

UNIVERSITY OF IDAHO  
AGRICULTURAL EXPERIMENT STATION

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## ANNUAL REPORT

For YEAR ENDING DECEMBER 31, 1917

BULLETIN NO. 104

JANUARY, 1918

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# UNIVERSITY OF IDAHO

## Agricultural Experiment Station

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*To the President of the University of Idaho:*

I have the honor to present to you and thru you to the State and Federal authorities the annual report of the Idaho Experiment Station. The financial statement of Federal funds covers the fiscal year ending June 30, 1917. In all other respects this report is for the calendar year ending December 31, 1917.

Events of tremendous national importance have transpired since the writing of the last annual report of Experiment Station activities. This year's report has been written with due regard on the part of those who have contributed to it for the bearing of those events on agricultural thought and work the country over.

The agricultural forces in this institution accepted without reserve the statements of those high in the nation's service relative to the importance of food production and distribution in winning the war and have shaped their courses of activity accordingly. The Experiment Station forces have not wavered from the conclusion reached in conference immediately following our country's declaration of war that the most effective service they could render the State and nation, until as individuals they were called to the colors or into federal service for special lines of investigation, lay in the best possible use of their technical training and experience in advancing the several lines of research and experimentation in crop production and utilization that were already under way or could be started with facilities at hand. With every prospect of a long and bitter struggle ahead which will try severely our entire industrial organization, it appears that there is need now as never before of a sound basis of procedure in systematic efforts to increase the available supply of food stuffs and in utilizing them with the least possible waste. In providing that basis and keeping it sound, the Experiment Station is performing perhaps the most fundamental duty it owes the State. In substance the adoption of the course of procedure outlined has meant a "speeding up" of work already under way to the end that practical application of experimental and research work may be made with the least possible loss of time, and attention to needs on the part of the State for special and emergency investigations which Experiment Station equipment might permit of undertaking.

Due recognition has been given the functions of other agricultural divisions and working forces of the University and the State. An earnest attempt has been made to coordinate properly the work of the Experiment Station with them. Passage by Congress of the Food Production Act and the administration of its provisions by the States Relations Service has enabled the Extension Division in this State to make substantial progress in the realization of plans for thoroly covering the State with Extension forces in the form of field specialists, county agricultural agents, and workers in home economics to the end that every possible encouragement shall be given to the adoption by farmers and house-keepers of well established principles of farm practice and food utilization. The cooperation of the Office of Farm Management of the

Federal Department of Agriculture has been extended also to the State Office of Farm Markets in order that the farm-labor situation may be cared for effectively in those sections where heavy production demands large extra forces to care for it at harvest time. There appears to be a satisfactory adjustment of fields of work and of responsibility among the several agricultural forces of the State in taking care of the State's responsibility to the Federal government of its share of the nation-wide program for the greatest possible production of food supplies during the period of special need. As heretofore the coordinating agency of the work of the different agricultural forces within the State has been the President's office.

### THE YEAR'S WORK

The last annual report brought the work of the Experiment Station down to December 31, 1916. Without unduly anticipating departmental and substation reports which appear on subsequent pages, the more outstanding features of this year's work of the Station force as a whole will be briefly mentioned.

#### At the Central Station

As in previous years, the work of the central station has been conducted on the project basis under a departmental organization that is practically identical with that which prevails in the College of Agriculture. Ten departments have now in force one or more definitely outlined projects supported with Federal or State funds. The University campus is recognized as headquarters for the working forces of the central station altho they are identified with several lines of investigation conducted elsewhere within the State.

It cannot be stated too frequently that a project in the Experiment Station sense is nothing more or less than a definitely stated line of procedure in attempting to gain definite information by research or experiment. The Experiment Station worker seeks by research to establish fundamental facts upon which to base recommendations in farm practice; he seeks by experiment to try out under a given set of conditions the relative value of this or that recommended procedure. A sharp distinction between projects that are of a research character and those that are of an experimental nature is neither necessary nor advisable at all times. Both kinds are planned to make a definite contribution to the advancement of the State's agricultural interests. In presenting the work of this year, however, a fairly sharp distinction will be made between research and experimentation.

The research projects conducted by the men of the central station force are supported with the Adams Fund supplemented to some extent by the Hatch and State Funds. The Adams Fund can be used lawfully in no other way than in support of research that is considered fundamental in nature to some field of agriculture. The use of the Hatch Fund is prescribed within wider limits. The State funds are almost invariably appropriated for specific purposes. It seems necessary to restate these facts rather frequently in order to prevent misunderstandings in the State relative to what kind of work may and what kind may not be

undertaken by the Experiment Station forces. It should be clearly understood in all cases that the legal requirements of Federal and State appropriation measures and *not* arbitrary rulings on the part of the Station force decide the kind of work that is covered with a project in this or that field of agriculture.

The research projects for the most part are planned to be state-wide in importance. The experimental work is of necessity of more or less local application. The central station has in force at this writing eleven projects that are rightly classed as research in character. Two others that were in force at the beginning of the year are under suspension. The eleven are carried by departments as follows: Bacteriology, two; Botany, two; Chemistry, three; Entomology, one; Horticulture, one; Soils, two. From the reports of departments it will be noted that these projects have to do with the bacteria of certain soils and their relation to soil fertility, with a better understanding of orchard and small grain diseases and means for their control, with the problems of fruit storage, with the more intelligent use of feeding stuffs, with the production of high-grade milling wheat, with the control of forage-crop insect pests, with the principles of breeding applied to fruit trees, with the water requirements of plants, and with the utilization of alkali soils. It is apparent that with possibly two exceptions distinct progress has been made during the year in each line of investigation.

Forty-five projects that may be classed as experimental in nature have been in force during the year. They are carried by the departments as follows: Animal Husbandry, five; Bacteriology, one; Botany and Horticulture, two; Chemistry, four; Dairy Husbandry, two; Entomology, one; Farm Crops, nine; Forestry, four; Horticulture, twelve; Soils, three; Poultry Husbandry, two. These projects have to do with the breeding, feeding and general management of hogs, sheep, and dairy cattle; with milk production; with the production of small grains, forage crops, corn and other silage crops, and root crops; with the control of plant diseases and orchard insect pests; with the production of small fruits and vegetables; with the growing of potatoes; with the pruning of orchard trees; with crop rotations and fertilizer requirements; with soil surveys; and with poultry management and egg production.

Some striking, not to say startling, results appear from the work of the Soils Department in the use of nitrogen-containing fertilizers. On the Palouse silt loam and the Nezperce silt loam, the predominating soil types of the Palouse and Nezperce countries, it would seem to be perfectly possible to increase the annual yield of wheat by at least six or eight bushels per acre with a reasonable application of sodium nitrate. When oats follows wheat, a substantial increase in the yield of grain has also been noticed from the application of nitrate to the wheat crop. When it is realized that the Palouse and Nezperce countries grow annually at least seventy-five or one hundred thousand acres of wheat, the general application of this information would increase the State's production of wheat by no mean figure. Whether the grain producers of these sections can realize an immediate money return on these observations is somewhat questionable, inasmuch as the difficulty of securing nitrates for fertilizing

purposes is increasing. They will realize on them in time, however, if the more round-about way of increasing the soil's supply of available nitrogen by the growing of legumes in rotation is undertaken.

From work undertaken in 1916 but compiled during this year, it appears to be perfectly possible to grow the very best quality of hard spring wheats in at least some of the irrigated sections of south Idaho. This fact, too, should mean a great deal to the farmers of this State when it is realized that there is a greater demand for the hard milling wheats than the older wheat-growing sections can supply.

In attempting to find combinations of crops other than corn suitable for the silo, it has been found that red clover siloed with wheat straw produces the very best of silage. The significance of this observation lies in the fact that there are some sections of the State where clover is cured for hay with difficulty because of rainy weather and the straw of grain fields is frequently burned or allowed to rot in the stack.

Twelve projects or definite parts of projects have been completed and reported upon during the year. The reports will in due time appear in bulletin form or as contributions to technical or scientific publications.

#### **The Substations**

The substations are under the immediate supervision of technically trained resident superintendents who also conduct their work on the project basis. The projects are of an experimental nature and are intended to be of regional application only.

The Aberdeen station is supported jointly by the State and the Office of Cereal Investigations of the Bureau of Plant Industry. It is operated in the interests of dry farmers and irrigation farmers on the Snake River plains. On the dry-farm land particular attention is being given to a study of crop rotations in order to find those that are best adapted to the maintenance of soil fertility in sections where the tendency is strongly towards a one-crop system. The production of alfalfa seed and of field peas and sugar-beet seed is also given prominent consideration. On the irrigated portions of the station experiments in the production of clover and alfalfa seed and the conduct of variety tests of small grains and field and garden peas are prominent. The possibilities of flax culture and the production of sugar-beet seed are also being tried out. The Aberdeen station is on a thoroughly substantial basis. During the past year the superintendent contributed to experiment station literature, bulletins on the production of clover and alfalfa seed and a technical paper on potato growing.

The Caldwell station is supported entirely with State funds. For the first time in several years a substantial appropriation was made for its support by the 1917 Legislature. Approximately one hundred and

twenty acres of the half section set aside by the State for experimental purposes are under cultivation. Some twenty-five or thirty acres lie above the high-line canal. Experiments with dry-farm crops on this portion of the farm have thus far proven to be negative in results. The rainfall is too light. On the irrigated portions of the farm attention is being given to the development and management of a dairy herd, the breeding and feeding of hogs, variety tests of barley, oats and field peas, the growth of root crops, and soil improvement. Substantial progress has been made during the year in the further development of experimental work on this station and it is now in a much better position than ever before for the conduct of experimental work. From the report of its superintendent, it is plain that the station has made a substantial contribution to the country's supply of food stuffs.

The work on the Gooding station was closed out early in the year. The resignation of the superintendent, the termination of the cooperative agreement between the State and the Office of Public Roads and Rural Engineering, and the near expiration of the lease on which the station was operated made this course of action seem best to those who had the decision to make. There was practically no loss to experimental work in so doing. Bulletins 93, 94, and 95 cover the work of the Gooding station thoroly from the time of its organization in 1909 to the end of the year 1916. A part of the equipment was shipped to the Sandpoint station, a part to the Caldwell station, and a part was sold and the proceeds used in the purchase of similar equipment at Caldwell.

The Jerome station has been operated as heretofore by the Office of Horticultural Investigations of the Bureau of Plant Industry. The State owns the station and equipped it with the necessary buildings for work. The station is devoted entirely to a study of cultural methods in potato growing and to control measures for potato diseases. The superintendent's report indicates the present status of the work of that station.

The Sandpoint station is supported entirely with State funds. It is operated in the interests of farmers of the cut- and burned-over areas of north Idaho. In the belief that these areas are admirably suited to the dairy industry and can be developed most profitably along dairying and closely related lines, the work of the Sandpoint station centers pretty largely around its herds of dairy cattle and hogs. Particular attention has been given during the past year to the management of the herds and the growth of forage crops required in their feeding. The cultivated area of the farm has been considerably increased by the clearing operations of the year, acre cost accounts of which have been kept. The superintendent's report indicates that this station, too, has contributed during the year substantially to the food supplies of the State.

## CLIMATOLOGICAL DATA

As nearly as they can be shown by climatological data, the outstanding features of the weather for 1917 on the central station and the substations are given in the following table:

*Climatological data for the central station and the substations, January 1917 to December 1917, inclusive.*

*(Temperature in degrees Fahrenheit, precipitation in inches.)*

*The Central Station, Moscow*

	JAN.	FEB.	MCH	APR.	MAY	JUN	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Maximum .....	41	45	48	57	75	89	99	95	92	78	63	59	
Minimum .....	-2	12	8	26	30	32	35	44	39	21	23	14	
Mean maximum ..	29.8	34.4	37.3	47.9	59.4	69.2	85.5	84.7	73.9	62.8	50.8	43.7	
Mean minimum ..	17.9	24.0	23.2	33.1	41.4	44.4	52.0	52.3	48.4	37.5	36.0	34.6	
Mean .....	23.8	29.2	30.2	40.5	50.4	56.8	68.8	68.5	61.2	50.2	43.4	39.1	
Days clear .....	4	3	1	8	9	21	21	24	12	15	10	2	130
Days part. cloudy.	8	5	10	10	12	7	7	6	12	6	4	5	92
Days cloudy .....	19	20	20	12	10	2	3	1	6	10	16	24	143
Precipitation .....	2.86	1.76	1.13	3.63	1.81	.72	.05	.00	1.57	T	1.39	5.62	20.54

Last killing frost (32°) June 3; first killing frost (24°) October 15. Length of growing season 134 days. Highest temp. (99°) July 15; lowest temp. (-2°) January 30. Average length of growing season, 1907-17 incl., 164 days. Average precipitation, 1907-17 incl., 20.6 inches.

*The Aberdeen Substation*

	JAN.	FEB.	MCH	APR.	MAY	JUN	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Maximum .....	40	50	50	68	82	91	97	94	89	80	69	59	
Minimum .....	-29	-15	-18	12	23	29	37	39	28	4	16	15	
Mean maximum ..	23.5	31.5	32.4	50.8	63.2	77.1	91.3	84.8	78.1	56.5	54.1	47.2	
Mean minimum ..	0.0	9.6	9.0	28.7	35.7	41.4	51.8	45.6	39.5	27.3	26.0	28.2	
Mean .....	11.8	20.6	20.7	39.8	49.4	59.2	71.6	65.2	58.8	41.9	40.0	37.7	
Days clear .....	12	9	17	11	15	27	27	27	18	31	18	9	221
Days part. cloudy.	4	9	7	14	7	3	4	4	11	0	6	20	89
Days cloudy .....	15	10	7	5	9	0	0	0	1	0	6	2	55
Precipitation .....	.45	1.17	.54	1.40	3.19	.19	.31	.02	.26	.00	1.89	.20	9.62

Last killing frost (29°) June 13; first killing frost (28°) September 15. Length of growing season, 94 days. Average length of growing season, 1912-17 incl., 96 days. Highest temp. (97°) July 9, 22, 26, and August 4; lowest temp. (29°) January 23. Mean annual precipitation, 1912-17 incl., 9.73 inches. Evaporation from a free water surface, April to September incl., 38.61 inches.



*The Caldwell Substation*

	JAN.	FEB.	MCH	APR.	MAY	JUN	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Maximum .....	45	54	68	70	87	96	103	97	93	82	70	65	
Minimum .....	-9	8	7	25	28	29	43	44	34	16	13	19	
Mean maximum ..	32.0	40.5	46.1	60.9	70.9	81.3	95.4	90.5	83.7	71.6	56.0	50.8	
Mean minimum ..	12.5	22.6	23.4	35.2	41.6	44.2	55.5	51.5	44.9	32.0	26.6	32.9	
Mean .....	22.2	31.6	34.8	48.0	56.2	62.8	75.4	71.0	64.3	51.8	41.3	41.8	
Days clear .....	12	.....	10	.....	8	21	25	23	19	28	19	6	171
Days part. cloudy ..	0	.....	1	.....	18	6	5	4	10	3	7	7	61
Days cloudy .....	19	.....	20	.....	5	3	1	4	1	0	4	18	75
Precipitation .....	.65	.79	1.20	1.58	1.49	.31	T	T	.99	.00	.84	.84	8.69

Last killing frost (29°) June 10; first killing frost (28°) October 17. Length of growing season 129 days. Highest temp. (103°) July 26; lowest temp. (-9°) January 16.

