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P. V. Cardon

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Biennial Report of Utah Agricultural Experiment Station

July 1, 1928 to June 30, 1930

P. V. CARDON



Sheep Grazing, Duck Lake, Utah. (Photo, R. D. Adams.)

Utah Agricultural Experiment Station

Utah State Agricultural College

LOGAN, UTAH

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GEORGE D. CLYDE, M. S.	Associate Irrigation and Drainage Engineer
A. C. ESPLIN, B. S.	Associate Animal Husbandman
GEORGE F. KNOWLTON, M. S.	Associate Entomologist
CHARLES J. SORENSON, M. S.	Associate Entomologist
H. LORAN BLOOD, Ph. D.	Associate Plant Pathologist
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CLARENCE BURNHAM, B. S.	Fellow in Fertilizer Experiments
DeWITT SMITH, B. S.	Graduate Research Assistant
GEORGE T. BLANCH, B. S.	Graduate Research Assistant
FLOYD CLARK, B. S.	Graduate Research Assistant

In Cooperation with U. S. D. A.

WESLEY KELLER, B. S.	Agent, Sugar-Beet Investigations, Bureau Plant Industry
HENRY DAINES, B. S.	Assistant in Sugar-Plant Investigations, Bureau Plant Industry

*On leave.

Biennial Report of Utah Agricultural Experiment Station

July 1, 1928 to June 30, 1930.

President E. G. Peterson.

Sir:

I have the honor to transmit herewith the report of the Utah Agricultural Experiment Station for the biennium ending June 30, 1930. This report includes the reports of the various departments as well as other information pertaining to the work and investigations of the Station during this period.

Respectfully,

P. V. CARDON, Director.

STAFF CHANGES

Director William Peterson, appointed Director of the Utah Agricultural Experiment Station on September 1, 1921, resigned on July 1, 1928, to become Director of the Agricultural Extension Service. P. V. Cardon, in Charge of Farm Management Investigations, was appointed Director of the Station beginning July 1, 1928.

Dr. H. J. Pack, Station Entomologist since July 1, 1926, died on January 5, 1930. No one was appointed to fill this position for the balance of the fiscal year.

H. Loran Blood and A. L. Wilson were each granted two years' leave of absence for further study at the University of Wisconsin and Cornell University, respectively.

The following changes in rank became effective on July 1, 1929:

- W. P. Thomas from Assistant in Farm Management to Agricultural Economist.
- R. J. Becraft from Assistant in Range Management to Associate in Range Management.
- G. D. Clyde from Assistant Irrigation and Drainage Engineer to that of Associate Irrigation and Drainage Engineer.
- A. C. Esplin from Assistant Animal Husbandman to that of Associate Animal Husbandman.

Acknowledgement: Acknowledgement is freely made of the work done by Blanche Condit Pittman, in charge of the Editorial and Publications Division, in connection with the preparation of this report. She is responsible for the compilation of results from departmental reports and for the organization of the biennial report as a whole.

Publication authorized by Director, July 11, 1930.

Resignations

- Miss Harriet Morgan, Assistant in the Department of Home Economics, resigned on July 1, 1928, to continue her studies.
- Mr. Charles A. Hymas, in Charge of the Sheep Experimental Farm near the college campus, resigned on January 1, 1929, to become county agricultural agent in Piute and Garfield Counties.
- E. G. Carter, Dr. P. H., associated with the Utah Station since 1914, resigned to give his full time to teaching work in the college.
- C. M. Tompkins, Ph. D., working under a cooperative arrangement with the Bureau of Plant Industry, U. S. Department of Agriculture, as Assistant Pathologist, and the Utah Station resigned early in January, 1930, to become Chief Pathologist of the Plant Research Department of the Goodyear Rubber Company at Dolok Marangir, E. C. Sumatra. This work was reorganized at the time of Dr. Tompkins' departure with Mr. F. G. Larmer, formerly at Rocky Ford, Colorado, in charge of the work with headquarters in Salt Lake City and with Henry Daines, B. S. '29, U. S. A. C., located in Logan working cooperatively with the Department of Botany and Plant Pathology, Utah Agricultural Experiment Station.

Appointments

- Kathleen L. Hull, Ph. D., appointed on July 1, 1928, as an assistant in the Department of Botany and Plant Pathology.
- D. E. Madsen, D. V. M., formerly Assistant in the Pathological Laboratories, State Department of Agriculture, Harrisburg, Pennsylvania, appointed Animal Pathologist, effective August 1, 1929.
- Harry H. Smith, B. S., connected with the teaching staff of the college since 1926, appointed Assistant Station Animal Husbandman, effective July 1, 1929.
- Hamlet C. Pulley, a graduate of the Utah State Agricultural College in the class of '29, appointed Assistant Bacteriologist, effective July 1, 1929.
- Edith Hayball, also a graduate of the Utah State Agricultural College, appointed Assistant Statistician, effective July 1, 1929.
- Stella Sorenson and Maida Muir, '29 graduates of the U. S. A. C., appointed Stenographers in the office, effective July 1, 1929.
- Clarence Burnham, graduate in the class of '29, U. S. A. C., appointed as Fellow for the Barrett Scholarship, effective July 1, 1929.
- George Whornham, B. S., U. S. A. C., appointed Assistant Field Agronomist, effective July 1, 1929.
- Cyrus Clark, Claude Zobell, W. W. Stuart, George Henderson, and Alden Lillywhite, were appointed Graduate Assistants in the Departments of Physics, Chemistry, Botany, Animal Husbandry, and Rural Sociology, respectively, for the biennium beginning July 1, 1929.
- Wesley Keller, B. S., '29, U. S. A. C., on July 1, 1929, appointed Agent, Sugar-Beet Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, to work cooperatively with the sugar-beet breeding work at this Station.

SALES

The sales for the past biennium totaled \$44,663.33.

EQUIPMENT

During the past biennium equipment purchased by the various departments of the Experiment Station included the following major items:

Thelco electric incubator; International centrifuge; Bausch and Lomb compound microscope; two electric muffle furnaces; electric refrigerator unit; sensitive galvanometer; millammeter; 2 gas tanks; platinum dishes; H-ion concentration apparatus; binocular microscope; self-recording thermograph; hygrometer; potentiometer; microphone hummer; 4-dial resistance box; two sets meteorological equipment; R. K. Rokym Metabolism machine and other necessary equipment for conducting metabolic tests; binocular microscope; five electric calculating machines; herbarium equipment; abney level; planimeter; two Ford trucks; 1 house costing \$800 constructed on Carbon County Substation; 1 machine shed, stable, granary, etc., costing \$700 constructed on the Carbon County Substation; machine shed costing \$500 erected on San Juan County Substation; two teams of horses and harness outfits; beet and bean cultivators; grain drill; potato and corn combination cultivator; beet drill; mowing machine; 1 set of platform scales; side delivery rake; grain binder; manure spreader; two steel grain bins; bookcases, office desks, filing cases, etc.

Several departments of the Station have purchased books on Station funds during the past biennium. Outstanding among these is ZOOLOGICAL RECORD, Vols. 53-61, to complete the set which has been in the Station Library for many years. These last volumes were purchased by the Department of Entomology. Records of all books purchased by various Station departments are kept in the Station Library where each book is properly accessioned and then returned to the department making the individual purchase.

SUBSTATIONS

During the past biennium no substations have been added and two substations heretofore carried by the Station have been formally dropped during this period. These are: (1) The experimental farm near Kanab in Kane County, in the extreme southcentral part of the state which had been operated formerly as a dry-land substation but which had served its purpose. (2) The Sheep Experimental Farm, located near the college campus, which had been leased from the county, the lease of which expired during this period. Plans were made to transfer the sheep investigations to the Panguitch Livestock Experimental Farm near Panguitch, Garfield County. This transfer was accomplished on October 1, 1929.

ESTABLISHMENT OF ANIMAL DISEASE LABORATORY

During the regular legislative session of 1929-30 a special State appropriation of \$25,000 was made for building, equipment, and maintenance of an animal disease laboratory. This appropriation became available July 1, 1929. The purpose of this laboratory is to render such service to the state as may be necessary in regard to diagnosis and the solution of serious animal disease problems confronting the livestock industry of Utah. A competent graduate veterinarian has been placed in charge of this laboratory.

COOPERATIVE RESEARCH

Through the aid of cooperative research with other agencies, both federal and private, the Experiment Station has been able to make greater progress along certain investigational lines than would otherwise have been possible. Briefly stated, this cooperative research is as follows:

(A) U. S. Department of Agriculture**1. Bureau of Plant Industry.**

Development of Uniform Types of Pure Lines of Sugar-beets for Testing for Resistance to Curly-top.

Plant Disease Survey of Utah.

Sugar-beet Disease Investigations: Root and Storage Rots.

Diseases of Vegetables and Related Plants: Potato Diseases.
(In cooperation with Oregon and Montana Stations.)

2. Bureau of Entomology.

Feeding Value of Alafalfa Hay Treated with Calcium Arsenate for Destroying Injurious Insects.

Sugar-beet Leafhopper (*Eutettix tenellus*)—Life-History, etc.
(In cooperation with Idaho Station.)

Psyllid Yellows of Potatoes—Insect Aspect.

3. Bureau of Dairying.

Study of Relation of Conformation and Anatomy of the Dairy Cow to Her Producing Ability.

Continuous Use of Proved Sires to Breed Dairy Cattle That Will Be Pure in Their Inheritance for High Milk and Butterfat-Producing Capacities.

4. Bureau of Public Roads.

A Study of Some Factors Which Influence the Reclamation of Waterlogged and Alkali Lands.

5. Bureau of Agricultural Economics.

Economic Factors Affecting the Production and Marketing of Utah's Poultry Products.

Wheat Statistics.

6. Forestry Service.

Sheep and Wool Studies.

Range Studies.

Snow Surveys.

7. Weather Bureau.

Underground Water Studies.

Snow Surveys.

(B) Miscellaneous

1. **California Agricultural Experiment Station.**
The Nutritive Value of High vs. Low Calcium and Phosphorus-Carrying Wheat.
2. **Wisconsin Agricultural Experiment Station.**
Tomato Diseases in Utah—Fusarium Wilt and Bacterial Canker.
3. **Amalgamated Sugar Company.**
Commercial Sugar-beet Varieties (Miscellaneous Field Crops.)
4. **Extension Service, University of Nevada.**
Cooperative Marketing of Utah's Agricultural Products.
5. **Utah Poultry Producers Association.**
Economic Factors Affecting Production and Marketing of Utah's Poultry Products.
6. **Federal Farm Board.**
Grain Survey.
Economic Factors Affecting Production and Marketing of Utah's Poultry Products.
7. **Extension Service, Utah State Agricultural College.**
Cereal Variety Tests.
Use and Effects of Fertilizers on Soils of State.
Analysis of Irrigation Waters of State.
8. **Department of Dairy Manufacturing, Utah State Agricultural College.**
Effect of Physical Curd Character of Milk on the Quality, Yield, and Physical Texture of Cheese.
9. **State Department of Agriculture.**
Weed Control.
Alfalfa-seed Production in Millard County.
Alfalfa-seed Production in Uintah Basin.
Cereal Variety Tests.
Virus Diseases of the Potato and Factors Influencing Their Development and Control.
10. **Monroe and Delta Lamb Feeders Associations.**
Lamb-feeding Experiments on Winter Dry-lots.
11. **The Barrett Company, New York.**
Fellowship established in 1928-29 for purpose of ascertaining the ultimate value of use of ammonium sulphate as a commercial fertilizer.
12. **Various Fertilizer Companies.**
Fertilizer experiments conducted throughout state.
13. **Farmers.**
Soil, crop, and livestock investigations in different parts of the state.

Preliminary arrangements have been made with the U. S. Bureau of Agricultural Economics, Plant Industry, and Weather Bureau, Forest Service, and Dairy Industry for further cooperation beginning July 1, 1930. It is possible, also, that by the time this report is published further cooperation with feeders will have been established.

LIBRARY

No. Bound Volumes on Shelves:

Experiment Stations	1354
U. S. Department of Agriculture	1107
Department of Interior	581
Miscellaneous, including Technical and Scientific Journals	574
State Departments of Agriculture	429
Smithsonian Institution (U. S. National Museum)	177
Bureau of Commerce	69
Library of Congress	31
Foreign	739
Total Bound Volumes on Shelves	5061
Technical Journals and Popular Magazines	
Received and Regularly Checked	150*

In the summer of 1929 a new system of filing was installed which greatly facilitates this work. A list of technical and popular journals and magazines regularly received by the Station Library is accessible to all interested members of the Station Staff. The Library has made remarkably rapid growth during the past biennium. It is used constantly by staff members and by senior and upperclass students.

