UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION

WORK AND PROGRESS OF THE AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDED DECEMBER 31, 1922

BULLETIN NO. 131 JANUARY, 1923

Published by the University of Idaho, Moscow, Idaho.

UNIVERSITY OF IDAHO AGRICULTURAL EXPERIMENT STATION

BOARD OF REGENTS

MRS. J. G. H. GRAVELEY, President ..... Boise
I. E. ROCKWELL, Vice-President ..... Bellevue
STANLY A. EASTON, Secretary ..... Kellogg
HUNTINGTON TAYLOR ..... Coeur d'Alene
J. A. LIPPINCOTT ..... Idaho City
ETHEL E. REDFIELD, Superintendent of Public Instruction, ex-officio ..... Boise

ENOCH A. BRYAN, Ph.D., Commissioner of Education ..... Boise

EXECUTIVE COMMITTEE

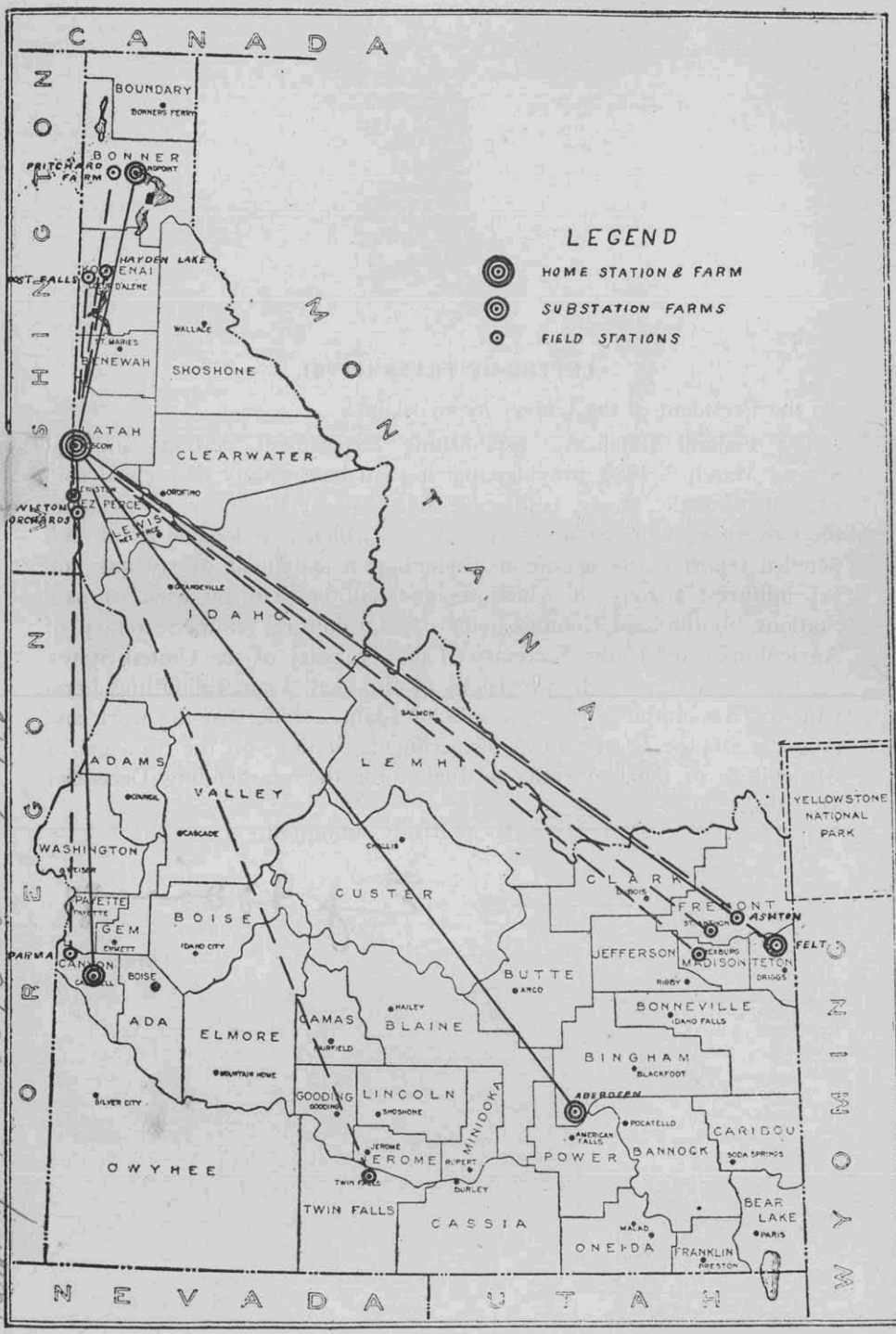
STANLY A. EASTON — HUNTINGTON TAYLOR — ENOCH A. BRYAN
J. A. LIPPINCOTT — A. H. UPHAM

EXPERIMENT STATION STAFF

A. H. UPHAM, Ph.D. ..... President
E. J. IDDINGS, M.S. ..... Director

R. B. GRAY, B.S. (A.E.) ..... Agricultural Engineer
M. R. LEWIS, B.S. ..... Irrigation Engineer
R. K. BONNETT, M.S. (Agr.) ..... Agronomist
H. W. HULBERT, M.S. (Agr.) ..... Associate Agronomist
G. R. McDOLE, M.A. ..... Soil Technologist
F. L. BURKART ..... Field Superintendent
C. W. HICKMAN, B.S. (Agr.) ..... Animal Husbandman
J. E. NORDBY, M.S. (Agr.) ..... Assistant Animal Husbandman
W. M. GIBBS, Ph.D. ..... Bacteriologist
H. W. BATCHELOR, B.S. ..... Assistant Bacteriologist
R. E. NEIDIG, M.S. ..... Chemist
R. S. SNYDER, B.S. ..... Associate Chemist
H. P. MAGNUSON, B. S. ..... Assistant Soil Chemist
F. H. COLLINS, B.S. ..... Analyst
C. L. VON ENDE, Ph.D. ..... Associate Chemist—Apple Storage
F. W. ATKESON, B.S. ..... Dairy Husbandman
H. A. BENDIXEN, M.S. (Dairying) ..... Assistant Dairy Husbandman
G. C. ANDERSON, B.S. ..... Assistant Dairy Husbandman
*BYRON HUNTER, M.S. ..... Specialist in Farm Management
F. G. MILLER, M.F. ..... Forester
CLAUDE WAKELAND, B.S. ..... Entomologist
C. C. VINCENT, M.S. (Agr.) ..... Horticulturist
L. E. LONGLEY, M.S. (Agr.) ..... Assistant Horticulturist
C. V. SCHRACK, B.S. (Agr.) ..... Gardener
*C. W. HUNGERFORD, M.S. ..... Plant Pathologist
*J. M. RAEDER, M.S. ..... Assistant Plant Pathologist
R. T. PARKHURST, B.S. ..... Poultry Husbandman
C. B. AHLSON, B.S. ..... Seed Commissioner
JESSIE C. AYERS ..... Seed Analyst
B. L. TAYLOR, D.V.M. ..... Veterinarian
J. E. WODSEDALEK, Ph.D. ..... Zoologist
*A. E. McCLYMONDS, B.S. (Agr.) ..... Superintendent, Aberdeen Substation
D. A. STUBBLEFIELD ..... Superintendent, Caldwell Substation
W. A. MOSS, B.S. (Agr.) ..... Superintendent, High Altitude Substation
J. H. CHRIST, M.S. (Agr.) ..... Superintendent, Sandpoint Substation

*In cooperation with U. S. Department of Agriculture.



Hunting # 1158846 287 3/25/45

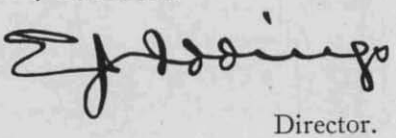
LETTER OF TRANSMITTAL

To the President of the University of Idaho:

The Federal Hatch Act establishing Experiment Stations and approved March 2, 1889, provides that it shall be the duty of each of said Stations annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent by each of said Stations, to the said Commissioner of Agriculture (now Secretary of Agriculture) and to the Secretary of the Treasury of the United States.

In accordance with the provisions of this Act, I am submitting herewith for transmittal to the Governor of Idaho a report of the work and progress of the Agricultural Experiment Station of the College of Agriculture of the University of Idaho, for the year ending December 31, 1922.

Respectfully submitted,



Director.

REPORT OF THE DIRECTOR

The work of the Agricultural Experiment Station has been characterized by numerous substantial contributions to the progress and success of the agriculture of Idaho. It has pointed the way to practices that have made farming more successful and profitable; it has developed and made known effective methods for warding off insect pests, plant diseases and other destructive agents; it has raised the farmer's average expectation of yields from crops and animals by the introduction of new varieties and new methods; and it has served as the connecting link between the farmer of Idaho and the helpful agencies of modern science. It has created and will continue to create new knowledge invaluable in the state's agricultural progress.

Brief reference will be made to a few of the more important undertakings and accomplishments of the Idaho Station.

1. The Station has made extensive feeding tests of Idaho grown feeds in the finishing of steers and lambs for market. These experiments have been concerned with the relative value of commonly grown grains, the value of silage as a supplement, the advantage of cutting and grinding alfalfa hay, and the cost of finishing steers and lambs for market. In 1922 two cars of lambs were taken to Chicago by representatives of the Station for the purpose of getting the shrinkage, marketing costs, and slaughter data.

2. Field tests with sweet clover have indicated its very high value for both hay and pasture in the non-irrigated sections. The advantage of sweet clover for hay is particularly marked in the cut-over regions as indicated by tests on the Sandpoint Substation.

3. Various silage crops have been under investigation. These experiments have dealt with cultural practices, relative yields, chemcal composition at various stages of growth and during siloing and the relative value of various silages for animal feeding. Sunflower silage has been found to have certain special advantages for the cut-over lands.

4 Members of the Station staff have pointed out the great importance of the "slick spot" problem to the farmers of southwestern Idaho and now have under way extensive tests aimed at solution.

5. At the Aberdeen Substation, Dicklow wheat was tested in comparison with other varieties and recommended for the irrigated regions of the state.

6. Trebi barley was found in the Aberdeen experiments to be a superior variety for Idaho, and is now largely grown to the exclusion of other varieties of barley on irrigated farms.

7. The Idamine oat, another Aberdeen product, is making marked headway in competition with other well-known varieties.

8. A new wheat, Federation, indicates, as a result of five years of comparative tests at Aberdeen, that it is superior to any wheat now grown on the irrigated farms.

9. Exhaustive duty of water experiments at Gooding gave reliable data regarding the proper use of water to secure maximum yields.

10. Experiments in Twin Falls County have revealed the life history of the clover aphis and have yielded control measures.

11. A new method of alfalfa weevil control, killing with poison in the form of dust, has been introduced, and material improvement made in mechanical devices used in dusting. One parasite of the alfalfa weevil is an important factor in control. Station officials have called the attention of the federal Bureau of Entomology to the seriousness of the alfalfa weevil problem in Idaho and have urged the hastening of measures for the importation of other European insect enemies of the weevil. There is prospect of the early importation into the United States of parasites of the alfalfa weevil and their introduction to the alfalfa growing regions of Idaho.

12. Means have been found of increasing to a marked degree the productivity of the peat soils of Idaho.

13. The department of dairy husbandry has given official supervision to the advanced registry testing of dairy cattle, and thereby has assisted in the improvement of dairy herds.

14. The Station, on its High Altitude Substation at Felt, is selecting new grains and other crops and developing new methods for high altitude farming.

15. A method of destroying the false wire worm has been discovered by the Station Entomologist.

16. Casein as a spreader for orchard sprays has been carefully tested and recommended to fruit growers.

17. The plant pathologist has rendered invaluable assistance in advising with reference to the control of potato diseases.

18. Soil surveys and classifications have been made in eight counties of the state.

19. The codling moth has been studied and correct spray dates discovered for two of the state's leading fruit growing sections.

20. An employee of the Station discovered the wide prevalence of tuberculosis in poultry flocks of Idaho, called attention to the

necessity of controlling the disease and outlined methods for tuberculosis eradication.

21. Seed production has been studied by the Station's agronomists, and bulletins published giving valuable suggestions regarding the most successful cultural practices.

22. Station chemists have found the beneficial influence of crop rotation on the protein content of wheat.

DATA FROM THE 1920 CENSUS

During the year the reports of the 1920 Census were made public and showed remarkable development of Idaho agriculture. In size Idaho ranks with the very largest states of the Union. Its area is nearly as great as that of Pennsylvania and Ohio combined, or the total acreage of Scotland and England. In 1920 there were 42,106 farms in Idaho. These contained 8,375,872 acres of which 53.9 per cent, or 4,511,860 acres, were improved land. Of the improved land, 55.2 per cent, or 2,488,806 acres, were irrigated. The above figures, when compared with 1910, show that substantial increases were made. In ten years the number of farms in the state increased 36.7 per cent, or 11,299. Land in farms increased 58.6 per cent, or 3,093,269 acres. Improved land in farms increased 62.4 per cent, or 1,732,940 acres. Irrigated land increased 73.9 per cent, or 1,057,958.

The total value of all farm property in the state, namely, land, buildings, implements and machinery, and livestock, totaled $716,137,910.00 in 1920 and only $305,317,185.00 in 1910. This represents an increase in ten years of $410,820,725.00 or 134.5 per cent. In 1909 the value of farm crops produced was $32,880,915. In 1919 the total was $126,492,411, an increase of 285.0 per cent. The irrigated area of Idaho has increased more than ten fold in the period 1890-1920; from 217,005 acres to 2,488,806 acres. The number of irrigated farms has increased in the same period from 6,603 to 42,106; the value of land and buildings per farm from $2,640.00 to $13,811.00; value of farm property in the state from $25,857,530.00 to $716,137,910.00; and the value of farm products from $3,848,930 to $126,492,411.

STATE-WIDE SERVICE

The rapid growth of the state's agriculture, the increasing diversification of farm practice, and the introduction of specialization in certain fields have called for increased service from the Agricultural Experiment Station. Funds have been available during the year to meet only a part of the calls for experimentation. An effort has been made in directing the work of the Station to plan and assign projects to take care of the

most important problems. The various departments are requested to survey their respective fields and adapt their activities to meet the most pressing needs. In attempting to be of the greatest service to Idaho as a whole much of the Station activities have been carried into the field. Four Substation farms are maintained, as follows:

Aberdeen Substaton, at Aberdeen, 80 acres.

Caldwell Substation, at Caldwell, 320 acres.

High Altitude Substation, at Felt, 200 acres.

Sandpoint Substation, at Sandpoint, 170 acres.

Additional points of contact with agricultural problems have been established through temporary field stations. The advantage of the field station is in its mobility. When work is completed at a field station the equipment and temporary shelter may easily be transferred elsewhere. In some cases, where investigations are conducted away from Moscow, a minimum of equipment and no erection of laboratory or office structures are reqiured. Agricultural field studies have been conducted during the past year as follows:

Experiments with the leaf-roller near Post Falls; tests with orchard fertilizers near Coeur d'Alene; peat soil studies on the Prichard farm near Sagle; spraying experiments in the Lewiston Orchards; studies of tomato and vegetable production under irrigation and the investigation of tomato blight near Lewiston; life history studies of clover aphis and orchard insect investigation at Twin Falls; investigations of leaf-roll and mosaic of potatoes at Parma; dusting experiments for the control of alfalfa weevil and cooperative studies with the U. S. Department of Agriculture on the eelworm at Parma; investigation of the methods of control of the false wire worm at Rexburg; experiments with potato diseases at Ashton. In addition, members of the Experiment Station staff have been fortunate in establishing co-operative agreements with county agents which have permitted methods that promise success under laboratory conditions to be tested on a larger scale in the field.

THE MAILING LIST

The Station mailing list has increased year by year, and the list to date contains the following:

Residents of Idaho	11,800
Residents of other states	3,200
Foreign	200
Total	15,200

PUBLICATIONS DURING 1922

Much data of vital interest to the farmers of the state have been published. The year's publications total 16 bulletins and circulars, in addition to research papers, of which two are bulletins of the newly-instituted research series aimed to afford an avenue of publicity for those investigations of a fundamental character. Five are of the regular bulletin series and nine are circuilars. The bulletins and circulars have been written in popular style and are much in demand. A list of publications follows:

Bulletin, Title and Author

No.		Pages	Copies
126.	Tuberculosis of Poultry, C. H. Werkman and William M. Gibbs.	12	5,000
127.	The Measurement of Water: A Hand Book for Ditch Riders and Water Users, W. G. Steward.	32	5,000
128.	The Farm Septic Tank, J. C. Wooley and W. M. Gibbs.	20	5,000
129.	Work and Progress of the Agricultural Experiment Station for the Year Ending December 31, 1921, E. J. Iddings.	16	3,000
130.	The Eelworm Disease of Red Clover, R. H. Smith.	16	5,000

Research Bulletin, Title and Author

1.	The Effect of Available Nitrogen on the Protein Content and Yield of Wheat, Ray E. Neidig and Robt. S. Snyder.	56	5,000
2.	Farm Costs and Relative Profitableness of Seven Crops. Twin Falls County, Idaho, 1919 and 1920, Byron Hunter and S. B. Nuckols.	24	5,000

Circular, Title and Author

21.	Growing Head Lettuce in Idaho, C. C. Vincent.	12	10,000
22.	Sweet Clover, R. K. Bonnett and H. W. Hulbert.	16	5,000
23.	The Important Orchard Insects of Idaho and Their Control, R. H. Smith.	8	7,500
24.	The Root Maggot of Radishes, Turnips, Cabbage, and Related Vegetables, R. H. Smith.	4	5,000
25.	Spider Mites Affecting Orchards and Garden Fruits, R. H. Smith.	8	5,000
26.	Aphids Attacking Stone Fruits in Idaho and Methods for Their Control, R. H. Smith.	12	5,000
27.	Relative Value of Certain Protein Feeds for Egg Production; First Year's Work, 1920-1921, R. T. Parkhurst.	8	7,500

28. Steer Feeding Experiments 1921-1922, C. W. Hickman and E. F. Rinehart. 8 5,000

29. Lamb Feeding Experiments 1921-1922, C. W. Hickman and E. F. Rinehart. 8 5,000

Research Papers

Phytopathology, Vol. XII, No. 2, March, 1922, Leaf Roll, Mosaic and Certain Other Related Diseases in Idaho, C. W. Hungerford.

Phytopathology, Vol. XII, No. 7, March, 1922, The Relation of Soil Moisture and Soil Temperature to Bunt Infection in Wheat, C. W. Hungerford.