*The Jerome Substation*

	JAN.	FEB.	MCH	APR.	MAY	JUN	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Maximum .....	44	48	52	66	.....	.....	.....	.....	.....	.....	73	62	
Minimum .....	-19	-13	0	22	.....	.....	.....	.....	.....	.....	18	19	
Mean maximum ..	27.2	35.1	36.0	52.6	.....	.....	.....	.....	.....	.....	.....	48.8	
Mean minimum ..	8.6	15.7	16.4	31.8	.....	.....	.....	.....	.....	.....	.....	30.5	
Mean .....	17.9	25.4	26.2	42.2	.....	.....	.....	.....	.....	.....	42.4	39.6	
Days clear .....	9	7	7	11	.....	.....	.....	.....	.....	.....	9	6	
Days part. cloudy ..	11	6	11	8	.....	.....	.....	.....	.....	.....	17	24	
Days cloudy .....	11	15	13	11	.....	.....	.....	.....	.....	.....	4	1	
Precipitation .....	1.24	1.31	1.21	2.43	.....	.....	.....	.....	.....	.....	1.05	1.42	

*The Sandpoint Substation*

	JAN.	FEB.	MCH	APR.	MAY	JUN	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Maximum .....	43	44	47	57	78	87	96	91	85	78	61	58	
Minimum .....	-20	-9	0	21	27	31	35	35	32	15	20	6	
Mean maximum ..	31.5	34.7	38.8	49.9	64.6	67.4	85.5	83.6	72.6	59.5	47.0	39.7	
Mean minimum ..	15.9	19.8	17.5	31.5	38.5	41.8	45.4	43.4	43.4	31.1	31.6	26.4	
Mean .....	23.7	27.2	28.2	40.7	51.6	55.8	65.4	63.5	58.0	45.3	39.3	33.0	
Days clear .....	6	1	4	4	10	11	24	23	16	15	6	2	122
Days part. cloudy ..	8	14	10	13	12	10	6	8	8	6	5	3	103
Days cloudy .....	17	13	17	13	9	9	1	0	6	10	19	26	140
Precipitation .....	2.40	1.96	2.62	3.77	1.64	1.70	.01	T	.44	.66	1.04	9.52	25.76

Last killing frost (32°) June 12; first killing frost (32°) September 30. Length of growing season, 110 days. Highest temp. (96°) July 16; lowest temp. (-20°) January 31. Highest daily mean (74°) July 19; lowest daily mean (-6.5°) January 30. Highest monthly mean (65.4°) July; lowest monthly mean (23.7°) January. Average precipitation, 1911-17 incl., 27.09 inches.

## PUBLICATIONS

Twelve bulletins and one circular have been published during the year. They are indicated by number and title below:

No.	Title	Pages	Copies	Cost	
				Total	Per copy
91	Methods of Clearing Logged-off Lands .....	60	19,000	\$ 505.70	\$ .027
92	The Annual Report of the Experiment Station for the Year Ending June 30, 1916.....	72	2,500	196.06	.098
93	Experiments with Small Grains Under Irrigation .....	24	12,500	250.70	.020
94	Experiments with Legume Crops Under Irrigation .....	16	12,500	169.58	.014
95	The Management of Irrigated Grass Pastures .....	20	12,500	209.97	.017
96	The Management of Farm Flocks in Idaho .....	20	12,500	201.50	.016
97	Commercial Onion Culture in Idaho .....	16	12,500	177.50	.014
98	Winter versus Summer Pruning of Apple Trees .....	28	10,000	416.50	.042
99	Experiments in the Irrigation of Apple Orchards .....	48	5,000	314.60	.063
100	The Production of Clover Seed Under Irrigation in Southern Idaho .....	20	12,500	242.60	.019
101	Alfalfa Seed Production Under Irrigation .....	20	12,500	238.42	.019
102	The Management of Dairy Herds	42	7,500	297.26	.039
4	(Circular) Forest and Shade Trees and Basket Willows Recommended for Planting in Idaho .....	4	10,000	28.50	.003
		390	141,500	\$3248.89	

The Hatch fund bore the expense of publication to the extent of \$196.06. Local station and State funds have borne the remainder. Acknowledgment is due the State Board of Education for the setting aside of \$2300 for bulletin publication during the present biennium. Something over one-half of that amount remains for use in 1918. Nine thousand copies of bulletin No. 91 were sold at cost for distribution in neighboring states, five thousand to the Washington Experiment Station and four thousand to the Montana Experiment Station. One thousand copies of a bulletin entitled "The Home Drying of Fruits and Vegetables" were purchased at cost of the Washington Experiment Station for distribution in Idaho. It is believed that this manner of exchange between neighboring stations should be encouraged. It might well be the beginning of cooperative work and a mutual understanding relative to certain kinds of investigation each station has under way. Besides the publications mentioned above, technical papers were approved for publication as fol-

lows: \* "Whole versus Cut-Seed Potatoes" by L. C. Aicher, and "Whole versus Cut-Seed Potatoes" by J. S. Welch. Both papers were the result of several years' experiments in potato growing under irrigation in southern Idaho.

Manuscripts approved and awaiting publication as bulletins at this writing are: Sprays for the Control of San Jose Scale; The Home Garden in Idaho; Soil Survey of Latah County; Performance Records of Some Eastern Wheats in Idaho; Trees—What, Where, When and How to Plant. A manuscript entitled "The Acids of Corn and Other Silage" has been approved and is awaiting publication in a scientific or technical journal. All of these manuscripts are the results of work completed during the year.

It is not out of place at this time to mention the fact that the work of editing bulletins, which at other stations is handled by a regularly employed editor, at this station falls entirely upon the Director's office. The work involved requires no small amount of the Director's time. The services of a well trained and experienced bulletin editor would be highly appreciated by the several departments of the Experiment Station.

#### Bulletin Distribution

While we are not forgetful of the fact that bulletins and circulars are written for the widest possible use by the people of the State, we have reached the conclusion that there is too much waste involved in the practice of sending bulletins as issued to the mailing list, classified or otherwise. Notices are now given several times during the year thru the columns of the News Letter which goes regularly twice a month to all names on the mailing list and by special announcement circulars sent to all names on the mailing list of recently issued publications that may be had free of all charge upon request. This practice perhaps does not give the publications of the Station as wide a circulation as they would otherwise receive but it is believed that those that are sent out fall into the hands only of those who really wish to read them. The mailing list was increased by over three thousand names during the year. It now numbers thirteen thousand—nine thousand residents of Idaho, and four thousand residents of other states, a portion of whom, of course, are experiment station workers or employes of the Federal Department of Agriculture. The cooperation of the Extension Office has been asked in securing the names of all farm-bureau members in the several counties for listing in this office. A recently purchased graphotype machine makes possible the prompt addition to the mailing list of all names received.

#### IMPROVEMENTS

An appropriation made at the last session of the Legislature for fencing the University farm and tile-draining a portion of it has been used to good advantage. The field plats required by the Department of Soils, Farm Crops, and Agricultural Chemistry are now permanently located. Barns and sheds erected during the year on the University farm for the housing of sheep and hogs will permit of the best work on the

\* Journal American Society of Agronomy, Vol. 9. No. 5.

part of the Department of Animal Husbandry in the conduct of experimental feeding projects. The newly erected dairy building will provide splendid facilities for research and experimental work on the part of the creamery division of the Dairy Department. It will also provide a suitable cold storage room for the use of the Chemistry Department in its work on fruit storage. The greenhouses provided for by the last Legislature have not yet been erected. They will be early in the coming year. They will relieve the present congestion of work in the old greenhouses.

On the Sandpoint substation a helper's cottage has been erected with a comparatively small outlay of funds. It will be the means of helping to solve the problem of competent labor for that station. At the Caldwell station fences have been renewed, the dwelling house repainted, and a part of the much needed plumbing for the dwelling house installed. At the Aberdeen station the dwelling house has been equipped with a furnace. The severe winters of that portion of the State made this expense seem perfectly justifiable. It is the intention to maintain the buildings and equipment of the substations in a thoroly attractive condition.

#### **SPECIFICALLY APPROPRIATED FUNDS**

A fund provided by the Legislature to defray traveling expenses when expert opinion is asked by taxpayers in different parts of the State on soil troubles, insect pests, and plant and animal diseases has enabled thus far the prompt dispatch of expert help on several occasions to sections more or less remote from the central station. The appropriation for the study of insect pests is being used in the clover-growing sections of southern Idaho in the study of the clover aphid which in preceding years has done so much damage to the clover-seed industry. The appropriation for the continuance of soil survey work has been partly used in support of cooperative work with the Bureau of Soils in the survey of Nezperce and Lewis counties which was completed in October. The station is fortunate in not being burdened with police work. The pure-seed work is administered by a pure-seed commissioner appointed by the Director of the Experiment Station. His headquarters are in Boise. A cooperative arrangement has been effected with the Extension Division whereby the Pure Seed Commissioner becomes an extension specialist in agronomy. There are as yet no fertilizer or feed-control laws in operation in this State.

#### **SPECIAL PATRIOTIC SERVICES RENDERED**

The head of the Department of Farm Crops was called upon in October by the state leader to organize Latah County in the interests of food conservation. The work was very quickly and effectively done. He was also placed in charge of all work in the State in the certification of seed stocks. The Station chemist was called upon in October to take over the management of the Red Cross work in Latah County. Various other members of the Station force have helped to organize and push along the various drives that have been made in the interests of the Liberty Loan bonds, the Army Y. M. C. A. funds, and the funds for the support of the Red Cross work in Armenian relief. Four members of the Station force are now with the colors.

**BROADENING OF EXPERIMENT STATION ACTIVITIES**

Recommendation was made some two years ago that definite recognition be taken of the need for entomological work of the highest order in this State. Our insect pests have never been given the attention that is required to hold them in control. I am pleased to report that a beginning has been made in this direction, but man power, laboratory facilities and equipment are as yet entirely inadequate to give us the control of the situation that is possible. Practically the same may be said of plant diseases. Our efforts at the control of wheat smut and potato diseases of various kinds is based far too largely on the observations and investigations of other people and many of them we fear are not entirely applicable to Idaho conditions. The force engaged in the investigation of plant diseases should be sufficiently large and its facilities of the kind that will permit first hand information relative to all of the more common diseases that threaten root, forage, grain and orchard crops. A splendid beginning was made several years ago in orchard irrigation investigations. They have been interrupted by the withdrawal from the State of the men who were responsible for their planning and execution. Work in that direction ought to be renewed and intensified. The Department of Farm Engineering of the Agricultural College is denied participation in the work of the Experiment Station because of the lack of funds to finance investigations in the fields of irrigation, sanitation and farm machinery it would gladly undertake if it were in a position to do so. These are only a few of the situations we hope to remedy with the least possible delay as funds and facilities permit.

Our State legislature has done splendidly by the Experiment Station organization in the matter of appropriations. It has almost invariably given the full amounts asked for the support of definite lines of investigation. Unfortunately the personnel of the organization changes so rapidly that all too frequently work that is undertaken in perfectly good faith fails of completeness in the fullest sense of that word. Continuity of effort is absolutely essential for genuine progress in Experiment Station work. That can be secured only by making and keeping the conditions which surround the work decidedly attractive and the tools and implements of investigation objects of personal pride. A far greater intensity of training is demanded of Experiment Station forces than is required of the workers in any other division of agricultural work. Definite and substantial recognition must be taken of this fact if Experiment Station forces are to be held intact and kept steadily at work.

The reports of departments follow. In two or three instances the work has been presented in far greater detail than is customary in a publication of this kind. The continuity of the work in question, however, was seriously threatened by the operation of the selective draft act and sufficient warrant was found in that fact for the publication now of material which ordinarily would make its appearance in connection with reports of the completed work in purely technical journals.

It is a pleasure to acknowledge the hearty support given the Director at all times by the Experiment Station forces in the advancement of Experiment Station work thruout the State.

#### DEPARTMENT OF ANIMAL HUSBANDRY

E. J. IDTINGS, C. W. HICKMAN

Projects: (1) A study of the leading breeds of sheep with special reference to factors that influence production. (2) The growing and use of silage other than corn in the feeding of beef cattle and sheep. (3) Experiments with field peas in pork production. (4) Experiments with forage crops for swine. (5) Experiments in lamb feeding.

It has been a very difficult year in which to carry on Station work in Animal Husbandry on account of the high cost of live stock used in such work and the very high cost of practically all feeding stuffs. For those reasons the work in Projects 3 and 4 has been especially hampered.

Some phases of Project 1 will need to be continued. Considerable data are at hand in regard to various production factors of the five leading breeds. The growing and use of silage other than corn under Project 2 should be continued; so also should the experiments in the growing of field peas for pork production and the use of various forage crops for swine. A progress report of the "hogging-off" work with field peas would be timely.

It was recommended in the last annual report that work in steer and lamb feeding should be initiated on the Caldwell station, using such numbers as would enable commercial feeders to rely upon the results of our work with considerable confidence. Funds have not been available for this work which, when once organized, would be almost self-supporting and would be of immense practical value in aiding the proper development of the beef cattle and sheep industry of the State.

Bulletin No. 96 issued in January gives general information for the use of farm flock owners and offers suggestions based in some instances on results secured from Experiment Station work in sheep management. During the winter of 1916-17 unusually favorable results were secured in using silage made from crops other than corn in maintaining the University herd of beef cattle and the University flock of sheep. It was a long severe winter and farm stock wintered on dry feed came out in the spring in thin condition, with harsh hides, and lacking in vigor and bloom. These factors had a directly unfavorable effect on the calf crop and the lamb crop of 1917. The University beef cattle and sheep came out of the winter in the best of vigor and the finest of bloom. By the cattle, the peas and oats and the peas and wheat silages were most relished. Straight wheat silage threw some of the cows off feed and appeared to be less palatable to a great many of the animals.

The breeding flock of sheep was maintained for the first time on peas and oats silage as the sole succulent. The results were uniform success in lambing, no loss of ewes and approximately 150 per cent live lambs. The ewes ate from two to five pounds of silage daily and had hay in addition. A short time before lambing and after lambing grain was added to the silage and hay ration.

The "hogging-off" work with peas, and with peas and wheat, with the hogs on a ration of barley in connection with the forage, was successful in the summer of 1916. All feeding work since the spring of 1916 has been hampered as mentioned before by the high price of feed and the difficulty of securing suitable animals for feeding tests.