PUBLICATIONS

The Station activities in publications have increased considerably during the past biennium. Twelve bulletins, 15 circulars, and 44 reprints of technical articles have been edited and issued, making a total of 71 publications as compared with 48 for the previous 2-year period. In addition, there are several others ready which will appear in the near future in printed form.

The findings of the Utah Agricultural Experiment Station are published in the following series of publications: (1) Bulletins, (2) circulars, and (3) technical articles which appear in various scientific journals.

At the end of each fiscal year an annual summary of publications is issued which is sent to the entire mailing list of some 10,000 names. Circular No. 78, annual summary of publications from July 1, 1928 to June 30, 1929, reviews four bulletins, five circulars, and 22 reprints of technical articles which appeared during that period. Circular No. 88, which is now in course of preparation, will review the 71 publications appearing for the period from July 1, 1929 to June 30, 1930.

A concise statement regarding publications edited and published by the Division of Publications for the past biennium follows:

*Does not include regular publications of U. S. D. A., state experiment station publications, state extension service divisions, state departments of agriculture, etc.

Bulletins

No.	Title	Author or Authors	No. Ordered	Total Pages	Cost Data		
					Printing	Engraving	Total
208	An Economic Study of the Apple Industry in Utah, 1926 and 1927	W. P. Thomas P. V. Cardon	3500	252,000	\$421.45	\$ 65.36	\$486.81
209	Biennial Report of Experiment Station, 1926-28, inclusive	Wm. Peterson*	2000	168,000	184.80	.....	184.80
210	The Mineral Content of Grains	J. E. Greaves C. T. Hirst	3000	114,000	150.00	.....	150.00
211	Silage Corn Varieties for Utah	George Stewart A. L. Wilson	3500	56,000	100.00	12.70	112.70
212	Studies on the Morphology of the Beet Leafhopper	G. F. Knowlton	2000	48,000	95.96	54.50	150.46
213	Food Habits of Utah Farm Families	Almeda P. Brown	3100	62,000	118.78	.....	118.78
214	An Economic Survey of the "Dixie" Section, Washington County, Utah	W. P. Thomas	2500	140,000	284.30	34.19	318.49
215	Cost Reduction in Dry-farming in Utah	P. V. Cardon	2500	90,000	138.65	27.81	166.46
216	Notes on Miscellaneous Insects of Utah	H. J. Pack**	2000	64,000	155.20	34.30	189.50
217	Prices of Farm Products in Utah	W. P. Thomas	3000	180,000	380.65	70.80	451.45
218	The Alfalfa-seed Chalcis-fly in Utah, 1927-29, inclusive	C. J. Sorenson	3500	126,000	186.00	26.34	212.34
219	Twenty-eight Years of Irrigation Experiments Near Logan, Utah, 1902-29, inclusive	D. W. Pittman George Stewart	3500	56,000	84.00	31.00	115.00
TOTALS			341,000	1,356,000	\$2,299.79	\$357.00	\$2,656.79

*Resigned as Director of Utah Agricultural Experiment Station, July 1, 1928.

**Compiled by G. F. Knowlton. H. J. Pack died January 5, 1930.

Circulars

No.	Title	Author or Authors	No. Ordered	Total Pages	Cost Data		
					Printing	Engraving	Total
73	Annual Summary of Publications, July 1, 1927 to June 30, 1928	B. C. Pittman	7,000	84,000	\$104.00	.....	\$104.00
74	Rules and Regulations for the Fifth Utah Intermountain Egg-laying Contest	Byron Alder	2,000	8,000	20.00	.....	20.00
75	Selecting Dairy Cows	G. Q. Bateman	5,000	40,000	45.00	10.25	55.25
76	The Utah Agricultural Experiment Station	P. V. Cardon	4,000	16,000	26.50	.....	26.50
77	Measurement of Irrigation Water . . .	G. D. Clyde	5,000	200,000	283.05	13.75	296.80
78	Annual Summary of Publications	B. C. Pittman	10,000	80,000	103.00	.....	103.00
79	Rules and Regulations for the Sixth Utah Intermountain Egg-laying Contest	Byron Adler	2,000	8,000	19.00	.....	19.00
80	Domestic Slaughtering, Cutting, and Curing of Pork	H. H. Smith	5,000	100,000	138.40	8.88	147.28
81	Beef Slaughtering, Cutting, and Curing	H. H. Smith	5,000	80,000	110.72	6.00	116.72
82	Lamb Slaughtering and Cutting	H. H. Smith	5,000	80,000	110.72	81.50	192.22
83	Planning, Planting, and Caring for the Young Orchard	F. M. Coe	5,000	160,000	192.00	54.34	246.34
84	Building Young Deciduous Fruit Trees	F. M. Coe	5,000	160,000	192.00	42.47	234.47
85	Chlorosis: Yellowing of Plants	F. B. Wann	3,500	42,500	62.82	4.60	67.42
86	Coccidiosis of Chickens	D. E. Madsen	6,000	24,000	37.00	3.40	40.40
87	Raising Dairy Calves	G. B. Caine	4,000	48,000	100.00	9.20	109.20
TOTAL			76,000	1,130,500	\$1,544.21	\$234.39	\$1,778.60

Technical Articles

Reprint No.	Title, Author or Authors, and Source of Publication	No. Ordered	Cost Data		Total
			Printing	Cuts	
107	The Drainage of Land Overlying Artesian Basins. By W. Gardner, O. W. Israelsen, and W. W. McLaughlin. ² SOIL SCIENCE, 26: 33-45 (July, 1928)	300	\$15.15	\$.....	\$15.15
108	Effect of Size of Seed Set on Yield and on Certain Other Characters in Potatoes. By D. C. Tingey and George Stewart. JOUR. AMER. SOC. AGRON., 20:710-21 (July, 1928)	200	13.75	.....	13.75
109	Penetration of Ultraviolet Rays through Clothing Materials, Pt. II. By Harriet Morgan. ³ AMER. JOUR. PHYSIOL., 86:32-35 (August, 1928)	450	12.14	.....	12.14
110	A Few Western Aphids with Descriptions of Three New Species. By G. F. Knowlton. ANN. ENT. SOC. AMER., 21:259-268 (June, 1928)	300	8.00	19.17	27.17
111	The Nitrogen-fixing Microorganisms of an Arid Soil. By E. G. Carter and J. Dudley Greaves. SOIL SCIENCE, 26:179-197 (September, 1928)	250	12.70	.....	12.70
112	Correlated Inheritance in Kanred x Sevier Varieties of Wheat. By George Stewart. JOUR. AGR. RSCH., 36:873-896 (May, 1928)	250	4.75	.....	4.75
113	Notes on a Few Species of Neothomasia from Utah (Homop.: Aphididae). By G. F. Knowlton. ENT. NEWS, 39:233-235 (October, 1928)	200	5.00	3.85	8.85
114	The Influence of Soluble Salts and Organic Manures of Soil Nitrogen. By J. E. Greaves. PROC. and PAPERS 1st INTERN. CONG. SOIL SCI., 3:213-221 (June, 1927)	300	18.52	.....	18.52
115	Soil Microbial Stimulants. By J. E. Greaves. PROC. and PAPERS 1st INTERN. CONG. SOIL SCI., 3:222-228 (June, 1927)	300	12.79	.....	12.79

²Associate Chief, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture.³Resigned July 1, 1928.

Technical Articles

Reprint No.	Title, Author or Authors, and Source of Publication	No. Ordered	Cost Data		Total
			Printing	Cuts	
116	A Genetic Recombination for the Expression of Awns in Wheat. By George Stewart and D. C. Tingey. <i>AMER. NATURALIST</i> , 62:532-539 (November, 1928)	300	15.15	.....	15.15
117	The Influence of Iodine upon the Growth and Metabolism of Yeasts. By J. E. Greaves, C. E. ZoBell, ⁴ and J. Dudley Greaves. ⁴ <i>JOUR. BACTER.</i> , 16:409-430 (December, 1928)	300	16.88	.....	16.88
118	Notes on a Few Species of Macrosiphini (Aphididae) from Utah with Descriptions of Two New Species. By G. F. Knowlton. <i>PAN-PACIF. ENT.</i> , 5:79-84 (October, 1928.	250	16.50	.....	16.50
119	Development of Storage Diseases in Sugar-beets resulting from Hook Injury. By C. M. Tompkins ⁵ and S. B. Nuckols. ⁵ <i>PHYTOPATH.</i> , 18: 939-941 (November, 1928)	300	9.05	.....	9.05
120	Notes on a Few Species of Myzini (Aphididae) from Utah with Descriptions of Two New Aphids. By G. F. Knowlton. <i>CANAD. ENT.</i> , 61:9-15 (January, 1929) . .	200	16.00	24.57	40.57
121	The Usefulness of Capillary Potential to Soil-Moisture and Plant Investigators. By L. A. Richards. ⁶ <i>JOUR. AGR. RSCH.</i> , 37:719-742 (December, 1928)	250	5.00	.....	5.00
122	A New Juniper Aphid from Utah. By G. F. Knowlton. <i>FLA. ENT.</i> , 12(Pt. 1):59-62 (December, 1928); 13(Pt. 2):4-8 (March, 1929)	250	13.96	14.76	28.72
123	White-spot of Alfalfa and Its Relation to Irrigation. By B. L. Richards. <i>PHYTOPATH.</i> , 19:125-141 (February, 1929)	400	17.80	.....	17.80
124	Moving Water over Mountains in Irrigation. By G. D. Clyde. <i>HYDRAULIC ENGINEER</i> . 5:17-22 (April, 1929)	100	13.75	.....	13.75

⁴Graduate Research Assistant and Graduate Student, respectively, Department of Chemistry and Bacteriology.

⁵Assistant Pathologist and Associate Agronomist, respectively, Bureau of Plant Industry, U. S. Department of Agriculture.

⁶Graduate Student, Department of Physics

Technical Articles

Reprint No.	Title, Author or Authors, and Source of Publication	No. Ordered	Cost Data		Total
			Printing	Cuts	
125	The Mineral Content of Grain. By J. E. Greaves and C. T. Hirst. JOUR. NUTRIT. , 1 : 293 - 298 (March, 1929)	500	18.43	.....	18.43
126	The Phosphorus of Grains. By J. E. Greaves and C. T. Hirst. CEREAL CHEM. , 6 : 115 - 120 (March, 1929)	250	5.27	.....	5.27
127	Temperature Control Apparatus. By L. A. Richards. ⁶ JOUR. OPT. SOC. and REV. SCI. INSTRUM. , 18:131-137	100	4.90	.....	4.90
128	Inheritance Studies in Sevier x Odessa Wheat Cross. By George Stewart and Harold Price. ⁷ JOUR. AMER. SOC. AGRON. , 21:493-512 (May, 1929)	250	33.91	.....	33.91
129	Is Suphur a Limiting Factor of Crop Production in Some Utah Soils? By J. E. Greaves and W. Gardner. SOIL SCIENCE , 27: 445-457 (June, 1929)	300	11.40	.....	11.40
130	The Tribe Pemphigini (Aphidi- dae) in Utah. By Asa C. Maxson ⁸ and G. F. Knowlton. ANNALS ENTOMOLO. SOC. AMER. , 22: 251-271 (June, 1929)	300	14.00	.....	14.00
131	Comparative Acre-yields of Sug- ar-beet Varieties in the United States and Canada during 1928. By George Stewart. JOUR. AMER. SOC. AGRON. , 21:774- 791 (July, 1929)	500	42.00	.....	42.00
132	Correlated Inheritance in a Wheat Cross between Federation and a Hybrid of Sevier x Dicklow. By George Stewart and D. E. Heywood. JOUR. AGR. RSCH. , 39:368-392 (September 1, 1929) ..	300	8.00	.....	8.00
133	Influence of Organic Manures on the Chemical and Biological Prop- erties of Arid Soils. By J. E. Greaves. JOUR. AMER. SOC. AGRON. , 21:979-984. (October, 1929)	250	9.00	.....	9.00

⁶Graduate Student, Department of Physics.⁷Graduate Student, Department of Agronomy.⁸In Charge of Experimental Research, Great Western Sugar Company, Longmont, Colo.