Soil Science, Vol. XIII, No. 4, April, 1922, Effect of Tree Products on Bacteriological Activities in Soil. Ammonification and Nitrification, William M. Gibbs and C. H. Werkman.

Research Papers Accepted for Publication

Journal of Agricultural Research, Sweet Clover Investigation: Composition of Sweet Clover Hay and Silage, Ray E. Neidig and Robt. S. Snyder.

Journal of Agricultural Research, Sunflower Investigations, Ray E. Neidig and Robt. S. Snyder.

Journal of Biological Chemistry, The Determination of Ammonia in Alkali Soils, W. M. Gibbs, Ray E. Neidig and H. W. Batchelor.

ACTIVE PROJECTS

All the work in the Agricultural Experiment Station is organized on a project basis. Each piece of work in progress at the present time is conducted according to a written plan, a copy of which is on file in the Director's office, a copy for the project committee of the station, and one or more copies for the use of those conducting the work. A list of projects follows:

Agricultural Chemistry

The influence of available nitrogen upon the protein content and yield of wheat.

The tolerance of crops for alkali.

Slick spots in soils, their nature and reclamation. (In cooperation with Agronomy).

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

Sunflower investigations. (a) The composition of sunflowers at different periods of growth. (b) The composition of the ash of sunflowers at different periods of growth.

Silage investigations. (a) A comparison of different varieties of corn silage. (b) Artichokes as a silage crop. (c) The composition of sweet clover and sweet clover silage. (In cooperation with Agronomy).

The effect of adding lime, calcium phosphate and sulphur to Idaho soil types. (In cooperation with Agronomy).

Rotation and fertility investigations at Moscow and Sandpoint. (In cooperation with Agronomy).

Peat soil investigations. (In cooperation with Agronomy).

The comparative value of various silages for milk production. (In cooperation with Dairy Husbandry). (a) Winter rations for young dairy stock in Idaho. (b) The value of feeding cows during the dry-rest period. (d) Feeds for wintering dairy heifers under practical farm conditions in Idaho.

Timber soil investigations at Sandpoint. (In cooperation with Agronomy).

Chemical analyses of soil survey samples. (In cooperation with Agranomy).

Steer and lamb feeding at Caldwell. (In cooperation with Animal Husbandry).

Sugar beet investigation, variety tests. (In cooperation with Agronomy).

Agricultural Engineering

Investigation of the practicability of irrigating certain comparatively level portions of farms in the semi-arid regions.

A study of the most practical methods for the mechanical distribution of poison dust for combatting the alfalfa weevil. (In cooperation with Entomology).

A study of pressure exerted in silos by sunflower silage. (In cooperation with Animal Husbandry).

Design and installation of farm water systems.

*In cooperation with the U. S. Department of Agriculture.

Agronomy

Slick spots in soils, their nature and reclamation. (In cooperation with Agricultural Chemistry).

Small grain improvement. (In cooperation with the Substations).

*Forage investigations. (In cooperation with the Substations).

Field and Garden pea investigations. (In cooperation with the Substations).

Corn Breeding. (a) Work at the Home Station. (b) Work at Aberdeen Substation. (c) Work at Caldwell Substation.

Silage crop investigation. (In cooperation with Agricultural Chemistry). (a) Cultural tests of corn for silage production. (b) Cultural experiments with sunflowers. (c) Improvement of sunflower silage production by selection and breeding

Tests with commercial fertilizers.

Soil amendments. (In cooperation with Agricultural Chemistry). (a) Use of sulphur, lime, gypsum leguminous crops.

Rotation and Fertility investigations. (In cooperation with Agricultural Chemistry).

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

*Soil survey. (a) A detailed survey of a designated area each season as funds permit.

Silage crop investigation. (In cooperation with Agricultural Chemistry). (a) Plots located at Home Station. (b) Plots located at Sandpoint Substation.

Timber soil investigations. (In cooperation with Sandpoint Substation). (a) Plots located at Sandpoint Substation.

Irrigated soil investigations. (In cooperation with Agricultural Chemistry and Caldwell Substation). (a) Correction of alkali and "slick spot."

Animal Husbandry

Growing and use of silage crops other than corn for the feeding of beef cattle and sheep.

Hogging-off field peas.

Different protein supplements with barley and corn for fattening hogs.

Steer feeding investigations at Caldwell. (In cooperation with Agricultural Chemistry).

Lamb feeding investigations at Caldwell. (In cooperation with Agricultural Chemistry).

Farm sheep management at Caldwell and Sandpoint Substations.

Pasture experiments with beef cattle.

Bacteriology

Effects of tree products on bacteriological activities in soil.

Effect of alkali salts on bacteriological activities in soil. (In cooperation with Agricultural Chemistry).

Legume culture preparation.

Causes of unproductiveness of recently cleared coniferous timber soils, relation of toxicity thereto, and corrective measures. (In cooperation with Agricultural Chemistry).

The isolation and study of nitrifying bacteria.

Chemistry

Apple storage.

Dairy Husbandry

*In breeding and linebreeding compared with out-crossing as regards its effect upon dairy cattle, their milk and butterfat production, fecundity and general characteristics.

A study of the normal growth of dairy cattle.

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

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

The best winter ration for youg dairy stock in Idaho. (In cooperation with Agricultural Chemistry).

The value of feeding grain to dairy cows during the dry-rest period. (In cooperation with the Agricultural Chemistry Department).

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

Official testing for advanced registry and register of merit in Idaho.

A study of the value of feeding silage with alfalfa hay for winter-feeding of heifers.

A study of the value of feeding grain with hay and silage for milk production. (In cooperation with Caldwell Substation and Sandpoint Substation).

Entomology

Alfalfa Weevil: Study of climatic conditions affecting control; further experiments in control; breeding and liberation of parasites.

Eleodes beetles: The life cycle studies for *E. Hispilabris;* experiments in spring poisoning of adults; taxonomy of eleodes beetles of the state.

Codling Moth: Life cycle studies at Parma.

Fruit tree leaf roller; control experiments under Idaho conditions.

Snowy Tree Crickets: Studies of biology and control on prune trees in the Boise Valley.

Wire Worms: Locality survey at Parma; studies in bionomics and control; taxonomy of wire worms of the state.

Grasshoppers: Experiments in sprays for protection of alfalfa seed crops.

Spreaders: Tests of value of calcium caseinate under southwestern Idaho conditions.

Cutworms: Taxonomy study of cutworms of Idaho.

Potato Diseases: A study of insect vectors of potato diseases. (In cooperation with Plant Pathology).

**Farm Management*

Investigations of farm organization, including cost of crop production studies, in northern Idaho.

Investigation of farm organization, including cost of crop production studies, in the irrigated sections of southern Idaho.

*In cooperation with the U. S. Department of Agriculture.

Forestry

Experimental tree planting.
Relative durability of Idaho woods.
Studies of farm wood lands.
Agricultural possibilities of logged-off lands.
Grazing studies.

Horticulture

Apple breeding.

Summer versus winter spraying.

Variety testing of fruit trees, small fruits, and vegetables.

Potato-production experiments.
Experiments with seed production.
Tests of orchard fertilizers.

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

Testing of the value of various sprays and spraying methods.

Cherry pollination studies.

A study of varieties and cultural methods of head lettuce.

**Plant Pathology*

The relation of soil moisture and soil temperature to bunt infection in wheat.

A study of russett dwarf and calico diseases in potatoes.

Investigations of potato mosaic in Idaho.

*Investigation of stripe rust caused by *Puccinia glumarum*.

*Investigation of the eelworm disease of clover.

Investigation of western yellow tomato blight and methods for its control. (In cooperation with Horticulture).

Experiments in the control of the rhizoctonia disease of the potato. (In cooperation with Horticulture).

Experiments with various chemical dusts for the control of bunt in wheat.

Poultry Husbandry

A study of high winter egg production as a factor in the single comb White Leghorn.

The comparative value of proteins from different sources for laying hens.

The inheritance of weight, color and texture of shell of eggs in the single comb White Leghorn.

The relation of the fat soluble vitamine A, lactic acid, and milk salts to egg production.

Zoology

Cytological studies.

**Aberdeen Substation*

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) Value of the various pea varieties as nurse crops for alfalfa. (c)Seed bean investigations.

Silage crop investigations. (a) Varietal experiments with corn for silage production. (b) Breeding and selection of corn for eastern Idaho. (c) Rate of seeding sunflowers as related to yield of silage.

Potato investigations. (a) Varietal experiments. (b) Tuber-unit potato improvement.

Study of trees with respect to environment.

Seed production. (a) Sugar beets; selection and improvements of sugar beets for high sugar content by propagation of mother beets showing highest percentage of sugar. (b) Production studies with carrot and parsnip seed growing.

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

Soil-fertility investigations. (a) To determine the effect of sulphur on yield of alfalfa.

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

Caldwell Substation

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 best combination of 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 proper management.

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.

Feeding investigations. (a) Steer-feeding investigations. (b) Lamb-feeding investigations.

Corn investigations. (a) To determine the yielding capacity of introduced varieties as compared with those locally grown for the production of silage. (b) Later, a system of corn breeding will be established to produce an improved variety for this section of the state.

Soil investigations. (a) To determine the needs of the soils of this area. (b) A study of the methods of eliminating "slick spots."

High Altitude Substation

Small grain investigations. (a) Varietal tests with wheat, oats, barley, and miscellaneous grains under high altitude conditions. (b) Rate, date and depth of seeding winter wheat on dry land. (c) Variety test of cereals for the production of hay.

Fallow and cultural tests with wheat.

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

*In cooperation with the U. S. Department of Agriculture.

Forage and miscellaneous crop investigations. (a) To determine the best varieties of grasses 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.

Horticultural investigations. (a) The introduction and testing of apples, pears, and plums and small fruits to determine their winter hardiness and adaptability to high altitudes. (b) The planting of ornamental trees and shrubs for the improvement of the homestead.

Sandpoint Substation

Small grain and field pea investigations. (a) Varietal experiments with winter wheat and barley, spring wheat, barley, oats and field peas. (b) Rate of planting peas and oats. (c) Rate and date of planting winter wheat.

Forage crop investigations. (a) Various legumes for hay and seed. (b) Method and date of planting legumes. (c) Cultural experiments with alfalfa and red clover. (d) Pasture investigations. (e) Timothy variety test. (f) Vetch variety test.

Silage crop investigation. (a) Rate and date of planting sunflowers. (b) Variety test of corn. (c) Comparison of sunflowers and artichokes.

Root crop investigations. (a) Tuber-unit potato breeding. (b) Comparison of different selections of potatoes. (c) Variety test of potatoes. (d) Rate of planting potatoes. (e) Comparison of various root crops.

Soil investigation. (a) Use of legumes in building up soil fertility. (b) The value of lime, gypsum and phosphate as fertilizers. (c) Rotation experiment.

Dairy cattle experiments. (a) Carrying capacity of pastures. (b) Feeding experiments. (c) Cost of milk production.

Sheep raising. (a) Cost of production.

NEEDS OF THE STATION

In order that the work of the Agricultural Experiment Station may be most effective several of its departments must have more adequate provision in the way of land, equipment and other working facilities.

The department of agronomy is in serious need of more land for experimental plot work and for increasing the more promising varieties. Additional support is required for the work in soil physics. The studies of "slick spots," of alkali soils, of fertilization of cut-over mineral soils and of improving the peat soil lands are among the most important of all of the work of the Station. Additional funds are needed for carrying on cooperative experiments with farmers, for travel and for technical help.

The departments of agricultural chemistry, bacteriology and plant pathology deal with fundamental problems of plant and animal production. These departments are in need of further allowance for equipment, for technical help and for labor.

The steer and lamb feeding investigations, carried on at the Caldwell Substation, are fundamental to the future of livestock production and finishing within the state. It has been necessary to secure livestock for these investigations thru loans and contracts, and it has not always been possible to secure the livestock at the time desired and of the uniform quality necessary for accurate experiments. Furthermore, it is necessary, if these investigations are to be of the greatest value, that the livestock be marketed and followed thru to slaughter by representatives of the Experiment Station. This is not possible with lambs and steers secured by the loan or the contract method. Sufficient funds should be made available, therefore, to enable the animal husbandry department to buy steers and lambs to be used in each year's investigations. Once the initial appropriation is made the sales each year will restore the original amount

invested and the fund will become a rotating one to carry on the work indefinitely.

The department of dairy husbandry has been handicapped for equipment and help in carrying on its investigational program. A rapidly developing dairy industry and an extensive system of creameries and cheese factories require new knowledge and new methods. Those who are actively engaged in the field of dairying must look to the dairy husbandry department of the Station for new information and guidance.

The department of poultry husbandry is requesting an experimental poultry farm separate and apart from the plant used for instructional purposes. The present plant is not of adequate size for both teaching and investigational work. The income from the poultry has rapidly increased and a new experimental plant, when once established, can be largely self-supporting.

Particular effort must be put forth to develop effective control methods for alfalfa weevil. Field headquarters for entomological experimentation have been located at Parma. The work has been supported during the past two years by a special appropriation under the general title, Alfala Weevil and Other Insects.

There is a popular demand for information and assistance in the field of farm economics. The farm management investigations have been exceedingly valuable to the state, and this work should be continued and new investigations initiated in the related fields of distribution, storage and other phases of farm economics.

The substation farms, four in number, are strategically located with reference to the large regions that have special problems in farming. Of the utmost importance is the securing of funds for the purchase of the Aberdeen Substation. This farm is contributing data of very great importance in the development of irrigated agriculture. The fifteen-year lease will expire in 1926. The state can not afford to relinquish the lease of this well organized and wisely directed experimental farm.

The productivity of the Caldwell Substation has increased from year to year as a result of the policies now in operation. The farm affords an admirable location for feeding investigations, and the experimental livestock furnishes a market for the hay, grain and silage produced upon the farm. The manure returned to the farm brings increased fertility. The money expended is yielding facts of value to the farmers of southwestern Idaho and the increased production has added to the total value of the capital investment. The improvements are inexpensive and are rapidly deteriorating. Within a few years permanent barns and other buildings must be erected in order that substantial housing and equipment may be available.

The Sandpoint Substation is reasonably well equipped and the buildings are adequate. Maintenance funds should be provided for sufficient amount so that the experimental work may be properly cared for.

Adequate support for the work of the Agricultural Experiment Station will yield facts of the utmost importance to the instructional work in agriculture, to the extension program and to the permanence and prosperity of Idaho farming.

AGRICULTURAL CHEMISTRY

Rotation Experiments

Nine years' data have been collected on the yield and protein content of wheat when grown under different systems of crop rotation. The total and available nitrogen of the soil was determined in soil samples collected in 1920, and the total nitrogen determined on each soil in 1922. A report of progress on this work will appear as a research publication. The work includes the following rotation systems: Continuous wheat; wheat, oats and peas; wheat, oats and corn; wheat, oats and potatoes; wheat, oats and fallow; wheat, barley, oats and corn; wheat, barley, oats and potatoes. The effect of manurial applications to each of these rotation systems is also included in the study. It is intended to continue this project and issue reports of progress from time to time, since the results become more valuable as time elapses. From this investigation it is hoped to discover the best rotation system for producing large returns in crops and for maintaining a high state of soil fertility. Both are essential to permanent agricultural practices.

Coniferous Timber Soils Investigations

This investigation was undertaken to ascertain whether the unproductiveness of the recently cleared coniferous timber soils is due to a toxic substance in the soil or whether the soil is deficient in fertility. Sixty-six pots were made up with Helmer silt loam and to some the fertilizers, nitrogen, phosphorous, potassium and lime were added, singly and in combination. Wheat was planted on each of the check pots and on the fertilized pots. The present wheat crop is indicating that there is possibly both a lack of fertility and a toxic substance in the soil which causes decreased yields. Water and alcoholic extracts of substances obtained from the twigs, roots, and organic matter will be added to productive soil to determine the presence or absence of toxic substances. These extracts will be obtained by using the Morgan Oil Pressure Extractor. If a toxic substance is found to be present an attempt will be made to identify it, and tests will be made of corrective measures.

Slick Spots in Soils, Their Nature and Reclamation

In cooperation with the department of agronomy work on the "slick spot" soils of Idaho is under way both under greenhouse conditions at Moscow and under field conditions at Caldwell. The effect of gypsum, sulphur, sulphuric acid and inoculated sulphur on the chemical and physical nature of the soil is being studied both under field and greenhouse conditions.

Tolerance of Crops for Alkali

Progress has been made on the alkali investigations. The alfalfa series has been completed with data on five crops of alfalfa grown in potometers on soil containing varying amounts of alkali salts. The soil has been analyzed to determine the amount of alkali recoverable in water solution both at the beginning and at the end of the experiment.

Two crops of wheat have been grown in pots and the data recorded. The alkali concentrations were determined both at the time of planting and after harvesting each crop. Data are on hand on all the alkali studies in the greenhouse on the amount of alkali added and the amount recovered. The data secured on the alfalfa and wheat series led to slight changes in the alkali concentrations for further crops. Higher concentrations were found necessary. At present there is underway in the greenhouse crops of oats, wheat and sweet clover.

In cooperation with the bacteriology department the effect of these impregnated alkali soils on the bacterial activities is being studied. The effect of these different alkali concentrations on the moisture equivalent is being investigated in cooperation with the agronomy department.

Equilibrium Studies in Idaho Soils

Four definite Idaho soil types have been treated with four different amounts of sodium carbonate and the equivalent amount of sodium bicarbonate. These soils have been kept in the greenhouse under favorable moisture conditions. Frequent samplings were made to determine the ratio of carbonate to bicarbonate recoverable in the water extracts. After eight months study, the same amounts of sodium carbonate and bicarbonate were added to each pot as were added in the beginning of the experiment. The pots werer allowed to stand and were analyzed at frequent intervals until equilibrium seemed established. The experiment was completed after continuing for 22 months. The data for each soil are being assembled for publication.

Sunflower Investigations

The composition of sunflowers at different stages of growth has been

determined. These studies included sunflowers planted at different distances apart in the row and in hills with one, two, three, and four plants to the hill. The results have been accepted for publication in the Journal of Agricultural Research and will appear at an early date. In addition, a circular will be prepared for popular distribution.

Sweet Clover Investigations

The composition of white and yellow sweet clover was determined at various stages of growth, also silage was made from both varieties of sweet clover. Excellent silage resulted from both varieties at all stages of growth studies. The results have been accepted for publication in the Journal of Agricultural Research.

Sulphur Investigations

Alfalfa has been grown in the greenhouse on six widely different types of Idaho soils to which applications of sulphur, gypsum, lime and sulphur and phosphorous have been added. Yields of alfalfa have been secured which show an increased yield with the application of certain fertilizers and soil amendments. The alfalfa crops have been harvested, dried and composited and are being analyzed for total sulphur and protein. The soils are being analyzed for total sulphur and water soluble potassium. This work will be reported in a joint publication with the department of agronomy.