The experimental work with sheep breeds and management was especially successful during the winter and spring of 1917. The Lincoln was added to the breeds already on trial. For this purpose four excellent ewes were secured from William Riddell and Sons of Oregon. In connection with other breed-management work, there was introduced this year growth-management studies of twenty-five lambs representing six different breeds of sheep.

In order to obtain information in regard to the value of silage in lamb feeding, 254 lambs have been secured for experimental feeding. These lambs have been so divided into three equal lots that the average weight of the lambs in each lot is between sixty and sixty-one pounds. The basic ration is barley and alfalfa hay. The barley is grown in the Inland Empire section and the alfalfa hay is an irrigated product. Lot 1 consists of eighty-five head of lambs and is fed alfalfa hay in the amount that can be readily cleaned up, and whole barley. Lot 2 consisting of eighty-four lambs is fed the same amount of barley with alfalfa hay and corn silage in addition. Lot 3 consists of eighty-five lambs and is fed the same ration as Lot 2 excepting that peas and oats silage is used instead of corn silage.

These lambs are doing well with the exception of Lot 1, in which on the morning of December 26, thirty-six lambs were either killed or injured in an attack by dogs. The remaining lambs, however, will be carried thru the experiment with the expectation that in spite of the interruption considerable data of value will be secured.

## DEPARTMENT OF BACTERIOLOGY

T. L. HILLS, J. J. PUTNAM

Projects: (1) Commercial preparation of cultures for the inoculation of legumes with nitrogen-gathering bacteria. (2) The influence of various woods on bacterial activity in the soil (Adams). (3) The relation of nitrates to nodule formation (Adams).

*Cultures for inoculating legumes.*—The department this year continued its practice of providing the farmers of the State with dependable cultures for the inoculation of legumes with nitrogen-gathering bacteria at a nominal cost. This work was carried on during the past year under considerable difficulty because there has been no well organized system of financing the work. Purchase of materials and supplies has been made at a great disadvantage. Nevertheless the department prepared and sent out cultures sufficient for the inoculation of seed required in planting 21,265 acres as follows: peas, 11,272; beans, 4,817; clover, 2250; alfalfa, 2926. The total output for the preceding year was sufficient for the planting of 6536 acres and that for the year before was sufficient for 3139 acres.

There is still a large portion of the northern part of the State yet

to be developed which will require the accumulation of available nitrogen thru the activities of the legume bacteria for years to come. The manufacture and distribution of inoculating material is recognized as an important function of the Department of Bacteriology. There has been an element of uncertainty in the financial outcome of the project, but, aside from salaries, the income has thus far been sufficient to meet all disbursements with a small margin of profit. It is recommended that this profit to the extent of at least \$1500 be retained in the department for the support of future work. The summarized financial statement of the work follows:

RECEIPTS	
Checks and cash, bank account.....	\$ 3894.10
Checks, delivered to Francis Jenkins, Bursar.....	104.80
Cash .....	223.00
Stamps received .....	31.24
Total .....	\$ 4253.14
DISBURSEMENTS	
Equipment and supplies .....	\$ 1653.92
Labor, checks and cash.....	783.04
Postage .....	137.01
Stamps on hand.....	4.44
Cash on hand.....	1673.81
Unaccounted for .....	.92
Total .....	\$ 4253.14

Methods for the improvement of the work are being studied and efforts are being made to devise still better culture media on which to grow the organisms.

*The influence of various woods on bacterial activity in the soil.*— This project, in a way, is a new phase of the original project on timbered soils begun in 1910 under the title of "Bacteriological Studies of North Idaho Soils." In this work an endeavor is being made to determine the influence which different woods exert on biological activity in the soil. From it the reason may appear why the cut and burned-over lands in this State are not usually as productive as they might be when first brought under cultivation, even tho chemical analyses have shown that there are sufficient plant-food materials present to insure good plant growth. Studies thus far have involved the use of white pine, yellow pine, white fir, red fir, larch, cedar, maple, and ash. The two last mentioned woods were chosen because it was thought that interesting results might be secured from the use of some woods that are not coniferous. It was found that all amounts of woods added (in the form of sawdust) to both soil and solution up to five per cent considerably reduced bacterial activity. Remedial measures were sought and it was found that the addition of one per cent of calcium carbonate overcame the detrimental effect and caused an increase in biological activity which was greater than in the original soil or solution containing no added wood or carbonate.

The bacterial activity was determined by experiments in ammonification, nitrification, and nitrogen assimilation.

Ammonification has as yet been studied only in soil. Interesting re-



sults have been secured. Two soils were used. They are of the same type but have been under different systems of cultivation. One per cent of dried blood was added as a source of nitrogen and when woods were included they were added at the rate of one and one-half per cent. When calcium carbonate was added it was mixed in at the rate of one per cent. It was found in all instances that cedar reduced the bacterial activity to the greatest extent. It was followed by maple. This was surprising at first but it is probably due to the fermentation of the natural sugars present in that particular wood with subsequent formation of acids. The pines appeared as a general rule to be the next most toxic, followed by larch and the firs. Practically the same order was maintained when calcium carbonate was present. Extensive studies in solution have not been made but are planned and will be undertaken at an early date.

Nitrification has been studied with the same soils as those used in the ammonification experiments. Thirty milligrams of nitrogen as ammonium sulphate (as a source of inorganic nitrogen) were added. Maple appeared to be the most toxic in these experiments followed by cedar and the pines. The addition of calcium carbonate caused a greater nitrate increase as a general rule than in those cultures containing no added woods. Some nitrification studies in liquid cultures were made but the coloration of the solutions by the added wood interfered considerably with the color reactions. Further studies along this line are being made, however.

In studies of nitrogen assimilation, liquid cultures have been used thus far. Mannite solution with the added woods has been inoculated with a strain of azotobacter known to possess excellent "nitrogen-fixing" qualities. Determinations of total nitrogen have shown that the various woods influence the increase of total nitrogen considerably. Cedar once more caused almost no increase whatever. When maple and ash were present, as much increase in total nitrogen occurred as in the control cultures containing no added wood. It seems quite evident that the maple contains some substance (probably soluble sugars) that served as a source of energy for the nitrogen-assimilating organisms. The experiments are planned for continuing this phase of the problem in both liquid and soil cultures.

No extended studies have as yet been made on the influence of these woods on the number of bacteria in the soil. The results of a few preliminary studies appear to indicate that a slight increase in numbers is brought about by the addition of the same quantity of wood as was used in experiments in ammonification, nitrification and nitrogen assimilation. Further studies are necessary before any conclusions can be drawn from this part of the work.

Altho the results on this particular project appear to be as yet rather unsatisfactory, it does seem that progress has been made in the right direction toward a more thoro understanding of the problems involved and that from now on more rapid progress can be made. It seems quite probable as far as laboratory experience would indicate that a fairly cheap and readily obtainable soil corrective has been found to eliminate the

harmful effect of the woods present in the soil, but practical field tests should be made before arriving at a final decision.

*The relation of nitrates to nodule formation.*—In the presence of nitrates, nodules are not produced on the roots of legumes to any extent. Studies are being made in order to determine whether this is due to a weakening of the infecting power of *Bacillus radicicola* as a result of growth in an environment containing an excess of nitrate, or whether the roots of the plants are made more resistant to the attack of the bacteria as a result of some reaction between the nitrate and the plant root.

The first part of the problem, namely, the influence of nitrates on the infecting power of the organism, is practically completed. Cultures of the alfalfa and red clover strains of bacteria were grown on mannite agar slopes and in thin layers of mannite solution containing various amounts of nitrates of potassium, sodium, calcium and magnesium ranging from five milligrams of nitrogen as nitrate to and including 100 milligrams of nitrogen as nitrates in 100 cc. of the medium. These cultures were incubated at temperatures ranging from twenty-five to twenty-eight degrees Cent. Every two weeks for sixteen weeks a small quantity of the growth of the organism was removed and used as an inoculant for seeds of the respective legumes growing under sterile conditions in soft mannite agar in large test tubes. These tubes subsequent to inoculation were incubated in the light but away from the direct rays of the sun at temperatures ranging from twenty-five to twenty-eight degrees Cent. They were allowed to remain for five weeks and at the end of that time were examined for the presence or absence of nodules.

With the alfalfa in but two instances during the period did this organism lose its infecting power when grown in the presence of any of the nitrates in solution or on solid media. At the end of sixteen weeks the highest concentration of  $Mg(NO_3)_2$  apparently caused the alfalfa organism to lose its infecting power. The red clover strain, however, proved much more susceptible to the influence of nitrates. This was especially marked in the liquid cultures. With these cultures the toxic effect of all nitrates, except calcium nitrate, was evident even after two weeks of incubation. All quantities above ten milligrams of nitrogen as nitrate in 100 cc. of medium proved to be quite consistently toxic. Only after sixteen weeks incubation did the highest concentration of  $Ca(NO_3)_2$  begin to show its effect. In the case of slope cultures the toxic effect of potassium nitrate was evident but not to such an extent as in the liquid cultures. Here again calcium nitrate proved quite without effect, for its inhibiting influence did not become apparent until the latter stages of the incubation period.

That the organisms from the cultures which did not produce nodules were not dead was clearly shown by plating out a small quantity of the cultures; in all instances an excellent growth was obtained.

It seems fairly evident that nitrates of potassium, sodium, calcium and magnesium in the amounts studied had no appreciable influence on weakening the infecting power of the alfalfa strain. The higher concentrations appeared to exert a marked influence on the red clover strain. Preliminary experiments appear to indicate that the solution

of the problem may be found in the study of the influence of nitrates on the plant root. This part of the problem is now under way and should be completed in a short time.

### DEPARTMENT OF BOTANY

M. A. WILLIS

Projects: (1) A study of apple rosette (Adams). (2) A study of *Puccinia glumarium*, the striped rust of wheat (Adams). (3) Control of rhizoctonia of potatoes. (4) Control of powdery mildew of apples.

*Apple rosette*.—During the past year observations have been made on the factors and combinations of factors producing the various types of apple rosette. Experimental work on the value of these factors will be started next spring.

*Puccinia glumarium*.—Inoculation experiments have proved that the strain of *Puccinia glumarium* that causes striped rust upon *Hordeum jubatum* near Moscow will also cause striped rust of wheat. The climatic conditions of 1916 and 1917 proved very unfavorable for this fungus. Observations indicate that under favorable climatic conditions *Puccinia glumarium* can live over winter on *Hordeum jubatum*.

*Control of rhizoctonia of potatoes*.—As the ground used for this purpose was not uniform, the results are of no value except to show that town lots that have been partly cultivated for a number of years are not adapted to this type of experiment.

*Control of powdery mildew of apples*.—Owing to the rainy weather last spring it was found impossible to follow the spray calendar that had been planned for the control of powdery mildew of apples.

The Department stands in great need of much more extensive greenhouse facilities.

### DEPARTMENT OF CHEMISTRY

R. E. NEIDIG, C. W. COLVER,\* H. P. FISHBURN, C. L. VON ENDE\*\*

Projects: (1) Silage investigations. (a) The relation of the kind and quantity of acids formed in silage made from different crops. (b) An investigation of protein changes in silage made from corn and leguminous crops. (2) The relation of proteins of various kinds of silage to milk production. (3) A study of the milk of different breeds of sheep. (4) Factors which determine the protein content of the wheat kernel (Adams). (5) The ash content of irrigated and non-irrigated fruits. (6) Rare elements in feeding stuffs and their physiological role. (7) Factors involved in the ripening of fruits, particularly apples (Adams).

*The acids of silage*.—Attention was called in last year's report to the various kinds of silage that would be available for chemical work during the present year. The determination of the kinds and quantity of acids in the different silage mixtures was completed early in the year. It is proposed to publish the results of the work in some technical journal in the near future. In this connection, however, it may be said that several crops and mixtures of crops develop an acid fermentation in the silo that is very similar to that developed in normal corn silage. The silage made from these crops and crop mixtures is, therefore, said to be normal

\* Absent on leave Oct. 1—

\*\* Directing an investigation on apples in storage.

silage. The acid fermentation typical for all good silage produces lactic, acetic, and propionic acids. Of these three, lactic is usually present in excess of acetic and propionic, while acetic is present greatly in excess of propionic.

The crops which made good silage and showed a typical acid fermentation were peas, oats, and peas and oats in varying proportions. From the standpoint of acid fermentation, it was immaterial what proportion of oats and peas were siloed. Clover also developed a good acid fermentation as did the clover and wheat straw mixtures. The clover-straw silage was more keenly relished by dairy stock than was the straight clover silage. It is believed that this mixture will permit the dairyman to secure the maximum food value out of a crop residue that is all too frequently burned in the stack. In sections where clover is cured with difficulty for hay, the feeder of live stock may find it feasible and profitable to combine the crop with a liberal proportion of straw.

Alfalfa was also siloed alone and in combination with straw. Neither the straight alfalfa nor the alfalfa-straw mixture developed a typical acid fermentation. The silage was judged unfit for feeding purposes. Considerable butyric acid was present, indicating abnormal fermentation. Lactic acid, the predominating acid in normal silage, was present in traces only.

*Silage proteins.*—The newer interpretations of protein composition have shown that proteins obtained from different sources have different food values. Recent work on the amino acid derivatives of proteins have shown that certain amino acids are more important than others in sustaining growth, hence, it is essential in feeding work to know the composition of the proteins from different sources. In a State where so many silage crops and crop mixtures other than corn are being used for silage purposes, it is believed that protein analyses of silage of different kinds will yield information of practical value in feeding work. The Van Slyke methods are being used. No results can be presented at this time.

*Protein in silage and milk production.*—In this work it is proposed to determine the relative value of the protein in corn, peas, oats, and clover and alfalfa silages for milk production. The various crops were siloed in small silos and material is available for work during the coming spring months.

*The milk of ewes.*—A chemical study of the milk from six different breeds of ewes has been carried on during the past year. The project is carried on in cooperation with the Department of Animal Husbandry. The object of the work is to correlate the composition and quantity of milk given by the ewes of the different breeds with the rate of growth of the lambs. Three ewes from each breed were used. Samples of milk were taken every ten days after the birth of the lambs for a period of fifty days. Analyses were made of the milk for protein, fat, lactose, and ash. A record of the weight of each lamb was also kept for the ten-day periods. The results show that in general the rate of growth depends upon the quantity of milk, but it is to be noted also that inherited capacity

for growth must not be overlooked. A complete report of this work will be made in some technical journal in the near future.