Technical Articles

Reprint No.	Title, Author or Authors, and Source of Publication	No. Ordered	Cost Data		Total
			Printing	Cuts	
134	Some Aphid Notes from Utah. By G. F. Knowlton. PAN-PA- CIFIC ENTOMOLOG., 6:33-42 (July, 1929)	250	20.00	5.00	25.00
135	The Effect of Rain on the Snow Cover. By G. D. Clyde. MO. WEATH. REV., 57:328 (August, 1929)	250	3.50	.....	3.50
136	Notes on a Few Homoptera from Utah. By G. F. Knowlton. FLA. ENTOMOLOG., 13:45-51 (Sep- tember, 1929)	250	11.29	.....	11.29
137	Saving Time and Storage in Breeding Sugar-beets. By George Stewart. SCIENCE, 70:458 (No- vember 8, 1929)	300	4.37	.....	4.37
138	The Microflora of Leached Soils: I. Synthetic Alkali Soil. By J. Dudley Greaves. ⁹ SOIL SCIENCE, 28:341-346 (November, 1929) ...	250	6.25	.....	6.25
139	Change in Density of Snow Cover with Melting. By G. D. Clyde. MO. WEATH. REV., 57:326-327 (August, 1929)	250	6.25	.....	6.25
140	Stem-Rust-Resistant Segregates from Wheat Crosses between Two Susceptible Parents. By George Stewart. PHYTOPATH., 19: 1129-1130 (December, 1929)	260	2.52	.....	2.52
141	Snow Cover Measurements in Utah, 1914-29, inclusive. By G. D. Clyde. HYDRAULIC ENGI- NEER., 5:32-36, 43 (December, 1929)	None	.....	.....	.....
142	The Microflora of Leached Alkali Soils: II. A Leached Sodium- Chloride Soil. By J. Dudley Greaves. ⁹ SOIL SCIENCE, 29: 79-83 (January, 1930)	250	6.25	.....	6.25
143	A Few Match Brush Aphids from Utah. By H. J. Pack ¹⁰ and G. F. Knowlton. CANADIAN ENTO- MOLO., 61:199-204 (September 1929)	250	16.74	16.23	32.97

⁹Graduate Student, Department of Bacteriology and Chemistry.¹⁰Deceased.

Technical Articles

Reprint No.	Title, Author or Authors, and Source of Publication	No. Ordered	Cost Data		Total
			Printing	Cuts	
144	An Index of Friability of Soils. By Oswald Christensen. ¹¹ SOIL SCIENCE, 29:119-135 (February, 1930)	250	11.43	.....	11.43
145	Physician's Test for "Curds and Whey" Finds the Best Milk for Baby's Bottle. (Relates to R. L. Hill's curd test). SCIENCE NEWS-LETTER, 17:68-69, 76 (February 1, 1930)	None	.....	.....	.....
146	Soil Moisture Phenomena in a Saturated Atmosphere. By Leon B. Linford. ¹² SOIL SCIENCE, 29:227-238 (March, 1930)	250	8.43	.....	8.43
147	Who Should Control the Public Domain? By George Stewart. AMER. FORESTS AND FOREST LIFE, 36:156-160, 166. (March, 1930)	1000	40.00	.....	40.00
148	Notes on Utah Syrphidae. By G. F. Knowlton. PAN-PACIFIC ENTOMOLOG., 6:182-189 (April, 1930)	100	10.00	.....	10.00
149	Notes on Utah Coleoptera. By H. J. Pack. ¹⁰ ENTOMOLOGICAL NEWS, 41:219-222. (July, 1929)	250	7.37	.....	7.37
150	The Effect of Barnyard Manure on a Calcareous Soil. By D. W. Pittman. JOUR. AMER. SOC. AGRON., 22:549-552 (June, 1930)	300	6.00	.....	6.00
TOTAL COST			\$538.20	\$83.58	\$621.78

Cost Data Pertaining to Publications for Biennium

	Printing	Engraving	Total
Bulletins (Nos. 208-219, incl.)	\$2,299.79	\$ 357.00	\$2,656.79
Circulars (Nos. 73-87, incl.)	1,544.21	234.39	1,778.60
Reprints (Nos. 107-150, incl.)	538.20	83.58	621.78
GRAND TOTAL	\$4,382.20	\$ 674.97	\$5,057.17

¹¹Graduate Student, Department of Physics.

¹²Graduate Student, Department of Physics.

PROJECTS

Early in the spring of 1929 all projects then under way were revised and all revisions covering projects under federal funds approved by the Office of Experiment Stations, U. S. Department of Agriculture. A special project outline form was adopted and all projects now conform to this revision. At present some seventy-odd projects are being carried by the Experiment Station. Those which have been begun and approved during the past two years are as follows:

Purnell Fund

- Project 90**—A Study of Factors Influencing the Financial Condition of Certain Utah Irrigation and Drainage Projects¹⁵ July 1, 1928
- Project 98**—Cooperative Marketing of Agricultural Products January 4, 1929
- Project 101**—Economic Factors Affecting the Production and Marketing of Utah's Poultry Products .. April 15, 1929
- Project 102**—Food Habits of Elementary Rural School Children in Relation to Their Physical Well-Being June 24, 1929
- Project 103**—The Physical Curd Character of Milk and Its Relationship to the Digestibility and Food Value of Milk for Infants June 24, 1929
- Project 103A**—Physical Curd Character of Evaporated Milk April 4, 1930
- Project 105**—The Nutritive Value of High vs. Low Calcium and Phosphorous-Carrying Wheat ... September 16, 1929
- Project 107**—The Mineral Content of Wheat November 4, 1929

Hatch Fund

- Project 106**—Effect of Physical Curd Character of Milk on the Quality, Yield, and Physical Texture of Cheese August 29, 1929
- Project 110**—Feeding Value of Alfalfa Hay Treated with Calcium Arsenate for Destroying Injurious Insects January 25, 1930

State Fund

- Project 99**—Fattening Lambs in Winter Dry-lot
A. Lamb-feeding Experiments at Monroe September 13, 1928
B. Lamb-feeding Experiments at Delta October 24, 1929
- Project 104**—High-Altitude Metabolism Studies on Women April 14, 1930
- Project 111**—Pasture vs. Dry-lot Production of Swine May 10, 1930

¹⁵Date of official approval or authorization.

A comprehensive but brief statement of projects carried by fund, department, leader, etc., for the past biennium follows:

No.	Title	Date of Beginning	Leader or Leaders	Department or Departments
Hatch Fund				
24	Composition of Irrigation Waters of Intermountain Region	1916	J. E. Greaves C. T. Hirst	Chemistry and Bacteriology
51	Miscellaneous Insects	1919	H. J. Pack ¹⁴ G. F. Knowlton	Entomology
57	Poultry Feeding	1920	Byron Alder	Animal Husbandry (Poultry)
93	Orchard Rootstocks	1928	F. M. Coe	Horticulture
95 ¹⁵	Variety Testing	1928	F. M. Coe	Horticulture
106	Effect of Physical Curd Character of Milk on the Quality, Yield, and Physical Texture of Cheese	1929	R. L. Hill	Human Nutrition
110	Feeding Value of Alfalfa Hay Treated with Calcium Arsenate for Destroying Injurious Insects	1930	H. J. Frederick	Animal Husbandry (Veterinary Science)
Adams Fund				
12 ¹⁶	Technical Studies of the Physical and Physico-chemical Properties and Processes in Soils	1912	D. S. Jennings W. Gardner O. W. Israelsen	Soils, Physics, Irr.-Drainage
17	A Study of Some Factors Which Influence the Reclamation of Waterlogged and Alkali Soils	1917	O. W. Israelsen D. S. Jennings W. Gardner	Irr.-Drainage Soils Physics
22	Factors Influencing the Bacterial Activities of the Soil . .	1912	J. E. Greaves	Chemistry and Bacteriology
23	Permanent Fertility Studies . .	1916	J. E. Greaves	Chemistry and Bacteriology
31	Virus Diseases of the Potato and Factors Influencing Their Development and Control . . .	1914	B. L. Richards K. L. Hull	Botany and Plant Pathology
Purnell Fund				
25	Study of Underground Water	1915	Wm. Peterson	Geology
33	Tomato Diseases in Utah—Fusarium Wilt and Bacterial Canker	1916	B. L. Richards	Botany and Plant Pathology
61	Range Reseeding Studies with Native Forage Plants	1921	R. J. Becraft	Range Management

¹⁴Died January 5, 1930.

¹⁵Also carried on State Fund.

¹⁶Carried on State Fund also.

No.	Title	Date of Beginning	Leader or Leaders	Department or Departments
Purnell Fund (Cont.)				
62	The Genetics of Spike Density, Awning Resistance to Bunt and Black Stem Rust and Other Characters in Wheat . .	1920	G. Stewart A. F. Bracken D. C. Tingey	Agronomy
72	Relationship of Stream Discharge to Precipitation with Special Reference to Forecasting the Supply of Water for Irrigation from Seasonal Surveys of Snow Cover on Mountain Watersheds	1923	G. D. Clyde	Irrigation and Drainage Engineering
77	Effect of Winter Feed and Shelter vs. Open-range Wintering on the Quantity and Quality of Wool from Utah Range Ewes	1925	A. C. Esplin	Animal Husbandry
78	Injurious Effects on Livestock of Sugar-beets and Their By-Products	1925	H. J. Frederick	Animal Husbandry (Veterinary Science)
80	Chalcis-fly in Alfalfa-seed . . .	1925	C. J. Sorenson	Entomology
82	Beet Leafhopper Investigations	1925	G. F. Knowlton	Entomology
84	Pasture Studies with Beef Cattle	1927	K. C. Ikeler	Animal Husbandry
88	Studies of Utah Towns and Villages	1927	J. A. Geddes	Rural Sociology
89	Nature and Cause of Chlorosis in Utah and Practical Methods of Control	1928	F. B. Wann	Plant Physiology
90	A Study of Factors Influencing the Financial Condition of Certain Utah Irrigation and Drainage Projects:			
	A. Engineering Aspects . . .	1928	O. W. Israelsen	Irrigation
	B. Soil Productivity Aspects	1929	D. S. Jennings	Soils
	C. Sociological Aspects	1929	J. A. Geddes	Rural Sociology
	D. Economic Aspects	1929	W. P. Thomas	Agricultural Economics
91	The Effect of Fertilizers on Various Properties of a Highly Calcareous Soil and on the Yield and Quality of the Crops Produced	1928	D. W. Pittman G. Stewart D. S. Jennings J. E. Greaves	Agronomy Agronomy Soils Chemistry and Bacteriology
92	Psyllid Yellows of the Potato:			
	A. Disease Aspects		B. L. Richards	Plant Pathology
	B. Insect Aspects	1928	H. J. Pack ¹⁷ and G. F. Knowlton	Entomology

¹⁷Died January 5, 1930.

No.	Title	Date of Beginning	Leader or Leaders	Department or Departments
Purnell Fund (Cont.)				
98	Cooperative Marketing of Agricultural Products in Utah . . .	1929	W. P. Thomas	Agricultural Economics
101	Economic Factors Affecting the Production and Marketing of Utah's Poultry Products.	1929	W. P. Thomas	Agricultural Economics
102	Food Habits of Elementary Rural School Children in Relation to Their Physical Well-being	1929	Almeda Perry Brown	Home Economics
103	The Physical Curd Character of Milk and Its Relationship to the Digestibility and Food Value of Milk for Infants. . .	1929	R. L. Hill	Human Nutrition
103-A	Physical Curd Character of Evaporated Milk	1930	R. L. Hill	Human Nutrition
105	The Nutritive Value of High vs. Low Calcium- and Phosphorus-Carrying Wheat	1929	J. E. Greaves	Chemistry and Bacteriology
107	The Mineral Content of Wheat	1929	J. E. Greaves	Chemistry and Bacteriology
108	Relative Market Value of Cross-bred Lambs from Crosses of Pure-bred Hampshire, Suffolk, Rambouillet, and Corriedale Rams on Utah Range Ewes	1929	A. C. Esplin	Animal Husbandry
109	Comparative Values of Fleeces from Types A and B Rambouillet Ewes	1929	A. C. Esplin	Animal Husbandry
State Fund				
1	Nephi Dry-farm Substation . .	1908	A. F. Bracken G. Stewart	Agronomy
2	Widtsoe Dry-farm Substation	1917	G. Stewart	Agronomy
3	Irrigation Practice	1902	D. W. Pittman G. Stewart	Agronomy
4	Soil Moisture Studies in Tanks of Cropped Soil	1902	D. W. Pittman	Agronomy
5	Moisture, Soil, and Crop Relations (Irrigation and Manuring Studies with Corn)	1911	D. W. Pittman G. Stewart	Agronomy
9	Rotation and Fertility Tests . .	1910	D. W. Pittman G. Stewart	Agronomy
10	Miscellaneous Crops		"Early" G. Stewart D. C. Tingey	Agronomy