Peat Soils of Idaho

In cooperation with the department of agronomy a survey and classification of the peat lands of Idaho is under way. Chemical analyses are made of all the peat samples collected. Greenhouse experiments are carried on with different types of peat to assist in making recommendations for the fertilizer requirements.

Soil Survey

Chemical examinations of the soil samples representing the different types of soils collected by the agronomy department in the soil survey are under way. The work has been completed on samples from the Twin Falls area.

Sugar Beet Investigations

A variety test on nine different varieties of the sugar beet seed has been conducted the past year. Three hundred and fifteen individual beets were analyzed for sugar content. These beets were grown at the Aberdeen Substation.

Alkali Survey

During the past summer several portions of the state were visited and

samples of soil collected for alkali determinations. Over 200 samples of soil were analyzed for alkali. The data secured from this work established the salts present in a particular locality. Their effect on crops grown in the field are also noted.

Other Cooperative Work

Considerable cooperative work has been carried out with the departments of dairy husbandry, poultry husbandry, animal husbandry and horticulture. A discussion of these projects is found under each of the departmental reports.

Miscellaneous Work

In addition to the regular project work, numerous soils sent in from various parts of the state have been tested for acidity and also for alkali content.

AGRICULTURAL ENGINEERING

Devices for Distributing Dust Poison

Considerable time was given to a study of the most practical methods for the mechanical distribution of the poison dust for combatting the alfalfa weevil with a view to a more even distribution of the poison and its more rapid application. The different makes and types of dusters were equipped with similar distributors and tested for effectiveness.

Duster number one, Johnson Traction Duster, was equipped with two twelve foot tapered V-shaped sheet metal pipes each leading out sidewise from the dust supply. The lower side or point of the V was drilled with holes at 2 inch intervals thruout the entire length. The holes in the first two feet on either side of center were 5-32 inch in diameter, next two feet 1-32 inch larger until at the outer end of the pipe the holes were 5-16 inches in diameter. The pipes or distributors were equipped for raising or lowering over a range of 16 inches to allow for varying heights of alfalfa. This machine so equipped distributed the dust very uniformly.

Duster number two, Dosch Power Duster, was equipped similarly to number one as regards distributors. The dust was distributed from the pipes fairly uniformly but the feed from the supply box was more or less intermittent. This machine was heavier than the Johnson machine and required more attention. With improvements as suggested by experience in the field the past season and recommended to the manufacturers, this duster may be made satisfactory.

Another season apparently is necessary to determine conclusively the practicability of dusting as a means of combatting the alfalfa weevil pest.

Farm Water Supply Systems

Considerable investigational work has been done on design and installation of farm water supply systems and the results put into lecture form. Slides were made which will be used as cuts when the lectures appear in bulletin form.

AGRONOMY

The projects carried by the department of agronomy have been increased by the addition of the investigation of the fertilizer requirements of orchard crops in cooperation with the department of horticulture. More extensive work was done in the investigation of peat soils, as well as field studies of alkali soils and of the "slick spots" found in certain irrigated soils. The department has been called to assist in the solution of many soil problems, for information concerning forage crop adaptation and for advice concerning the adaptability of many crops new to the agriculture of the state.

Small Grain Improvement

The small grain improvement work has been continued. Average yields of winter grains taken the past five years, show the following rank of varieties grown during the period: Jenkins Club, Triplet, Washington Hybrid 123, Turkey Red, Washington Hybrid 128, Washington Hybrid 143, Kharkov, and Little Club. Coppei, while grown only the past three seasons, shows considerable promise. Two awnless Turkey selections, developed at the Station, show much promise as to yield and milling quality. One of these strains will be increased for limited distribution the coming year. White Winter barley has produced very profitable yields during the five year test, ranking first in yield, followed by Michigan Winter, Wisconsin 519, and Tennessee Winter. Rosen rye has outyielded the common winter rye by an average of 7.2 bushels during the three year test.

In the spring wheat trials for the past three seasons, Baart, Marquis and Jenkins Club lead in yield. Federation shows considerable promise in this area as well as in the irrigated region. Peruvian, Trebi and White Winter barleys gave the highest yields when spring sown. Victory and Idamine oats seem best adapted to the Palouse, altho three varieties imported from Sweden produced higher yields the past season.

Field and Garden Pea Investigations

The six-year average yield of field peas shows the following rank of the varieties grown: White Canada, Blue Prussian, Bluebell, McAdoo, Early Britain, Alaska, and Bangalia. The cultural test with field peas, which has been continued since 1915, shows only a slight difference in yield as influenced by row or drill seeding when the same rate of seeding

is used. A medium depth of seeding early in the season produced best results, but at the later dates little effect is observed from varying the depth. Early seeding has produced an average of 6.5 bushels increase over delaying two weeks, and 13.6 bushels average increase over four weeks delay in date of seeding; the late date of seeding resulting in a complete failure three seasons out of six. The pea classification nursery was continued with the addition of a number of strains from the New York Station at Geneva.

Forage Crops

The pasture grass mixtures were harvested for comparative yields in the forage investigations. The plots of grass varieties and legumes were continued, harvesting those showing promise for seed and the remainder for hay yields. Brome grass, slender wheat grass, and timothy produced profitable seed yields. Grimm alfalfa produced 13 per cent more hay than common alfalfa grown in an adjacent plot. Various strains of red clover seeded in the spring of 1921 showed only slight differences in yield. All were free from disease and winter killing. Light yields of hay and a following seed crop were secured from these strains, the yield of seed varying from 40 to 176 pounds to the acre. An extensive experiment was carried on with Hubam clover, testing the effects of gypsum, phosphate, and a combination of the two fertilizers. The growing season was favorable for setting seed, and yields as high as 180 pounds to the acre were secured. While fair yields of Hubam hay were obtained the quality was inferior to that of other legumes of longer life period and equal productivity. The cultural test with the biennial white sweet clover substantiated the results secured in former years that a nurse crop (except peas) should not be used in the Palouse area; that early seeding of 15 pounds of scarified seed will produce a profitable crop for hay or for pasture the first season.

Plant Breeding

The ear-to-row breeding of Rustler's white dent corn was continued. While the precipitation was lower, the growing season was longer than in 1921, thus producing a fair yield of well-matured corn. Some inbreeding work was started with this variety for the improvement of the type of ear and kernel. A large population of second generation segregates of crosses of pea varieties were grown and studied. Self fertilized mother plants of orchard grass were harvested for seed and the progeny will be grown during the winter for transplanting to the field in the coming spring.

Silage Crops

Silage investigations were continued with several strains of corn. The

early date of planting permits varieties requiring a long growing season to be used and still produce silage of good quality. While the later dates of planting corn and sunflowers often results in a greater yield of silage, so much of this weight is moisture, that the dry matter yield from the early dates is greater. The 8-inch rate of spacing sunflowers has produced the best yield of silage.

Study of Timber Soils

The work on the timber soils of northern Idaho has been along the lines of finding crops that are suited to these soils, working out the fertilizer requirements and finding methods of securing a stand of legumes. Experiments have been conducted at the Sandpoint Substation for the past two years. Judging from results obtained, a stand of most of the common legumes can be obtained even in a dry year where sufficient care is taken in the preparation of the seed bed and in the seeding. Lime and sulphur have both shown marked increases when applied to legumes.

Peat Fertilizer Requirements

A set of experiments was started near Sagle to test the effect of fertilizers on peat soil. This work was done on a farm having a representative peat of that district. Considerable information was secured regarding the fertilizer requirements and crops adapted to this type of soil. A combination of phosphorus and potash gave the greatest increase with all crops. Oats gave a profitable return where only phosphorus was added and proved to be the most profitable crop last season. The possibilities of head lettuce, cabbage, potatoes and clover also were shown. In cooperation with the department of agricultural chemistry a survey is being made of a number of peat bogs to determine the variation in fertilizer requirements.

Crop rotation and Fertility

The rotation and fertilizer plots located at the Home Station at Moscow have been continued as originally planned. Their chief value has been in showing that summer fallow is not needed in this section if a proper rotation is used. Of the commercial fertilizers used, nitrogen only gave satisfactory increase in the production. Barnyard manure properly applied has produced some marked increases in yield.

Orchard Fertilization

The fertilization of orchards was started the past season. Owing to peculiarities of the season, the results were not sufficiently marked to justify definite recommendations. This work was done on orchards in the following districts: Coeur d'Alene, Moscow and Lewiston. It is planned to carry this work on for at least five years to eliminate the effect of seasonal variations.

"Slick Spots" in Irrigated Soil

The field work on the "slick spots" of the Boise Valley region has been done on the Caldwell Substation, where a set of plots was laid out in 1921. Various treatments were made together with some work in blasting. The field experiments have not been continued sufficiently long to be conclusive, but the first season's results indicate that blasting in connection with heavy applications of gypsum have a beneficial effect. Pot experiments are being conducted to test the effect of the different treatments on the growth of alfalfa.

A study of the chemical and physical properties of these soils is under way in order to determine the cause of the slick spots and discover remedies.

Soil Survey

The soil survey of the Twin Falls area was completed during the season of 1921. The policy of selecting areas to be surveyed was changed to include lands that are to be brought under cultivation instead of confining this work to areas now under cultivation. In keeping with this policy a survey was started on what is known as the Minidoka Extension which includes desert land to be irrigated from the proposed American Falls reservoir. The work on the desert portion was finished in 1922. It was considered desirable to include a larger acreage in this survey, so the area was enlarged to include the irrigated land of the Rupert and Burley districts. The work on this enlarged area will be completed during the 1923 season.

Miscellaneous Soil Investigations

A study of the effect of alkali on the moisture equivalent of soils is being made in connection with the alkali studies of the department of agricultural chemistry. Soils to which different amounts of alkali have been added are compared with the same soils without the addition of alkali. Natural-occuring alkali soils are also being compared with good spots in the same fields. A series of cylinder experiments were started last winter to study the effect of layers of sand of different sizes on the water carrying capacity of alkali soil. The first series of cylinders has been completed and the results are being prepared for publication. Another series of cylinders includes different sizes of material.

ANIMAL HUSBANDRY

Steer Feeding Investigations

Beef cattle is one of the major livestock industries of the state. A considerable number of steers are shipped to market as feeders during the fall months. A part of these steers, at least, should be finished for

market before shipping. Idaho annually produces a surplus of alfalfa hay, which is an excellent feed for making beef, especially, when combined with grains and such other forage as silage.

The purpose of the beef cattle investigations is to determine the most economical and efficient methods of utilizing alfalfa hay for fleshing animals for market.

During the winter of 1921-1922, seventy-five head of two-year-old steers were fed. These steers were furnished on contract by the Idaho Provision and Packing Company of Boise, Idaho, to be fed one hundred days. They were divided into seven lots of ten and eleven steers per lot, as follows:

Lot I. Alfalfa hay, barley 5 pounds.
Lot II. Alfalfa hay (cut), barley 5 pounds.
Lot III. Alfalfa hay, corn silage 15 pounds.
Lot IV. Alfalfa hay, corn silage 25 pounds.
Lot V. Alfalfa hay (cut), corn silage 15 pounds.
Lot VI. Alfalfa hay, barley 5 pounds, corn silage 25 pounds.
Lot VII. Alfalfa hay, barley 10 pounds, corn silage 15 pounds.

Long Alfalfa and Barley versus Cut Alfalfa and Barley

Lot I, fed on 5.28 pounds barley and long alfalfa hay gained 1.62 pounds per head daily compared with an average daily gain of 1.93 pounds for Lot II fed on 5.45 pounds barley and cut alfalfa hay, a difference in the average daily gain of 0.31 pounds in favor of the cut hay. The feed cost per hundred pounds gain in Lot I was $7.97 compared with a feed cost in Lot II of $7.51, or a difference in the feed cost of one hundred pounds gain of $0.46 in favor of the cut hay. The percentage of hay wasted by the long hay lot was 11.7 per cent and by the lot fed on cut hay 3.7 per cent, showing 8 per cent less waste when the hay was cut. Cutting the hay effected the saving of 29.6 per cent of the amount of hay and 13.1 per cent of the amount of barley required to produce one hundred pounds of gain.

Addition of Silage to Long Alfalfa and Barley

The addition of 26.6 pounds of silage per head per day to a ration of long alfalfa hay and 5.28 pounds of barley increased the average daily gain from 1.62 pounds in Lot I, where no silage was fed, to 1.82 pounds in Lot VI receiving the silage. The feed cost of one hundred pounds gain in Lot I was $7.97 compared with $8.98 in Lot VI. The amount of hay wasted was greater in the lot fed silage, namely 20.6 per cent compared with a waste of 11.7 per cent in Lot I. One thousand pounds of silage replaced 449.1 pounds of hay and 20.6 pounds of barley.

Alfalfa Hay with Varying Amounts of Silage

Lot III fed on long alfalfa hay and 16.1 pounds silage per head per day made an average daily gain of 1.41 pounds at a feed cost of $7.10 per hundred pounds gain. Lot IV fed on long alfalfa hay and 27.1 pounds of silage per head daily, made an average daily gain of 1.55 pounds at a feed cost of $7.93 per hundred pounds gain. Lot III wasted 11 per cent and Lot IV 12.5 per cent of the hay.

Long Alfalfa and Silage versus Cut Alfalfa and Silage

Lot III, fed on long alfalfa hay and silage, made an average daily gain of 1.41 pounds compared with 1.67 pounds in Lot V where the hay was cut, a difference in the average daily gain of 0.26 pounds in favor of the cut hay. The feed cost per hundred pounds gain on long alfalfa and silage was $7.10 compared with $8.22 on cut alfalfa and silage. The long hay lot wasted 11 per cent and the cut hay lot 4.2 per cent of the hay. Cutting the hay saved 8.5 per cent of hay and 10.4 per cent of silage required to produce one hundred pounds of gain.

Barley Added to a Long Alfalfa and Light Silage Ration

In Lot III, fed on long alfalfa hay and 16.1 pounds of corn silage, the feed cost of one hundred pounds of gain was $7.10 compared with $8.70 in Lot VII fed the same ration plus 10.88 pounds barley. Lot III wasted 11 per cent of the hay and Lot VII 23.2 per cent. One thousand pounds of barley as fed in Lot VII replaced 1915 pounds of the hay and 615 pounds of the corn silage as fed in Lot III. Altho the addition of barley to the ration added to the cost of gains, it produced a higher finish and a more rapid gain, the average daily gain per steer in Lot III being 1.41 pounds compared with 2.02 pounds in Lot VII.

Barley Added to a Long Alfalfa and Heavy Silage Ration

In Lot IV, fed on long alfalfa hay and 27.1 pounds of corn silage, the feed cost of one hundred pounds of gain was $7.93 compared with $8.88 in Lot VI fed the same ration plus 5.37 pounds of barley. Lot IV wasted 12.5 per cent of the hay and Lot VI 20.6 per cent. One thousand pounds of barley as fed in Lot VI replaced 1437 pounds of hay and 977 pounds of corn silage as fed in Lot IV. As in the previous comparisons, the addition of barley to the ration increased the average daily gain per head from 1.55 pounds in Lot IV to 1.82 pounds in Lot VI.

Barley and Corn Silage fed with Cut Alfalfa

Lot II, fed cut alfalfa hay and 5.45 pounds of barley, gained 1.93 pounds per head daily as compared with 1.67 pounds for Lot V fed cut alfalfa hay and 17.07 pounds of corn silage. The feed cost per one hundred pounds of gain was $7.51 for Lot II as compared with $8.22 for

Lot V. One thousand pounds of barley as fed in Lot II replaced 3610.2 pounds of corn silage and 1223.1 pounds of cut alfalfa hay.

The results of these investigations in detail are reported in Station Circular No. 28.

For the experimental feeding of 1922-1923 eighty-eight two-year-old steers and thirty cows have been secured on contract from the Idaho Provision and Packing Company of Boise. These steers are divided into eight lots of ten steers per lot to be fed one hundred days, as follows:

Lot III. Alfalfa hay, corn 5 pounds.
Lot IV. Alfalfa hay, barley 5 pounds.
Lot V. Alfalfa hay (cut), barley 5 pounds.
Lot VI. Alfalfa hay.
Lot VII. Alfalfa hay, corn silage 15 pounds.
Lot VIII. Alfalfa hay, corn silage 25 pounds.
Lot IX. Alfalfa hay (cut), corn silage 15 pounds.
Lot X. Alfalfa hay (cut).

The cows were divided into three lots to be fed one hundred days, as follows:

Lot I. Alfalfa hay, corn silage 25 pounds.
Lot XI. Alfalfa hay.
Lot XII. Alfalfa hay (cut).

Lamb Feeding Investigations

Idaho is one of the leading sheep states, and sheep production is one of its major livestock industries. In fact, some consider the sheep industry the "business barometer" of Idaho. Many feeder (cut-back) lambs are produced annually on Idaho ranges. These lambs should be finished in Idaho before shipping to the eastern markets. This is especially important since the state generally produces a surplus of alfalfa hay. Alfalfa hay combined with other Idaho-grown feeds makes an economical and efficient feed for fattening lambs to be shipped to market as finished rather than as feeders.

During the winter of 1921-1922 five hundred and three lambs were fed. These lambs were received October 5th, 1921, weighing 56.1 pounds per head. They were given a preliminary feeding period of 41 days on alfalfa pasture with alfalfa hay at night from October 6th to November 17th. The lambs weighed 70.9 pounds, after allowing four per cent shrink at the close of the preliminary feeding (pasture period), or a gain of 0.32 pounds per head daily at a cost of 1.4 cents per pound gain. While on pasture 14 lambs were lost from bloat. On November 19th these lambs were divided into seven lots of seventy lambs per lot and fed for seventy-three days, as follows:

Lot 1. Alfalfa hay, barley, corn silage 2.5 pounds.
Lot 2. Alfalfa hay, barley, corn silage 1 pound.
Lot 3. Alfalfa hay, corn.
Lot 4. Alfalfa hay, wheat 3 and oats 1 part.
Lot 5. Alfalfa hay (1st 30 days); Alfalfa hay, barley (last 43 days).
Lot 6. Alfalfa hay (cut), barley.
Lot 7. Alfalfa hay, barley.

Various Amounts of Corn Silage

Lot 1 was started on silage, the amount being gradually increased to 2½ pounds per head daily making an average of 1.63 pounds per head daily for the entire period. The amount given to Lot 2 was increased to 1 pound per head per day, or an average of 0.77 pounds daily for the entire period. Lot 1 gained 0.357 pounds per head daily and Lot 2 0.295 pounds per head daily.