*Factors affecting the protein content of wheat.*—During the year data secured on the behavior of eastern wheats in this State with particular reference to quality of grain for milling purposes were compiled for publication. The data clearly show, contrary to a frequently expressed opinion in some quarters, that the highest quality of milling wheat can be grown in many sections of this State. The Turkey Red wheats grown on the dry farm at Aberdeen were fully the equal in quality of Turkey Red grown in the hard red winter wheat district of Kansas and Nebraska. Moreover, a high quality of Turkey Red was grown with irrigation under conditions that insured rapid nitrification of soil organic matter. On the Gooding substation the highest quality of hard spring wheat (Minnesota Bluestem and Glyndon Fife) was grown for three successive years with no indication at the end of that time of a deterioration in quality. During the year data secured in the course of work on this problem which sought to establish the influence of irrigation on the protein content of the wheat kernel were compiled and a report covering the work partially prepared. The work was commenced in 1910 and was concluded in 1916. Five varieties of spring wheat have been grown. Variations in amounts of water applied unquestionably caused some variation in the protein content of the wheat. Under conditions which provided no substantial supply of soil nitrates, the protein content of the grain was invariably low, but under conditions that supplied liberal quantities of soil nitrates the protein content of the grain was invariably high, even with the maximum applications of irrigation water (24 inches or more). The correlation of data on soil nitrates and protein content of the grain leaves no doubt as to the direct connection that exists. The highest quality of hard spring wheat can be grown under irrigation if due attention is given to the supply of soil nitrates. Soil nitrates can be made abundant thru the growing of alfalfa, clover, and field peas.

The wheat lowest in protein is probably grown in north Idaho in a section where heavy yields are characteristic and rainfall is not excessive. Previous work led to the suggestion that under ordinary field conditions nitrification of organic matter in these soils might be too slow for the most perfect development of the wheat plant. An extensive series of rotation plats was laid out last year on which to grow four varieties of wheat in rotations which we believe will favor rapid nitrification of organic matter. The 1917 data are for the second year's work. The rotations are not yet fully developed. The high percentage of protein in the Bluestem and Marquis samples, however, is remarkable. The nitrate determinations were not altogether satisfactory but in general the data point quite decisively to a direct connection between the supply of soil nitrates and the percentage of protein in the grain. The exceedingly dry fall of 1916 prevented the preparation of the ground for the sowing of the two fall varieties of wheat chosen for the work. They were sown for the first time in the fall of 1917 but under conditions not entirely satisfactory because of the lack of rainfall.

*The ash of irrigated and non-irrigated fruits.*—It has been impos-

sible to give any time during the year to the quantitative analysis of the fruit-ash samples that are now in the department. The work can be completed in a comparatively short time when conditions permit.

*Rare elements in feeding stuffs.*—This project is not much more than started. Its goal is indicated in the title, that is, first a quantitative estimation of some of the least common mineral elements in feeds and subsequently the determination of their physiological importance. The work to date has concerned itself only with the estimation of the manganese. The percentage of manganese in most feeds is too minute to be determined quantitatively by the ordinary method of analysis. The colorimetric method was tried and found to be accurate for small amounts of the element. The feeds studied include wheat, oats, barley, peas, cottonseed meal, alfalfa, apples, potatoes, carrots, turnips, and beets, all of which contain small amounts of manganese. A study was made of the beet plant as a whole; it is interesting to note that the leafy or green part contains about five times as much manganese as the root.

*Factors involved in the ripening of fruits.*—The general plan of experimental work was outlined in the report for 1916. As in previous years the experimental material consisted of Jonathan, Rome Beauty, and Wagener apples, samples of each variety having been collected from specified trees in the University orchard. The experimental work for 1917-18 has been seriously interrupted by the call into military service of two trained assistants, Mr. Stephen J. Kroh and Mr. Tillman Gerlough. Since it is impossible to plan definitely for the future it is thought best to review the work thus far in some detail. This report on the work has been made possible by the summaries and notes furnished by Mr. Kroh and Mr. Gerlough.

Perhaps the most notable results of the series of tests were obtained from September 1, 1916, to July 29, 1917, the accumulation of data indicating quite clearly the relationship between the physical and chemical characteristics of the apple. The physical constants determined thruout the greater part of the series were osmotic pressure, refractive index, and electric conductance. To follow the chemical change, starch, total sugars, invert sugar, total solids and acidity were determined.

The graphs can hardly be reproduced in this connection. A few brief statements will have to suffice. It can be seen by careful observation that there exists a close relationship between the curves for constants and the curves for sugar and total-solids. In fact, by careful plotting, these curves can be almost superimposed. The difference between the osmotic-pressure and the total-sugar curves at the beginning of the series may be ascribed to the presence of considerable quantities of cane sugar at this period. As the cane sugar becomes inverted by enzyme action, the osmotic pressure approaches the total-sugar curve. After this inversion the osmotic pressure curve becomes a function of the total-sugar curve, the sugar being mostly invert sugar.

Comparing refractive index, osmotic pressure and sugar, the refractive index stands out as a very important physical constant for actually measuring the carbohydrate change. The use of the interferometer

(C. A. 9, 2260, 1915) promises to make this a most delicate means of investigation.

Difficulties in technique have hampered the getting of true results on total solids. The results as they are, tho incomplete, follow the curves for sugar and physical constants quite uniformly.

It is quite easy to see why there is a striking correlation between the curves just mentioned if we stop to consider the gross chemical composition of the apple. From fourteen to eighteen per cent approximately is total solids, the rest being water. Of this percentage of total solids, from forty to seventy is sugar. So, roughly speaking, sugars are a function of the total solids and vice versa. Osmotic pressure and refractive index are proportional to the dissolved substances in the juice, these substances being for the most part sugars. Calculations show that the osmotic pressure is due almost entirely to the sugar content.

The conductance is proportional approximately to the potassium content of the cell. It is affected by desiccation and respiration, which in turn concentrate or dilute the solution in the cell.

#### Summary of Carbohydrate Change

A discussion of the carbohydrate change in the apple will be limited to a consideration of starch, sucrose, invert and total sugar. Cellulose, hemicellulose, pentosans, pectin bodies, and fructose were not investigated. Results are on the basis of grams of apples taken and not on a total-solid basis. The changes may be summarized as follows:

##### DURING—

*Growth.* (1) Rapid increase of invert sugar. (2) Rapid increase of starch which begins to diminish about September 1.

*Ripening.* (3) The decrease in starch corresponds to the rapid increase in sucrose. (4) Sucrose content is low until starch begins to disappear when it increases rapidly. The rise corresponds to the rapid rise in total sugars and the decrease in starch.

*After ripening and storage.* (5) Slight increase in invert sugar followed by continual decrease. (6) Sucrose gradually decreases. (7) Desiccation has a marked effect upon the percentage of sugar in the last stages of storage. (8) No marked chemical differentiation can be noticed between cellar and cold storage. (9) Rome Beauty in cold storage is most markedly affected.

#### Discussion of Carbohydrate Change

Analyses of very green apples (1917) indicate that the hexoses are the base sugars from which the reserve material, starch and sucrose, are synthesized. During the early period of growth, the hexoses for the most part are changed into reserve material, starch. The change, however, is not altogether in that direction for some of the reducing sugars are constantly being used up in respiration so that the hexoses maintain the balance in the cell by increasing.

We find that sucrose begins to increase most rapidly when starch disappears, in fact the disappearance of the starch corresponds almost identically with the increase in sucrose. These facts indicate that a very

delicate balance exists between the enzyme processes which take place in the carbohydrate metabolism, that the process is reversible, that the synthesis of starch and sucrose is a matter of the concentration of the hexoses. The work of Campbell\* indicates the same conclusions. Working with the starch transformation in leaves during the period of twenty-four hours, he finds that the hexoses are the base sugars from which the starch and sucrose are formed. Sucrose is formed when the hexoses reach a certain concentration; starch is formed when the sucrose reaches a certain concentration. Reasoning from this by analogy and assuming that the starch is hydrolyzed to dextrose, the concentration of the invert sugar may be such at this time as to make it possible that invert sugar is synthesized to sucrose,—a more accessible carbohydrate than starch. The formation of constant amounts of fructose over dextrose in the early stages of growth of the apple is a point in favor of this theory.

Another evidence of the delicate balance that exists between the enzymes and carbohydrates concerned is shown when sucrose is inverted to invert sugar during the processes of after-ripening. Respiration during this time is most rapid and reducing sugars are used up in the process. Hence when the excess of reducing sugars is used up by respiration, part of the sucrose is inverted to make up for the loss and to keep the cell well balanced. This sucrose hydrolysis is usually ascribed to the enzyme invertase. Thatcher hints that this inversion may possibly be due to the presence of organic acids in the cell since he found no invertase. (The determination of hydrogen ion is important in this investigation.)

#### Enzymes of the Apple

The carbohydrate changes in the apple are usually associated with the action of specific enzymes in the cell. During the years 1916-17, the activity of a few of the more common enzymes was determined. These experiments were more in the nature of preliminary work, matters of technique giving considerable trouble. More refined methods must be devised if the activity of some of these enzymes is to be determined. Up to this point the work may be summarized as follows:

(1) Thru the action of diastase, starch is supposed to be changed to dextrose. No conclusive evidence was found that indicated that such an enzyme was present. The subject should be reinvestigated with a more refined method, neutralized solutions, and longer periods of contact.

(2) It is well known that sucrose is changed to invert sugar. This hydrolysis until recently has been explained thru the action of the enzyme invertase. No invertase was found, confirming Thatcher's work. Hydrogen ion undoubtedly produces this inversion.

(3) Esterase was found.

(4) Oxidase was found in very green apples with the exception of the Wagener variety. The Wagener showed at this time a strong catalase. Rome Beauty showed the strongest oxidase. As ripening takes place the oxidase activity seems to decrease. Oxidase probably plays an important part in apple scald when apples are placed in cold storage. (Powell and Fulton, 1905.)

\* Simple Carbohydrates and Glucosides. Armstrong. Pg. 94.



Since Buchner's epoch-making discovery of the enzyme zymase, most theories of respiration of plants are based on its presence and activity. Recently, however, it has been shown that catalase and carboxylase are of importance. The enzyme carboxylase splits off carbon dioxide from alpha keto acids. This takes place during the last stages of degradation of the sugars during the process of alcoholic fermentation.

Circumstances have unfortunately interfered with the experimental study of the hydrogen ion concentrations in the juices.

### DEPARTMENT OF DAIRY HUSBANDRY

E. F. GOSS, R. D. CANAN

Projects: (1) A study of the type of organisms present and multiplying in cottage cheese (Adams). (2) Scoring contests of commercial creamery butter.

During the past year the projects entitled "Dairy Herd Management" and "Experiments to find a Basal Ration for the Most Economical Feeding of Dairy Cattle Under Northwest Conditions" have been completed. The reports are available in Bulletin No. 102 entitled "Dairy Herd Management," prepared by E. V. Ellington, formerly head of the department. Since July 1st of this year an Adams project entitled "A Study of the Types of Organisms Present and Multiplying in Cottage Cheese" has been organized. The work under this project will be mainly bacteriological and will, as far as methods and facilities permit, involve qualitative and quantitative determinations of the types of organisms found in cottage cheese at various intervals during the storage period. The effects of various methods of manufacture and different conditions of storage upon the bacterial flora will be studied. Some attention will also be given to the yeasts and molds. It is expected that the data obtained in this work will be of value in attacking the commercial problem of improving the keeping quality of cottage cheese.

In an endeavor to be of assistance in a practical way to the creameries of the State in improving and standardizing Idaho creamery butter, the Department has conducted a number of monthly scoring contests in which a majority of the creameries of the State have participated. The report to the creameryman on the sample of butter which he submits includes commercial score, criticisms of the judges, a color and composition score, the salt and moisture content of the sample, and suggestions for improvement. A summary of the scores of all the samples submitted is also included so that the creameryman can compare his score with the scores of other creameries in the State. The results thus far are encouraging. It is planned to continue the work another year.

During the year official tests for advanced registry in the breed associations have been conducted under the supervision of the Department in one Jersey and seven Holstein herds.

Altho the past year has been a particularly trying one from the standpoint of the dairyman, new conditions in general have been met with a degree of success which promises well for the future of the dairy industry. The feed situation has been met by many dairymen by the elimination of those animals in the herd which can not because of their low-

producing ability properly utilize feed at present prices. The labor shortage has been met to a greater extent than before by the use of the mechanical milker. The dairymen of Idaho who have been able successfully to meet the unusual conditions of the past year must necessarily have put their business on a basis which leaves them better prepared to take advantage of the more favorable conditions which are to come later.

Too great importance can not be attached to the necessity of encouraging and keeping on a sound financial basis the dairy industry of Idaho. The Department realizes the complexities of the problems which the dairyman must solve and is anxious to give assistance in any possible way that each dairyman may not only conduct a successful business but may do his full part in producing food.

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## DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY

A. C. BURRILL

Project: A study of the clover aphid and methods for its control.

### Losses Caused by the Clover Aphid

On coming into the State for work in economic entomology in the summer of 1916, the attention of the Station entomologist was sharply called to the destructiveness of clover aphid (*Aphis bakeri* Cowen) in the clover-seed areas of the Snake River valley. The losses start with a reduction in the yield of seed thru loss of sap by the plants at the time the seed is filling. These losses may amount to as much as seventy-five or eighty per cent of a normal yield. Later on in the season the copious accumulation of aphid honey dew or liquid excreta gums up the threshing machines and causes the seed to solidify like cement in the sacks, in this way causing no end of trouble and expense in harvesting and marketing operations. The seed crop in 1916 fell far behind a normal yield. No other cause was assigned to the sudden decrease in yield.

*Control by spraying.*—An attempt was made in 1916 to use certain chemical sprays in control work. It was proved on one-third acre plats that a nicotine spray made from the commercial brand Black Leaf Forty had an efficiency of from ninety to ninety-eight per cent with varying strengths of solution with laundry or other aphicide soap as a spreader, and that it would work just as well when combined with the sodium arsenite spray for grasshoppers then being recommended by the Extension Division. Control experiments, however, were undertaken too late in the season to determine what the commercial value of Black Leaf Forty would be in increasing clover-seed production. This preliminary control work, however, revealed many doubtful points in the life history of the aphid and raised many questions about the proper mixture of sprays and the application of other control methods.

*Field headquarters.*—In May of 1917 field headquarters were established at Twin Falls for the purpose of trying out thoroly control methods and for completing a study of certain doubtful points in the life history of this pest. The growing season of 1917, however, proved to be an abnormal one as regards weather conditions and a poor one for the pest, so that no progress has been made in the application of the

control methods planned the preceding season. Unexpected methods of control, however, presented themselves—in the use of sheep to clean clover aphid out of stubble clover fields and in the use of the lady beetle and other parasites of the aphid. Most of the time spent at field headquarters was given up, necessarily, to a study of the pest itself.

*Points determined.*—(1) The literature suggests two distinct times of migration by winged forms of this aphid—from fruit trees to clover in the spring, and from clover to fruit trees again in the fall. We have determined that winged forms are produced continuously thru the summer and fall and even into mid-winter. This fact tends to upset any plan of control by crop rotation, cultivation or irrigation, and makes of little avail a dormant aphid spray on fruit trees to cut off the source of spring migration from fruit to clover.

(2) The chief migration from clover to fruit trees occurs in September and October but the irregular season rendered uncertain the limits of the migration period. Contrary to conditions reported elsewhere, clover aphid showed no preference for apple tree leaves but instead a decided preference for Anjou pear, Hungarian prune and the quince. It scattered to some extent to the Rome Beauty apple.