No.	Title	Date of Beginning	Leader or Leaders	Department or Departments
State Fund (Cont.)				
12 ¹⁸	Technical Studies of the Physical and Physico-chemical Properties and Processes in Soils	1912	D. S. Jennings W. Gardner O. W. Israelsen	Soils Physics Irrigation
34	Plant Disease Survey	1913	B. L. Richards	Botany and Plant Pathology
36	Breeding for Egg Production ..	1907	Byron Alder	Animal Husbandry (Poultry)
42	Grain Varieties	1918	G. Stewart D. C. Tingey	Agronomy
59	Davis County Substation	1920	A. L. Wilson ¹⁹ A. Manning	Horticulture
64	Cultural Methods with Sugar-beets	1921	D. W. Pittman	Agronomy
65	Weed Control	1921	D. C. Tingey G. Stewart	Agronomy
66	Panguitch Livestock Substation	1920	B. F. Hulme K. C. Ikeler	Animal Husbandry
73	Production Costs in Dairying (Dairy Substation)	1924	G. Q. Bateman	Animal Husbandry (Dairy Husbandry)
74	Egg-laying Contest	1924	Byron Alder	Animal Husbandry (Poultry)
75	Uintah Basin Alfalfa-seed Substation	1925	J. W. Carlson G. Stewart	Agronomy
86	Peach-Harvesting Indexes	1925	F. M. Coe	Horticulture
87	Miscellaneous Investigations in Veterinary Science	1925	H. J. Frederick	Animal Husbandry (Veterinary Science)
94	Cherry Pollination Studies ..	1928	F. M. Coe	Horticulture
95 ²⁰	Variety Testing	1928	F. M. Coe	Horticulture
96	San Pete County Substation ..	1927	LeMoyne Wilson G. Stewart	Agronomy
97	Carbon County Substation	1927	I. D. Zobell G. Stewart	Agronomy
99	Fattening Lambs in Winter Dry-Lot: A. Lamb-feeding Experiments, Monroe	1928	K. C. Ikeler	Animal Husbandry
	B. Lamb-feeding Experiments, Delta	1929	A. C. Esplin	Animal Husbandry
100	San Juan County Substation ..	1925	A. F. Bracken J. H. Eager	Agronomy
104	High - Altitude Metabolism Studies on Women	1929	C. B. Clayton R. L. Hill	Home Economics Human Nutrition
111	Pasture vs. Dry-lot Production of Swine	1930	H. H. Smith	Animal Husbandry

¹⁸Also carried on Adams Fund.¹⁹On leave.²⁰Also carried on Hatch Fund.

SUMMARY OF RESULTS OF INVESTIGATIONS²¹

Agricultural Economics

Completion of Project 79 (**Influence of Cropping Systems on Production Costs**) and Project 85 (**Studies on Marketing Utah's Apples**) and the publication of Station Bulletins 215 and 208, respectively, represent part of the activities in the field of agricultural economics.

A **cooperative marketing survey** has been in progress in which 35 cooperative marketing associations were surveyed to determine the types of organization, trends in membership, trends in value of products sold cooperatively, and marketing methods. Data collected have been tabulated. (**Project 98.**)

In cooperation with the Department of Farm Management, U. S. Bureau of Agricultural Economics, and with the Department of Cooperative Marketing of the Federal Farm Board, an investigation has been under way regarding **economic factors affecting the production and marketing of Utah's poultry products**. Detailed farm records from 140 commercial poultry producers in the north and central parts of the state have been collected and tabulated preparatory to final summarization and analysis. (**Project 101.**)

A study of **factors influencing the financial condition of certain Utah irrigation and drainage projects** has been conducted to study economic factors that affect farming operations in Millard County under the Melville Irrigation and Delta Canal projects. Approximately 150 farm business records have been secured from farmers living in West Millard County. However, this information has not yet been checked, tabulated, nor analyzed. (**Project 90-D.**)

In addition to the regular project work assigned, investigations in agricultural economics have been conducted as follows:

1. In the spring of 1929 **survey records based on the 1928 year's business** were obtained from 69 representative farmers in the "Dixie" section of Washington County, Utah, and from a smaller group of farmers in the Moapa Valley, Nevada. The work conducted in Nevada was under a cooperative agreement between the Utah Station and the Extension Service of the University of Nevada. Station Bulletin 214 (January, 1930) represents the findings of this survey.

2. The **index numbers and purchasing power for various farm commodities** in Utah have been determined from prices paid Utah producers since 1910. These data have been analyzed to determine the relationship between various farm prices in Utah and non-agricultural commodities. The results of this study have been published in Bulletin 217 (June, 1930).

3. Cooperating with the Federal Farm Board, **statistics on wheat, barley, and oats**, which have an application in the grain industry in the intermountain territory, have been compiled and published:

²¹The summaries given have been compiled from detailed reports submitted by project leaders. (See pages 17-20) for project number, leader, or leaders, supporting funds, and specific department.

"Wheat Compendium for Intermountain States." Compiled cooperatively by the Federal Farm Board and the Utah Agricultural Experiment Station. By W. A. Schoenfeld²² and W. P. Thomas. (April, 1930.)

"Compendium of Statistics on Oats and Barley for Utah and 24 Counties in Southeastern Idaho." Compiled cooperatively by the Federal Farm Board and the Utah Agricultural Experiment Station. By W. A. Schoenfeld and W. P. Thomas. (April, 1930.)

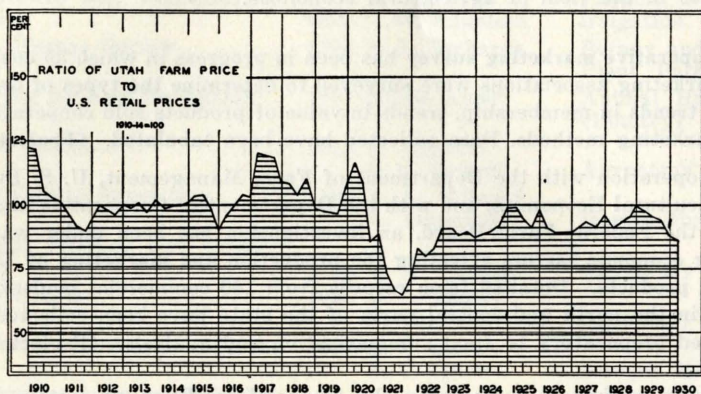


Fig. 1.—Purchasing power of the Utah farm dollar.

4. **Production and price analyses**, as they relate to Utah's agriculture, have been assembled for use in county economic surveys. Assistance has been given the Utah Agricultural Extension Service in tabulating and analyzing data for the various surveys conducted in the state. Utah Extension Service Circular (N. S.) 21 entitled "Agricultural Outlook for Utah, 1929," by W. P. Thomas, represents one phase of the assistance given.

Agronomy

Investigations conducted on the seven experimental farms under the jurisdiction of this department have progressed in a satisfactory manner.

Fertilizer tests showing their effect on a highly calcareous soil are proving of value in determining the possibilities for commercial fertilizer in the state. However, to date, the response to fertilizers has not been as marked as had been expected. Grain has shown some response to all of the fertilizers used, particularly nitrogen. Potatoes and alfalfa have shown no notable response to fertilizers. This past year sugar-beets showed most response to barnyard manure followed by nitrogen, phosphorus, and potassium in the order given. Alfalfa showed a marked increase to phosphorus fertilizer, the yield being increased nearly 60 per cent; the nitrogen content of the hay was also somewhat increased. Cooperative work has also been conducted with the Extension Service of the college in a series of cooperative experiments under the supervision of the county agricultural agents in various parts of the state. In the spring of 1929 the Barrett

²²Regional representative, Federal Farm Board, Seattle, Washington.

Company of New York, distributors of ammonium sulphate and other products, established a fellowship to study the proper method of using ammonium sulphate fertilizer under Utah conditions. Many interesting results are being shown. (Project 91.)

Twenty-eight years of research in irrigation of farm crops has been completed and published as Utah Station Bulletin 219 (June, 1930). Included in this publication are the results of the tank experiments on the effect of soil moisture. With the publication of Bulletin 219 it is recommended that further work, covering results as indicated in this publication, be discontinued. (Projects 3, 4.)



Fig. 2.—General view of the plats on the Greenville (Central) Experimental Farm near Logan, Utah. The plats are about $1/25$ -acre in size and diked around the edges. This holds all the water until it sinks into the soil. The flume delivered the water to whatever plat was to be irrigated. Some of the rotation crops are shown in the middle foreground.

A study of the effect of barnyard manure and of various cropping systems on the productivity of the soils represented on this farm is being continued with the idea of including another series of plants discontinued in Project 3 (irrigation studies) and including as well as much work as possible with green manure. (Project 5.)

Beginning in a small way several years ago as a few scattered experiments, the rotation and fertility tests on the Central (Greenville) Experimental Farm have gradually become enlarged as fertility became a more significant factor in determining the yields of all the plats until now it is one of the major experiments on the farm. It includes seven different rotation systems, both with and without manure where possible, and for com-

parison the same crops grown continuously without manure and with various quantities of manure. Results show that on this soil manure is highly beneficial to all of the crops and quite essential to sugar-beets. Rotation is shown to be essential for wheat and the small grains and beneficial to all crops except that sugar-beets yield fairly high results with continuous cropping when plenty of manure is provided and provided further the soil is kept free from nematode and various pests and diseases. The surface soil of many of the plats is being tested periodically for nitrate nitrogen and soluble phosphate. The close correlation between yield of sugar-beets on these plats and the soluble phosphate and nitrate nitrogen in the surface soil in May or June is shown in Reprint 150 (June, 1930). (Project 9.)

Cultural methods with sugar-beets have been continued as a study of the method and distance of thinning sugar-beets. A sled has been prepared on which beet thinners may sit at their work, being drawn across the field by a slow-speed tractor with a transplanting machine; however, it has not yet been possible to contrive a tractor moving at sufficiently slow speed to give this an adequate trial. (Project 64.)

Miscellaneous crop studies at the present time includes the following divisions: (1) Pasture studies, (2) sugar-beet varieties, (3) sugar-beet breeding, (4) silage corn varieties, and (5) miscellaneous studies. A cooperative pasture experiment is being conducted with the Dairy Division on the Dairy Substation in which two sets of 3-field trials are under way. Each set includes a field treated with farm manure, one with ammonium sulphate, and an untreated check. Of commercial sugar-beet varieties, yielding more sugar to the acre than any others tried, the leaders are Uladovka,



Fig. 3.—View of sugar-beet breeding plats. It is necessary to grow sugar-beet seeds under bags in order to prevent crossing. An attempt is being made to improve the yield and quality of sugar-beets and to obtain strains resistant to leafhopper. This project is cooperative with the U. S. Department of Agriculture.

Verchiatchka, Dippe, Pioneer, Ramon, and Fredericksen. Similar tests are being conducted in Benson, Cache Valley, in cooperation with the Amalgamated Sugar Company, and on the Carbon County Experimental Substation, with varying results but all corroborating the Logan test in general.

At the beginning of 1929-30 a cooperative project on sugar-beet varieties was begun with the Office of Sugar Plants, Bureau of Plant Industry, U. S. Department of Agriculture. Over 70 strains of sugar-beets are being used in this test. Utah Station Bulletin 211 (June, 1929) covers the results of the test on silage varieties. Reprints Nos. 131, 137, and 147 represent further publications. (Project 10.)

In a test of grain varieties, varieties of spring wheat were tested at Logan and at Newton in plats about 1/30-acre in size, each replicated three times. Most promising of the spring wheat strains is 01-24, a hybrid between Little Club and Federation, which has a short stiff straw and is a high yielder. Among winter wheats Utac was highest in 1928-29, Sevier-59 second, and Kanred third. In 1929-30 Silvercoin and Utac were somewhat higher yielders than Turkey, which was third. Silvercoin was first by a narrow margin. As an average of the two years and also of the last several years Utac is first, with Turkey second, both being somewhat ahead of Kanred. Of about twelve varieties of barley under irrigation, Trebi was the highest yielder. Of about 50 oat strains, Swedish Select was the highest variety. (Project 42.)