Cut Hay versus Long Hay

The lambs on long hay made an average daily gain of 0.328 pounds compared with 0.279 pounds for the lambs fed cut hay. The lambs on the long hay required 9.2 per cent more hay and 2.8 per cent less grain to make one hundred pounds gain. The lambs on long hay wasted 20.2 per cent of the hay against a waste of 13.1 per cent by the cut hay lot. The lambs on cut hay shipped with less shrink than any lambs in the shipment, losing 2.01 pounds per head between Caldwell and Kirkland, Illinois, compared with a loss of 2.73 pounds per head on the long hay and barley lot.

Corn versus Barley

Lot 3 fed on alfalfa hay and corn gained 0.357 pounds per head daily. Lot 7 on alfalfa hay and barley gained 0.328 pounds per head daily. Lot 3 fed on corn required 2.7 per cent less hay and 7.9 per cent less grain to make one hundred pounds of gain than did the barley and hay lot. The cost of producing one hundred pounds of gain on the lambs in Lot 3 was 45 cents more than in Lot 7 due to the higher cost of corn. This test showed barley to have a feeding value of 87.8 per cent of the value of corn. The shipping loss in weight was practically the same in both lots.

Wheat and Oats versus Barley

Lot 4 fed on wheat and oats gained 0.314 pounds per head daily compared with Lot 7 which made an average daily gain of 0.328 pounds. Lot 4 required 7.6 per cent more grain and 19.2 per cent more hay to produce one hundred pounds of gain. The lambs fed on wheat and oats lost 3.5 pounds per head between Caldwell and Kirkland compared with a loss of 2.73 pounds per head in Lot 7.

Deferred Barley Feeding

Lot 5 was started on hay alone and fed in this way for 30 days after which a full feed of barley was given. In the 73-day period the lambs in this lot made an average daily gain of 0.314 pounds as compared with 0.328 pounds made by Lot 7 which was fed barley for the entire period. They ate 10.4 per cent more hay and 15.2 per cent less grain than Lot 7, but at a feed cost of $5.24 as compared with $5.16 for Lot 7. This was the heaviest shrinking lot of the experiment, losing 7.42 pounds per head between Caldwell and Kirkland as compared with a loss of 2.73 pounds on Lot 7. This lot wasted 24.5 per cent of the hay compared with a waste of 20 per cent on Lot 7.

At the close of the experiment the lambs were shipped to Chicago where they were sold. The trip to Chicago took nine days. The shrinkage on the lambs between Caldwell, Idaho, (Stock Yards after trailing three miles) and Kirkland, Illionis, was 9.5 per cent. The lambs were fed and watered at Kirkland for six days. The shrinkage between Caldwell, Idaho, (Stock Yards) and the selling weight (Chicago) was 4.3 per cent. The results of this work are reported in Station Circular No. 29.

Funds were not available for continuing the lamb feeding investigations this year, nor was it possible to contract lambs for feeding.

Swine Feeding (Dry Lot)

Thirty-six fall pigs, averaging 78.17 pounds, were fed for a period of 76 days during the winter of 1922 to determine (1) the value of peas (Canada field) as compared to tankage when supplementing corn or barley; (2) the relative value of corn and barley when supplemented with peas or tankage for fattening hogs; (3) the influence of the length of the feeding period with peas.

These pigs were divided into four lots and fed, as follows:

Lot 1. Barley (rolled) 75 pounds, tankage 8 pounds.

Lot 2. Barley (rolled) 2 pounds, peas (cracked) 1 pound.

Lot 3. Corn 75 pounds, tankage 8 pounds.

Lot 4. Corn 2 pounds, peas (cracked) 1 pound.

The gain on all lots was quite similar for the first six weeks. After this time, and especially after eight weeks, the pigs in the lots receiving peas combined with either corn or barley gained very slowly. Some of the pigs lost in weight and were very unthrifty. The feed requirements per one hundred pounds gain for the various lots were as follows:

Lot 1. 435.15 pounds.

Lot 2. 535.39 pounds.

Lot 3. 399.06 pounds.

Lot 4. 476.75 pounds.

Pasture Experiments—Beef Cattle

Pasture experiments were started in 1922 to compare sweet clover with mixed pasture (blue grass and timothy) for beef cattle. Two two-acre plots were fenced for this purpose. The sweet clover was seeded in May, 1922. The cattle were turned on the pastures July 11, 1922. Each plot carried two Shorthorn heifers until October 3, 1922. The heifers in the mixed pasture gained 182.3 pounds, or an average daily gain of 1.07 pounds per head. Those in the sweet clover plot gained 152.7 pounds, or an average daily gain of .89 pounds per head. The sweet clover made a very satisfactory showing for the first year.

Range Management

Idaho possesses vast areas of winter, spring and fall range for the most part known as the public domain. In general, these lands have deteriorated in grazing value primarily as a result of over-grazing. The school of forestry and the animal husbandry department have proposed cooperative range and range management studies with a view of finding methods of increasing the value of the winter, spring and fall range.

BACTERIOLOGY

Effect of Tree Products on Bacteriological Activities

Needles, cones, bark, and other products from the trees common to Idaho forests were found to have an inhibiting action on ammonia and nitrate accumulation and nitrogen fixation in soil. In all cases cedar proved the most toxic, but sawdust, bark and leaves each were found to have a toxic effect. In some cases the nitrate accumulation was retarded seventy-five per cent. The same products proved toxic to nitrogen fixation in soils, bearing much the same relationship as was found for ammonia and nitrate accumulation.

The presence of the free nitrogen fixing organism in the forest soils was determined by collecting a great number of samples over an extensively forested area in the northern part of the state. Fifty-eight samples were taken under aseptic conditions. In general, the nitrogen fixing organism was not present in the samples, indicating that conditions were not favorable for its development, probably due to presence of timber residues. These samples are being tested as to their ability to support the organism when inoculated.

The Effect of Alkali on Soil Bacteria

The department of agricultural chemistry is determining the effect of sodium carbonate, sodium chloride, and sodium sulphate, separately and in combinations of two or three of the salts, on plant growth in pot experiments. Several hundred pots have been treated. These are seeded

to suitable crops, and plant growth compared with chemical analyses of the soils at regular periods. The department of bacteriology is determining the effect of these salts from the same pots on ammonia and nitrate accumulation. This is an important study since the effect of these salts on bacteriological activities in soil never has been checked against accurate chemical analyses of the soil. The rate of absorption of the salts as measured by analysis and effect on bacteriological activities is of particular interest.

1. Ammonification: There is a general decrease in ammonia accumulation in the soils with the addition of any of the salts with the exception of sodium carbonate which seems to bring about a slight increase. In general the favorable action of sodium carbonate does not overcome the toxic action of the other salts when used in combination.

The method for the determination of ammonia in soils containing alkali salts has been a subject receiving considerable attention for many years. In this work the excessive number of determinations to be made required that a rapid method be found for the accurate determination of ammonia. After considerable experimentation a new method was developed. This method, together with the results obtained by it, has been outlined in a scientific paper submitted for publication to the Journal of Biological Chemistry.

2. Nitrification: Small differences have been found in nitrate formation in the soils from the various pots. In general sodium carbonate brings about a very slight increase in nitrate formation. Sodium chloride and sodium sulphate are slightly toxic. Sodium carbonate has a tendency to overcome the toxicity of sodium chloride, but this action is slight.

Legume Cultures

The department of bacteriology prepares legume cultures and distributes them to farmers at cost of preparation, which is approximately seventy-five cents for three acres. These cultures are carefully prepared and sent out only when fresh to insure maximum inoculation. The distribution of these cultures during the biennium is shown in the following table:

	1921	1922	Biennium
Alfalfa	3,595	2,955	6,550
Peas	2,853	2,878	5,731
Vetch	221	53	274
Bean	93	159	252
Clover	771	1,044	1,815
Sweet Clover	222	615	837
Total	7,755	7,704	15,459
Number of Farmers	466	501	967

In addition to the distribution as listed above culture for 422 acres was prepared for the Washington State College for distribution to farmers in that state, bringing the grand total for the biennium to 15,881 acres.

Public Welfare Work

The department of bacteriology cooperates with the state department of public welfare by handling water analysis for north Idaho. All persons in the northern part of the state desiring bacteriological analysis of home water supply (private) should write to the department of bacteriology and request a special container for shipping sample. There is no charge for the service. It is necessary that the samples be collected in sterile containers and packed in ice for shipping. All chemical analyses are made at the Boise laboratory, since it is not necessary to pack a sample in ice for chemical analysis. During the first ten months of 1922 ninety-two samples were analyzed, of which 31 samples were found unfit for human consumption.

DAIRY HUSBANDRY

The Dairy Herd

Some good official records were made during the past year, including a junior two-year-old record of 614 pounds of butterfat, a junior three-year-old record of 608 pounds of butterfat, and a senior three-year-old record of 653 pounds of fat in 298 days. Two cows have almost completed records that will run over 800 pounds of butterfat and one will make over 950 pounds of butterfat. One record of 30 pounds of butterfat in seven days was made on a four-year-old and 32 pound record on a mature cow. Twenty-three cows are now on yearly test.

The average production per cow is being gradually raised thru proper feeding and management. The average production has been figured by crediting every cow with each day that she was actually producing milk fit for human consumption. The production of the past year is as follows:

Year	Total Production		Average No. of Cows	Average Production Per Cow		
	Lbs. Milk	Lbs. Butterfat		Lbs. Milk	Lbs. Butterfat	% Fat
1919	111,708.0	4,632.65	13.86	8,059.7	334.24	4.14
1920	197,471.0	7,734.53	18.25	10,816.5	423.00	3.91
1921	206,846.4	7,931.19	17.94	11,429.8	437.69	3.89
1922	355,902.9	13,274.30	24.80	14,296.8	533.46	3.73

The increase in 1922 over 1921 was 2,867.0 pounds of milk and 95.77 pounds of butterfat, or 25 per cent in milk and 21 per cent in fat.

Official Testing

During the period December 1, 1921 to December 1, 1922, the dairy husbandry department through its representatives supervised the following number of official two-day tests: 134 Jersey, 113 Holstein, 29 Guernsey, 3 Ayrshire, and 7 Shorthorn, making a total of 286 two-day tests conducted, an increase of 69, or 31.3 per cent, over the previous year. In addition to the yearly testing, 7 Holstein breeders tested 41 cows for short-time strictly official tests covering a period of 815 days in all. Including both the long-time and short-time tests, 34 breeders received service from the Station in this manner. The test supervisors spent 643 days actually conducting tests on semi-official tests and 815 days on official tests making a total of 1458 days that they actually conducted tests in the field besides the time necessary for traveling. During the past year, 7 state records for fat production have been broken in the classes of less than ten months and ten state records in the classes of ten months to one year. The state record for all breeds and ages is held by Idaho Violet Posch Ormsby 337275, a pure bred Holstein cow bred, owned and developed by the College of Agriculture. Her total production was 21,379.3 pounds of milk and 805.91 pounds of butterfat.

Breeding Studies with Dairy Cattle

This work, started in July, 1919, is in copoeration with the dairy division of the U. S. Department of Agriculture.

The Holstein herd is being used to compare inbreeding with outcrossing. The two bulls used were Friend Hengerveld Pontiac Aaggie 258625 and Matador Violet Idaho 273447, the former loaned by the U. S. Department of Agriculture. Up to date Friend Hengerveld Pontiac Aaggie has sired 12 female calves, ten of which are living and eight are out of cows in the herd at present. Two of his daughters will freshen in February so that data on his transmitting ability will soon be available. The second bull has sired seven females, five of which are living and four are out of cows in the present herd. There is a noticeable difference in the type of the offspring from the two bulls.

The Jersey herd is being used to compare line breeding with outcrossing. The two bulls used were St. Mawes Baronet 146613 and Pogis Torono Investigator 177267, the latter loaned by the U. S. Department of Agriculture.

Corn Silage versus Sunflower Silage for Milk Production

Two groups of four cows each were fed a definite amount of alfalfa hay daily, a grain mixture in proportion to the milk produced and silage at will. The reversal system of feeding was used with thirty-day feeding periods and with ten day preliminary periods. One group was started on

corn silage, then was changed to sunflowers and then back to corn silage. The second group was started on sunflowers, then was changed to corn silage and then back to sunflowers.

Chemical analysis indicates that sunflower silage is nearly equal to corn silage. Both silage crops fed with a balanced ration maintained the average body weights of the cows at normal. The corn silage seemed slightly more palatable but all the cows ate the sunflower silage with relish. The average production per period of thirty days for all the cows while on corn silage was 740.3 pounds of milk and 31.52 pounds of butterfat, while the average production per cow on sunflower silage was 827.8 pounds of milk and 30.79 pounds of butterfat. These figures show that the sunflower silage produced 11.8 per cent more milk and 2.3 per cent less fat than the corn silage. However, the groups did not eat exactly the same amount of each food while on each silage crop. To put them on equal basis the production per pound of dry matter consumed was calculated while on each silage crop. The sunflower group produced 11.4 per cent more milk and 1.07 per cent less butterfat than the corn silage.

It is safe to conclude that the sunflower silage during this experiment was at least equal pound for pound to the corn silage. The average yield for the years 1921-1922 for corn silage was 7.18 tons per acre in this section while the sunflower silage averaged 10.38 tons per acre. Figured in a dairy ration, the corn silage from one acre would produce 12,170 pounds of milk while the sunflower silage from one acre would produce 17,590 pounds of milk, a difference in favor of sunflower silage of 5,420 pounds of milk per acre, or 44.6 per cent.

Idaho Pasture Crops for Milk Production

Sweet Clover: During the summer of 1922 a field of 1.8 acres of second year biennial white sweet clover was tested for carrying capacity with dairy cows. The 1.8-acre field was divided into two fields of one acre and .8 acre and the fields pastured alternately. A crop of hay was cut off of the .8-acre field before it was pastured. The cows were pure bred Holsteins and were fed a grain mixture at the rate of one pound for each four pounds of milk produced per day. The cows maintained their body weight on the ration of pasture and grain. The acre field furnished pasture for 234.5 cow days and the cows produced 10,087.1 pounds of milk and 308.64 pounds of butterfat. During this time the cows ate 2,850 pounds of grain valued at $49.88, leaving a value of $107.87 for the pasture when figuring the skimmilk at 40 cents per cwt. and 40 cents per pound for butterfat. The .8-acre field furnished pasture for 116.5 cow days and the cows produced 4,474.9 pounds of milk and

150.64 pounds of butterfat. The cows consumed 1,409.4 pounds of grain valued at $24.66 leaving a value over cost of grain for the pasture of $50.81. Adjusting these figures to the acre basis we have 145.6 cow days per acre and a profit of $63.51 for the pasture when a crop of hay is cut. The hay yielded at the rate of 813 pounds and at $7.00 per ton its value was $2.85 which added to the pasture value makes a total of $66.35. More feed per acre was produced when hay crop was not removed. It was necessary to clip one of the fields to keep the plants from getting coarse and woody. Since this seems the best system the average returns per acre from combining the two systems is of interest. The average cow days of pasture per acre was 190 and the profit over grain was $89.58 per acre. The average production of the cows thruout the pasturing period was 41.5 pounds of milk and 1,308 pounds of fat.

These result swere obtained during a very unfavorable season as during the six months growing period there was 44.07 per cent less rainfall than normal. No difficulty was experienced from bloat with the cows. The sweet clover seemed to flavor the dairy products somewhat.

Mixed Grass Pasture: The pasture used was on a hillside with a north slope. The pasture was mostly Kentucky Blue grass and Orchard Grass and was formerly seeded for a meadow. Four acres were fenced off and two pure bred Jersey cows turned on May 23, 1922. The cows received one pound of grain for every three pounds of milk produced per day in addition to the pasture. The cows remained on the pasture 128 days, making a total of 256 cow days obtained. The cows produced a total of 3,287.9 pounds of milk and 195.29 pounds of butterfat valued at $89.20. They consumed a total of 1,352 pounds of grain worth $23.67, leaving a value for the pasture over the price of grain of $65.62 or $16.41 per acre. These cows were farther along in lactation than the cows on sweet clover and were not as heavy producers. This indicates that even under dry weather conditions, two acres will support fairly well one dairy cow if she is fed grain and that good returns can be obtained from the pasture even with mediocre cows. It was poor economy to turn on the pasture too early or pasture too heavily in the early part of the season.

Wintering Young Dairy Cattle

Three groups, each consisting of three heifers and a bull, were selected from the Holstein and Jersey herds. Group I received alfalfa hay fed at will; Group II received alfalfa hay and corn silage, both fed at will; Group III received alfalfa hay and dried beet pulp (soaked with water—1 part beet pulp to four parts water), fed at will. Group I received less of all the nutrients than required by the Wolff-Lehman feeding standard and the nutritive ratio was too narrow according to the same standard.

The animals came thru the winter in good flesh and appeared thrifty, but failed to make definite gains as indicated by the standard for normal growth as published by C. H. Eckles of the Missouri Station. The average age of the animals at beginning was nine months and twenty-seven days. They were on experiment 154 days and consumed an average of 16.71 pounds of hay per day and made an average daily gain of 1.02 pounds in weight and .047 c. m. in height at withers.

Group II received less of all the nutrients than required by the above mentioned feeding standard but the nutritive ration was about correct. The animals did not make quite normal growth according to Eckles' standard. They averaged eleven months and two days of age at beginning of experiment and were on feed 154 days. The average daily feed consumption was 11.95 pounds of alfalfa hay and 20.96 pounds of silage and the daily gain was 1.57 pounds in weight and .056 c. m. in height at withers. The animals appeared thrifty and in good flesh.

Group III received less of all the nutrients than required by the above mentioned feeding standard and the nutritive ration was a little too wide according to the same standard. The animals appeared thrifty and in good flesh but did not quite make normal growth on the average as indicated by Eckles' standard for growth. The average age at the beginning of the experiment was eleven months and three days and they were fed 154 days. The daily feed consumption was 10.62 pounds of alfalfa hay and 34.34 pounds of dried beet pulp (soaked with water), and the daily gain was 1.52 pounds in weight and .063 c.m. in height.

It appeared that the animals could not consume sufficient roughage to obtain enough nutrients for normal growth. It would appear, therefore, that a small amount of concentrates in the form of grain should be fed daily in addition to the roughage in order to get best results in wintering young dairy stock. This seemed more necessary with the Jerseys than with the Holsteins. The animals were larger for their age at the beginning of the experiment than Eckles' standard indicated. The addition of succulent feed high in carbohydrates to the alfalfa ration seemed to affect the growth in weight more than the growth in height.

The hay ration was the cheapest, the hay and silage ranking a close second, and the hay and beet pulp the most expensive. It appears that a ration of alfalfa hay and corn silage with a little grain is the best ration judged from the standpoint both of economy and growth of the animals.