(3) While eggs were laid abundantly on the above mentioned varieties of fruit trees, no satisfactory explanation of a former claim that eggs could also be laid on clover was established, altho confusing evidence was gathered. An explanation of the supposed infestation of clover fields earlier than is possible merely by the spring migration from fruit trees was stumbled upon in the discovery of an unusual multiplication of clover aphid in November and December upon the red clover. Bearing continued into January, 1918, with snow on the ground and more falling.

(4) It has been shown that the convergent lady beetle (*Hippodamia convergens* Guer) occurs in commercial quantities in the mountainous portions of the State and can be kept for many months in screened apple boxes in cold storage until needed in infested clover fields and when they are released will at once attack the clover aphid. The lady beetles experimented with were secured in the mountains northeast of Moscow and were kept for ten months in cold storage previous to their release in a clover field near Gooding. This plan of attack, borrowed from California, apparently offers a far cheaper method than is possible from the use of sprays. There is much, however, yet to be determined relative to the reliability of the lady beetles and their vitality when kept under the conditions mentioned. We are not at all sure as to the commercial success of this method of control.

(5) It was shown during the summer that the pasturing of a few head of stock continuously in clover stubble does not completely destroy the clover aphid. On the other hand, pasturing a flock of one thousand sheep for a full week in December on a sixty-acre tract partly in grain stubble and partly in alsike clover resulted in the complete extermination of the aphid in that field. This discovery does not settle the problem of seed production since an aphid infestation may arise anew in the summer

time within six or eight weeks, the usual time required by the growers in producing a crop of red clover seed.

(6) The early part of January, 1917, demonstrated that clover aphid, both eggs on fruit trees and wingless reproducing individuals on clover, may be completely killed out by severe cold at the higher clover-growing altitudes if properly conditioned by other factors preceding, and that it will over-winter in spite of severe cold at lower altitudes and in protected canyons. Due to the lack of aphid on red clover until after the seed harvest, a doubling in the average yield of seed per acre is claimed by seedsmen for the season of 1917. This claim is probably a justifiable one.

No opportunity to gather data on the vitality of the eggs or of the period of migration of winged forms from fruit trees to clover has occurred because of our inability to get into field quarters until after this period. Data on this point, control studies, and a statistical study of the rate of reproduction and other hosts accepted by the aphid await another year.

#### Other Work

Altho the field office was established primarily for research, knowledge that an entomologist was in that section for work brought to his office a great number of inquiries. During the summer over five hundred callers came to the office or the field insectary building. During the summer more than thirteen hundred letters were written in response to requests for information and twelve lectures were given to about two hundred people. There is abundant and pressing need for a research assistant in keeping continuous breeding records. The many miles of travel necessitated by the demands for assistance or advice in the fields seriously interrupts continuity of research and experimental work.

Approximately eight thousand pages of printed matter on insects and insect control were distributed from the office during the summer and many timely articles were prepared for the local press. The research notes have been carefully kept and compiled to date and eight thousand eight hundred new specimens have been added to the Station collections; they include over four hundred microscopic slides. Of the \$4000 appropriated for a study of insect pests, there has been spent to date a total of \$1630.

From the many new problems presenting themselves for solution, the following may be mentioned as the most pressing.

(1) The relation of insect carriers to fire blight.

(2) The substitution of cheaper chemicals than those now recommended for grasshoppers, clover aphid and field pests of that kind. The steady increase in the cost of insecticide chemicals during the past few years is somewhat disconcerting to those who might make liberal use of them in the control of field pests.

(3) A study of temperature and humidity relations to field insect epidemics is essential and fundamental if we are ever to know how to forewarn farmers on the prospects of epidemics on given field crops.

(4) There is need of further study of poison field sprays and crop

plant bloom with regard to the possible killing of honey bees and insectivorous birds.

(5) There is need of a survey of conditions favoring the breeding of house flies, fever ticks, and other insects injurious to the health of man and beast in this State.

(6) Present recommendations for spraying for codlin moth and peach twig borer are seriously at fault in saving the apple and prune crops. Data similar to that mentioned in No. 3 above are much needed.

(7) Soil insecticides should be investigated in the search for much needed methods of control in the case of wire worms, root magots, ants and root aphids of sugar beets and apples. The present method of re-planting or plowing under crops as soon as they are found to be heavily infested hardly makes for efficiency in agriculture.

(8) The bean crop is in great danger from another disaster like that of 1916 from the activity of the bean thrips. Some methods recommended by the Federal Department seem to be inapplicable here. Other control methods must be devised.

(9) There is need for further cooperative work with the United States Department of Agriculture on the distribution and control of the alfalfa weevil. This pest is spreading its area of infestation in Idaho at the rate of ten radial miles a year.

(10) Rumors of the presence of many serious and important pests in various sections of Idaho have come to the field office. The entomologist is without traveling funds for investigating the facts and is without the necessary specimens to prove whether warnings to certain classes of growers are necessary. A pest survey of the State should be made in the most expeditious and least expensive way possible. It might be well to note that a pest survey is being carried on by automobile travel in Montana and Washington with State funds appropriated for the purpose.

#### DEPARTMENT OF FARM CROPS

G. S. RAY, H. W. HULBERT

Projects: (1) Varietal tests of small grains. (2) Forage crops. (3) Winter barley culture. (4) Varietal tests of field peas. (5) Cultural methods for field peas. (6) Cultural and varietal tests for beans. (7) Corn: varietal tests for silage production and the breeding of an acclimated variety. (8) Root crops. (9) Nursery work.

Experimental work in the Department of Farm Crops is carried on with Hatch and Local Station funds. The projects reported upon are the same as for 1916 with the exception of the work on beans.

On the whole, the cropping season 1916-17 was much more unfavorable than the preceding season. A dry fall rendered fall plowing quite impracticable in many instances. Enough ground was plowed upon the station to allow the usual fall seedings to be made. However, winter grain in the varietal tests winter-killed. The summer of 1917 was much drier than the average summer. This drought with comparatively hot weather in July and August reduced crop yields considerably. These

climatic conditions account for much lower average yields from all crops than were secured in 1916.

The location of the Farm Crops plats on the University farm has been changed. In making this change, plats of 1-40 acre size have been adopted for the cultural and varietal tests. Each fifth plat in all experiments is a check plat.

*Varietal tests of small grains.*—Three plats of Turkey Red wheat grown on ground which was cropped to peas in 1916 gave an average yield of 27.7 bushels per acre.

In order of yield the spring wheats rank as follows:

Bushels per acre		Bushels per acre	
Jenkins Club .....	28.6	Minnesota 169 .....	19.6
Palouse Bluestem .....	27.1	Minnesota 163 .....	19.5
Little Club .....	26.5	Defiance .....	18.8
Early Baart .....	25.6	Marquis .....	18.6
Sonora Red Chaff .....	21.5		

The ten oat varieties yielding best the past season were:

Bushels per acre		Bushels per acre	
Banner .....	65.4	Corn Oats .....	59.9
Swedish Select .....	62.0	Colorado 37 .....	59.3
Big Four .....	62.0	Shadeland .....	57.8
Abundance .....	61.5	White Russian .....	57.3
Danish Giant .....	59.9	Silvermine .....	55.4

Of fifteen barley varieties the following six produced the highest yield:

Bushels per acre		Bushels per acre	
Oderbrucker .....	51.2	White Winter .....	31.8
Beardless .....	40.7	Abed .....	31.5
White Smyrna .....	32.8	California Feed .....	30.5

Spring rye yielded 13.4 bushels and spring emmer 13.3 bushels per acre.

*Forage crops.*—Mixtures of peas and oats, peas and wheat, and peas and barley at various rates of seeding were grown for hay. Blue Prussian, Bangalia, White Canada and White Colorado peas were used in these mixtures while Swedish Select oats, Palouse Bluestem wheat, and beardless barley were the cereals used.

Judging from all of the yields, Blue Prussian peas and Swedish Select oats, each sown at the rate of 1½ bushels per acre are recommended for a hay crop. This mixture yielded 1.9 tons of cured hay per acre, a yield considered quite satisfactory due to the fact that no rain fell after the seed was sown. Such a crop mixture gives a good annual hay crop in a normal season.

Grasses, alfalfas, clovers, and the various mixtures seeded, some in 1915 and some in 1916, have given the yields recorded below. None of the forage crops was sown with a nurse crop. The figure immediately following the name of the crop indicates the number of pounds of seed sown per acre.

	Tons per acre	Number of years grown
Red clover 10 .....	2.16	2
Timothy 12 .....	1.53	2
Brome grass 15 .....	1.80	3
Timothy 12, Red clover 8 .....	1.91	3
Timothy 12, Alfalfa 10 .....	3.01	2
Brome grass 6, Alfalfa 15 .....	2.29	3
Timothy 6, Orchard grass 8, Red clover 4 .....	2.55	2
Brome grass 8, Orchard grass 12, Red clover 6 .....	3.33	2
Timothy 2, Orchard grass 8, Brome grass 3, Alfalfa 2, Red clover 3 .....	1.98	2
Timothy 5, Orchard grass 10, Red top 3, Alfalfa 2, Red clover 4, Alsike 1 .....	3.03	2
Timothy 3, Perennial rye grass 2, Orchard grass 3, Tall oat grass 2, Brome grass 3, Alfalfa 2, Red clover 2, Alsike 2 .....	2.59	2
Grimm alfalfa 6 .....	2.32	3
Grimm alfalfa 8 .....	2.05	3
Grimm alfalfa 10 .....	2.22	3
Grimm alfalfa 12 .....	2.16	3
Dry-land alfalfa 9 .....	1.88	3
Cherno alfalfa 9 .....	2.43	3
Cossack alfalfa 9 .....	2.80	3
Grimm alfalfa 8, 24-inch rows .....	2.80	2
Grimm alfalfa 8, 36-inch rows .....	2.09	2
White sweet clover 20 (hulled seed) .....	3.62	2
Yellow sweet clover 12 (hulless seed) .....	2.58	2

Millets and sorghums, grown only in the nursery, matured better than in previous years, due to the warm fall and late frosts. These crops, as well as soy beans, are of practically no importance in northern Idaho.

*Field peas.*—Fourteen varieties of field peas and four of garden peas according to yield ranked as follows:

	Bushels per acre		Bushels per acre
Kaiser .....	22.5	Solo .....	15.1
Bluebell .....	21.6	Potter .....	14.9
White Canada .....	20.2	White Marrowfat .....	14.5
New Canadian Beauty .....	19.2	American Wonder (garden) .....	14.4
Amraoti .....	18.9	Black-eyed Marrowfat .....	14.1
Bangalia .....	18.4	Alaska .....	13.2
Blue Prussian .....	16.7	Admiral (garden pea) .....	11.4
Early Britain .....	16.7	Gradus (garden pea) .....	11.1
White Colorado .....	16.1	Advancer (garden pea) .....	10.1

Of these varieties, due to their average yield for several seasons, the following are recommended: Blue Prussian, Bluebell, Alaska, White Canada, White Colorado, and White Marrowfat.

A continuation of the cultural methods including dates, rates, depths, and methods of seeding when compared with results of the three preceding years warrant the following recommendations:

1. Early seeding (as early in the spring as possible).
2. Medium deep to deep seeding (2½ to 4½ inches).
3. 90 to 110 pounds of seed per acre.
4. Drilling, in preference to broadcasting and plowing or discing under.
5. Ordinary drilling rather than seeding in rows which may be cultivated.

*Beans.*—Three varieties were grown both in hills and in drill rows. With each variety the planting in hills produced a larger yield of seed than did drilling. The rate of seeding in each case was 30 pounds per acre.

	Bushels per acre
White Navy	
Hills .....	21.7
Drills .....	17.7
Refugee	
Hills .....	19.5
Drills .....	18.2
Lady Washington	
Hills .....	17.0
Drills .....	13.9

*Corn.*—Silage yields were secured from five varieties.

	Tons per acre
King Phillip (flint corn) .....	12.0
Minnesota 13 .....	11.2
Pride of the North .....	10.3
Minnesota 23 .....	6.9
Minnesota King .....	5.5

Minnesota 13, the dent variety producing the highest yield, is recommended for silage production, judging not alone from the present season's record but from the yields of previous years also. While the flint corn outyielded the dent varieties, its tonnage was due to a very heavy production of leaves and stalks and very few ears in comparison with Minnesota 13.

Rustler, a white dent corn, matured seed well. This variety is being used in breeding work where the aim is to secure an acclimated variety producing a medium sized ear and also a variety which will give good yields of forage.

*Root crops.*—Yields of from 4.9 to 13.3 tons were obtained with carrots, rutabagas, and mangels. Due to the extremely dry growing season the yields produced by all of the root crops was much below normal.

*Nursery work.*—Practically all of the fall-sown wheats in the nursery winter-killed.

Of 111 varieties of oats, 15 varieties yielded better than the check variety, Swedish Select. Some of the most promising varieties were Golden Beauty, Abundance, White Bonanza, Big Four, Victory, and Danish Giant.

The nursery work with spring wheat and barley was enlarged considerably and many new varieties were added to the tests.

Pure lines of field peas started in 1916 were continued and the best of these will be transferred to increase plats the coming season.

### SCHOOL OF FORESTRY

F. G. MILLER

Projects: (1) Clearing of logged-off lands. (2) Forest by-products. (3) Experimental tree planting. (4) Grazing studies.

*Clearing of logged-off lands.*—The School of Forestry has brought



to a close its experiments on land clearing, and published the results the past year in Bulletin 91, entitled "Methods of Clearing Logged-off Land." This publication may be obtained upon application.

*Forest by-products.*—As stated in our last annual report, the experiments in the utilization of by-products from stumps carried on for the past several years by the School, in cooperation with the Federal Bureau of Chemistry, have been completed, the publication of the report, now on file with the U. S. Department of Agriculture, has been delayed on account of the war. The School has this year, in cooperation with the School of Mines, inaugurated a series of experiments to determine the value of certain wood oils in connection with flotation processes in the separation of minerals.

*Experimental tree planting.*—Based upon careful experimentation covering some eight years, the School is now issuing a bulletin on tree planting in Idaho, entitled "Trees: What, Where, When, and How to Plant." It is hoped to have this bulletin ready for distribution in time for the spring planting. It gives a full discussion of the tree species best adapted for windbreaks, shelter belts, woodlots, and for ornamental planting; also details as to methods of planting and manner of arrangement. The cooperative agreement entered into some years ago with the Office of Foreign Seed and Plant Introduction to test foreign trees for their adaptability to Idaho conditions, still continues and a number of new species is received and planted each year. About 200 different forest tree species including exotics are now growing in the University arboretum.

In pursuance of its policy to encourage tree planting in Idaho by the distribution of planting material at approximate cost, the School has available for this spring a suitable stock of forest and shade trees which it will send out to citizens of the State in limited quantities. These trees are listed and priced in Circular No. 5, "Tested Forest Trees for Planting in Idaho," which may be had upon application to the School of Forestry.