Wheat breeding and genetics investigations are progressing under the following heads: (1) Rod-row tests, in which some 400 strains of spring

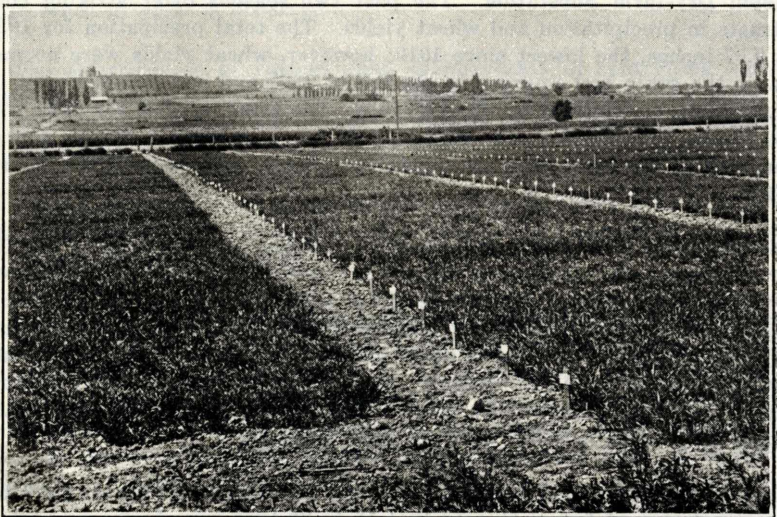


Fig. 4.—View of wheat-breeding plats on Greenville (Central) Experimental Farm, near Logan. On these plats valuable new strains have been produced and several important scientific studies of inheritance have been made.

wheat and about 300 strains of winter wheat have been tested for yield in comparison with the standard commercial varieties, and in which eight wheat strains, four barley strains, and four oat strains have been extended on to farms in about a dozen typical localities in the state; (2) **Genetics of spike density and of awns**, with crosses made for wheat improvement with especial regard to genetic inheritance largely in the F_3 generation; (3) **Resistance to bunt**, in which an attempt is being made to develop resistant varieties of wheat and in which some promising results are being obtained; (4) **Rust studies**, one group of highly rust-resistant strain being found; (5) **Other genetic studies**, including glume and kernel color, dwarfs, height of plant, number of culms, and one study on neck thickness. In addition to these studies under wheat breeding and genetic investigations, cereal breeding investigations along the same line are being conducted on the Nephi-Dry-farm Substation. (Project 62.)

During the summer of 1929 an intensive and extensive campaign on the **control of perennial weeds by chemical means** was begun. This was made possible by the cooperation of the State Department of Agriculture. Calcium chlorate and sodium chlorate were the principal chemicals used, together with a few trials made with mixtures of sodium chlorate, magnesium chloride, and calcium chloride. One season's tests indicate that sodium chlorate, calcium chlorate, and possibly magnesium chlorate are effective in the eradication of certain troublesome weeds, especially on small areas. Experiments on the control of dandelion and chickweed indicate that possibly these lawn weeds may be largely controlled by a combination of spraying with iron sulphate and the use of some nitrate fertilizer, such as ammonium sulphate. (Project 65.)

Nephi Dry-farm Substation. The past two seasons offer striking contrasts in precipitation and wheat yields. The total precipitation for 1928 was 9.57 inches, the lowest since 1910; however, wheat yields were normal because the grain had emerged in the fall of 1927 and had finished most of its vegetative production by June 1, 1928. The total rainfall for 1929 was 13.69 inches, yet wheat yields were only 70 per cent normal, due to winter emergence of the grain with all vegetative growth delayed until the spring of 1929.

Plowing tests for 1928-30 gave yields somewhat contradictory to the 15-year averages. Spring-plowing has given higher yields than has fall-plowing which is the reverse of average yields under normal tillage conditions. Frequent harrowing of the fallow actually reduced yields; data indicate that no tillage for spring plowing is equal to normal cultivation, which consists of two harrowings and one leveling. Seven-inch plowing proved of greater value than either shallower or deeper depths, which is an important fact because of present activity favoring deep tillage.

The effect of barnyard manure in varying quantities with spring plowing and normal care of fallow showed that 15 to 20 tons gave increased yields. Results over a 14-year period indicate that ordinary fall-plowing has an advantage over green-manuring with peas.

Burning of stubble is not advised except under certain special conditions which require such treatment for control of weeds and insects.

When safety and **cost of cropping** are considered, it is doubtful that any cropping sequence, except alternate, could be recommended where the rainfall is 13.04 inches or less, as is the case in Juab Valley.

In a **rotation experiment**, in which wheat is the major crop, with peas, corn, potatoes, oats, and barley serving as supplementary crops in various combinations of cropping, yields indicate that corn and potatoes yield more after wheat than after fallow, the difference being due probably to the organic relationship in the soil. Wheat also produces higher yields after fallow than after a row crop.

In a **varietal trial of winter and spring cereals**, with twenty winter wheat varieties, Sevier 37 in 1928 gave the highest 3-year average (21.5 bushels); Newturk and Alton came first in 1929. Spring wheats yield only half what the winter varieties yield, their only place on the dry-lands being to supplement winter wheats in case of winter-killing.

In a **rate-and-date-of-seeding test** conducted on the Nephi Dry-farm Substation, late sowings for Juab Valley have been found more advantageous than sowings in August or early September. Five pecks to the acre are now recommended; this reduction from six pecks has been made possible by the copper-carbonate treatment.

It has been found that **cultivation of the growing wheat** has no advantage, and that up to and including 21 inches as spacing between rows little difference in yield is observed.

The effectiveness of **various smut disinfectants in controlling smut** on smutted grain is clearly in favor of treating with calcium carbonate, formalin, copper sulphate, and copper carbonate rather than with commercial disinfectants.

From a series of tests of the **furrow drill vs. ordinary drill** it is evident that the furrow drill has no advantage over the ordinary drill under intermountain dry-land conditions.

Included in the **genetic and breeding work** conducted on this substation, under Project 62, are purelines of Turkey, Kofod, and Sevier as well as hybridized strains of Turkey and Kofod, Kanred and Kofod, Kanred and Alton, Kanred and Sevier, and Kanred and Odessa, based on strong straw and high yield. Hoping to develop a high-yielding white winter wheat, several crosses were made between high-yielding purelines of Kofod and Turkey. (Project 1.)

Uintah Basin Alfalfa-seed Substation. Results from **clipping or pasturing-off alfalfa** show that either no clipping of the first growth or a clipping

applied not later than the beginning of bloom is most favorable for seed production. When the clipping is given in the late-bloom stage or the alfalfa is grazed off by sheep until the middle of June, the seed crop produced by the later growth is decreased and is of inferior quality.

Seven different methods of cultivating alfalfa have been tested to determine the effects in relation to seed production. Shallow cultivations which are sufficient to destroy weeds in the early stages of growth, but which do not thin the alfalfa stand, have but little influence on the yield of seed.

Nine different treatments in the practice of applying irrigation water to alfalfa before or while producing seed have been tested. Under conditions prevailing in the Uintah Basin the highest yields and the best quality of seed have been produced without applying irrigation water. A light irrigation of 4 or 5 inches applied the previous fall, or early in the spring, decreased the yield from 20 to 30 per cent when compared with no irrigation. A similar application of water following an early clipping stimulated an excessive vegetative growth, and the yield of seed was reduced to about 5 per cent of the yield obtained with no irrigation.

Manure has been applied at the rate of 5 and 15 tons to the acre with check plats receiving no manure, and the effects on seed production have been noted. Actual yields of seed have been highest in case of plats receiving no manure and lowest where 15 tons have been applied.

Fourteen varieties and strains of alfalfa have been tested for seed production and winter-hardiness. Utah Common, Hardigan, Argentine, and Grimm have averaged highest in seed yield during the past three seasons. Some of the poor seed producers were found to be excellent hay plants. Peruvian alfalfa has been found to be decidedly non-winter-hardy under Uintah Basin conditions. Argentine and Italian alfalfa are not fully hardy.

Alfalfa, grown in hills and rows with respect to seed production, has yielded 10 per cent better for rows than for check plats planted in the ordinary way (sown broadcast with 5 pounds to the acre). The average yield of the hill plats was 30 per cent higher than that of the check plats in 1928 and 73 per cent higher in 1929.

An experiment to determine the proper rate of seeding alfalfa when used for seed production indicates that 2 pounds to the acre gave 60 per cent more seed than 4 pounds to the acre and 83 per cent more than the 9-pound seeding.

Experiments conducted to test the value of growing alfalfa in short rotations when used for seed production show that alfalfa seeds best the first season following that in which it is planted.

In the technical studies of the alfalfa plant considerable work has been done to determine the value of artificial tripping of alfalfa in relation to

seed production. It has been found that artificial tripping of the flowers will result in an average increase in the yield of seed of about 150 per cent. An article will appear in the JOURNAL OF AMERICAN SOCIETY OF AGRONOMY during the coming summer or fall entitled "Artificial Tripping of Flowers in Alfalfa in Relation to Seed Production." Several interesting and worthwhile phases of this technical work with alfalfa are now under way.

In addition to the investigational work with alfalfa on this substation, some promising varieties of wheat, oats, and barley have been tested. Dicklow wheat has been found to be the highest yielder, closely followed by Federation. Early Baart and Defiance excel in milling quality. Swedish Select oats and Trebi barley have given exceptionally high yields. Work on certain promising varieties and strains of corn has been summarized, and results are available in Station News Circular No. 65 entitled "Corn for the Uintah Basin." (February, 1930). (Project 75.)

San Pete County Substation.—This project was initiated to make careful tests of the agricultural possibilities of arid peat soils in Utah and to discover if possible successful methods of farming such soils. To carry out the object of this project four general lines of investigation have been under way: (1) General field-crop studies, (2) vegetable-crop studies, (3) soil-management studies, and (4) miscellaneous.

Included in the **general field crops** are barley, oats, sweet clover, canning peas, and early potatoes, all of which seem to show promise of being adapted to such conditions. However, wheat, sugar-beets, and alfalfa at present seem to be of doubtful value. Wheat has proved successful where the soil is composed of a mixture of peat and clay but not on straight peat soil. Sugar-beets were a complete failure during the 1928-29 season because of curly-top disease. While the yield was satisfactory in 1929-30, the sugar content was extremely low. So far Irish Cobblers have proved to be the best yielders of the early varieties of potatoes; late varieties have been a failure.

Most of the different **vegetable crops** commonly grown in the state have been tested on this substation. Those crops, apparently not adapted to Utah conditions, include tomatoes, squash, melons, cucumbers, beans, and corn. Crops showing promise of being adapted are carrots, parsnips, beets, cabbage, cauliflower, and celery. In growing cabbage, cauliflower, and celery it was found necessary to irrigate at the time the plants were set out. Tests with celery plants have shown later irrigations to be necessary.

Under **soil-management studies** a heavy cement roller weighing 650 pounds to the linear foot was used. Four tenth-acre plats have been seeded to barley and four to oats. After seeding, half of each plat was rolled. The average acre-yield of barley for the rolled portion was 42.3 bushels and for the unrolled portion, 16 bushels. The oat plat yielded 57.4 bushels on the rolled portion and 46.9 bushels on the unrolled area.

A **plowing-and-seedbed-preparation test** has also been conducted, which includes four different soil treatments, each treatment having five different crops replicated three times. One year's results indicate that fall-plowing with fall seedbed preparation yielded slightly better results than did other treatments given.

Five different **rotations** have been planned and are just getting started. Each rotation includes as its basic crop either sweet clover or alfalfa.

The **soil fertility test** includes applications of manure with different combinations of commercial fertilizers and commercial fertilizers without manure. The plats have been seeded to barley. To date, crop yields do not indicate any benefits from the treatments.

Some **technical studies** on nitrates, soluble phosphorus, and alkali have been begun. (Project 96.)

Carbon County Substation.—The main work of this substation is divided into: (1) Cropping experiments, (2) fertility tests, (3) rotations, (4) irrigation tests, and (5) horticultural crops.

The most promising varieties of wheat, oats, corn, beans, barley, potatoes, and sugar-beets have been tested in **cropping experiments**. Dicklow seems to be the best variety of wheat; however, the new hybrid 14-85 is highly promising. Of the oat varieties tested, Swedish Select is the best. Corn does not do as well here as it does in many places; up to the present, Northwestern Dent is the best variety tested. Trebi is the most favorable variety of barley tested. A 50-acre bushel yield may be expected from this variety. Beans is one of the most promising crops grown at present. Of six varieties being tried, Great Northern is the best. From 15 to 20 varieties of sugar-beets are being grown each year. Tests have not been carried on sufficiently long to definitely determine which varieties are best adapted to the Carbon County section. Eight varieties of potatoes are being tested; of the early varieties Cobbler appears to be the best and Rurals of the late varieties.

Three different kinds of **fertility tests** are being conducted: (1) Barnyard-manure studies, (B) green-manure studies, and (C) commercial fertilizers. Where barnyard manure is applied at the rate of 20 tons to the acre there is a large increase in crop production; the crop requires less water to mature it and the soil tends to hold the moisture much longer; there is also less tendency for the soil to wash and erode when barnyard manure has been applied. The experiment with green manure has not been carried on long enough to secure accurate data. Sweet clover is used as the green-manure crop. Ammonium sulphate, phosphoric acid, and potassium chloride are being used on a series of crops. The phosphoric acid is responding especially well on the alfalfa. Applying it at the rate of 125 pounds to the acre, alfalfa was increased 50 per cent. Hay from those plats treated with phosphoric acid was of higher quality, having finer stems and

more leaves than those on the untreated check plats. During the early part of the growing season, phosphoric acid seemed to stimulate young beet seedlings more than the other fertilizers; these beets also ripened earlier in the fall. Where nitrogen was distributed with the seed, the beet seedlings were delayed in their normal growth and the seeds did not germinate as well. More work is to be done along this line.

