fertile eggs with an average relative humidity of 54.7 per cent.

Further evidence with regard to the effects of various ranges of humidity is the mortality which occurred during the third

week of incubation. The mortality during the period for the two best hatches mentioned above was 25.27 per cent and 22.2 per cent respectively. A mortality of 43.01 per cent occurred during the third week with the low range of humidity and a mortality of 34.44 per cent during the same period with the high range of humidity.

The per cents of relative humidity noted above are not quoted as being absolutely accurate, due to the variation in the recording of the Precision Hair Hygrometer used. Further work on this project is planned for the coming year in which attempts will be made to study conditions of humidity required for successful hatching results in different types of machines.

## Aberdeen Substation

**Barley Nursery.**

The barley nursery at the Aberdeen substation this year included about 400 different varieties of barley and some 2000 hybrids. The mechanical mixture of barleys and composite crops nurseries were carried on by Dr. H. V. Harlan of the United States Department of Agriculture. These are showing quite a preponderence towards the Manchurian barleys. The Trebi is in this class, apparently indicating that this country is better adapted to the Trebi type of barley than to any other. Trebi barley is spreading rapidly through Montana, Wyoming, Colorado and Utah. Colorado conducted a feeding test comparing Trebi with Coast barley. The Trebi proved about eight per cent better for fattening lambs than the coast variety.

**Oats Nursery.**

The oats nursery included around 300 different varieties of oats. The Markton, Victory, and Markton Idamine crosses are segregating out some very promising smut resistant strains. The nursery plantings were increased this year to include a smut nursery for oats, barley and wheat.

The varieties were all carried in triplicate this year. This adds to the reliability of the results and cuts down the probable error. In addition to the variety testing of grains and legumes, attention was given in 1928 to two irrigation experiments. The first is concerned with the stage of the growth of the potato plant best suited to the application of the first irrigation, and the second to determine the frequency of irrigation that gives the highest yield of marketable potatoes.

A series of plots also was given over to grasses and grass pasture mixtures. The object of this experiment is to determine the best grass pasture mixture for Idaho irrigated lands. Each variety is planted separately and notes are taken on habits of growth, vigor and palatability. The cutting is done with a lawn mower and the air dry weights are taken.

**Lamb Feeding.**

The lamb feeding experiments were continued to determine

the value of the waste products, cull beans, alfalfa seed screenings, and dried beet pulp, as supplements to a basic ration of barley and hay.

**Other Projects.**

Other projects in the substation program are rotation experiments, sugar beet irrigation and thinning tests, and clover nursery. The objective in the clover project is to develop a superior quality, winter hardy, vigorous, high seed yielding strain, combining with these characteristics a good foliage and freedom from disease.

The scientific work of the substation is increasing yearly. Better equipment and facilities of all kinds are now available, more co-operation is had from other research organizations and more interest is manifested by the general public.

## Caldwell Substation

The Caldwell Substation has a varied program partly in the interest of the special agricultural problems of southwestern Idaho and partly concerned with state-wide investigational enterprises.

**Soils Improvement.**

A highly important project of special interest to the region deals with the improvement of the particular type of soils existing in the vicinity and is concerned both with controlled conditions on small plots and various applications in the open fields.

**Dairy Cattle Feeding.**

As a special service to a rapidly expanding dairy industry in the irrigated regions of Idaho, much attention is being devoted to studies of the growth of young cattle under various systems of feeding, the use of pastures for growth, maintenance, and milk production and the feeding of milk cows upon hay alone and hay supplemented with silage and concentrates. The whole program of dairy cattle feeding aims at the development of the most efficient system of nutrition for dairy cattle at all stages of growth and production. The main point at issue is the most economical use of alfalfa hay, the leading forage crop of the irrigated farms. The Caldwell Substation is now well equipped with a modern dairy barn and attached milk rooms, milking machine and other equipment for handling the experimental work in this field.

**Farm Electrical Machinery.**

In co-operation with the Idaho committee on the relation of electricity to agriculture, the substation has been used as an electric experimentation and demonstration farm. The tests carried out in co-operation with the committee have dealt with the application of electricity to general farm, livestock, and home purposes. Much data have been collected on the con-

sumption of current in operating such equipment as milking machines, sterilizers, cooler, pump, feed grinder, silage cutter, hay hoist, and other machinery of common farm use. There also is included in the information available, facts upon the current consumption of home refrigeration plants, ranges, irons, etc. The substation is now well equipped electrically.

**Steer and Lamb Feeding.**

Steer and lamb feeding have been conducted during this year as in former years. These investigations are concerned with the utilization of various home-grown feeds in different combinations in the fleshing of steers and lambs for market. This particular investigation is intended to assist the development of a permanent Idaho feeding industry, which in time will result in the range lambs and steers serving as a means of carrying to market in concentrated form the grain and forage products of Idaho farms. Further reference to the feeding work is found in this report under animal husbandry.