*Grazing studies.*—In recognition of the great importance of the grazing industry of the State and its vital relation to forest management, the School some three years ago undertook a series of grazing studies looking to the improvement of the grazing lands. It is well known that thru overgrazing and other forms of abuse, the carrying power of these lands has been seriously impaired. The problem now is to rebuild them and bring them back into the fullest possible usefulness. This opens up a very large field, and one in which, with proper support, the School can render the State a real service.

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#### DEPARTMENT OF HORTICULTURE

C. C. VINCENT, W. C. EDMUNDSON, G. J. DOWNING

Projects: (1) Apple breeding (Adams). (2) Summer vs. winter pruning experiments. (3) Small fruits experiment. (4) Variety tests of vegetables. (5) Strawberry variety tests. (6) Apple variety tests. (7) Potato experiments.

*Progress in apple breeding.*—The apple-breeding project which has

for its object the improvement of existing varieties of apples by crossing, has progressed along definite lines the past year.

The work during the year has consisted largely of correlation studies. Many trees have been studied from various angles with a view to working out fundamental principles of plant breeding that will not only be true in Idaho, but applicable in other sections as well, if breeding work is taken up. As far as time and funds will permit, data will be secured on such factors as diameter of tree, the date at which growth starts, color of bark, color and type of foliage, size and shape of leaves, characteristic growth of tree, tendency to revert back to seedling type, susceptibility to disease, vigor of trees, annual terminal growth, formation of terminal buds, and date of leaf fall.

As 92 trees, resulting from the crosses made in 1910 and 1911, have fruited this year for the first time, they will give us material for a study of the Mendelian inheritance of apples. The characteristics that will be taken into consideration are: color of skin, shape of fruit, size, flavor, color of flesh, keeping qualities, and factors of similar import.

The crosses that have fruited this year and the numbers of trees from each cross follows:

Ben Davis x Jonathan .....	33 trees
Ben Davis x Spitzenberg .....	11 "
Ben Davis x Wagener .....	2 "
Wagener x Ben Davis .....	18 "
Jonathan x Jonathan .....	4 "
Spitzenberg x Ben Davis .....	6 "
Jonathan x Ben Davis .....	7 "
Delicious x Jonathan .....	1 "

#### New Experimental Work

1. *Experiments with tomatoes.*—The objects of this work are: (a) To determine the early maturity and most profitable age of tomato plants when set in the field. (b) To determine the early maturity and yield of plants from which the terminal bud has been pinched while in the plant bed. (c) To compare the difference in early maturity and yield of transplanted and non-transplanted plants of the same age.

2. *Experiments with cabbage.*—The objects of this experiment are: (a) To determine the best time for transplanting cabbage plants to the field in order to obtain the most profitable yield. (b) To compare the difference in production between large and small plants. (c) To compare the difference in yield and earliness, between hot-bed and field-grown plants.

3. *Experiments with garden beans.*—The objects are: (a) To compare the difference in yield of string beans when planted in drills and hills. (b) The improvement of garden beans by selection.

#### Projects Completed

The following three projects have been completed and offered for publication as Station bulletins:

1. Evaporation of fruits and vegetables. Believing that there is a future for the small evaporator in the State of Idaho, as well as oppor-

tunities for sun-drying, and realizing that possibly thru this medium, commercial lines of work would be further developed, the Horticultural Department has been gathering data on the following problems: (a) Sun-drying of fruits and vegetables; (b) Relative merits of different types of evaporators, such as cook stove, hot-air, and steam; (c) The time required to exaporate different products, temperature required, number of pounds of fresh fruits or vegetables necessary to make one pound of dry fruit or vegetables, moisture content of dried products; (d) Different methods of preparing dried fruits and vegetables for the table.

2. Testing spray materials for the control of San Jose scale. Various kinds of spray materials such as lime-sulfur, spru sulfur, soluble sulfur, dry lime-sulfur, scalecide, crude oils, dormant soluble oil, were used in making these tests. During the past three years the following results were secured.

Material used	Year	Formula	Per cent killed
Lime-sulfur .....	1915	5° Baume .....	95
" .....	1916	5° " .....	92
" .....	1917	5° " .....	95-8
Soluble sulfur .....	1915	20 lbs. to 100 gal. of water.....	64
" .....	1916	25 lbs. to 100 gal. of water.....	82
" .....	1917	25 lbs. to 100 gal. of water.....	93
Spray sulfur .....	1915	10 lbs. to 100 gal. of water.....	65
Scalecide .....	1915	7 gal. to 100 gal. of water.....	99
" .....	1916	6 gal. to 100 gal. of water.....	96
" .....	1917	7 gal. to 100 gal. of water.....	98
Crude oil 16° .....	1915	Liquid soap 30 gal., crude oil 25 gal., water to make 200 gal. ....	79
Crude oil 16° .....	1916	Liquid soap 30 gal., crude oil 20 gal., Water to make 200 gal. ....	80
Crude oil 26° .....	1916	Liquid soap 30 gal., crude oil 20 gal., Water to make 200 gal. ....	64
Dormant soluble oil	1915	7 gal. to 100 gal. of water.....	94
Dormant soluble oil	1916	7 gal. to 100 gal. of water.....	95

3. *Vegetable gardening in Idaho.*—This report contains a list of different varieties of vegetables that do well in the irrigated and non-irrigated sections of the State, as well as directions for planting, making the hot-bed, preparation of ground, and irrigation.

#### DEPARTMENT OF POULTRY HUSBANDRY

PREN MOORE

Projects: (1) Flock management. (2) Feeding experiment to determine the relative value of vegetable and animal protein in egg production.

*Flock management.*—The outstanding observation in flock manage-

ment for the year is that the fowls do best in winter when not kept confined within doors. When they are allowed to run out of doors they are healthier and produce more eggs, there is a greater percentage of fertile eggs, and the chicks are stronger.

*Feeding Experiment.*—The plan of this experiment is fully indicated in Circular No. 3 and in the last report of the Experiment Station. This year has seen the completion of the second and the beginning of the third and last year of work. The first year's work showed the superiority of the ration narrowed to the nutritive ratio, 1:4.2 with animal protein. One additional pen, No. 8, was introduced at the beginning of this year's work to determine the relative value of a ration narrowed with animal protein to a point intermediate between the wide and the narrow rations of the preceding year. The results of the year point to the superiority, in so far as production is concerned, of the ration given this pen.

From the tabulated results of the year's work, it is found that pen No. 5 produced 60.13 per cent more eggs than pen No. 4, 61.26 per cent more than pen No. 6, 24.36 per cent more than pen No. 7, and 2.17 per cent less eggs than pen No. 8. In the table below are presented data on the weights of eggs from the five flocks:

Pen No.	Feed	Nutritive ratio	Per cent under two ounces	Per cent two ounces	Per cent over two ounces
4	Vegetable	1:4.2	32.02+	67.14—	.83—
5	Animal	1:4.2	11.26+	79.26+	9.48—
6	Vegetable	1:5.5	34.67+	64.72+	.61—
7	Animal	1:5.5	17.00+	76.44+	6.56—
8	Animal	1:4.8	5.53+	89.30+	5.17—

A comparison of the cost of feeding now and before the war is a matter of much interest and importance. This experiment was planned in normal times and the cost of feeds to be used in calculating costs of production was based upon the average price of feeds in this locality for the ten years previous to July 1, 1915. Using this average as a basis of feed costs, we find that it would have cost \$15.04 to feed pen No. 4, \$20.86 to feed pen No. 5, \$17.25 to feed pen No. 6, \$18.90 to feed pen No. 7, and \$23.84 to feed Pen No. 8. The feed consumed by pen No. 8 between November 1, 1916, and November 1, 1917, actually cost \$56.49, a difference of \$32.65 in the cost of production because of the increase in the price of feed stuffs since 1915. Using pen No. 8 as an illustration, we find that the cost of feeding fowls has increased 57.8 per cent in the last two years. The increase in the price of poultry products is not commensurate with the increased cost of production.

The greatest problem confronting the poultry industry in Idaho at this time is to meet the demands of the times in wheat conservation. The department is getting under way extensive war-time feeding experiments. It is believed that some rations will be found that will meet the situation without detriment to the poultry industry. The poultrymen of the State will be kept advised of the results of these experiments.

## DEPARTMENT OF SOIL TECHNOLOGY

P. P. PETERSON, E. B. HITCHCOCK

Projects: (1) Rotation and fertilizer experiments. (2) A soil-corrective experiment. (3) Experiments to determine the duty of water for common field crops under different conditions of climate (Adams). (4) Tolerance of various crops and trees for alkali salts (Adams). (5) Soil surveys.

*Rotation and fertilizer experiments.*—The data obtained in these experiments conducted on the Station farm at Moscow support the data obtained in previous years. With this year's crop the first full rotation was completed in the fertilizer part of the experiment. The results indicate that the effect of nitrogenous fertilization is carried into the third crop after application. The data obtained are summarized in the following table. Those plats which received phosphorous and potassium fertilizers again showed no appreciable difference in yields from the check plats.

*Comparative results with plat experiments from fertilization with nitrate of soda on the Palouse silt loam of the University farm at Moscow.*

Year fertilized	Crop	Yield from fertilized plats in bu. per acre	Yield from unfertilized plats in bu. per acre	Increase in yield due to fertilization bu. per acre
1915	Wheat, 1915 .....	30.2	23.6	6.6
	Oats, 1916 .....	82.2	59.0	23.2
	Potatoes, 1917 .....	125.0	99.8	26.0
1916	Wheat, 1916 .....	96.6	69.8	26.8
	Oats, 1917 .....	42.0	38.9	3.1
1917	Wheat, 1917 .....	25.7	20.5	5.2

The figures are averages of four plats of 1-10 acre each receiving nitrogenous fertilizer and of eighteen plats of 1-10 acre each receiving no nitrogenous fertilizer. Some of the eighteen received potash in the form of muriate and some received phosphorus in the form of acid phosphate. The nitrate was added at the rate of two hundred pounds per acre. This is probably a heavier application than is needed.

In this connection it may be mentioned that the continuous wheat plats receiving no manure or other fertilizer yielded this year 8.8 bushels per acre, whereas the one receiving manure yielded 17.4 bushels per acre. This indicates the necessity of returning all farm manure to the land.

In that part of the experiment concerned with rotations some factors of great value have been secured. In rotation No. 2 which is wheat, oats, and fallow, the wheat this year yielded 23.5 bushels per acre. In rotation No. 1, wheat, oats and peas, a yield of 24 bushels per acre was obtained. In rotation No. 3, wheat, oats and corn, a yield of 23.1 bushels was secured, and in rotation No. 4, wheat, oats and potatoes, we received 27.7 bushels per acre. With various crops substituted for fallow, 24.9 bushels per acre were obtained, whereas fallow gave an average of 23.5 bushels per acre. This is certainly an argument for the abolishment of the practice of summer fallowing. The data are given in a more condensed form in the following table:

*Influence of crops on yields of wheat as compared with fallow*

Previous crop	Fallow	Peas	Corn	Potatoes	Average of last three columns
Yield per acre .....	23.5	24.0	23.1	27.7	24.9

Other results are beginning to show but probably need not be mentioned until a detailed report is made.

The influence of a crop of clover on the productivity of this soil was well shown in 1917 by plat No. 7A which bore 3.2 tons of clover hay in 1916. The yield of wheat in 1917 was 16.9 bushels per acre, the next highest yield being 13.4 bushels, and the average yield of all other plats for the year being 11.5 bushels.

The soil-corrective experiment being conducted on the Sandpoint station has given no distinctive results. The productiveness of the plats has been increased but apparently not because of the application of lime or gypsum. There has been a steady increase in production both on treated and untreated plats. A table of averages in yields is submitted here which shows the increases apparently due to the subduing of the land by cultivation.

*Average yields of various crops on 1-10 acre plats at Sandpoint*

Crops—	Wheat	Peas	Oats	Corn	Potatoes	Hay
1915 .....	7.1 bu.	2.1 bu.	13.5 bu.	1.0 ton	20.4 bu.	ton
1916 .....	8.4	5.5	13.7	.5	43.0	3½
1917 .....	12.3	6.0	16.1	1.2	46.0	1¾

It is the intention, if suitable arrangements can be made, to introduce into this project a fertilizer experiment before planting a new crop.

*Duty of water.*—As heretofore this experiment has been conducted at three places. The part hitherto conducted at Gooding has been moved to Jerome because of the abandonment of the Gooding station. The work has been carried out successfully at Moscow and Idaho Falls but with very little data from Jerome. The following table gives some of the more general data obtained.

*Moisture equivalents of peas grown at Moscow and Idaho Falls*

Time of planting—	Ratio of H <sub>2</sub> O to grain			Ratio of H <sub>2</sub> O to total dry matter		
	April	May	June	April	May	June
Moscow .....	349	397	776	133	133	204
Idaho Falls .....	1248	989	1290	611	475	616

These data when considered in connection with the hydrograph, thermograph and evaporimeter readings, take on added value.

**Alkali Investigations**

This work was undertaken to determine what concentrations of various salts different crops will withstand under various conditions. A part of the work is being conducted at the central station in the open and in the greenhouse with such plants as can be grown in jars and potometers. The work thus far has involved the growing of wheat, barley, and alfalfa. Data of some value have already been secured. Another part of the work is being conducted on the substation at Caldwell. This involves the growing of fruit trees in alkali soils of different concentrations. Al-

kali soils are being diluted with non-alkaline soil to the concentration required and the non-alkaline soils are being impregnated with salts of known characteristics in order to permit of controlling conditions as completely as possible. The trees will be planted during the coming spring.

### THE ABERDEEN SUBSTATION

L. C. AICHER

Projects: Dry farming. (1) Crop rotations. (2) Small grain variety tests. (3) Time, depth, and rate-of-planting tests. (4) Seed production. Irrigation. (1) Variety tests of small grains. (2) Variety tests of field and garden peas. (3) Alfalfa and clover-seed production. (4) Potato culture. (5) Production of sugar-beet seed. (6) Seed marketing. (7) Extension service.

The 1917 work at the Aberdeen station has been very largely a continuation of work begun on the farm several years ago. Certain lines of work have been given greater emphasis. Experimental data of great value are accumulating from year to year. Whenever it is seen that a sufficient amount of reliable data are available from which to draw practical conclusions the results of the experimental work are written up and published for the benefit of the farmers of the State.

During the year a bulletin on the production of clover seed under irrigation in southern Idaho and one on the production of alfalfa seed in southern Idaho were published. They are Nos. 100 and 101 of the Idaho Experiment Station series. They may be had by any one upon request. A paper entitled "Whole versus Cut-Seed Potatoes" was given for publication in the Journal of the American Society of Agronomy. It appeared in Volume 9, No. 5. A circular on the irrigation of farm gardens has just been written for the boys' and girls' garden clubs of the State, and a bulletin on cereals for irrigated lands in southern Idaho is now in course of preparation.