The rotation experiments, including 3-year through 8-year rotations, have not been carried long enough to report definite results.

Experiments have been conducted to determine the value of pre-irrigation of crops in comparison with irrigating the land after the seeds have been planted. Three years' results seem to indicate that pre-irrigation is not as successful as irrigating after the seed is planted; however, for corn and potatoes pre-irrigating is advisable. Because of constant winds in the spring in this section it has been found necessary to irrigate sugar-beets two or three times before they are large enough to thin. On fall-plowed land it is possible for grain to attain 3 to 4 inches in height before irrigation is necessary.

In a vegetable test, onions, tomatoes, cabbage, and asparagus have been grown, but aside from asparagus they do not seem to be well adapted to this section. Early and late varieties of tomatoes matured at the same time. The onion seeds did not germinate well and a large portion of those which did germinate developed into "bottle-necks." Asparagus may develop as a more or less important crop because of its resistance to alkali. (Project 97.)

San Juan County Substation.—Work on this project is divided into six divisions: (1) Alfalfa-seed production, (2) testing forage and root crops, (3) winter and spring cereal trials, (4) rotation of wheat with intertilled crops, (5) miscellaneous crops and tests, and (6) cooperative tests with farmers in San Juan County.

Because one of the main purposes in the establishment of the San Juan County Substation was to test alfalfa-seed growing the major portion of it is limited to this problem of alfalfa-seed production. Acre-yields this past season varied from 1 to 4 bushels. Because of damaging frosts and too much vegetative growth, acre-yields of alfalfa-seed during the past two seasons have not been especially promising.

Of the outstanding forage and root crops in 1928, carrots produced over 8 tons to the acre; corn, 2600 pounds; and amber sorghum, 2900 pounds. In 1929 white flint corn produced 5.5 tons of fodder; Minnesota No. 13 corn, 4.5 tons; carrots, 4 tons; and yellow sweet clover produced 2299 pounds to the acre. Carrots, sweet clover, corn, and alfalfa all have a definite place in the feeding program of San Juan County.

Of eight winter wheats under test in 1928, Black Hull, with an acre-yield of 43.4 bushels, stood first, followed by Montana 36 with 43 bushels. In

1929, Turkey 926, a Nephi pureline selection, produced the highest yield—32.3 bushels; Blackhull followed with 31.5 bushels. **Spring wheats** in 1928 were low in yield, single plat yields being recorded for Hard Federation and Baart of 13 and 12 bushels, respectively. The general average is lower than this, however. In 1929, Kota, a spring wheat, produced 26 bushels, followed by Baart with 21.2 bushels; Kubanka yielded 10.6 bushels. Oats in 1928 failed, while Coast, a spring barley, produced an average of 15.2 bushels and Trebi 9 bushels. Yields of 1929 were similar to those of 1928, although Swedish Select oats produced 47.2 bushels and Khearsen 36.5 bushels. Data for the last two seasons indicate that winter wheat is much better adapted to San Juan conditions than are the spring varieties.

In the tests of **rotation of wheat with intertilled crops**, wheat after fallow in 1927 yielded 38 bushels, while wheat following intertilled crops yielded 10 bushels. Peas yielded 5.3 bushels and potatoes 60 bushels. In 1929 there was slight difference between wheat after fallow as compared to wheat after intertilled crops. All yields of wheat after fallow were low. Yields of intertilled crops were high, however. Potatoes yielded 97 bushels; peas, 21 bushels; and corn, 7360 pounds of fodder.

Under **miscellaneous crops and tests**, 2 to 3 pecks of wheat are found to be sufficient for seeding winter wheat. Field peas in 1928 yielded 6.6 bushels; in 1929 the Carleton variety produced 22.6 bushels and Canadian 19 bushels. Beans in 1928 were a complete failure because of frost. In 1929 Mexican Reds produced 600 pounds, Mexican Pintos 247 pounds, and Navy 115 pounds. Low yields in 1929 were due to frost damage. With more favorable climatic conditions, yields of 800 to 1000 pounds may be expected.

Since eventually this area will become one of the most important agricultural sections of the state, better tillage practices and crop adaptations are necessary. Therefore, because of the marked variations in soils and climate in San Juan County, it is planned to conduct **cooperative tests** on about eight farms distributed over this section, these tests to include varietal trials of cereals, peas, beans, corn, and potatoes. Tillage tests will also be included. (Project 100.)

Widtsoe Dry-farm Substation.—Common varieties of grain have been grown on this station, located at an elevation of 7800 feet. Both dry-farming and irrigation are practiced. Turkey wheat, Trebi and Colsess barley and Swedish Select oats have given best results. Rosen rye has done well and Canada field peas fairly well. Strain 01-24 of wheat is being added in 1930. Peruvian alfalfa from Arizona winter-killed completely, whereas Grimm alfalfa has not been injured. (Project 2.)

Alfalfa-seed Investigations in Millard County.—From 40 to 50 years alfalfa-seed has been produced in the neighborhood of Hinckley and Deseret, Millard County, during which time no serious crop failure had been experienced until the seasons of 1926, 1927, and 1928. Much of the land in the seed section had become water-logged, and in 1918 drainage canals were constructed and the land drained. Many farmers have felt that this drain-

age of the land has been the cause of seed failure; others think it has been due to insect pests; and still others feel that climatic conditions have been responsible. Because of the difference in opinion and because short seed crops had become so common, investigation of actual conditions became necessary. In 1929-30 the State Legislature appropriated \$6000 for a 2-year period beginning July 1, 1929, to investigate conditions and offer possible suggestions and help. At this time Mr. George Whornham, a graduate of this institution, was placed in charge of this investigation.

Plans of procedure included: (1) Irrigation studies, (2) cultivation work, (3) clipping, and (4) spacing experiments. In addition, a study of methods of production as shown in the successful farms in the Millard area are to be the basis of determining, if possible, the important factors influencing the successful growing of alfalfa-seed. Since no experimental farm was established, cooperation with reliable farmers in each area was effected. The county agricultural agent and state agricultural inspector for this region are also cooperating in this work. The Station Department of Entomology has also cooperated in chalcis-fly control. The area is divided into ten sections: North Delta, East and South tract, Hawbush and Greenwood, Bog section (southwest Deseret), Hinkley, Oasis and Deseret, Abraham, Woodrow and Sugarville, Leamington, Meadow and Hatton, Sutherland, and Milford (Beaver County). (No project number assigned).

Animal Husbandry

Poultry production in the state has been greatly stimulated during the past two years. The Station has been conducting three major poultry experiments during this period. Some high **production** records have been obtained, with the highest individual records since the project was begun in 1907. (Project 36.)

During this past biennium work has been continued on a study of the value of milk as a part of or as the only source of protein in a laying ration with various proportions of dried milk supplementing meat meal and with meat meal and skim milk as the only source of animal protein. Another phase of the **feeding project** included a study of the comparative value of some common local feeds and cod liver oil as a source of vitamin A and the importance of cod liver oil as a source of vitamin D under local climatic conditions. There seems to be little advantage in the use of cod liver oil in the mash at the rate of 1.5 per cent as compared with keeping well-cured alfalfa leaves before the birds continuously. There appears to be a slight advantage, however, as indicated by egg production and lowering of death losses, when cod liver oil and well-cured alfalfa leaves were both supplied. (Project 57.)

The Fourth and Fifth Annual Utah Intermountain Egg-laying Contests ended during this biennium and the Sixth **Egg-laying Contest** was begun. In the Fourth Contest there were 25 entries of S. C. White Leghorns, 2



Fig. 5.—Typical sheep-shearing plant, Iron County, Utah.

entries of S. C. Rhode Island Reds, and 2 entries of Barred Plymouth Rocks. Fifteen of these 29 entries were owned by Utah breeders and 14 by breeders from other states. The average for all contest birds was 202.7 eggs, with a high pen (10 birds) record of 2452 eggs, or an average of 245.2 eggs each. The highest individual record was 302. In the Fifth Contest 22 pens entered, with thirteen of them owned by Utah breeders and nine by breeders out of the state. The birds made an average production of 225.4 eggs each. According to a statement in one of the leading poultry magazines this was the highest average production made in any contest in America this year. The leading pen had an average production of 251.6 eggs each and the leading individual record 297 eggs for the 51-week period. The average monthly value of the eggs produced by the contest flock was \$123.19 and the average monthly feed cost \$40.17, or a monthly average of \$82.97 above feed cost. (Project 74.)

Beginning July 1, 1929, the original Purnell Project No. 77 on sheep and wool studies (begun July 1, 1925) was subdivided into three main Purnell Projects: (1) **Effect of Winter Feed and Shelter vs. Open-Range Wintering on the Quantity and Quality of Wool from Utah Range Ewes**, (2) **Relative Market Value of Crossbred Lambs from Crosses of Purebred Hampshires, Suffolk, Rambouillet, and Corriedale Rams on Utah Range Ewes**, and (3) **Comparative Values of Fleeces from Types A and B Rambouillet Ewes**. The sheep which originally had been kept on the Experimental Sheep Farm near the campus were transferred on October 1, 1929, to the Panguitch Livestock Substation (Garfield County). Cooperation with the U. S. Forest Service premitted 100 Station ewes to be placed on the Dixie-Sevier National Forest early in June, 1930. (Projects 77, 108, 109.)

Many complaints are received each year claiming that **sugar-beets and beet by-products** are responsible for enormous losses among livestock consuming such feed. During the past two years animals eating beets and their by-products have been under observation. Different amounts alone and in combination with other feeds were fed. Such observations have led to the opinion that sugar-beets and their by-products are not injurious to livestock where properly fed and that direct poisonous properties have resulted from spoilage and contamination of these feeds. (Project 78.)

During this biennium all cattle belonging to the College and Station herds have been retested with the tuberculin test. A few animals were apparently suspicious although none showed positive reactions. Skin lesions found on animals reacting to the tuberculin test have been inoculated on guinea pigs, calves, hogs, and rabbits, but no transmission of tuberculosis has resulted. Young animals were inoculated with blackleg aggrassin. The agglutination test has been applied to all dairy cows, with a positive reaction in some cases. Such animals have been isolated and are receiving separate care. Where botulism among animals occurred, the botulinus antitoxin was used with fairly satisfactory results. This antitoxin is recommended where animals show symptoms of this disease for that condition formerly called "forage poisoning." This antitoxin, which is both prophylactic and curative, is usually recommended before the outbreak

actually occurs. Lung disease among sheep was further investigated. This affection was not transmitted either by contact or by inoculation from affected to healthy sheep. Severe or rough handling of sheep on the range or in the corrals is, therefore, thought to cause lung disease. All hogs belonging to the college were inoculated with anti-hog cholera serum and hog cholera virus. The young stock have been re-vaccinated. Isolation and treatment were recommended for keratitis, an eye affection among sheep, goats, and cows. Isolation and treatment were recommended. (Project 87.)

A field of alfalfa containing 11 acres was secured and dusted with calcium arsenate. One-half of the field received 3 pounds of poison to the acre, the other half being given 6 pounds. The hay was harvested and stacked ten days after dusting, when samples were taken for chemical analysis. The hay remained in the stack about six months and was then fed to horses, cattle, and sheep, which were allowed all the hay they would eat at two daily feedings. Water and block salt were available at all times. Fed for a period of 80 days, nearly all animals gained in weight and presented a splendid appearance. Cooperating on this project is the U. S. Bureau of Entomology. (Project 110.)

Animal disease investigations in the animal pathological laboratory²³ have two special lines of endeavor in mind: (1) animal disease research and (2) animal disease diagnostic service. No research projects have as yet been outlined, but it is planned to do this in the near future. Specimens submitted for diagnosis to the laboratory are examined without cost to the owner or sender. In cooperation with the Veterinary Science Department an effort is being made to eliminate Bang's abortion disease from the College and Station herds. It is also hoped to establish several herds throughout the state which will be free from this disease. With this in mind, agglutination tests of the blood serum of individual cows are made to distinguish the diseased from those not diseased. During the period from February 1 to July 1, 1930, the following examinations were made:

Bang's disease	1816
Poultry	578
Sheep	3
Calves	4
Miscellaneous	7

Total No. Specimens Examined 2408

Utah Station Circular 86 (June, 1930) on coccidiosis of chickens covers this phase of the work. (No project number assigned.)

Pasture studies with beef cattle have been conducted to determine: (1) The hay-making capacity of irrigated pastures, (2) the carrying capacity of rotated and non-rotated pasture upon pasture improvements. This project, started June 15, 1927, will continue indefinitely during successive years, started June 15, 1927, will continue indefinitely during successive pasture seasons. The work is carried on at the Panguitch Livestock Sub-

²³Established July 1, 1929, by special act of State Legislature, 1929-30.

station where two 6-acre areas are fenced off and irrigated for conducting the experiment. The average of three years' work is in favor of the rotated pasture. Considerable information will eventually be available upon those cows in the lot which are the most efficient beef producers on pasture. This information will be of much value in the breeding program which is being followed for constructive herd improvement. (Project 84.)