Wintering Dairy Cattle (Conducted at Caldwell Substation)

This work differed from the above project on wintering young dairy cattle in that the animals were much older and were fed in an open lot all winter without shelter, also the quality of hay was much better.

Two groups of Holstein heifers of seven each were selected. Group I received chopped alfalfa hay at will and Group II chopped alfalfa hay and corn silage at will. The average age of Group I was nineteen months and twenty-three days and the average weight was 863 pounds at the beginning of the erperiment. The average number of days on feed was 125. The average daily gain in weight was 1.2 pounds and the average daily feed consumption was 26.37 pounds of hay. Group II was on feed an average of 118.3 days and the average age of the animals was nineteen months and twenty-seven days, the average weight at the beginning of the experiment was 877 pounds. The average daily gain was 1.3 pounds and the daily food consumption was 21.53 pounds of alfalfa hay and 12.27 pounds of corn silage. The supply of corn silage was exhausted and the last nineteen days Group II received hay only. The average amount of silage eaten while it was being fed was 14.8 pounds. According to the Wolff-Lehman and Armsby method of feeding both groups received rations that were too narrow in nutritive ratio.

When fed cut alfalfa hay of excellent quality and corn silage, the heifers ate more of the hay than of the silage by preference. The difference in rate of gain in weight was very slight because of the small consumption of silage.

The cost per month of wintering the heifers on hay alone was $2.77, when cut hay was figured at the prevailing price of $7.00 per ton. Figuring hay at that price and corn silage at $4.00 per ton the cost of wintering the heifers on hay and silage was $3.00 per heifer per month. Both groups came thru the winter in good condition and showed no ill effects from being without shelter. This is in accord with the general practice of that region. It would seem that heifers of this age could be wintered well on either of the above rations.

ENTOMOLOGY

Location of Experimental Work

During the past year experimental work was conducted in two widely separate districts comprising the dry farming grain area of eastern Idaho and the heavy alfalfa producing section of the southwestern portion of the state. Projects which have been under investigation in southern Idaho for a number of years were completed in 1921, and in 1922 the field station was moved to the Boise Valley where there are a number of insect problems demanding investigation.

Alfalfa Weevil

Experiments in control of alfalfa weevil by calcium arsenite dust were continued. An attempt was made to determine the optimum poison dosage, to apply arsenicals undiluted, to determine cost per acre of ap-

plication, to determine working capacity of dust machines and to improve the device used for distributing the poison. Owing to the difference in the activity of the weevil, due presumably to a variation in climatic conditions, it is not possible to draw conclusions on certain phases of the experiment. Fields dusted at the stage of weevil development when control is usually undertaken showed improvement for a time but were later severely injured by newly-hatched larvae that attacked the new, unpoisoned growth. It was impossible, therefore, to determine optimum dosage or to make entirely satisfactory comparisons. It was found that the dust could be successfully applied in small quantities but difficulty was encountered because dusting machines were not positive in feed and a variation occurred in the amounts per acre with a given small feed opening. The cost per acre for labor and materials was determined to be about seventy-five cents for what appeared to be an effective amount of poison. The working capacity of a power duster equipped with an alfalfa dust distributer is about ten acres per hour. For the traction duster the capacity is about eight acres per hour. An improvement was made in the dust distributer that rendered it very efficient and eliminated entirely the difficulty of clogging that has so seriously hindered previous experimental work. Improvements in dusting machines are still necessary and it is probable that two applications per year instead of one will be required before dusting (or spraying) will be entirely successful under southwestern Idaho conditions.

The alfalfa weevil parasite, *Bathyplectes curculionis,* introduced into the Parma community in 1921, has become establised as indicated by the collection of adults in field material in 1922. In some parts of the state this parasite seems to be assisting materially in controlling the weevil. The alfalfa weevil is not known to have spread to new counties since 1921 but infested areas in counties where it occurs have become more extensive and the amount of injury greater.

Eleodes Beetles (False Wire Worm)

A detailed study of the biology of Eleodes beetles injurious to dry farmed grains was conducted in eastern Idaho and control undertaken on an extensive scale. It was learned that there are eight species of the tribe Eleodiini occurring in the area under investigation. One species only, *E. hispilabris,* occurs abundantly enough to warrant investigations in control. It was learned that eggs of this beetle are laid most abundantly in June and the average incubation period is 1.35 days. Larvae (false wire worms) hatching from them do serious damage to spring and fall planted wheat by destroying the germ in the seed, by killing the developing sprout and by feeding on tender leaves below the surface

of the ground. Counts made during the season showed that as many as 49 larvae were present in a single drill row of wheat a rod in length or at the rate of 2,587,200 per acre. Larvae feed thruout the remainder of the summer and fall and during the following spring. Detailed life history studies are still in progress but field observations indicate that larvae remain in the soil for approximately one year before transforming to beetles. A peculiar fact is that injury is as severe, apparently, in land that has been summer fallowed as in land that has been cropped continuously. A number of natural enemies were discovered but all are considered of minor importance because of their relative scarcity.

Experiments in control in 1921, successful over a small area, were tried the past season in cooperation with the farmers over an area of approximately 18,000 acres. Control is practical and economical by poisoning beetles soon after emergence and before they lay eggs for the succeeding generation. A poison mash made of bran, Paris green, amyl acetate and water distributed broadcast or in the bottoms of plow furrows killed the beetles effectively at a cost for material at about two and one-half cents per acre. Two men and a team readily treated 320 acres per day. Results were directly proportional to thoroness of application.

Poison experiments in out door cages in 1922 indicate that Paris green is far more toxic to the beetles than any other poison used, that it is as effective when used at the rate of one pound to 25 pounds of bran as when used at greater strengths and that more beetles are killed when amyl acetate is added than when no scent is used. Beetles in cages were given a choice of food and the average killing obtained with the mash mentioned was 95.25 per cent.

Codling Moth

Observations on the life history of the codling moth in Madison county indicate that 73.3 per cent of the spring brood of larvae transform to moths of a second generation and the remaining 26.7 per cent enter hibernation. Over-wintering material was collected in the Boise Valley as the beginning of life cycle studies of the codling moth to be undertaken there.

Fruit Tree Leaf Roller

This pest occurs in eight counties of the state and is established in every fruit raising locality. During the two years past it has spread alarmingly and injury from it has increased noticeably. It presents a problem for experimental work of major importance.

Insect Outbreaks

The past year has been notable because of the unusual insect outbreaks

that have occurred. About the average damage by grosshoppers has been done with outbreaks occurring, for the most part, in different localities than the preceding two years. A few complaints were received that poison mash was not as effective as in former years. In Franklin county an extensive outbreak of western (Mormon) crickets occurred and no control measures used were adequate for protection. The pests migrated from waste lands, had reached cultivated areas and were well advanced toward maturity before organized attempts toward control were undertaken. The false chinch bug was the most injurious of any of the unusual insects and was generally distributed. Injury to strawberries was reported first. Affected berries failed to develop. Later, injury was common to raspberries. In July and August many potato fields were seriously injured. Affected leaves curled and the pests sought protection in them. Leaves wilted, turned brown and died. The tarnished plant bug was also responsible for a similar wide-spread injury to potatoes. A very severe outbreak of forest tent caterpillar occurred in northren Idaho. In the fall, larvae and pupae were heavily parasitised and it is doubtful whether depredation by this insect will be so severe in 1923. In Adams and Valley counties there was a heavy defoliation of yellow pine by larvae of the pine butterfly. Approximately 30,000 acres were more or less severely attacked. Cutworms and sugar beet web worms were of minor importance during the year. The general and wide-spread injury from wireworms was not unusual but they assumed a new importance, seriously injuring many fields of head lettuce. Three insects of unusual importance were spotted blister beetles attacking sugar beets and alfalfa seed fields, the carrot beetle which injured head lettuce and the zebra caterpillar which damaged cabbage, sugar beets and head lettuce.

FARM MANAGEMENT AND FARM ECONOMICS

During the calendar year 1922 farm management and farm economic investigations were conducted under the same cooperative arrangements with the bureau of agricultural economics and the bureau of plant industry, United States Department of Agriculture, as during 1920 and 1921. Two problems were investigated during this period, namely, (1) farm organization under the irrigated conditions of Twin Falls county and (2) farm organization under the non-irrigated grain producing conditions of Latah county.

(1) The Investigation of Farm Organization in Twin Falls County

The study of farm organization in Twin Falls county naturally divides itself into (1) the analysis of the farm business, (2) the cost of crop production, and (3) the cost of milk production.

Farm Business Analysis

During June and July, 1922, 214 farms were visited and a record obtained for each covering the business for the farm year March 1, 1921, to February 28, 1922. A number of these records were discarded because of inaccuracies, incompleteness or because of unusual practices or features of the type of farming. The usable records were divided into three groups: 181 general cash crop farms; 11 dairy farms; and 10 fruit farms. These farms were so classified because approximately 50 per cent of the receipts were derived, respectively, from the dairy herd, the sale of fruit, or the sale of general farm crops.

Summary of Farm Business

In analysing the business of the general cash crop farms the capitals of the tenants and landlords were combined in order to treat the tenant farms on an owner basis. A summary of the business of these farms is shown in Table I.

Table I. Summary of the business of 181 general cash crop farms, 1921.

	40 acres and less	41 to 80 acres	Over 80 acres	All farms
Number of farms	72	70	39	181
Average acres per farm	36	72	135	71
Average acres in crop	32	62	113	61
Average value of land per acre	$ 289	$ 261	$ 250	$ 263
Average farm capital	11,891	21,070	38,120	21,086
Average receipts	1,583	2,621	4,754	2,666
Average expenses	1,114	1,860	3,558	1,928
Average farm income	469	761	1,196	738
Interest on capital at 7 per cent	832	1,475	2,668	1,176
Average labor income	-363	-714	-1,472	-738
Average family used perquisites	323	392	470	382
Labor income plus perquisites	-40	-322	-1,002	-356
Average unpaid family labor	64	82	118	82
Average value operator's labor	692	813	910	786
Average return on capital, %	.8	1.6	2.0	1.6
Crop index (average crop yeild)	103	98	100	100

Farm Income is the difference between receipts and expenses. It is derived from the earnings of the capital and the labor and management of the farmer.

Labor Income is the amount the farmer has left for his labor after paying the expenses and allowing 7 per cent for the use of the farm capital.

Family Used Perquisites represent the value of the farm grown foods consumed by the farmer's family and the residence value of the farm dwelling. In addition to labor income the farmer receives the family perquisites.

In Table I the farms are arranged in groups according to the size of farm. Note that the group of smallest farms returned .8 per cent on the

farm investment, the middle size-grop 1.6 per cent, and the group of largest farms 2.0 per cent. This difference is partly due to the difference in the value of land in the respective groups. However, if all lands were valued at $250 per acre, the return of capital would then be 1.0 per cent, 1.7 per cent and 2.0 per cent respectively for the three groups. The range in the return of farm capital was from plus 20 per cent to minus 10 per cent. Approximately half the farms were above the average and half below. In 1919 the average return of farm capital was 7.2 per cent and the average price of land was $373 per acre. In 1920 the average value of land decreased $7 per acre and 1921, $103.

Size of Farm

The size of farm has considerable influence on the possibility of efficiently organizing and managing these farms. There were 35 crop-acres per 12 months of man labor in the group of smallest farms, 56 in the middle size-group and 59 in the group of largest farms. Likewise there were 10, 13 and 15 crop-acres per work horse respectively in these three groups. There also was one-fifth more capital invested in machinery per crop-acre in the case of the small farms than the large ones.

Crops

Wheat occupied approximately 35 per cent of the total crop area of 181 farms; hay (mostly alfalfa) 25; clover seed 10; sugar beets 9; potatoes 7; beans 6. These percentages varied but little in the three size-groups. The average yield of these crops per acre in 1921 were: Wheat 45 bushels; alfalfa hay (3 cuts) 3.9; red clover seed 216 pounds; alsike clover seed 347 pounds; sugar beets 9.4 tons; potatoes 150 cwt.; beans 1123 pounds.

There was a very wide range in the yield of these crops on the individual farms. High and low crop yield contributed materially to success and failure. To demonstrate this fact the 181 farms were arranged into four groups according to crop index. The first group contained those farms with a crop index of 85 or less. The crop index of the second group ranged from 86 to 99; the third group from 100 to 114; and the fourth group contained those farms of 115 and over. The first group returned −1.1 per cent on the farm capital; the second group .6 per cent; the third 2.3 per cent; and the fourth 4.7 per cent. The importance of securing high crop yields is evident.

The average prices received for the crops produced in 1921 were: Wheat $.81 per bushel; red clover seed $.174 per pound; alsike clover seed $.15 per pound; beans $.041 per pound; alfalfa hay $4.63 per ton; sugar beets $6.00 per ton; and potatoes $1.03 per hundred. In 1919 the acreage prices received from these crops were: Wheat $1.848 per

bushel; red clover seed $0.44 per pound; alsike clover seed $0.39 per pound; beans $0.069 per pound; alfalfa hay $17.79 per ton; sugar beets $12.00 per ton; and potatoes $1.78 per hundred. Therefore, the great slump in the value of land and the profitableness of farming were inevitable.

Livestock

In order to compare the average amount of livestock kept by the three groups of farms, all farm animals were expressed in terms of animal units. As here used an animal unit is a horse, a mule, a cow or a steer. Also two head of young stock of the above kinds, or 7 sheep, or 5 hogs, or 100 chickens. The average number of animal units kept per farm was 8.5 for the smallest size-group, 11.9 for the middle size-group and 21.6 for the group of largest farms. That is approximately 1 animal unit for each 4 acres of land for the group of smallest farms and one animal unit for each six acres of the other groups. Work stock and dairy cattle each constituted about 37 per cent of the total animal units. Practically all of the sheep were found on the larger farms. The small farms carried a greater proportion of dairy cattle and poultry than the large ones.

Income and Costs

Sixty-four per cent of the total income was derived from crops in the group of smallest farms, 75 per cent in the middle- size-group, and 77 per cent in the group of largest farms. Livestock contributed 13, 9, and 11 per cent of the total income, respectively, of the three groups. Hence, cash crop farming strongly predominated in 1921 as it did in 1919 and 1920.

Taxes and hired labor (month and day hands and contract labor) made up the two largest items of cash costs. Non-cash costs are made up of three items: Interest for the use of capital, depreciation of buildings and equipment, and the unpaid labor performed by the farmer and members of his family. While these items are not actually paid out they represent the use of capital and services rendered. Interest averaged 35 per cent of the total costs for the 181 farms, depreciation 5 per cent and unpaid labor 21 per cent. Cash costs averaged 53 per cent of the total income and non-cash costs 84 per cent, the total costs being 137 per cent of the total income. Under the economic readjustment taking place in 1921 this was to be expected.

Tenure

Of the 181 general cash crop farms 132 were operated by their owners, 15 by part owners (men who farmed rented land in addition to that which they owned) and 34 by tenants. The return of capital of the

owner farms averaged 1.4 per cent. The return of the capital of the 132 owner operators averaged 1.4 per cent; of the 15 part owners 1.6 per cent; of the 34 tenant operators 5.8 per cent; of the 15 landlords of the part owner farms 4.7 per cent; and of the 34 landlords of the tenant farms 2.4 per cent. The six cash rent farms returned an average of 3.9 per cent on the landlord's investment and −25 per cent on that of the tenant. The 26 share rent farms returned 2.1 per cent on the investment of the landlord and −1.8 per cent on that of the tenant. This indicates that the decline in cash rent, like that of cash costs, lagged far behind the decline in the prices of farm crops. This placed the cash renter at a decided disadvantage.

Three Types of Farming

A summary of the business of the 11 dairy, 10 fruit, and 181 general crop farms is shown in Table II. With the exception of six of these 21 special farms (3 dairy and 3 apple farms) a considerable portion of the income was derived from other than the dairy herd and the sale of fruit. In other words, they practiced mixed farming, the dairy or apple being the chief source of the income.

Table II. Business summary of dairy, fruit and general cash crops farms, 1921

	Dairy Farms	Fruit Farms	General Cash Crop Farms
Number of farms	11	10	181
Average acres per farm	80	62	71
Average acres in crops	58	55	61
Average value of land per acre	$ 269.	$ 334.	$ 263.
Average farm capital	26,371.	22,411.	21,086.
Average receipts per farm	5,063.	5,166.	2,761.
Average expenses per farm	3,038.	2,572.	2,023.
Average farm income	2,025.	2,594.	738.
Average family perquisites	392.	492.	382.
	864.	722.	786.
Value of operator's labor	Per cent	Per cent	Per cent
Average return on investment	5.9	10.5	1.6

Note that the average value of real estate was $269 per acre for the dairy farms, $334 for the fruit (apple) farms and $263 for the general farms. The dairy farms, it will be seen, returned an average of 5.9 per cent on the farm investment, the fruit farm 10.5 per cent and the general farms 1.6 per cent. For the year 1921 the price of dairy products had not fallen in proportion to the decline of the price level of general farm crops. It must also be remembered that 1921 was an excellent apple year. There was a good yield as well as a very fair price.

Cost of Crop Production

In addition to the farm business analysis records obtained for the season of 1921 in the Twin Falls study data also were gathered to show farm costs per acre and per unit of producing the following crops: Wheat, oats, barley, corn, alfalfa hay, red clover seed, beans, sugar beets and potatoes. The data also will show the relative profitableness of these crops. The tabulation of the data is yet incomplete and for this reason the results can not be presented at this time.

Cost of Milk Production

The cost of producing milk at Twin Falls was undertaken in cooperation with the Pioneer Cow Testing association on July 1, 1922.

(II) *The Investigation of Farm Oreganization in Latah County*

The study of farm organization in Latah county embraces (1) the analysis of the business of approximately 250 Palouse farms and (2) the cost of producing crops grown on these farms. This is the third year of this investigation. It is carried on in cooperation with the Washington State College and the United States Department of Agriculture. About half of the farms studied are located in Washington and half in Idaho. After the field work is completed the Bureau of Agricultural Economics, U. S. Department of Agriculture, assumes the responsibility of tabulating and publishing the data.

Publication and Reports

During 1922, Research Bulletin 2, Farm Costs and Relative Profitableness of Seven Crops, Twin Falls County, Idaho, was published. The farm business analysis of the Twin Falls area was tabulated and summarized and a mimeographed copy report thereon issued and the bureau of agricultural economics, U. S. Department of Agriculture, issued a mimeographed progress report of the investigation being conducted in Latah county, Idaho, and Whitman county, Washington.