#### Dry Farm Work

The year 1917 was one of scant production on the dry lands. Prospects in the early spring were very bright. All dry farmers were very hopeful. Soil moisture was plentiful and the season started off well. The cold spring, however, hung on very late and crops failed to grow. Soil moisture, plentiful at first, was insufficient to carry the crops thru and the season turned out poorly for the dry farmers. Yields were small and the quality of grain only fair. High prices saved an otherwise bad situation. On the station the average yields from the dry land including all plats was less than eight bushels per acre, but winter wheat in variety tests made an average yield of eleven bushels per acre.

*Rotations.*—The results from the twenty-nine different rotation experiments on the dry land were not encouraging because of the low yields. The winter wheat on many of the late plowed and planted rotations winter-killed. With the exception of winter wheat in variety tests the spring wheats yielded almost as well as the winter wheats.

*Variety tests of small grains.*—The average yield of the spring wheats was five bushels per acre. Thus in spite of the severe winter-killing which took place on the dry lands, the winter-wheat varieties

yielded more than twice the spring varieties. This confirms the conclusion previously reached that on dry lands similar to those on which the Aberdeen station is located winter wheat should constitute the major part of the wheat crop. Spring wheat should be used mainly as a catch crop in case of failure on the part of winter wheat to live thru, or in case sufficient plowing had not been done in the fall to permit of the planting of winter wheat.

The Turkey winter wheat continues to lead all other varieties in point of yield per acre and in quality of grain for milling purposes. If this dry-farm country would unite in producing this one variety the yield of wheat in this section of the State would be increased and prices to the grower would be higher.

Early Baart has proved to be the best dry-land spring wheat. This station is now introducing this variety into eastern Idaho. In Farmer's Bulletin No. 769 this variety was recommended by the superintendent as best for spring sowing. Subsequent tests have proved its worth beyond all doubt. A carload of this wheat will be shipped into the Aberdeen country for sowing next spring. It will be distributed by the superintendent of the station at cost.

*Time, depth and rate-of-planting tests.*—Results from these tests for the past five years indicate that the best time to plant winter wheat is between August 15 and October 1. Planting should be made immediately after a good rain unless sufficient moisture is already available in the soil to bring about germination. Wheat sown in the early fall in moist ground should be planted from two to three inches deep. Late sowing in moist ground should be shallow. Plantings in dry ground early or late should be comparatively shallow. The best rate of planting varies between three and three and one-half pecks per acre. Three pecks should be sown if early planting is possible; three and one-half pecks if the sowing is late.

A series of experiments carried out on dry land for the purpose of testing out summer cultivation was not completed because of the winter killing which took place. The stands were so thin that the land was reseeded to spring wheat.

*Seed production.*—Considering the season, peas again made good yields. This crop seems to be the most promising one for use in the dry-land rotations for building up these soils for future wheat production. Wheat following peas in the rotation still yields more per acre than wheat following wheat.

Sugar-beet seed was grown on the dry land for the first time this year. A yield of fifty-four pounds was obtained from three rows one hundred and twenty-five feet long. Each plant yielded over six ounces of seed. The yield on irrigated land was a little over eight ounces per plant. If the mother beets had been spaced a little further apart on the dry land, the yields would have been better and the quality of the seed higher. This work will be carried on further as there appears to be possibilities of good returns from this crop on the dry lands. The great sugar-beet industry in Russia is essentially a dry-land industry in sections where slightly more rainfall occurs than at Aberdeen.



*Alfalfa seed.*—Alfalfa seed was produced on the dry land this year as usual but the crop did not prove to be a profitable one because of the lack of moisture at a critical period. The production of hay on dry land is out of the question. Wide spacing will usually insure the production of some seed. The great value of the alfalfa crop as indicated by returns this year is in the effect of the crop when plowed under on succeeding grain crops. Yields of grain are greatly increased. The trouble with this procedure, however, is that the land is not producing much while it is in alfalfa in preparation for the production of a good wheat crop.

#### The Irrigated Farm

The irrigated farm as usual produced good crops. The results from experiments this year, while not as satisfactory from the standpoint of yield last year, were nevertheless valuable in making up the annual average. The development of methods in seed production has been a primary object in most of the work on the irrigated farm. Aside from profits, the seed business must be kept up to a high standard if the seed business is to be developed. The following crops for seed production in addition to cereals were grown this year: Sugar beets, red, white, and alsike clover, Grimm alfalfa, garden and field peas, and flax.

*Variety tests.*—Five years' results in trials with cereals are now available. The Dicklow wheat has yielded 4.93 bushels per acre more per annum for the five-year period than any other variety. The superiority of this variety of wheat can not be questioned from such a record of performance. Owing to a scarcity of ground on the station for increase work, there are only about seventy-five bushels of the Dicklow available in this section of the State. That amount was grown by a neighboring farmer for the station. When the five years' results of the wheat tests were announced, practically all of the irrigation farmers in this section of the State wanted seed. The superintendent has been fortunate in being able to locate fifty thousand pounds of this wheat near Kimberly. A shipment will be received within a few days and distribution will be made to the farmers at cost.

Trebi barley, a new variety grown for five years on the station, has shown marked capacity for yield and is now being increased for distribution. One local farmer produced about one hundred and fifty bushels of barley this year. It will be planted next year and released to the farmers of the State after harvest. This variety has done remarkably well on this farm, outyielding the best barley grown in this section by several bushels per acre.

A new pure variety of oats is being developed and will be distributed as soon as performance, now indicated in plat tests, under field conditions prove its superiority.

Four varieties of flax were grown on the station this year. Thirty-five varieties yielded between twenty-three and twenty-four bushels per acre. At the present price of flax seed as compared to wheat and other commodities, flax is not a profitable crop for the farmers of southern

Idaho unless they can increase the yields to almost twice those obtained on this station.

In the cereal nursery hundreds of varieties and strains of cereals are grown annually with the idea constantly in mind of securing something better in the way of cereal crops.

*Variety tests of field and garden peas.*—Twenty-six varieties of field peas and fifteen varieties of garden peas were grown for seed under irrigation this year. Varieties superior in previous trials have again demonstrated their high capacity for yield and recommendations for planting these varieties will be made as soon as supplies of seed are available for distribution. The garden peas did especially well this year. A few varieties exceeded sixty bushels per acre. For the first time large companies dealing in pea seed were induced to contract peas in this section of the State. Sixteen hundred acres were planted. It is believed that this field and garden pea seed industry will remain and increase for the quality of seed peas produced in eastern Idaho is unsurpassed.

*Alfalfa and clover seed.*—Alfalfa seed constitutes the commercial crop of certain sections of the State. It is probably the most difficult of any now grown in the State to produce. There are many factors which enter into the successful production of a good seed crop. Various methods are under trial at the Aberdeen station to determine what methods in production are best to follow. The recently issued bulletin No. 101 of the Idaho Station sets forth the most recent information the superintendent of this station has at hand in the production of alfalfa seed in southern Idaho.

The clover varieties did not yield as well this year as last. All of them were more or less winter-killed. The yield and information obtained, however, are valuable in many ways. As a result of demonstrations on the station farm, many fields of clover will be planted in this section for seed production. Bulletin No. 100 of the Idaho Station on clover-seed production discusses most of the important essentials in the production of the clover-seed crop.

*Potatoes.*—The potato work has been carried on along the same lines as heretofore. Experiments to determine the proper size of seed piece, best methods of planting, proper distances of planting in rows, and best irrigation practice, and also in selection for improvement by means of the tuber-unit method, are being carried out. Valuable information has already been secured and will be available for publication in the near future. Several thousand pounds of good seed were sold to farmers this year. Every grower reports excellent returns. Potatoes of a better quality are being shipped out of this section and a reputation has already been established for this section of the State as a source of good seed. Shipments have been made to other localities in Idaho and Utah.

*Sugar-beet seed.*—Two hundred and eighty pounds of seed were obtained from .12 of an acre of sugar beets grown for seed production. There were five hundred and forty-two mother beets planted and the average yield of seed per beet including a few which did not grow was 8.2 ounces. Seed for the 1918 crop will cost farmers twenty-five cents per pound. From fifteen to twenty pounds of seed are usually planted

to the acre. At this rate of cost for seed, the home production of the seed crop is worth consideration on the part of the farmer. There is no reason why farmers should not grow their own sugar-beet seed instead of depending for it upon the sugar-beet companies who until very recently obtained practically all of their seed from Germany and Russia.

*Seed marketing.*—The cleaning plant installed two years ago is doing very good work and farmers as far away as fourteen miles bring seed to the station to be cleaned. A large car of peas grown on contract for the government was again shipped from this section. Several lots of Grimm alfalfa have been marketed by the superintendent for growers who obtained good prices for it. All seed cleaned over the station mill is guaranteed as to grade and purity and because of this many sales are being made.

*Extension and demonstration.*—Several trips were made into the various sections of the State. Some of them were made at government request to investigate the clover and cereal-seed situations. Others were made at the request of farmers of the sections visited and one was made into Owyhee county at the request of the University to see what could be done in the way of increasing hay production on a large cattle ranch.

The superintendent of the station has attended several institutes where he talked on dry farming and production of clover and alfalfa seed. He also visited four fairs for the purpose of judging the displays of farm crops.

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### CALDWELL SUBSTATION

C. M. EKLOF, Superintendent

Projects: (1) Dairy-herd management. (2) Pork production. (3) Variety testing of small grains. (4) Farm crops. (5) Land clearing. (6) Yard improvement.

The work of the Caldwell station for the year 1917 is the first in a number of years to have been carried on under the direction of a superintendent devoting his entire time to the development of the farm. Readjustments and changes were necessary and tended to reduce the attention and time that would otherwise have been used in experimental work. The uncertainty of the financial support at the first of the year and subsequently the shortage of labor left some of the improvements unfinished.

*Dairy herd improvement.*—At the beginning of the year the dairy herd numbered thirty head. It consisted of the foundation stock purchased in 1915 and a part of their offspring. No steps had been taken toward herd improvement by the weeding out of the unprofitable animals. It was soon found that some of the animals might well be disposed of. Six cows were sold during the summer because they were either low in milk production, gave milk of low butter-fat content, or showed poor dairy conformation. A number of yearling heifers and calves were also sold during the year. The herd at present consists of ten cows, six heifers and one pure-bred bull. Two of the cows, a dam and her daughter,

ter, are pure bred. The performance records of the nine older cows for two years are summarized in the following table:

*Production records.*

Cow	1916	Milk	1917 Test	B. F.
Bigenuf .....	4686.9 lbs.	9352.0 lbs.	4.2	392.78 lbs.*
Dinah .....	7806.5	7639.2	3.3	252.09
Silky .....	5129.0	7759.7	3.8	246.86
Minnie .....	5394.0	7673.9	3.6	275.25
Pride .....	8140.5	10567.6	3.3	337.73
Slim .....	3227.0	7178.5	3.5	251.25
Prilly .....	3591.7	4868.0	3.3	160.65
Newlywed .....	9553.7	11123.0	3.3	367.05
Precious .....		5762.9	3.1	178.65

It is to be noted that the poorest cow, Prilly, gave only 160.65 lbs. of butterfat which at the present price of fifty cents makes her butterfat yield for the year amount to only \$80.30. Under ordinary years she would be very low. Considering the present high cost of feed stuffs, she falls far below her cost of maintenance. She would have been disposed of long ago but for the fact that she was the only pure-bred cow in the herd and it was desired to give her another chance.

*Pork production.*—This is a continuation of the "hogging-off work" conducted on this station last year. Five different crops were used for the hogging-off: (1) alfalfa, (2) peas, (3) peas and wheat, (4) wheat, (5) corn. The results of the experiment are summarized in the following table:

*Results of hogging-off work*

Crop	Area acres	No. pigs	Days on crop	Initial wt. lbs.	Final wt. lbs.	Gain or loss lbs.	Gain or loss per acre	Value per acre at 14c per lb.
Alfalfa .....	2	25	62	2340	2234	106	83.0 loss	\$11.74
Peas .....	1½	33	17	2637	3054	417	275.2 gain	38.53
Peas and wheat .....	1	33	14	3054	3420	366	366.0 "	51.25
Wheat .....	1	32	15	3270	3688	418	418.0 "	58.50
Corn .....	1	32	7	3688	4237	275	275.0 "	38.50*

It is interesting to note that in the case where the pigs were on alfalfa alone, they lost in weight. The greatest loss was sustained by the ten largest of the pigs turned in. This was due to the fact that they were much fatter than the others. It is quite evident from this experiment that it is not advisable to feed a one-sided ration.

*Variety-testing of small grains.*—The various plats of varieties very plainly showed the necessity of conducting all such experiments in duplicate and preferably in triplicate. The necessity for this lies in the extreme variability of the soil. "Slick spots" are scattered thru the good soil so thickly that a newly-plowed field looks like patch work. Their area makes up from forty to seventy-five per cent of the fields. Conse-

quently hardly one of the grain plats had a uniform height. All varied in height from seven inches up to three feet.

A few plats planted on the dry-farmed part of the station were doomed to failure. The soil there as a rule is shallow. It varies in depth from six inches to three feet and is underlaid with a hard calcareous hardpan. The soil reservoir for water storage is very poor. Dicklow and Marquis wheat, Beldi barley, Amraoti peas, Kursk millet and Sudan grass were planted in twenty-inch rows to obtain some idea of the possibility of growing grains with cultivation under dry-land conditions. Three acres of Marquis and three of Early Baart wheat were planted with straight drilling. Everything looked favorable until the first hot weather in June when all the crops withered away within a week's time.

Acre-increase plats of peas of the following varieties were planted: Amraoti, Blue Prussian, White Colorado, Bangalia and Wellwood. Due to a bad break in the New York canal above Boise in midsummer these suffered with lack of water. Average yields of four bushels per acre were obtained.

Altho the remaining grain varieties had sufficient water they were variable because of the lack of uniformity of the soil. Lack of ground prevented their being planted in duplicate.

Of the oats, the varieties showing the best were: Swedish Select, Victor, and Silvermine.

For wheat, Palouse Bluestem ranked first and Dicklow second. Dicklow as a rule is the heaviest yielder.

For barley, Bohemian, Beldi, Holland, Trebi, and Sandrel were the best.

*Farm Crops.*—During the summer about one hundred and ten tons of alfalfa hay were put up from the forty acres of meadow. The greater part of the hay was injured by the lack of water during the summer, resulting in the lowering of quality and acre-yield.

Other crops raised were: corn for silage, oats, and barley. The corn and oats were also affected by the shortage of water. The barley made a good account of itself averaging fifty-two bushels per acre.

*Land clearing.*—It was the intention of clearing, thoroly leveling, and cropping forty acres of sagebrush in addition to that already in cultivation. The uncertainty of funds made it possible to plow but thirty-five acres and crop fifteen. There still remain about one hundred and thirty acres of sagebrush land which should be cleared gradually and cropped as time and funds permit.