**Machinery Experiments.**

There has been much interest in recent years in the program of greater efficiency in farming, and especially in attaining decreased cost of farm operation. In nearly every part of the state interest has been manifested in various types of farm power and farm equipment apparently adapted to serve the purposes indicated above. With the co-operation of agricultural engineering, tillage and farm machinery experiments have been initiated at the Caldwell Substation to determine how far various tillage devices can be substituted for such standard methods as plowing, and to secure facts with reference to the possibility of using mechanical devices in many phases of farm operation.

During the past year a Killifer chisel has been used as a substitute for disking and plowing and a deep tillage disk has been compared with plowing in its effect upon crop yields. The chisel was loaned for the purpose indicated above and two tractors have been loaned by the manufacturer as a contribution toward these experiments. Data were obtained in 1928 on the use of a tractor pulled mower with side delivery rake attached as a rapid method of cutting and windrowing hay. The initial experiment indicated a material reduction in the time required and in the cost of hay making, by the introduction of this equipment. With the entire operation reduced to the man unit basis it was found that one man could put an acre of hay in the windrow in twenty-six minutes. Some data are available on the grinding of feed in a small grinder driven by an electric motor and fed automatically.

## High Altitude Substation

**Wheat Experiments.**

Cultural work with wheat has been carried on for the last

five years. Valuable facts have been brought out showing the value of harrowing the summer fallow to maintain the soil moisture and increase the yield of grain. An increase in yield of from three to five bushels per acre has been secured by two to four extra harrowings, depending on the time of harrowing and date of plowing. The harrow should follow the plow before the soil has time to dry out. This is very important in conserving the soil moisture. The value of the disk in working the ground previous to plowing is shown by increased yields of grain. The disk seems to conserve the soil moisture and to make plowing easier.

Each year new varieties of grain are added to the list for testing out in the variety plots for yield. Some very promising new varieties have been introduced within the last few years, among them is Ridit, a hard red smut immune variety put out by the Washington Experiment Station. Several hundred bushels of seed of this variety were distributed among farmers for further trial this year.

Good results were obtained by different seed treatments. The average per cent of smut in the treated plots planted with badly smutted grain was 10.5 per cent while the amount in the untreated plots of badly smutted seed was 68.2 per cent smut. The yield of grain in the treated plots was 25 bushels per acre. The theoretical yield if no smut had been present would be 27.77 bushels per acre, therefore 68.2 per cent smut would leave a yield of only 8.84 bushels per acre for badly smutted seed untreated. In the plots with Ridit wheat which had been heavily smutted and planted without treating, there was no smut to be found.

**Crop Rotation.**

Several experiments with crop rotations are under way, sweet clover being used as the leguminous crop in the rotation for furnishing the nitrogen. Already some very good results are showing up from the effects of the sweet clover on the yields of grain following. Sweet clover is not only a good fertilizer but makes a very good quality of dry farm hay if cut before the stems are too large. It is one of the best dry farm pasture grasses that we have.

## Sandpoint Substation

**Forty Projects.**

The investigational program of the Sandpoint substation embraces approximately forty projects, including variety tests of fall wheat and barley, spring wheat, oats, barley, peas, vetch, grasses, corn, potatoes, and leguminous forage crops; rate and time of seeding studies with fall and spring wheat, potatoes, peas, and corn; selection work with alfalfa, red clover, reed canary grass, potatoes, corn, wheat and barley; soil tests of various sulphur carriers; rotations; manuring

studiest combination seedlings of legumes; and the effect of various cultural treatments upon crop yields.

Each year certain projects are completed and new ones inaugurated. Mosida continues to be the highest yielding of the winter wheats and Jenkin and Pacific Bluestem lead the spring varieties. Trebi and Charlottetown are the most promising in the barley tests and for the oat varieties Banner, Abundance, and Idamine are the leaders. Kaiser and White Canada are the highest yielding of the pea varieties.

August seedings of fall wheat have given greater yields than subsequent plantings and a mid-yearly planting of spring wheat outyielded both earlier and later plantings. Field peas planted as soon as the soil can be prepared in the spring have given larger yields than later plantings. The maximum rate of seeding of peas of 150 pounds per acre has given the highest yield. Yellow Flint, Gehu, White Flint, and Northwestern Dent have been most dependable in giving mature corn.

**Potato Tests.**

In the potato variety tests the north Idaho strain of the Idaho Rural has been the leader of the late varieties. For the early maturing varieties the Bliss Triumph appears very promising. Hill selected potato stock has proven conclusively to be a better method of seed selecting than bin selection or other bulk methods of obtaining seed. In studies on the effect of time of planting potatoes upon yield, the last of May and first of June plantings have been the best. Slightly immature seed has outyielded well matured seed potatoes. The hot formaldehyde treatment of potatoes has not only given better control of tuber diseases than cold formaldehyde or bichloride of mercury, but has also given larger yields.

**Forage Crops.**

Grimm alfalfa has been the most dependable and highest yielding of any of the hay crops tested. The highest yielding grasses have been tall meadow oat, smooth brome, meadow fescue, slender wheat, and orchard grass. Distribution has been made of the better yielding varieties of grain, particularly Mosida and Jenkin wheat, Idamine and Victory oats, Trebi barley, and Kaiser peas.