Because of the demand made by lamb feeders in the state as to the value of fattening lambs in winter dry-lots, a cooperative arrangement was made with the Monroe Lamb Feeders Association in the fall of 1928 to secure information relative to the feeding value of the various cuttings of alfalfa hay, brown-cured hay, and of home-grown grains as compared to corn. On November 18, 1928, the first year's work was begun; the second year's work was begun on November 21, 1929 and concluded on February 19, 1930. The second year's work was designed primarily as a check on the first year's results. During both tests cuttings of alfalfa ranked: Third, second, and first. The grinding of barley resulted in a loss during both years. (Project 99-A.)



Fig. 6.—Lamb-feeding experiments conducted at Monroe, Utah, showing pens in which sheep were fed.

Early in the fall of 1929 arrangements were made with the Pahvant Mercantile and Investment Company of Delta (by J. F. Roe) to carry on a similar lamb-feeding experiment in the Delta vicinity. The purpose of this experiment has been to determine: (1) The feeding value of alfalfa-seed by-products, (2) the feeding value of chopped alfalfa hay and of barley straw, (3) the feeding value of some protein supplements, and (4) the relative efficiency of wrinkled (heavy-pelted) lambs as compared to the smooth ones. Arrangements have been made for carrying on this experiment a second year. The experiment was begun on November 18, 1929,

and was concluded on February 12, 1930; it comprised 12 lots of 125 lambs each. Results at Delta verified those at Monroe—that alfalfa hay and whole barley are capable of making large and economical gains in lamb-feeding. Results also indicated that the limited use of alfalfa chaff and barley straw was not satisfactory for feeds and that the chopping of alfalfa hay was unprofitable. The feeding of protein supplements did not prove advantageous. Contrary to common opinion, the lot of heavy-pelted lambs made unusually heavy gains. (Project 99-B.)

On May 18, 1930, work on **pasture vs. dry-lot production for swine** was authorized and begun. The general purpose of this project is to test the amounts, quality, and economy of gains made by swine with different rations under pasture and dry-lot conditions. Fifty pigs of spring farrow, weighing approximately 40 pounds each, are divided according to breeding and size into five lots of ten pigs each, each lot being fed a different ration. It is expected that the experiment will continue for three years. At present this investigation is being conducted on the Dairy Substation. (Project 111.)

Panguitch Livestock Substation.—This substation, at an elevation of 6700 feet, contains 150 acres of land and is in the center of one of the largest sheep and cattle-producing sections of Utah. The farm is well fenced and the soil is improving rapidly in productivity. It contains 18 head of well selected, pedigreed Shorthorn beef cows. Surplus cattle have been readily sold to ranchmen interested in the production of better cattle. A new proved sire has been purchased for the 1930 breeding. Sixty hardwood trees and 14 hardy plum and apple trees have been set out. A small grain nursery has been begun and 16 varieties of small grain are being tried in cooperation with the Agronomy Department. An open surface well has been replaced by a deep-driven well, thus insuring a safe water-supply for culinary purposes. Several old and useless outbuildings have been removed and the general appearance of the farm greatly improved. A small flock of sheep, under Purnell Project 77, has been added to the farm. (Project 66.)

Dairy Substation.—Located about a mile and a half north of the campus, this substation is most conveniently located for its research and investigational work. Three groups of Holstein cows have been fed the following different feeding combinations: (1) Alfalfa hay, corn silage, and grain; (2) alfalfa hay, wet sugar-beet pulp, and grain; and (3) alfalfa hay and grain. Additional data have been secured on **cost of production** on the three combinations of feeding and observations made on the accumulative effect of feeding pulp to dairy cattle over a long period. This phase of the work, which has been in progress since February 11, 1926, is being brought to a close. A complete record of lactation has been kept of the amount of feed consumed and the amount of milk produced. Beginning January, 1930, a clean-up of contagious abortion was begun in the Station herd; animals were given the blood test and the herd divided into positive and negative groups, the positive group being isolated. During the spring of 1930 pasture work was started: (1) to measure carrying capacity of pas-



Fig. 7.—Calves using stanchions.

tures and (2) to study the flora and fertilization of pastures, fertilizers used being barnyard manure and ammonium sulphate. This work is being carried on in cooperation with the Agronomy Department. An experiment on pasture vs. dry-lot production for swine is also being conducted on this substation under the immediate supervision of the Animal Husbandry Department. The U. S. Bureau of Dairying is cooperating in the following special projects:

“Continuous Use of Proved Sires to Breed Dairy Cattle That Will Be Pure in Their Inheritance for High Milk and Butterfat Producing Capacities.”

“A Study of the Relation of the Conformation and Anatomy of the Dairy Cow to Her Producing Ability.”

Utah Station Circular No. 75 (November, 1928) covers part of the work under this project. (Project 73.)

Chemistry and Bacteriology

With the aim of discovering the basic laws governing the microflora of the soil and then to apply them to systems of permanent fertility, thirty-one organisms were obtained from a reclaimed alkali soil, eleven of which fixed nitrogen where grown in soil, the quantity varying widely with the specific organism. Station Reprint No. 142 (January, 1930) has been published covering this phase of the project.

It has been found that numerous microorganisms in a leached synthetic alkali soil develop on Ashby agar; of 16 organisms which were obtained in pure culture, 12 fixed nitrogen, the nitrogen-fixing ability varying from 1.4 mgm. to 7 mgm. Results of this phase of the work are found in Station Reprint No. 138 (November, 1929). (Project 22.)

A comprehensive study of wheat, oats, barley, and corn grown under varying conditions shows a marked variation in their ash, calcium, magnesium, potassium, phosphorus, sulfur, and iron content. Results indicate that the great variations found may be of fundamental importance in the nutrition of man and the domestic animals. Utah Station Bulletin 210 (May, 1929) and Utah Station Reprint No. 125 (March, 1929) have been published along this line. Not only the total phosphorus but the nature of the phosphorus shows wide variations, as brought out by Reprint No. 126 (March, 1929). These last two phases of Project 22, beginning July 1, 1929, were revised to become new Purnell Projects under Nos. 105 and 107—"The Nutritive Value of High vs. Low Calcium—and Phosphorus-carrying Wheats" and "The Mineral Content of Wheat," respectively. (Projects 22, 105, 107.)

To determine the effect of systems of cropping on the chemical and biological properties of the soil for economic permanent fertility studies is the object of this study. The sulfur content of Cache Valley soils was found to vary from 252 to 1764 pounds of sulfur per acre-foot or 3,600,000 pounds. The average sulfur content of the soils analyzed was 963 pounds per acre-foot. The analyses of the water of 45 streams used for irrigation purposes showed them to carry from 3 to 676 pounds of sulfur per acre-foot of water. The average quantity of sulfur brought to the soil annually was 9.5 pounds. The quantity carried from the soil varied with the crops, nature of the soil, and method of cropping; it is, therefore, concluded that sulfur may become a limiting factor of crop production in some Cache Valley soils (Reprint No. 129.)

It was found that the application of organic manures to the irrigated and dry-farm soils of the state increase the ammonifying, nitrifying, and nitrogen-fixing powers of the soil. The gain in nitrogen, attributable to non-symbiotic nitrogen-fixers, occurring under vegetation-house conditions, varied from 0 to 304 pounds per acre-foot of soil. Greatest gains occurred where legumes were used as the manure. The annual acre-gain occurring in the soil under field conditions and attributable to non-symbiotic-nitrogen fixation was 44 pounds. Approximately 3000 pounds of applied organic material was decomposed annually. (Project 23.)

An extensive survey of the irrigation waters of the state was begun in the spring of 1930. (Project 24.)

Entomology

Until the time of his death early in January, 1930, the investigations on miscellaneous insects had been under the supervision of Dr. H. J. Pack. The results of his investigations for the past biennium have been published in Utah Station Bulletin 216 (April, 1930). Reprints Nos. 110, 113, 118, 120, 122, 130, 134, 136, 143, 148, and 149, also cover investigations on this problem. (Project 51.)

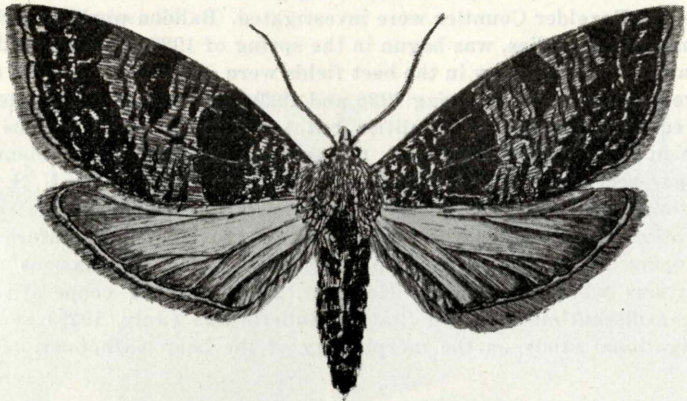


Fig. 8.—Adult codling moth, *Carpocapsa pomonella* (Linn.)

Investigational field work on the study of the **chalcis-fly** in alfalfa-seed was begun in the spring of 1926, with the majority of the field work done in the Uintah Basin. The principal topics of investigation have included the following: (1) Seasonal distribution of chalcis-flies in alfalfa-seed fields; (2) life-history of the alfalfa-seed chalcis-fly; (3) methods of control; (4) parasites; and (5) amount of chalcis-fly infestation in the annual alfalfa-seed crop of Utah. Results of this investigation to date appear in Station Bulletin No. 218 (June, 1930). (Project 80.)

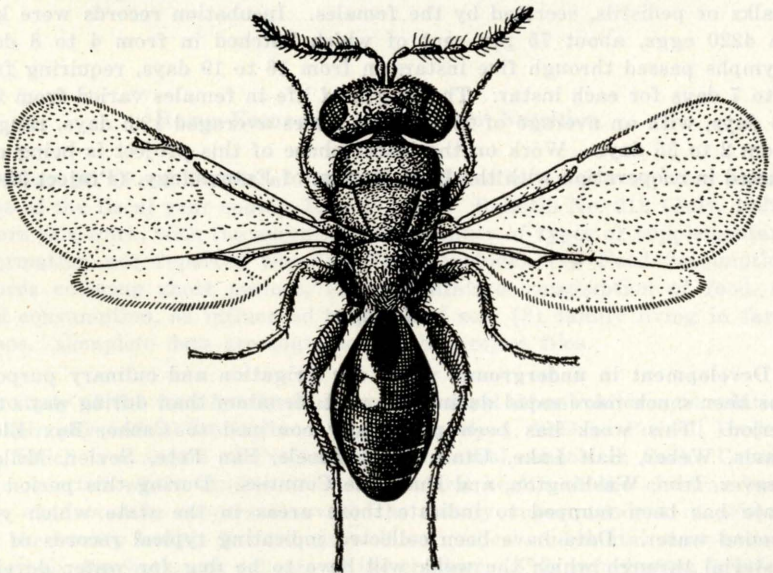


Fig. 9.—Male alfalfa-seed chalcis-fly (*Bruchophagus funebris* How.) (Enlarged.)

Studies of the more important breeding grounds of the beet leafhopper in Tooele and Boxelder Counties were investigated. Balloon work, in connection with migration studies, was begun in the spring of 1929. Studies on development and extent of injury in the beet fields were conducted, showing damage to have been less severe during 1928 and 1929 than during 1926. Late injury occurred in a number of localities but too late to be of serious consequence in reducing beet tonnage. Cooperation during the past biennium in the **sugar-beet leafhopper investigations** has been given by the U. S. Bureau of Entomology. Work on resistance to curly-top has been carried on in cooperation with the Station Agronomy Department. Viruliferous beet leafhoppers were secured and approximately 11,000 inoculations and re-inoculations were performed. However, this phase of cooperative work has been discontinued. Utah Station Bulletin 212 (July, 1929) represents investigational study on the morphology of the beet leafhopper. (Project 82.)