FORESTRY

The character and extent of research carried on by the School of Forestry the past biennium, bearing more or less directly upon agricultural problems, is summarized as follows:

Agricultural Possibilities of Logged-Off Land

In cooperation with the U. S. Forest Service, the School of Forestry has made studies to determine the quantity, character, and location of the potential forest lands of the state as distinguished from the agricultural forest lands as well as to find ways and means for keeping the

former in continuous forest production. In connection with these studies a map has been compiled showing the location of cut-over and burned-over lands in North Idaho.

Tree Planting

Owing to the increasing interest in the matter of establishing home centers of wood supply in the treeless belts, a survey was made the past summer of tree planting conditions in these sections. With the data collected, together with the data previously on hand, the School of Forestry is now able to give reliable advice on tree planting in all sections of the state. The School has also continued its plan of supplying the planting material at cost.

Yield of Yellow Pine

Another line of research has included the compilation of a yield table showing the quantity, size, and quality of mateiral which can be produced at different ages in second growth stands of yellow pine. This information will be of special value to owners of farm woodlands.

White Pine Blister Rust

In cooperation with the Office of White Pine Blister Rust Control, U. S. Department of Agriculture, and other interested agencies, the School of Forestry has supervised an extended investigation to determine whether white pine blister rust has made its appearance in Idaho; also to discover methods of combatting it, should it be found here. So far no trace of the disease has been discovered in this state, altho it will, in all probability, invade our forests sooner or later.

Grazing Studies

Research in forest ranges management has been undertaken the past year, preliminary studies being underway in range reconnaissance methods.

Publications

The following publications relating to agriculture, the first two more especially to by-products which may be realized in the clearing of logged-off lands, have been issued within the biennium.

Bulletin 1003, Distillation of Stump Wood and Logging Wastes of Yellow Pine, in cooperation with U. S. Department of Agriculture.

The Availability of Western Wood Oils for Flotation Concentration, jointly with the State Bureau of Mines and Geology.

Bulletin No. 1, Laboratory Tests on the Relative Durability of Some Western Coniferous Woods with Particular Reference to Those Growing in Idaho.

HORTICULTURE

Apple Breeding Project

Work is being continued on this project along the lines indicated in former reports. A large number of trees that never before have borne fruited this past year, so that considerable additional data have been secured. Records were made on the keeping qualities of the different seedlings every two weeks thruout the winter. Additional notes were taken on color, flavor, and quality.

Thus far no seedlings have produced fruit that is greatly superior to both parents when all characters are considered. In some few characters a large number of them excell the parents. A study of the table given below reveals some interesting facts. Out of 498 trees that fruited during the season of 1921, representing crosses between Ben Davis X Jonathan and Jonathan X Ben Davis, 29 are as good as the Ben Davis, 16 better than Ben Davis, and one as good or better than the Jonathan. This is particularly true when quality is considered, which is a combination of texture, flavor and aroma. Macoun of Ottawa states that quality in the parent has proved highly essential in obtaining quality in the progeny. A study of Station seedlings, where the Ben Davis has been used as one of the parents, indicates this to be true as only two promising seedlings have been found out of over 800 trees.

Tomato Project

In cooperation with the department of plant pathology work is being continued at Lewiston and at Moscow in testing out varieties of tomatoes with special reference to their resistance to western tomao blight. The season of 1921 was ideal for the development of tomato blight and valuable data were secured on this point. The past season very little blight developed.

Besides the study of tomato varieties and their resistance to tomato blight, considerable work is being done in selecting types of tomatoes that are better adapted to the Palouse country and other similar sections where an early maturing tomato is necessary to secure a crop. Selections are being made in several strains of Earliana and other early varieties. This work was begun three years ago and already certain strains selected are showing great promise. Special attention is paid to selection of strains that are earlier as well as heavy yielders of well-shaped fruit. Effort is being made to eliminate in the Earliana the tendency to crack at the stem end.

The following table shows the yield of the ten highest yielding strains at Moscow during the season of 1922.

Summarized Report of a Study of Apple Seedlings

CROSS	No. Fruited	No red Color	Percentage Red Color				Flavor			Quality				Season		
			1-25	25-50	50-75	75-100	Sweet	Sub Acid	Sour	Poor	Fair	Good	Very Good	Early	Mid	Late
Jonathan X Ben Davis.....	294	1	65	145	80	3	131	106	57	272	13	9	0	82	94	118
Ben Davis X Jonathan....	204	1	75	93	32	3	89	73	42	180	16	7	1	46	74	84
Ben Davis X Spitzenburg...	69	7	29	29	4	0	36	22	11	61	6	2	0	14	24	31
Spizenburg X Ben Davis..	72	8	33	27	4	0	35	29	8	72	0	0	0	23	17	32
Ben Davis X Wagener.....	43	1	10	20	10	2	19	16	8	38	5	0	0	2	16	25
Wagener X Ben Davis.....	200	2	89	79	24	6	125	52	23	161	28	10	1	43	61	96
Wagener X Jonathan.....	64	0	10	36	10	8	23	29	12	48	13	2	1	26	19	19
Jonathan X Wagener.....	18	1	0	3	9	5	4	8	6	11	7	0	0	4	6	8

Variety	Yield per acre in lbs.
June Pink—1	19,281
Burbank—2	19,063
John Baer—e	18,627
Early June (Field)	18,162
Earliana 86-1	17,101
Moores Early	16,775
Earliana 93-1	16,122
John Baer—b	15,468
Earliana L. R. 7—a	15,359
Earliana 1—1	15,359

Potato Project

In cooperation with the department of plant pathology work has been conducted for the purpose of determining the results in control of rhizoctonia by dipping with mercuric chloride and formaldehyde; also to determine what takes place when successive dippings are made in the same solution of mercuric chloride. This work has been in progress for seven years and sufficient data have accumulated to justify the publication in bulletin form.

The variety tests with potatoes were continued in 1922. To maintain stock of high yielding ability considerable rogueing is necessary each year. Where no effort was made to eliminate diseased specimens a material reduction in yield was noticeable, as shown in the following tabulations:

Variety	Year	Total Yield in Bushels per Acre	Percent Marketable
Bliss Triump	1921	149	74
Bliss Triump	1922	69	61
Netted Gem	1921	80	47
Netted Gem	1922	32	0

In an experiment on date-of-planting the following results were secured:

Variety	Date of Planting	Total Yield in Bushels per Acre	Per cent Marketable
Netted Gem	May 15	267	53
Netted Gem	June 8	201	88
Netted Gem	June 20	79	65
Idaho Rural	May 2	234	42
Idaho Rural	May 15	372	86
Idaho Rural	June 8	105	66
Idaho Rural	June 20	122	79

Leaf Roller Project

This past season the departments of horticulture and agricultural chem-

istry have cooperated in an experiment in Kootenai county to determine the degree of control of leaf roller that can be obtained by the use of various arsenical sprays. It was found in case of a heavy infestation of leaf roller that the larvae can be controlled to such an extent that the foliage of the tree can be saved for that year and also that a fair set of fruit can be obtained. For example, where no special spray was applied for leaf roller a tree yielded from one to a dozen apples, while in adjoining rows trees sprayed for leaf roller with proper amounts bore from 300 to 700 apples, this being a fair load for trees of the size under observation.

It was found that for good results two sprays were necessary, one just as the worms were hatching, which is about the time the Wageners are in the full pink stage, and another at the time of the calyx spray. It was further found that to be efficient these sprays must be triple the strength of the regular codling moth sprays, that is, 12 pounds of powdered arsenate of lead to 200 gallons of water. Very good results were obtained with Paris green, 6 pounds to 200 gallons with some lime added to prevent burning. It was apparent that a very strong active poison is necessary to control this pest as evidenced by the fact that Paris green and the acid arsenate of lead gave the best results. One very striking fact brought out was in the use of lime sulfur with the arsenic. In every case where this combined spray was made the value of the spray against leaf roller was almost totally destroyed. In sections where it is necessary to give "pink" spray of lime sulfur for scab it will be necessary to apply a spray of lead arsenate for leaf roller. It also will require two separate sprays at calyx spray time.

Seed Growing Project

This work has been in progress for the past four years and much additional data have been accumulated since the last report. One important phase of the work that appears promising is the wintering over of biennial vegetables for seed purposes. Instead of growing the roots one year, digging and storing over winter and then planting them out in the spring, the roots are grown and left in the ground over winter. Some have been covered with a layer of dirt, such as a plow would throw upon the row, and some have had a covering of coarse manure. A variation of this method that gives promise for some root crops, especially turnips and sugar beets, is to sow the seed in the early fall, about mid-August to early September. Still another method being tried is to sow the seed thickly in a cold frame in early September, covering it with ashes when the weather is cold. The seedlings grow slowly all winter and when planted in the field in the spring at once send up seed stalks. All of these methods eliminate much of the labor of storing and planting.

Small Fruits Projects

For several years the department has maintained a plantation of small fruits including raspberries, blackberries, grapes, currants and gooseberries. Of the raspberries, the Cuthbert is proving the best both as to yield and shipping quality. The St. Regis yields well, but the flavor is inferior to that of the Cuthbert and it does not ship well. Neither the Thompson's Red nor the King stands up well under shipment. Their berries shatter easily and sink down in the container.

Of the blackberries, Eldorado is superior, having both good shipping qualities and flavor. Mersereau, while not yielding so heavily, is of superior flavor and a good shipper. Wilson and Early King are only fair yielders and the berries are smaller and consequently more seedy. Himalaya Giant is very prolific and of fair quality.

Fertilizers for Orchard Trees

This experiment was started last year in cooperation with the department of agronomy. Apple orchards were selected in which to carry on this work in the Hayden Lake, Lewiston and Moscow districts. The plan in each orchard was as follows:

Plot 1—Nitrate of soda, 3 lbs. per tree.
Plot 2—Nitrate of soda, 5 lbs. per tree.
Plot 3—Nitrate of soda, 8 lbs. per tree.
Plot 4—Check, no fertilizer.
Plot 5—Nitrate of soda, 5 lbs., acid phosphate 8 lbs. per tree.
Plot 6—Nitrate of soda, 5 lbs., potassium chloride 2 lbs per tree.
Plot 7—Acid phosphate, 8 lbs. per tree.
Plot 8—Nitrate of soda, 5 lbs., acid phosphate 8 lbs., potassium chloride 2 lbs. per tree.
Plot 9—Sulphate of ammonia, 3 lbs. per tree.
Plot 10—Sulphate of ammonia, 5 lbs. per tree.
Plot 11—Sulphate of ammonia, 8 lbs. per tree.
Plot 12—Check, no fertilizer.
Plot 13—Sulphur 4 lbs. per tree.
Plot 14—Clark's Special, 10 lbs. per tree.

Records are being taken as to terminal growth, health and vigor of trees; color of leaves, yield of fruit, color of fruit, and size of apples.

PLANT PATHOLOGY

Substantial progress has been made during the past year with several important plant disease investigations.

Soil Moisture and Soil Temperature in Relation to Smut

Numerous field observations and field plot experiments tend to show that during the time when the soil is infested with viable spores of stinking smut the amount of moisture in the soil at planting time has a direct influence upon the amount of bunt in the resulting wheat crop.

Greenhouse experiments under controlled conditions have shown that low soil temperature and a fairly high percentage of moisture in the soil are both conducive to stinking smut infection. The highest percentage of infection was secured at a temperature from 9° to 12° C., (48° to

54° F.) and in soil containing 22 per cent moisture. Some bunt infection was secured when the soil was held at a temperature of 25-28° C., (77° to 82° F.), during the germination of wheat.

Preliminary experiments appear to indicate that spores of stinking smut in the soil lose their power to infect rather rapidly when the soil is moist and cultivated frequently. Very little infection took place from spores which had been in the soil one month under the above conditions.

Calico and Russett Dwarf of Potatoes

It appears that the disease which has been called russett dwarf is very similar to some types of mosaic and in the light of certain recent work in this country and abroad dealing with this class of diseases it may be one of the several types of mosaic which have been described. Further investigations with this disease will be carried on in connection with the investigation of mosaic of potatoes. A preliminary report upon these diseases has recently been published.

Mosaic and Leaf Roll of Potatoes

The so-called "virus" diseases of potatoes, of which mosaic and leaf roll are types, are being more destructive each year. They are at present causing greater annual loss in the state than any other diseases and are a decided menace to the potato industry in Idaho. Preliminary results indicate that climatic factors may influence materially the amount of mosaic which may become apparent in a given lot of seed. A selected lot of each of the two principal potato varieites, Netted Gems and Idaho Rurals, was planted in various parts of the state under varying conditions. The plants were carefully rogued during the growing season and every plant showing any trace of mosaic or leaf roll was removed as soon as noted. Practically the same amount of leaf roll appeared in each of the various plantings. The amount of mosaic, however, varied materially. This may have been due to the effect of climatic factors upon the development of the disease or infection may have been spread to some of the plots from other fields or from wild plants. These plots were well isolated from other potato fields in order to reduce to a minimum the chance of infection from that source.

As shown by previous observations and by field experiments, both leaf roll and mosaic spread rather rapidly under Idaho conditions. In order to learn if possible what insects are responsible for transmitting these diseases, one hundred carefully constructed insect cages were used, fifty at Parma annd fifty at Moscow. Individual potato plants were grown under each cage and various insects were introduced upon healthy plants after having fed upon diseased plants. The following insects

were used: Green peach aphids, *Myzus persicae,* pink and green rose aphids, *Macrosiphum solanifolii,* false chinch bug, *Nysius ericae,* tarnish plant bug, *Lygus pratensis,* and several others. Positive results were secured with the pink and green rose aphids, *Macrosiphum solanifolii,* but not with any of the others. Further trials will be made next summer.

Control of Rhizoctonia of Potatoes

Seven years results are now available in testing the value of the cold formaldehyde and the corrosive sublimate methods of seed treatment when applied to seed infected with rhizoctonia and to clean seed. The influence of successive dippings of potatoes upon the strength of the corrosive sublimate solution has also been tested in the laboratory and field for the same length of time. As a result of these experiments it has been found that when clean whole tubers are treated the strength of the solution can be maintained at normal by adding one-quarter of an ounce of corrosive sublimate for every two bushels of potatoes treated. Cut or dirty potatoes break down the solution very rapidly. It has been found that potatoes should be treated loose, as sacks also reduce the strength of the solution..

In connection with this experiment, the department of plant pathology has for three years tested the hot formaldehyde method of seed treatment, advocated by the Iowa Station. The treatment as originally recommended does not appear to be effective against the sclerotia of rhizoctonia as they develop under our conditions. It has been found, however, that by sprinkling the tubers with water and covering for 24 to 48 hours before treatment either the corrosive sublimate or the hot formaldehyde treatment is rendered much more effective. A report of these studies is being prepared for publication.

Western Yellow Tomato Blight

This disease has for some years been a limiting factor in tomato production in Idaho. The department of plant pathology in cooperation with the department of horticulture has for three years tested various means for controlling the disease. More than eighty varieties of tomatoes as well as about an equal number of selections have been tested for resistance. Several of the varieties and some of the selections have proved promising.

Dust Treatments for the Control of Grain Smuts

Tests have been made during the last two years with several dust treatments for the control of stinking smut. None of these treatments has given as good control for this disease as the standard bluestone dip treatment under the conditions where they have been tried.

Preliminary tests carried on in 1921 seemed to indicate that copper

carbonate was not effective when applied to badly smutted seed but might be effective with seed not heavily smutted. In order to secure further data on this question as well as to compare the efficiency of copper carbonate dust and bluestone under the same conditions an experiment was conducted, the results of which are given in the following table. Jenkins Club wheat was used and was artificially smutted in the amounts shown. Part of each lot was then treated with copper carbonate, part with bluestone and part left as a check. The wheat was seeded in fortieth-acre plots October 7, 1921. The table gives the results of the tests. Smut counts were made July 20, 1922. Three counts were made in each plot and the average for the three counts is given.

Amount of smut by Weight	Per cent smut Copper carbonate 2 oz. to Bushel				Per cent smut Copper sulphate (Bluestone) 1 lb. to 5 Gal.				Per cent smut Control, not Treated			
	1	2	3	Ave.	1	2	3	Ave.	1	2	3	Ave.
1-10,000	26½	10	11	16	9½	2	5	5½	35	33	30	25
1- 5,000	24½	11	28	22	18	4	15	12	27	16	27	25
1- 1,000	24	27	16	23	12½	6	12	10	67	50	50	55
1- 500	23	7	19	17	15	2	17	11½	70	32	55	52
Stand	58				35				50			

Counts were also made on several plots of Jenkins Club wheat grown by the agronomy department, part of which had been treated with bluestone and part with copper carbonate, with the following results:

Dust—copper carbonate .....6 plots, average 9% smut
Bluestone—dip .....4 plots, average 7½% smut

Field tests were also made on several farms near Moscow in cooperation with farmers. The following table gives the results of these tests:

	Per cent smut	Stand
Triplet wheat—		
Bluestone dip	2½	27
Copper corbonate dust	3¼	40
Wash. hybrid 123—		
Bluestone dip	7½	30
Copper corbonate dust	7½	44
Bluestone dip	26	38
Bluestone & lime dip	23½	51
Carbonate copper dust	43	55

Experiments with the dry dust treatments are being continued and cooperative tests have been started with a large number of farmers in various grain-growing sections of the state. An experiment has also been started comparing various commercial brands of copper carbonate as to copper content and smut control.

Sulphur for Potato Scab Control

Reports from various sources have shown that sulphur when added to the soil is sometimes effective in controlling potato scab. An experiment was conducted at Ashton this year with various brands of sulphur, some inoculated and some not inoculated, applied at the rate of 300 and 600 pounds to the acre. None of the tretaments was satisfactory as the potatoes on all the plots were very scabby.

Investigation of Stripe Rust

This work was started at the Idaho station in January, 1921, in cooperation with the office of cereal investigation, U. S. Department of Agriculture, and substantial progress has been made since that time: During the last year two papers have been written which are to be published soon in the Journal of Agricultural Research. These contain for the most part the results of work which was begun before the project was transferred to the Idaho station. During the last year the work has been severely handicapped due to the fact that practically no stripe rust developed in the northwest because of the extremely dry season.

A grass nursery of about 250 collections of various grasses has been developed and adequate greenhouse facilities have been prepared for a thoro study of specialized races of this rust. Up to the present time over sixty wild grasses have been found to be hosts for this rust. The relationship of the race upon wheat has been quite thoroly worked out. No alternate host plant for the rust has yet been found. The summer stage of the rust over-winter on wild grasses and winter wheat in Idaho.