# DISBURSEMENTS BY DEPARTMENTS
from
## STATE APPROPRIATIONS
Jan. 1, 1928 to Dec. 31, 1928
Home Station

| | Admin. | Ag. Chem. | Ag. Econ. | Agron. | Bact. | Ag. Eng. | Dairy | Etom. | H. Ec. | Hort. | P. Path | Poultry | Soil Survey | Forestry | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salaries | $ 545.00 | $200.00 | $ — | $ 945.00 | $450.00 | $ — | $83.34 | $4191.63 | $ — | $410.00 | $ — | $1544.30 | $316.66 | $ — | $ 8685.93 |
| Help | 119.20 | 12.40 | — | 452.25 | 84.80 | — | — | 65.50 | — | — | 96.98 | 29.10 | — | — | 860.23 |
| Travel Expense | — | — | — | — | — | 60.70 | — | 363.59 | — | 17.20 | — | — | 618.79 | — | 1059.65 |
| Communication | — | — | .61 | — | 12.80 | — | — | — | — | — | — | — | — | — | 13.41 |
| Freight and Express | — | — | — | — | .15 | — | — | — | — | — | 2.13 | — | — | 3.86 | 6.14 |
| Printing and Advertising | 794.65 | — | — | — | — | — | — | 7.14 | — | — | — | — | — | — | 801.79 |
| Office Supplies | 5.15 | — | — | — | — | — | — | — | — | — | — | — | — | — | 5.15 |
| Laboratory Supplies | 28.93 | 9.61 | — | — | 22.43 | — | — | 239.64 | 30.89 | 56.60 | 15.77 | 181.34 | 11.40 | — | 596.61 |
| Repair to Equipment | 9.87 | — | — | — | — | — | — | — | — | — | — | — | — | — | 9.87 |
| Feed Stuffs | — | — | — | — | — | — | — | — | — | — | — | 249.58 | — | — | 249.58 |
| Equipment | — | — | — | — | — | — | 79.70 | 68.25 | — | — | — | — | — | — | 147.95 |
| Total | $1502.80 | $222.01 | $ .61 | $1397.25 | $570.18 | $60.70 | $163.04 | $4935.75 | $30.89 | $483.80 | $114.88 | $2004.32 | $946.85 | $ 3.86 | $12436.31 |

## SUBSTATION DISBURSEMENTS
Jan. 1, 1928 to Dec. 31, 1928

| | Aberdeen | Caldwell | High Altitude | Sandpoint | Total |
|---|---|---|---|---|---|
| Salaries | $2318.00 | $2040.00 | $1650.00 | $2340.02 | $8348.02 |
| Help | 2567.55 | 4682.62 | 887.75 | 1820.17 | 9958.09 |
| Expense and Supplies | 2711.80 | 5644.82 | 422.08 | 2186.01 | 10964.71 |
| Equipment | 146.90 | 1191.73 | — | 703.70 | 2042.33 |
| Total | $7744.25 | $13559.17 | $2959.83 | $7049.90 | $31313.15 |

# FINANCIAL STATEMENT

## University of Idaho Agricultural Experiment Station

### In Account With

### Federal Appropriations

| Dr. | | Hatch | Adams | Purnell |
|---|---|---|---|---|
| To balance from appropriations for 1926-27..... | | None | None | None |
| Receipts from treasurer of the United States for year ending June 30, 1928 ..... | | $15,000.00 | $15,000.00 | $40,000.00 |
| Cr. | Abstract | | | |
| By salaries ..... | 1 | $10,612.40 | $10,762.38 | $25,007.48 |
| By labor ..... | 2 | 3,028.04 | 2,003.11 | 2,472.12 |
| By stationery and office supplies ..... | 3 | 21.00 | 32.17 | 73.04 |
| By scientific supplies, consumable ..... | 4 | 521.49 | 1,176.13 | 199.69 |
| By feeding stuffs ..... | 5 | 23.00 | 123.65 | 559.97 |
| By sundry supplies ..... | 6 | 269.87 | 309.89 | 221.52 |
| By fertilizers ..... | 7 | ——— | ——— | ——— |
| By communication service ..... | 8 | ——— | ——— | 43.04 |
| By travel expenses ..... | 9 | 449.80 | 495.75 | 5,169.91 |
| By transportation of things ..... | 10 | ——— | ——— | 236.51 |
| By publications ..... | 11 | 10.73 | ——— | 2,226.62 |
| By heat, light, water and power ..... | 12 | 5.97 | 7.40 | ——— |
| By furniture, furnishings, fixtures ..... | 13 | 27.00 | ——— | 166.17 |
| By library ..... | 14 | 5.00 | ——— | 86.22 |
| By scientific equipment ..... | 15 | ——— | 80.58 | 266.61 |
| By livestock ..... | 16 | ——— | ——— | 3,043.25 |
| By tools, machinery and appliances ..... | 17 | 9.30 | 7.44 | 211.26 |
| By buildings and land ..... | 18 | 16.40 | ——— | ——— |
| By contingent expenses ..... | 19 | ——— | 1.50 | 16.59 |
| Total ..... | | $15,000.00 | $15,000.00 | $40,000.00 |