*Yard improvement.*—A number of old shacks have been torn down and a large roomy machine-shed built. A cellar has been dug around the water system and the pump and engine placed down in it to prevent their freezing in the winter. A small house has been built above it to be used for a milk house. The old milk house has been moved and with slight repairs will be made into a much needed bunk house for hired help. Fences have been built and repaired to a considerable extent.

*Relation of farm to the community.*—There is an urgent request

among the farmers that this station take up the problems peculiar to the farms situated under similar conditions.

Farmers all want pure and high-yielding seed and high-class live stock and naturally look to this farm to help supply their needs. The farm has the beginning of a pure-bred herd of Poland China hogs. After another year's experimentation with grain varieties, it should increase the best for distribution among farmers. It is to be regretted that the pure-bred cows should give such poor account of themselves. It will be necessary to sell them and substitute superior animals.

### THE JEROME SUBSTATION\*

G. W. DEWEY, Superintendent

Projects: (1) Greened vs. ungreened seed. (2) Mature vs. immature seed. (3) Investigation of foreign seed. (4) Whole vs. cut seed. (5) Irrigation investigations. (6) Investigation of varieties.

The potato investigations conducted at the Jerome substation for the season of 1917 were in continuation of the various lines of work started in 1915 and 1916. Climatological conditions were different in 1917 from preceding years, in that the hot dry weather came in July instead of August. The effect of this hot dry weather was the checking of vegetative growth and the appearance of disease. Moderate weather conditions during August had a tendency to counteract the disease and fair to good yields resulted.

*Greened vs. ungreened seed.*—Seed for the entire experiment was selected from two varieties, Netted Gems and Idaho Rurals, soon after digging. The experiment consisted of "fall greened," "greened and sprouted," and a check of ungreened seed.

One-third of the lot comprising the "fall-greened" seed was placed in a moderately warm lighted room and held for six weeks. The tubers at the end of this period were distinctly green in color and were then placed in storage.

The tubers for the "greened and sprouted" seed were taken from storage about four weeks before planting time, treated with corrosive sublimate and placed in a warm, lighted room. At the time of planting the skins were green and each eye had developed a short, sturdy green sprout about a quarter of an inch in length. The seed pieces were planted with considerable care to prevent breaking off the sprouts.

The tubers of the ungreened and "fall-greened" seed were treated with corrosive sublimate at the same time as those for the "greened and sprouted" lot, returned to storage and held until planting time.

Satisfactory results in favor of the "greened and sprouted" seed were obtained.

*Mature vs. immature seed.*—In this investigation, two varieties,

\* The Jerome Substation is owned by the State and was equipped by the State for experimental and research work with potatoes and root crops. At present it is being operated under a lease by the Bureau of Plant Industry of the Federal Department of Agriculture. The Superintendent makes detailed reports yearly to the chief of his department. The results of work done on this station are made public thru Farmers' bulletins and technical journals. This report merely indicates the principal lines of investigation. The superintendent, however, gives freely of his time to local extension work and will gladly answer questions put to him regarding the potato-growing industry.

Netted Gems and Idaho Rurals, were employed. A quarter of an acre was devoted to each variety and the experiment was carried on in three different plats. The *unmatured seed* was secured by planting the first of July, 1916, and harvesting immediately after the first killing frost. The *matured seed* was secured by planting the latter part of May and harvesting about two weeks after frost.

Favorable results were secured from the unmatured seed.

*Investigation of foreign seed.*—This work was undertaken to determine the relative merits of seed obtained from outside sources and hill-selected stock from the station. In every instance the results secured were in favor of the outside seed.

*Whole vs. cut seed.*—The whole and cut seed investigations were continued with both Netter Gems and Idaho Rurals. They consisted of three hundred hills each of six, five, four and three ounce tubers, whole, halved and quartered; two ounce whole and halved, and one ounce whole. A preliminary report is soon to be made on this work in a department publication.

*Irrigation investigations.*—The irrigation investigations, dealing entirely with the time of application of irrigation water, were conducted with both Netted Gems and Idaho Rurals. Results of a satisfactory nature have not as yet been obtained.

*Investigation of varieties.*—Fifty commercial varieties, twenty-five South American varieties and a number of seedlings were grown during the past season. Of the commercial varieties the Idaho Rural, Netted Gem, Irish Cobbler and Early Ohio ranked in the order named. The South American varieties developed nothing of commercial importance. Several of the seedlings show promise and will be given further trial.

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### THE SANDPOINT SUBSTATION

F. H. LAFRENZ, Superintendent

Projects: (1) Dairy-herd management. (2) Pork production from forage crops. (3) Variety tests of small grains. (4) Forage crops. (5) Soil improvement. (6) Land clearing. (7) General improvements. (8) Local extension.

The work on the Sandpoint station centers pretty largely around the dairy herd. Under ordinary conditions of ownership no better method is known of securing an immediate income from the stump lands from the time they are first taken over for farming purposes than that which converts them into clover and other tame-grass pastures for the use of dairy herds, sheep, and hogs. For the most successful growing of small grains and forage crops, the cleared stump lands require applications of barnyard manure in rather heavy amounts and that can be best and most quickly secured from a herd of dairy cattle. The development of these lands and the dairy industry then go well together. The climate of the "Panhandle" of Idaho is splendidly adapted to the dairy industry. The lumber, mining, and other manufacturing industries promise a steady and certain market for all dairy products. The station is not yet properly stocked with hogs. An increase will be made for the coming year's work. A flock of sheep will also be secured for flock-management work. To

a certain extent the Sandpoint station will become eventually a center for the distribution of good breeding animals.

Five colonies of bees were purchased during the year for the purpose of securing first-hand information on honey production in this section of the State.

*The dairy herd.*—From January 1 to December 31, 1917, the dairy herd produced a total of 62,238 pounds of milk. The production record of each animal is indicated in the table below. The milk was sold to the Pend d'Oreille Creamery and to local dealers for a total of \$1377.00. In the herd were born during the year two pure-bred heifer calves, three grade heifer calves, two pure-bred bull calves, and one grade bull calf. Unfortunately two of the heifer calves died from what appeared to be some sort of forage poisoning. In spite of the most careful search the actual source of poisoning has not been determined. Three yearling steers were sold during the year. The total income from the herd amounted to \$1542.00.

*Milk production record (in pounds), Sandpoint herd.*

Month	Edith	Jennie	Cameille	Bess	28	29	32	35
January		721	958		529	653	856	700
February	194	618	829	194	382	617	802	634
March	1226	500	900	973	52	629	716	583
April	1219	89	760	859	704	497	479	409
May	1193	267	641	815	913	524	569	415
June	1164	1359	783	925	901	484	579	176
July	1152	1250	686	746	814	873	277	1171
August	1071	1168	259	553	782	935	625	1160
September	816	972		331	614	780	859	995
October	576	741	670	58	437	550	731	744
November	550	420	1180		399	547	683	690
December		289	1017		333	550	682	612
Total	9031	8524	8683	5454	6860	7629	7868	8189

Mill stuffs have been used in the feeding of the dairy herd but at a price this year that was almost prohibitive. Present plans include the erection of a silo at the earliest possible opportunity. Silage crops like oats and peas or wheat and vetch can be grown very successfully in this part of the State.

*Pork production.*—Two-thirds of an acre of field peas were grown for "hogging-off" work. On September 15 three Berkshire shoats weighing 378 pounds were turned in to harvest the crop. They completed the work by October 7 with a total gain of eighty-four pounds. They received no other feed. The acre-income with pork at sixteen cents per pound was \$19.68. The acre-income last year on similar work was \$17.76 with pork valued at nine cents per pound.

*Variety tests with small grains.*—Three varieties representing early-, medium-, and late-maturing oats were grown this year under like conditions to determine which was best adapted to conditions similar to those which prevail on the Sandpoint farm. From the data given below it is evident that the later maturing varieties appear best adapted to this section.



Variety	Yield in bushels per acre	Days from sowing to maturity
Early Mountain .....	26.9	84
Clydesdale .....	41.6	93
Kerches .....	31.2	98

*Forage crops.*—Black winter emmer and winter vetch (*Vicia vilosa*) seeded on summer fallow August 10 produced excellent calf pasture in five weeks. There was a very heavy growth at least a foot in depth.

One pound each of Turkestan, dry-land, and Grimm alfalfa was hand-planted in a well prepared seed bed. One-half of each plat was given an application of lime at the rate of two thousand pounds per acre. The results thus far obtained are not very encouraging but the Turkestan variety appears to be most promising.

*Soil improvement and crop rotation.*—The average yield of seven one-tenth acre plats of wheat for the past three years is: 1915, 42.7 pounds; 1916, 50.4 pounds; 1917, 73.8 pounds. In the series given over to crop-improvement studies, plat 7A which was in clover in 1916 produced 101 pounds of wheat in 1917, a gain of 45 per cent over the average of the other six plats and a gain of 53 per cent over the three years' average yield of all the plat. There is no question as to the value of clover as an improver of soils in these cut and burned-over lands. (See also report of the Department of Soils.)

*Land clearing.*—Approximately thirty acres of land were slashed and burned. A total of 480 hours were spent in the work. On this freshly burned-over land experiments will be conducted with different pasture mixtures.

*General improvements.*—Two new buildings were erected during the year. The helper's cottage was erected at a total cost of \$284, the half-monitor poultry house at a total of \$62.60.

*Local extension work.*—In addition to the regular farm work, two hundred or more visitors with numerous questions to ask have been taken care of. One hundred and forty names and addresses have been taken. One hundred and thirty letters of inquiry have been answered. Four articles have been published in local newspapers. Weather and crop observations have been made and reported to the United States Department of Agriculture monthly and weather observations to the United States Department of Forestry weekly. Sixty-two names have been sent to the Director's office to be placed on the mailing list. Seventeen trips were taken among farmers to learn more of their problems and to vaccinate cattle when requested to do so. A total of forty-six farmers have been visited. The superintendent has served as judge at two local fairs and has spoken before gatherings of farmers on two different occasions.

## Financial Statement

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

	Hatch Fund	Adams Fund
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DR.		
To balance from appropriations for 1915-16.....	None	None
Receipts from the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1917, under acts of Congress approved March 2, 1887 (Hatch Fund) and March 16, 1906 (Adams Fund) .....	\$15,000.00	\$15,000.00
Cr.		

	Abstract		
By salaries .....	1	\$ 9,333.76	\$ 8,999.24
Labor .....	2	2,595.74	1,955.09
Publications .....	3	245.69	
Postage and stationery .....	4	281.50	43.70
Freight and express .....	5	69.55	515.64
Heat, light, water, and power .....	6	29.70	57.79
Chemicals and laboratory supplies .....	7	170.56	864.90
Seeds, plants, and sundry supplies .....	8	287.93	467.73
Fertilizers .....	9	.75	
Feeding stuffs .....	10	820.13	78.69
Library .....	11	11.25	
Tools, machinery, and appliances .....	12	333.10	129.82
Furniture and fixtures .....	13	353.80	77.67
Scientific apparatus and specimens .....	14	28.46	1,162.37
Livestock .....	15		
Traveling expenses .....	16	381.98	575.41
Contingent expense .....	17	20.00	
Buildings and land .....	18	36.10	71.95
Total.....		\$15,000.00	\$15,000.00

## Financial Statement—Local Station Funds

July 1, 1916 to December 31, 1917

## RECEIPTS:

Interest on deposits .....	\$ 335.71
Department of Animal Husbandry, sale of livestock.....	424.50
Department of Bacteriology, sale of legume inoculating cultures*.....	
Department of Chemistry, sale of flour.....	96.20
Department of Farm Crops, sale of seeds.....	237.39
Department of Horticulture, sale of produce.....	1,842.29
Department of Poultry Husbandry, sale of eggs and fowls.....	378.36
Department of Soils, sale of grains and potatoes.....	149.10
Total.....	\$3,463.55

## DISBURSEMENTS:

Disbursements	Ad-min.	An. Husb.	Bact.*	Chem.	Dairy	Farm Crops	Hort.	Poul-try	Soils	Totals
Labor .....		34.45		15.10	50.00	260.08	454.03			813.66
Freight and exp.	1.94		.50	2.20		.68	12.72		9.15	27.19
Supplies .....	57.07	36.77		57.49	13.85	84.78	137.58	5.85	14.52	407.91
Postage & staty..	24.51			28.92		1.49				54.92
H't, light, pow'r							13.42			13.42
Feeding stuffs ..		50.00					15.69	121.20		186.89
Livestock .....		140.40					400.00			540.40
Library .....	161.00			68.79						229.79
Furniture & fix.							6.50			6.50
Tools & Mach'y.		91.56		78.20		2.75	225.55		10.00	408.06
Traveling exp. .	52.45			5.90		89.40	80.25		62.87	290.87
Bldgs. & repairs		155.79					145.65	4.60		306.04
Advertising .....				.70						.70
Bulletins .....					49.50					49.50
Totals .....	296.97	508.97	.50	257.30	113.35	439.18	1491.39	131.65	96.54	3335.85

*Financial Statement—Substations' Receipts and Expenditures*

January 1, 1917 to December 31, 1917

RECEIPTS	Aberdeen	Caldwell	Gooding	Jerome	Sandpoint
Balance on hand .....	\$1,089.29	\$ 213.05	\$1,009.09	\$ 352.14	\$ 416.99 O. D.
Station receipts (from seed cleannig, sale of livestock, hay, surplus grain, pota- toes, milk) retained at Moscow .....		1,216.20	171.40	332.82	1,203.96
Station receipts (from same sources) remitted to Boise..	702.47	1,241.05			364.20
State appropriations, biennium	5,000.00	7,800.00			5,000.00
Totals .....	\$6,791.76	\$10,470.30	\$1,180.49	\$ 684.96	\$6,151.17

## DISBURSEMENTS

Salaries .....	\$ 675.00	\$2,674.77	\$ 306.81	\$	\$1,804.15
Sundry labor .....	792.25	868.10	9.50	112.35	69.75
Stationery & office supplies...	1.50	10.75	4.90		10.00
Freight and express .....	35.71	58.95	18.55		116.35
Bulletins and publications....	624.71		509.45	130.54	
Sundry supplies .....	262.11	374.48	4.00	35.80	215.20
Traveling expenses .....	291.72	86.29	119.90		15.50
Heat, light and power.....	83.78	80.65			21.09
Telephone and telegraph.....	35.38	33.60	7.75		21.65
Postage .....	12.90	12.66			5.00
Water .....		415.29	18.00		32.47
Feeding stuffs .....	225.00	83.57			749.38
Tools and machinery .....	262.80	582.20			529.65
Furniture and fixtures.....	5.85	15.10			66.55
Livestock .....		351.45			
Other equipment .....		66.40			6.55
Buildings and repairs .....	179.29	295.29		110.45	37.50
Totals .....	\$3,438.00	\$5,939.05	\$ 998.86	\$ 389.14	\$3,700.79

\* For income and expenditure of local station funds in the Department of Bacteriology see report of that department page 16.