The Stem Nematode of Clover

The investigations upon the clover nematode, in cooperation with the office of cotton, truck and forage crop disease investigation, U. S. Department of Agriculture, were transferred from the entomology department to the department of plant pathology last spring. This year the work has been located at Parma, Idaho, in direct charge of Dr. Geo. Godfrey, who is employed by the U. S. Department of Agriculture. Field experiments have been started at Parma this year to find if possible the effect of various rotations, the influence of various systems of irrigation and the common hosts for the stem nematode of clover.

POULTRY HUSBANDRY

The results of the second year of the feeding experiments to determine the comparative value of protein from different sources for laying hens show clearly that sour milk (skim) is a stimulating factor towards higher and more profitable egg production. The feeding of the sour

skimmilk results in greater returns from both animal protein feeds and the vegetable protein feeds.

Two Years Results Summarized

For the two years of the experiment, sour skimmilk as the main source of protein has proved satisfactory when self-fed with the scratch and dry mash of the basal ration. Larger eggs were obtained by using about 12 per cent meat meal in the dry mash with the milk. The ration mixed in this way, however, costs more and had a tendency to give some bloody eggs. A very satisfactory ration was obtained by using peameal in the mash to the extent of twenty-five per cent and giving the birds a limited amount of sour skimmilk in water. The profit over feed cost from this ration was more than twice that from the check pen that received no additional protein feeds. The check or basal pen gave such unsatisfactory production that a profit over feed cost of only 63 cents per pullet was realized. The results showed also that when skimmilk is not available meat meal or tankage can be used.

Dried buttermilk gave a lower per cent production, produced smaller eggs and showed much less profits than the skimmilk. It stimulated egg production, however, and when cheap enough and readily available it makes a satisfactory substitute for sour skimmilk. It has the great advantage of being easily handled and fed. The protein feeds apparently influence the size of eggs. The largest eggs were produced by a ration which included both meat meal and sour skimmilk. The check pen produced the fewest large eggs and the most small ones. The no-protein milk pen yielded small eggs compared to the sour skimmilk pen. Meat meal produced larger eggs than tankage. In the skimmilk pen the average consumption of the pullets for the year was 44.4 pounds of scratch, 25.3 pounds of mash and 158.5 pounds of sour skimmilk. The scratch ration consisted of two parts wheat, one of corn and one of oats. The dry mash was a mixture of two parts wheat bran, one part shorts, one part corn meal and one part ground oats. The sour skimmilk was given in unlimited amounts.

Breeding Experiments

The results of the outcrossing of Purdue and Oregon strains (White Leghorns) with the Idaho strain indicate that poultrymen should avoid mixing strains within a variety of poultry, as the results are likely to be less satisfactory than those obtained from the original strain. New blood should be introduced sparingly and its effects checked by trap-nesting.

Study of Eggs

From March 22 to November 1, 1922, a study was made of the eggs

from twenty-five single comb white leghorn hens. The eggs were graded into four classes with reference to color, three with reference to texture, four with reference to shape and five in regard to interior characteristics. Weights were taken to a tenth of a gram. Two thousand five hundred forty-four eggs were graded between March 22 and October 1, 1922. The average weight of these eggs was 63.1 grams. This is 5.1 grams higher than the average weight of eggs sold in the market. A two ounce egg weight 58 grams. Eighty-seven and seven-tenths per cent of the eggs were chalk white. 10.1 per cent slightly tinted, 1.7 per cent creamy and .5 per cent light brown. In texture 74.0 per cent of the 2398 eggs handled were normal, 22.0 per cent rough, and 4 per cent very porous. In shape 85 per cent were normal, 5 per cent were round, 5.6 per cent long and slender, and 4.4 per cent irregular in shape. There were 1214 eggs candled and 3.4 per cent found to be transparent, 56.6 per cent cloudy, 39.4 per cent dark reddish, and 0.6 per cent bloody.

There were no hens that consistently laid eggs with light colored yolks or bloody eggs. Some hens laid twice as many cloudy eggs as they did dark eggs with a dark reddish interior. Other hens laid a larger percentage of dark colored eggs. These hens were fed white corn in their scratch ration with the object of producing as many transparent eggs as possible. The interior quality of the eggs probably is not a question of either feed or the individuality of the bird.

Method of Feeding Oats

In an experiment comparing dry, soaked and sprouted oats, the dry oats pen gave the highest percentage production, the highest average yearly profit over feed cost, the cheapest feed cost per dozen eggs, and required the least amount of labor under the conditions of the experiment. Sprouted oats gave slightly better results than soaked oats. There is some question as to whether there is sufficient returns from soaking or sprouting oats to justify the expense and trouble of preparation. More work needs to be done on this problem. It will be continued as soon as the pens are available.

Other Investigations

The experiment with protein feeds has been continued and a comparison is being made of sour skimmilk, pea meal, meat meal, tankage, fish meal and sour skimmilk, meat meal and sour skimmilk, and pea meal and sour skimmilk.

A comparison is also being made of cod-liver oil, lactic acid, protein-free skimmilk and milk salts, the object being to determine (1) if vitamine fat soluble A is or is not a stimulating factor in egg production; (2) if lactic acid is or is not the factor in milk that stimulates egg

production; (3) the value of milk salts for laying hens; (4) the value of the protein of milk for the production of eggs.

PURE SEED

The pure seed law enacted by the legislative session of 1913, provides for inspection, analysis and tagging of seeds offered for sale in Idaho and provides for a means of determining the quality of seeds produced within the state. Since activities aimed at seed improvement are almost entirely educational in nature the adminstraton of the act is entrusted to the Agricultural Experiment Station.

Increased Demand for Analysis

There was a marked increase in number of samples submitted for analysis during the past two years as compared with previous years. The total analyses for the biennium just closed were as follows: Five thousand three hundred and sixty-six samples given complete purity analysis and 585 samples given germination analysis.

The number of samples from various sources and the percentage of samples from these sources are given in the following table:

	Co. Agents		Farmers		Dealers		Seed Pool	
1921	123	4%	1,012	35%	1,611	55%	178	6%
1922	28	1%	557	29%	1,101	54%	321	16%
Average		2.5%		32%		54.5%		11%

Quality of Seed Improves

The efforts at seed improvement, under the authority of the seed law, have been of great service in enabling the farmer to know the quality of seed bought or sold and have resulted in marked improvement in the quality of seed handled within the state. The laboratory analyses show that only 26 per cent of the samples were condemned in 1922 as compared with 54 per cent in 1920 and 43 per cent in 1921.

Statistics for the past eight years show that the price of seed has varied in direct proportion to its quality. An interesting fact is the greater percentage during the two years of condemnation following the peak of high prices. It is evident that the grower is tempted to sell all his high quality seed to realize the attractive prices and plant that portion of his seed crop that is of lower quality.

Weed Control

A part of the seed improvement program has had to do with the elimination of noxious weeds. Nineteen weed excursions and twelve demonstration meetings were held to acquaint farmers with various

kinds of noxious weeds and to point out methods for eradicating the same. These excursions were held in ten important clover and alfalfa seed producing counties of the state.

Inspection

Seed inspection, during the springs of 1921 and 1922 was carried on in 31 counties of Idaho. Two hundred and thirty-one visits were made to dealers' establishments in 60 towns and cities. The inspection made it possible to check over the different lots of seed offered for sale by the respective dealers to see that the seed was free of noxious weeds, except as allowed by law, and to give the dealers help in identifying bad weed seeds commonly found in seed. Assistance was also given in proper labeling and classifying of different lots of seed.

With few exceptions, it was found that the seed dealers thruout the state are very willing to cooperate in the interests of pure seed distribution among farmers. Violations of the law were most frequent in regard to labeling. The few lots of seed condemned the past two years were shipped out of the state. Re-checking at the shipping point showed the method of disposal of such seed.

Seed Certification

The names of 400 cooperative demonstrators are on file and to date 135 have met the requirements for certification. All bags will be inspected, sealed and tagged before seed will be considered certified.

Grimm alfalfa seed certification has reached large proportions. Over two hundred fields of Grimm alfalfa have been inspected in Bingham county and have met the certification requirements of the International Crop Improvement Association, of which Idaho is a member. Ninety-six growers in six other counties of the state have requested inspection of their alfalfa fields and 48 growers have received certification to the effect that their fields are genuine Grimm.

Pure Seed Work Valuable to State

The pure seed department renders service as follows:

1. **Protects farmers against the dealer who offers low quality seed for sale.**
2. **Protects the Idaho dealer against the outside dealer who ships him low grade seed.**
3. **Provides a seed laboratory where the farmer can secure help as follows:**
   - **(a) Assistance in growing good quality seed.**
   - **(b) Identification of weeds and weed seeds.**
   - **(c) Samples tested for purity and grades.**
4. **Establishing a seed laboratory, where the dealer may receive aid when selecting stocks for Idaho trade, thus insuring compliance with Idaho laws and assisting in the production of good seed.**

5. Enables our farmers to receive certification for their seed and meet the demands of eastern buyers for a certified product.
6. Enables our growers to get first hand information on market demands and control measures for noxious weed seed.

ZOOLOGY

Cytological Studies of the Reproductive Cells of Sheep

The study of the spermatogenesis, oogenesis, and sex-determination phases of this problem are completed and the results are being prepared for publication. The paper including the figures will be completed early in 1923. Over a thousand slides of the gonads of both sexes were thoroly studies. Hundreds of slides of sheep embryos and foetal tissues of both sexes were made and carefully studied in connection with the sex determining phase of this problem. The paper in its entirety will correspond to the thoro-going publication of the results of a similar investigation in the case of the cells of cattle. The studies show conclusively that sex in sheep is a matter of inheritance in a manner similar to that reported by the writer in the case of swine, horses, and cattle.

Studies of the Reproductive Cells of Goats

Hundreds of slides have been made of tissues obtained from both horned and hornless male goats. Preliminary studies indicate possibilities of some very interesting research. This investigation will show the cytological relationship of the sheep and goats. Thus far efforts to produce a sheep-goat hybrid have not been successful, and these studies may reveal the reason of this.

ABERDEEN SUBSTATION

The activities of the Aberdeen Substation for the year 1922 consisted of improving the useful plants by selection and breeding, carried on both in the field and more intensively in the nursery under the supervision of G. A. Wiebe, junior plant breeder; the introduction of new plants in cooperation with the bureau of plant industry, office of cereal investigations, U. S. Department of Agriculture; the improvement of cultural methods for producing crops; the duty of water on alfalfa seed; and the application of commercial fertilizers on crops and the improving of potatoes by selection and rogueing.

Wheat Experiments

Dicklow wheat was seeded and selections made early in the substation's history. This wheat, found to be a superior one, was distributed to the farmers of Idaho. The largest distribution was made in 1917 when 50,000 pounds were sold. Dicklow wheat yields 4.93 bushels more than any other wheat now generally grown under irrigation on the

farms of Idaho. It has established a reputation for itself as being an exceptionally fine wheat for making biscuit flour.

A new variety of wheat has been developed by the Aberdeen substation. It was introduced into this country about seven years ago by the office of cereal investigations. Federation, as it is called, has outyielded the Dicklow 5.5 bushels per acre in a four year trial on the Aberdeen Substation, and has exceeded Dicklow in milling and baking quality. Arrangements were made to distribute 8,000 pounds of this wheat to the farmers of Idaho during the fall of 1922. Head selections were made and these heads will be planted in 1923 to further improve the strain. Federation has a medium stiff straw, stands up well in the field and is more resistant to rust than Dicklow. The Federation does not give the appearance of making the yield that Dicklow does while standing in the field. It has a distinct color, the head having a dull bronze appearance.

Hard Federation, another one of the Federations introduced by the office of cereal investigations, has been grown on the Aberdeen Substation during the last four years. This wheat showed up unusually well on the dry lands of Camas county under the supervision of County Agricultural Agent Jesness. Further trials of this wheat will be made on the dry lands in 1923.

Oat Investigations

Three varieties of oats have been developed on the Aberdeen Substation. These oats stand at the top of the list in a ten-year variety test. They are the Golden Rain, Victory, and Idamine. The Golden Rain is the highest yielding oat grown on the Station, but it has a very small long, slim, yellow kernel. This has caused it to be used in the breeding work, but it has not been thought advisable to put it out to the farmers owing to this type of oat not being in demand on the market. The Victory is a good oat and has a white kernel.

The Idamine is a pure line selection of the Sivermine. It is well adapted to both the upper and lower Snake River Valleys. It is a white, plump, mid-season oat of good quality. The first distribution of Idamine oats was in 1920, consisting of 500 bushels. This oat has become quite popular with farmers in the irrigated sections.

Barleys

Trebi barley was obtained from Asia and placed in the variety tests at Aberdeen conducted in cooperation with the U. S. office of cereal investigations. It showed up remarkably well from the start, and has maintained its high yield up to the present time. Many barleys have been tried against it, but none has equaled it for the irrigated sections. It also has proved itself to be adapted to a wide range of conditions. It outyielded all other barleys at the Chico Station in California this year and

also the Montana Experiment Station. While it is primarily an irrigated barley it also does well on the dry lands, but not as well as the Smyrna barley. The Trebi barley was first distributed from the Aberdeen Substation in 1917 and is now practically the only barley grown in the state under irrigation. It is planned to try out a new set of varieties against the Trebi to see if there is any other barley that might be better adapted to Idaho conditions.

Corn Varieties

A variety test of corn was conducted this year. Several varieties showed up well enough to be continued. Wisconsin Cold Resistant Golden Glow made the highest yield and matured well . It is not as early as the Rustlers White Dent but last year, which was a frost-free period, the Golden Glow was well matured. Minn. No. 13 and U. S. Selection 133 also matured. The Reid's Yellow Dent and Iowa Silvermine only reached the milk stage. The Rustler's White Dent made 45 bushels per acre on the increase plot. This is ear-to-row selected and improved seed. The attempt is being made to develop a yellow dent that will mature as early and give as high a yield of grain and more forage than the Rustler's White Dent.

Cereal Nursery

The cereal nursery for the year 1922 was composed of approximately 3000 rows. A large share of the nursery was in rod rows of wheat and oats. Wheats from the U. S. cereal office and Australia were grown to determine their adaptability and yielding capacity. The promising varieties from these two sources will be increased so they can be included in the field plots for further study. The segregates from a number of oat crosses were grown and notes taken to determine their relative merit. Crosses were made with oats to study the inheritance of morphological characters, and also to improve some of the standard varieties for color of hull, yielding capacity and disease resistance. The work with barley was of physiological and genetic nature. Notes were taken on 6000 plants to study inheritance of various characters. Breeding projects are under way to improve some of the varieties now grown commercially.

Potato Investigations

Data have been obtained on the most desirable size of seed pieces of the Idaho Rural potato. The experiment was conducted with eight-ounce whole seed and eight-ounce halved and quartered, four-ounce whole seed and four-ounce halved and quartered and three-ounce whole seed and three-ounce halved and quartered potatoes. The conclusion drawn from this experiment is that eight-ounce whole seed produces more potatoes

and a stronger vine, but a lower percentage of marketable potatoes than either the halved or quartered. The four-ounce whole potato produces a greater quantity of marketable potatoes than the eight-ounce whole potato, but not as many as the halved four-ounce seed piece. The experiment shows that it is best to cut the potatoes, but a two-ounce seed piece is as small as should be planted. A better stand is obtained with the larger seed piece and more vigorous plants are developed, and the yield of marketable potatoes is higher.

An experiment has been completed showing the proper distance to plant in rows. Cut seed was planted 8, 12, 16, 20, 24 and 28 inches apart. The proper distance to plant the Idaho Rural was found to be 16 to 20 inches apart to obtain the highest yield per acre and the highest percentage of marketable potatoes on very rich land. Where the land is poorer 24 inch planting was found to give the highest yield and best quality of potatoes. The 28 inch planting gave the highest yield of all, but on a fairly rich soil the tendency towards a large potato was pronounced. The common practice is of planting potatoes 16 inches apart. The experiment shows that the yield could be increased by planting potatoes 20 inches apart instead of 16 and by using at least a two-ounce seed piece. If seed stock is to be gown, 8 to 12 inch planting will reduce the size of the tubers and increase the number of potatoes of seed size.

Some work in selection is being done with the Netted Gem and the Irish Cobbler in the attempt to develop high-yielding seed both free from and resistant to disease.

Sugar Beet Experiments

Experiments in progress with reference to sugar beets deal with tests of varieties, trials of various cultural methods and records on different systems of irrigation. In the varietal tests records are kept of yields and analyses made of typical beets of the various varieties by the Station Chemist.

Alfalfa and Clover Varieties

Seven different varieties of alfalfa were planted in duplicate last spring. All made a good stand. The plan of the experiment is to make a study of these varieties and to collect data as to their ability to withstand Aberdeen winters and the quality and quantity of hay produced. Seed will be taken off this coming year and, after that, the hay will be cut and weighed for hay production.

Twelve different varieties of clovers are being tried out on the Substation. Several imported varieties are being tried along with the seed grown in Idaho and other parts of the United States. It commonly is believed that the imported seed, especially that coming from Italy, will

not stand the winters this far north. The Substation is also trying to find the best red and the best white clover for Idaho conditions, so that some definite recommendations can be made as to what variety the farmers should demand when buying clover seed.

Alfalfa and Clover Seed

Work was started with alfalfa seed to determine the best cultural methods to apply to get the highest yield of seed. The same line of work is being carried on with clovers.

Mosaic and Leaf Roll of Potatoes

Investigation of the so-called degeneration diseases, mosaic, leaf roll and related troubles of potatoes, was carried on in cooperation with the plant pathology department of the Agricultural Experiment Station. Russets and Rurals were the two varieties used. These varieties were placed a quarter of a mile away from any other potatoes and were severely rogued for disease thruout the season, with the idea in mind of eventually developing disease-free stock.

Soil Fertility Experiments

The application of commercial fertilizers on alfalfa grown for hay production so far has not been found to be practical. The normal treatment gave as high an average yield as the plots where commercial fertilizer was applied. The only fertilizer that shows any promise of being of any value is the Anaconda Superphosphate, P_2O_5.

The Aberdeen Substation is being gradually put in a state of higher fertility. Twenty acres were covered with manure in 1922. The application was at the rate of 15 tons per acre. Further leveling was done so that water can be more easily applied. The farm is a valuable asset, having rendered remarkably valuable service to irrigated agriculture, and is equipped to do even more valuable work for an irrigated farming area largely expanded as a result of the construction of the proposed dam at American Falls.

CALDWELL SUBSTATION

The Caldwell Substation consists of three hundred and twenty acres located three and one-half miles south of Caldwell. Two hundred sixty-seven acres are below the ditch. Payments are being made on a permanent water right under the Boise Project of the United States Reclamation Service. For several years it has been necessary to expend a considerable portion of the money provided for maintenance in clearing the land of sage brush and in preparing for irrigation. All of the land, except that portion used for buildings, corralls and feed yards, and twelve acres plowed but not yet seeded, is now under cultivation.

Experiments Deal With Big Problems

This Substation is devoted primarily to investigations of three of the most important farm problems of southwestern Idaho, namely, soil improvement, feeding of steers and lambs and methods of dairy farming. The policy of the farm has been worked out by the superintendent in consultation with the various department heads of the Home Station and with the Director of the Station. There is afforded at Caldwell the opportunity to study in a comprehensive way the important problems as listed.

Study of Soils

This particular tract of land is somewhat higher than the lands nearer Caldwell, has a shallow soil and, prior to improvement, "slick spots" constituted a considerable portion of the entire area. Soil improvement trials have consisted of the application of hundreds of tons of manure and the utilization of certain rotations in which legume crops have a prominent part. In addition to soil tests on an extensive scale, twelve acres were carefully mapped for the purpose of definitely locating the "slick spots." This tract has been set aside for experiments with certain definite methods for "slick spot" elimination. These trials include the use of sweet clover and alflfa as green manures and the application of various soil amendments.

That the soil improvement work is effective is shown by the barley yield from four and one-half acres where the "slick spots" constituted a large portion of the entire field. The manure from the feeding plant was used freely on this field in the fall of 1921 and particular care was exercised in getting a good job of plowing. The barley yield in 1922 was at the rate of 62.4 bushels per acre. The yields of alfalfa are increasing year by year. Six experimental fields, with a total acreage of 50.73, grew alfalfa in 1922. The average per acre yield on these fields was 4.26 tons.

Dairy Cattle Investigations

The dairy herd consists of forty-five head of high grade Holstein-Friesians, including cows, heifers and calves. The pure bred bull that heads the herd is supplied from the Home Station herd. The feed for the herd is grown upon the farm, consisting of blue grass pasture, alfalfa hay, corn silage and some grain. The pastures are irrigated and a careful record is kept of the number of cows and other livestock kept on each pasture during each day of the year. Other records kept in this connection deal with the frequency of irrigation and labor required in pasture irrigation. One of these blue grass pastures, consisting of seven and one-half acres, carried during 1922 from ten to twenty-two cows. The

total carrying capacity was computed by securing the total number of cow-days. On this basis of computation each acre of this pasture carried one cow for 292.4 days of twenty-four hours each.

Experiments were started in 1921 to test methods of growing out dairy heifers, dividing the substation yearlings into two groups for this purpose. One lot was fed hay alone, a common practice in the irrigated regions, and the other lot was fed hay and silage. Further reference to experimental work with the Caldwell dairy herd will be found in this report under the department of dairy husbandry. The production of the Substation cows in milk average for a full year-period 12,652.4 pounds of milk and 440.0 pounds of butterfat.

Steer and Lamb Feeding

The experimental feeding plant, constructed on the substation farm in 1919, handles conveniently one hundred forty-four steers and from seven hundred to one thousand lambs. The feeding tests have had to do with the testing of various combinations of Idaho grown feeds in the fleshing of Idaho steers and lambs for market. In addition to experiments with various grains and roughages trials have been made of methods of preparing feeds and gains of steers and lambs on pasture. In 1922 two carloads of lambs purchased by the Station and finished for market, were taken to Chicago and sold there upon the open market. The data collected included shrinkage enroute, Caldwell to Chicago, cost of marketing, dressing percentage, and relative value of the various lots each fed a different ration. Further reference to the feeding investigations conducted at the Caldwell Substation will be found in this report under animal husbandry.

The dairy herd and the steers and lambs provide a market on the farm for all the feed it produces.

Clean Ditch Banks

A flock of pure bred Hampshire sheep is maintained on the Substation. The sheep are pastured on the ditch banks thruout the summer and fall. They render a useful service in keeping the ditch banks free from weeds and long grass and the cost of their maintenance is low.

Experiments with Corn

In addition to corn grown for silage, several varieties are under test for the purpose of determining those best adapted for the production of silage and those especially adapted for growing mature ear corn. The yield of silage from these various varieties, on the basis of harvesting one hundred hills of each, has ranged from 8.53 tons to 22.39 tons per acre.

HIGH ALTITUDE SUBSTATION

The High Altitude Substation consists of one hundred sixty acres of dry-farming land and forty acres of irrigated land, the former located four miles and the latter three-fourths of a mile from the town of Felt. During the past two years the irrigated farm has been used as headquarters and the land seeded to grains for feeding the work horses.

Dry-Farming Experiments

Extensive experiments on the dry farm have dealt with variety tests of cereals; with the introduction of new crops, such as legumes, buckwheat, and other crops not commonly grown in the district; rate, date, and depth of seeding of wheat; and cultural methods aimed at developing the most efficient methods of handling the summer fallow. These experiments are of direct interest and high value to a vast region extending from beyond Ashton on the north to the vicinity of Victor on the south and from the Wyoming line on the east to Rexburg on the west.

Rate, Date, and Depth of Seeding Wheat

There is a lack of uniformity of cultural practices in the region mentioned above. Exhaustive tests are in progress of methods of seeding, rates of seeding and dates of seeding, using Turkey Red wheat on all the experimental plots. The methods of seeding used are broadcasting and shallow and deep drilling. Rates varied from two pecks to seven pecks per acre. Dates of seeding are at 15 day intervals from July 15 to October 15, inclusive. Shallow drilling of the seed has been giving best results with deep drilling a close second. Shallow seeding with a drill has given 4.6 bushels per acre higher yield than broadcasting. Four pecks per acre gave the highest yield of the various rates of seeding. In all rates of seeding and all methods of seeding September first planting gave the highest yield. The average yield in 1922 from all September first plantings was 34.4 bushels per acre. The lowest average was from the October fifteenth seeding, 14.9 bushels per acre, a difference of 19.5 bushels per acre in favor of the optimum seeding date.

Wheat Varieties

The production of wheat is the major source of farm income in the region represented by the experimental fields at Felt. There has been a great deal of interest, therefore, in the variety tests of wheat, particularly with reference to winter varieties. Kanred, Kharkof, Triplet and Turkey Red made the highest yields. Kanred and Kharkof each yielded an average of 35.8 bushels per acre in 1922. Of the spring wheats Marquis and Dicklow are leading in yield. Eleven winter and ten spring wheats are grown in the experimental plots.

Oat Varieties

The oat experiments have been with variety tests and rates of seeding. Sixteen varieties have been grown and Victory oats have yielded highest with an average for the three years of 44.2 bushels per acre. No special efforts have been made to advertise results secured with this oat but farmers of the region have been watching the variety tests and there is now considerable demand for the Victory oat seed from the high altitude farming sections. The Victory oat is medium in length of growing season. The Idamine has been grown two years and has yielded less than the Victory by approximately ten bushels per acre. Idamine, however, is a heavy oat and yields highest of the early varieties.

Legumes

Biennial white sweet clover, Hubam clover and Grimm alfalfa made an excellent growth in 1922. Good stands were secured the past season with sixteen grasses, clovers, and alfalfas.

Other Crops

Giant Russian sunflowers made vigorous growth reaching an average height of six feet with heads from eight to ten inches in diameter. Buckwheat was injured by hail in early summer but recovered and made a fair yield of good quality seed.

Field Day

On August 5, 1922, a field day was held at the High Altitude Substation. One hundred farmers went over the farm and viewed the experimental plots. These men expressed a very great interest in the experiments under way, and many of them expressed the opinion that the results secured in the investigations at the High Altitude Substation will be of great economic importance in the progress and development of the dry-farming area in western Idaho.

SANDPOINT SUBSTATION

The Sandpoint Substation was established to deal with the peculiar problems of the cut-over regions. The experiments have been planned with the assistance of the various departments of the Home Station and are aimed at the testing of varieties to find those most suitable for the cut-over sections; the introducing and trial of new crops; the study of cultural methods, dates, and methods of seeding grains and legumes; the study of rotations and soil fertilization; and the development of a farm plan that will permit the use of livestock as a means of marketing the crops of the cut-over lands.

Three Accomplishments

The Substation has produced three pieces of information of real importance to the farmers of Bonner and neighboring counties. Sunflowers have been introduced, successfully grown and have yielded under favorable conditions ten tons of silage to the acre. Sweet clover has been grown successfully on the farm, and has yielded more hay per acre than any other legume. The testing of seeding and cultural methods has given information which when used by the farm superintendent this year enabled him to secure excellent stands of legumes in one of the driest seasons on record at Sandpoint.

Sunflowers for Silage

The first experiments at Sandpoint with sunflowers were with reference to yield. It has been found that the yields are low on land continuously cropped. Reasonably fertile timber soils planted to sunflowers can be expected to yield ten tons per acre of a quality of silage that is palatable to livestock. The most satisfactory planting has been found to be in rows three feet wide with a spacing of twelve inches in the row. Early seeding is preferred. The largest yield in 1922 was obtained from the earliest seeding, which was May 19th.

Sweet Clover for Hay

In addition to the need of a satisfactory silage crop for the cut-over sections, there is demand for a legume that will give a high yield of hay and for a pasture of greater carrying capacity per acre than the native grass pastures now commonly used. Sweet clover has given excellent results as a hay crop, yielding the second year as much as three and three-fourth tons per acre. When cut at proper stages the livestock on the Substation readily have eaten sweet clover hay. Sweet clover will be tried as one of the most promising pasture crops.

Potato Experiments

Farmers of several of the northern counties have manifested much interest in the growing of potatoes for seed. Work has been initiated on the Substation farm to secure information of interest to the grower regarding certain features of potato seed production. Among the potato experiments are the testing of seed from certified stock, both northern Idaho grown and southern Idaho grown, as compared with hill and bin selected in the total yield per acre and the percentage of culls; tests of such varieties as Idaho Rurals, Irish Cobblers, Netted Gems and Early Ohios; experiments in the rate of planting Idaho Rurals and Netted Gems; tests of various spacing of the seed and development of special strains of the more popular varieties. Planting of potatoes in rows with

the tubers spaced twelve to fourteen inches gave the highest yield but the check method with the rows three feet apart and the hills at spacings of three feet gave the largest return of marketable potatoes. The heaviest yield, 254.6 bushels per acre, was secured from a row planting and heavy rate of seeding of Idaho Rurals.

How to Seed Legumes

Some of the most important work at Sandpoint has had to do with methods of seeding legumes. Lime has been applied to alfalfa with and without rolling. Clovers have been seeded broadcast on the snow, broadcast when the soil is honey-combed, and broadcast as compared with drilling at various dates. The results from the use of lime are not sufficiently definite that recommendations can be made. The use of lime on some of the plots will be continued to obtain further data. The early dates of seeding and the broadcast method have been found the most satisfactory in the seeding of legumes. The roller has been found a valuable tool on the cut-over farm.

As a result of considerable experimental work the Substation superintendent makes the following recommendation of methods to obtain best results in getting stands of legumes:

1. Seed on fall plowed land.
2. Give the soil as good preparation in the spring as would be given for a crop of grain.
3. Seed broadcast. Use eight to twelve pounds per acre of red clover, sweet clover and alfalfa, and six to eight pounds per acre of alsike clover or timothy.
4. Inoculate the seed.
5. Follow the seeding with a light drag, either a brush drag or harrow is satisfactory.
6. Follow the drag with some sort of packer. On all the substation seedings a corrugated roller is used.

The methods as outlined have given good results with red clover, sweet clover, alfalfa, alsike clover, and timothy, and have succeeded on early spring seedings, late spring seedings, summer seedings and early fall seedings. In the case of the late summer and early fall date the clover has been seeded after light rains.

Other Lines of Work

Other crops, such as roots, buckwheat, flax, and artichokes are grown to determine their adaptability to the region. A small orchard is planted with the varieties of fruit that are recommended for a family orchard in the northern Idaho counties. The various root crops did well in 1922. The largest yield was secured with carrots which gave a return of 22,800

pounds per acre. Half-sugar beets and mangel wurtzels were next in yield, in order named.

Livestock

The Substation livestock consists of a small herd of pure bred Holstein-Friesian cattle, a carefully selected flock of Shropshire sheep and a small flock of Rhode Island Red hens. Records are kept of production and cost of handling the livestock.

Work with Bees

Five colonies of bees belonging to the Substation were successfully wintered in 1922. The bees are a part of the farm's experimental program. Observations are made and records kept of the honey flow by months, source of collection, and other facts of value in the successful management of the apiary. Data collected from the Substation colonies are supplemented by observations of colonies of other beekeepers.

FINANCIAL STATEMENT

HATCH AND ADAMS FUNDS

University of Idaho Agricultural Experiment Station in account with the United States Appropriations

DR.		HATCH	ADAMS
To balance from appropriation 1920-1921		None	None
Receipts from the treasurer of the U. S. for the fiscal year ending June 30, 1922		$15,000.00	$15,000.00
CR.	ABSTRACT		
By Salaries	1	$10,697.14	$10,080.87
By Labor	2	2,504.31	2,235.88
By Publications	3	373.38	
By Postage and Stationery	4	13.31	8.00
By Freight and Express	5	28.74	187.32
By Heat, Light, Water and Power	6	91.25	122.65
By Chemicals & Laboratory Supplies	7	107.36	698.87
By Seeds, Plants and Sundry Supplies	8	231.56	604.23
By Fertilizers	9	4.10	
By Feeding Stuffs	10	199.50	140.40
By Library	11	34.24	8.50
By Tools, Machinery, and Appliances	12	133.50	202.40
By Furniture and Fixtures	13	7.10	13.03
By Scientific Apparatus & Specimens	14	109.95	185.41
By Livestock	15		16.80
By Traveling Expense	16	385.39	489.64
By Contingent Expense	17		
By Buildings and Lands	18	79.17	6.00
By Balance		None	None
		$15,000.00	$15,000.00

LOCAL STATION FUND

Summary

January 1, 1922—December 31, 1922

Balance on hand, Jan. 1, 1922	$1,427.63
Receipts, Jan. 1-Dec. 31, 1922	2,424.25
Total	$3,851.88
Expenditures Jan. 1-Dec. 31, 1922	$2,744.75
Balance Dec. 31, 1922	1,107.13

Receipts by Departments

Interest and General	$ 293.65
Agr. Chemistry	489.00
Bacteriology	22.00
Agronomy	27.63
Dairy	135.00
Horticulture	828.03
Poultry	572.06
Plant Pathology	56.88
	$2,424.25

Disbursements

ITEM	Adm.	Agr. Chem.	Agronomy	An. Hus.	Bact.	Dairy	Hort.	Plant Path.	Poultry	Total
Labor	$ 85.69		$176.51				$378.42	$ 5.65	$207.90	$ 854.17
Postage & Stationery	16.46	$ 7.75	3.80			$6 .45		5.25	51.70	91.41
Frt. & Exp.				$3.00			3.30	26.00	26.00	58.30
Sundry Exp.	3.01	39.25	33.55		$5.71	36.56	30.70	71.77	331.99	552.54
Feed						4.10			127.05	131.15
Library										
Tools & Mach.									91.00	91.00
Refunds			2.00							2.00
Land Rental								23.00		23.00
Travel	113.38	95.39	32.27				261.08		51.00	553.12
Bulletins & Publications	323.24								66.82	390.06
Total	$541.78	$142.39	$248.13	$3.00	$5.71	$47.11	$673.50	$131.67	$953.46	$2746.75
								Less Refunds		2.00
										$2744.75

SUBSTATION FARMS

Receipts from Sales

The following are the receipts from Substations during the period Jan. 1, 1922- Dec. 31, 1922.

Receipts from sale of livestock, hay, grain, potatoes, milk, etc.	Aberdeen	Caldwell	High Altitude	Sandpoint
	$1,028.96	*$8,357,50		$934.39

*Includes receipts of $2,826.63 from feeding investigations conducted at the Caldwell Substation.

Expenditures

Jan. 1. 1922-Dec. 31, 1922.

	Aberdeen	Caldwell	High Altitude	Sandpoint
Salaries	$3,083.00	$5,822.65	$2,025.00	$3,101.73
Labor	259.60	851.24	351.50	133.60
Expense	836.57	837.66	330.16	840.93
Supplies	372.00	978.30	135.50	1,252.50
Equipment	971.27	959.55	89.20	311.49
	$5,522.44	$9,449.40	$2,930.36	$5,640.25

SUMMARY OF SECOND FEEDING TRIAL

Considering the feeds consumed, the milk and butterfat production obtained, and the body weights of the cows, apple pomace seemed to be at least equal, pound for pound, to corn silage as a succulent feed for dairy cows.

ACKNOWLEDGEMENTS

The writers wish to make the following acknowledgements:

To the Department of Agricultural Chemistry, Ray E. Neidig in charge, for chemical analyses of feeds as reported in Tables II and VIII.

To Professor H. A. Bendixen and Mr. H. C. Hansen of the Department of Dairy Husbandry, for assistance in determining the effect of apple pomace on the flavor of milk.

To Mr. Chas. E. Gabby, college dairy herdsman, for valuable assistance in supervising the feeding and management of the cows while on experiment and for help in collecting data.

LITERATURE CITED

(1) Walton, G. P., and Bidwell, G. L. Apple By-Products as Stock Foods. Bulletin No. 1166, United States Department of Agriculture.

(2) Cooke, W. W. Apple Pomace. In Vermont Agr. Exp. Sta. Animal Report (1887).

(3) Cooke, W. W. Apple Pomace. In Vermont Agr. Exp. Sta. Animal Report (1888).

(4) Hills, J. L. Apple Pomace and Corn Silage. In Vermont Agr. Exp. Sta. 3rd Annual Report (1889), p. 74.

(5) Hills, J. L. The Feeding Value of Apple Pomace. In Vermont Agr. Exp. Sta. 14th Annual Report (1900-1901), pp 359-362.

(6) Hills, J. L. The Feeding Value of Apple Pomace. In Vermont Agr. Exp. Sta. 15th Annual Report (1901-1902), pp. 282; 310-314.

(7) Hills, J. L. The Feeding Value of Apple Pomace. In Vermont Agr. Exp. St. Bulletin No. 96 (1902).

(8) Hills, J. L. Heavy Feeding with Apple Pomace. In Vermont Agr. Exp. Sta. 16th Annual Report (1902-1903), pp. 254-264.

(9) Lindsey, J. B. The Feeding Value of Apple Pomace. In Massachusetts (Hatch) Agr. Exp. Sta. 23rd Annual Report (1910), Part 2, pp. 84-86.

(10) Shutt, F. T. Fodders and Feeding Stuffs. In Canada Exp. Farms Report (1906), p. 170.

(11) U. S. Dept. of Agr. Official Exp. Sta. Apple Pomace for Milch Cows. In U. S. D. A. Farmers' Bulletin 186 (1904).