Work accomplished to the end of 1929 on the tomato psyllid, **Paratrioza cockerelli** Sulc., is reported by the late H. J. Pack in Utah Station Bulletin 216 (April, 1930). Since that time life-history studies have been undertaken and control measures will be tested during the summer. The following life-history studies were carried on in the laboratory during April, May, and June, 1930: Mating occurs in from two to four days after the psyllids become adult and at intervals thereafter. If the female is deprived of the male, the eggs produced after a few days are infertile. Mating requires from 4 to 14 minutes. The preoviposition period ranges from 5 to 19 days. Ten females laid 3109 eggs; five others did not oviposit. Individual females laid from 41 to 1151 eggs, and as many as 61 in 24 hours. The oviposition period ranged from 6 to 55 days. The eggs rest on the stalks or pedistils, secreted by the females. Incubation records were kept on 4220 eggs, about 75 per cent of which hatched in from 4 to 8 days. Nymphs passed through five instars in from 16 to 19 days, requiring from 2 to 7 days for each instar. The length of life in females varied from 2 to 68 days, with an average of 29.1 days. Males averaged 19.5 days, ranging from 2 to 35 days. Work on the insect phase of this project is being conducted in cooperation with the U. S. Bureau of Entomology. (Project 92-B.)

Geology

Development in underground water for irrigation and culinary purposes has been much more rapid during the past biennium than during any other period. This work has been principally confined to Cache, Box Elder, Davis, Weber, Salt Lake, Utah, Juab, Tooele, San Pete, Sevier, Millard, Beaver, Iron, Washington, and Duchesne Counties. During this period the state has been mapped to indicate those areas in the state which yield ground water. Data have been collected indicating typical records of the material through which the wells will have to be dug for water development. These data are now being arranged for publication. Cooperation

has been extended in this work by the U. S. Weather Bureau office in Salt Lake City. (Project 25.)

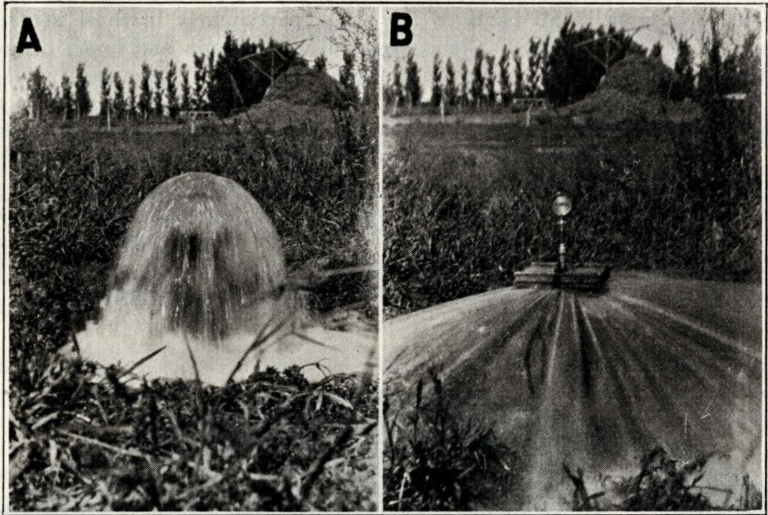


Fig. 10.—Flow-well district, Millard County, where careful record has been kept on this particular well for ten years.

A: An 8-inch well under full flow. This well furnishes irrigation water for an 80-acre alfalfa farm.

B: Same well in process of closing with a pressure gage to measure the static head.

Home Economics and Human Nutrition

Project 83 (**Food Habits of Utah Farm Families**) was completed at the close of the fiscal year ending June 30, 1929. Bulletin No. 213 (July, 1929) covers this work, with the exception of a number of types of supplementary information not reported therein. These include: (1) Food-consumption records covering short periods, (2) comparative consumption of food, or food consumption, as influenced by age and sex, (3) family living in farm homes. Complete data are contained in the project files.

A study of the food habits of elementary rural school children in relation to their physical well-being was begun on July 1, 1929 as Purnell Project 102, which is a sequel of Project 83. Two rural schools in Cache County were selected where studies of the diets and health of the children have been conducted in cooperation with the county superintendent of schools and the county health director, as well as medical and dental associations, principals, teachers, and parents of the children. This information is being analyzed and tabulated as a basis for future publication. (Project 102.)

Believing that knowledge of available plants rich in iron might lead to their increased use, a study of "greens" or pot plants was launched in the spring of 1930, to learn what plants, both cultivated and wild, are now being used for "greens" or pot plants in farm homes of Utah and to make available to Utah farm housewives information concerning kinds of "greens" available in all parts of the state, particularly in those sections remote from food markets. County agricultural agents and home demonstration agents assisted by providing names of leaders or groups organized for Extension work, which resulted in 530 questionnaires being sent to all counties in the state except to Daggett, Summit, and Wayne Counties. One hundred and seventy-five questionnaires have been returned, representing all counties to which questionnaires had been sent. It is planned to issue a circular giving cuts and descriptive matter which will enable housewives to identify plants which might be used for food. Sources of information will also be included on "greens" or pot plants that might well be made a part of the family garden. (No project number assigned.)

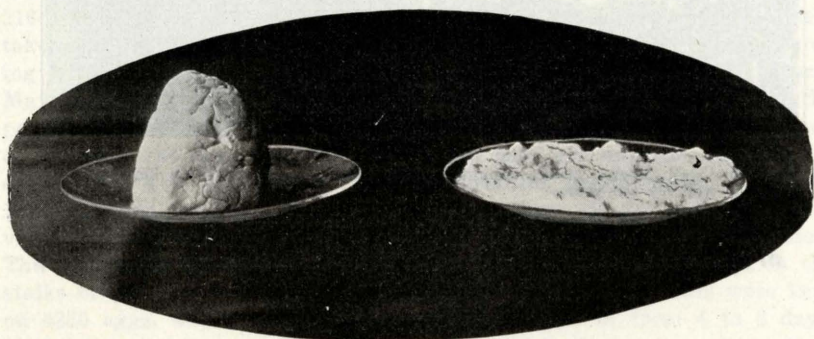


Fig. 11.—Difference in texture of curd from hard- and soft-curd milk.

As a continuation of Project 52, carried under Hatch Funds since 1919, Project 103 was begun as a Purnell project on July 1, 1929. The physical curd character of milk and its relationship to the digestibility and food value of milk for infants is the title under which this project is carried. Three phases of the project are under study: (1) The digestibility and food value of milk when fed to infants under a doctor's supervision, (2) variation in the physical curd character of milk of different breeds of dairy cattle, and (3) variation in the physical curd character of human and goats' milk. There are under study at the present time two groups of infants in the Salt Lake County Hospital—one being fed soft-curd milk and the other hard-curd milk. The work is under the supervision of the hospital pediatrician. Present indications are that soft-curd milk is more valuable than the hard-curd milk as a food for infants. This further substantiates results previously reported. More than 1000 cows in the state have been tested for physical curd character of their milk. This survey includes the following breeds which have been tested: Holstein, Guernsey, Ayrshire, Shorthorn (Durham), and some Herefords. Similar variations are found

in the different breeds which parallel the results reported in Station Bulletin 207 (June, 1928). The milk of a number of milk goats has been tested and a variation of from 20 to 180 grams' curd tension observed. It has also been noted that the curd from goats' milk is granular rather than elastic. Apparently, however, there is as much variation in the curd of goats' milk as there is in that of dairy cows. Difficulty has been experienced in obtaining sufficient samples of human milk to test. Samples of milk obtained from the Holy Cross Hospital, Salt Lake City, were all in the colostrum stage and the reaction was therefore not normal. An effort is to be made to obtain sufficient samples of human milk at later stages. (Project 103.)

In the spring of 1930 a preliminary investigation was begun at condensed milk plants in Cache Valley to determine the effect of evaporation of milk on its physical curd character. Present indications are that there is a softening of the curd of milk due to the evaporation process, the chief agencies causing this softening being boiling and sterilization. However, these results are only preliminary. (Project 103-A.)

In cooperation with the Dairy Manufacturing Department of the college proper a test was begun early in 1929-30 on the effect of physical curd character of cheese. Milk from purebred Holstein cows, with the hard-and soft-curd tests, has been utilized in the manufacture of cheese. Both hard-curd and soft-curd milk was placed in vats side by side and standardized to the same fat content. Cheese was then made from these two grades of milk, the hard-curd milk requiring about an hour less time in the setting process. The texture and quality of cheese made from the hard-curd milk was superior to that made from the soft-curd milk. Preliminary investigations indicate that hard-curd milk of the same fat content is worth about 38 cents per hundred more for the manufacturing of cheese than is the soft-curd milk. Further work should be conducted on this project. (Project 106.)

On March 12, 1930, an investigation on high-altitude metabolism studies on normal college women was begun. Five college women, normal in health and in their emotional reactions, were chosen as subjects for this experiment. They were housed in the Home Economics Building during the months of March, April, and May under conditions ideal from an environmental point of view. Duplicate daily readings of their basal rate were taken before rising. To avoid the after-effects of exercise and food, the subjects abstained from eating after seven o'clock in the evening and retired early. Approximately 170 basal readings were taken on each subject during this period and approximately 800 readings secured on these five subjects. No calculation of results has as yet been made. (Project 104.)

Horticulture

The peach-harvesting index studies, begun in 1925, have been carried on by harvesting fruit from orchards under different conditions at different stages of maturity and after classifying and testing, storing them under

conditions similar to those encountered in a refrigerator car; the fruit is then removed and tested for condition and quality. Color and pressure tests appear to be the best indications of maturity of Elberta type peaches under normal weather conditions prevailing during and preceding peach harvest in Utah. Under normal conditions peaches will develop best quality with least loss if picked when a lemon-yellow color, after most of the green has disappeared but before the orange shade develops. Fruit harvested at a less mature stage was of poor quality, smaller in size, and produced a lower yield. Peaches picked at a riper stage developed better quality but were too soft for commercial handling and continued more overripe and decayed fruit. Because of the difficulty of securing proper temperature in commercial storage and the lack of experimental cold storage equipment, work on this project will be discontinued beginning July 1, 1930. (Project 86.)

A collection of and the establishment of stocks of the different orchard rootstocks to be tested for propagation and observational purposes has been conducted in the Station nursery at Logan. A field test of apricots on peach and on apricot roots was planted this spring at Farmington. A shipment of pedigreed layered rootstocks was imported from England in 1929 for trial under Utah conditions. These stocks, propagated vegetatively and selected for vigor and uniformity, have done well and are being layered for increase. Particular emphasis is being placed on problems of sweet cherry and pear rootstocks. Several hundred seedlings of Mazzard and Mahaleb cherries and Japanese, French, Ussuriensis, and Calleryana pears are being grown and layered to enable selection of superior types and their propagation and testing as uniform clonal rootstocks. Additional land is needed for field trials of both seedling and selected layered stocks. Apple trees budded on uniform layered stocks are available from the U. S. Department of Agriculture for testing, provided land is made available. (Project 93.)

Sweet cherries are intersterile, that is, they require cross-pollination. In addition, the three principal varieties—Bing, Lambert, and Napoleon—are intersterile; hence, a fourth variety must be planted with these to secure good sets of fruit. **Cherry-pollination studies**, initiated in 1928, aim (1) to determine the best varieties and strains to use as pollinizers, (2) to find new pollinizers which are of greater commercial value than those now used, and (3) to determine the best number and distribution of pollinizing trees under intermountain conditions. Results to date indicate that certain strains of Black Tartarian, with Windsor and Black Orb, are satisfactory as far as pollination is concerned for Bing, Lambert, and Napoleon and that when used for this purpose the pollinizers, as well as the commercial varieties, will set fruit satisfactorily. Centennial and Black Republican have given fair results. From present data, Windsor and Black Tartarian (tested strains) are suggested as the best pollinizers to use in Utah cherry orchards. New varieties which promise to be of greater value and of equal service in pollination are Deacon, Giant, Schmidt Bigarreau, and Seneca, which have given satisfactory results in tests at other stations. Because of the poor set in 1930 from rainy weather, the main part of this project should be continued another year and that dealing with new varieties and methods for a longer period. (Project 94.)

Initiated in 1928, the project on **variety testing** is attempting to determine the best varieties of orchard and small fruits for fresh shipping, local market, canning and processing, and for home use under different conditions as found in the state. Variety orchards and small fruit trials are located at Farmington and at Logan. Farmington conditions are typical of the milder protected Utah valleys containing the commercial fruit sections, while Logan is representative of the less well-protected valleys. At Farmington the plantings of peaches, plums and apricots were extended and some additions made to the plantings of other fruits.

Summary of Fruit Plantings, 1928-30

	No. of Varieties	No. of Plants
Davis Experimental Farm		
Sweet cherries	24	186
Sour Cherries	14	140
Apricots	27	117
Peaches and nectarines	62	374
Plums and prunes	35	140
Nuts	8	16
Grapes	15	60
Experiment Station, Logan		
Apples	14	
Pears	3	
Plums	22	
Cherries	6	
Peaches	10	
Apricots	12	
Nuts	8	
Grapes	32 (140 vines)	
Gooseberries, currants	12 (320 plants)	
Raspberries, blackberries	45 (1440 plants)	
Pear stocks		400
Cherry stocks		1000
Peach and plum stocks		600
Apple stocks		400

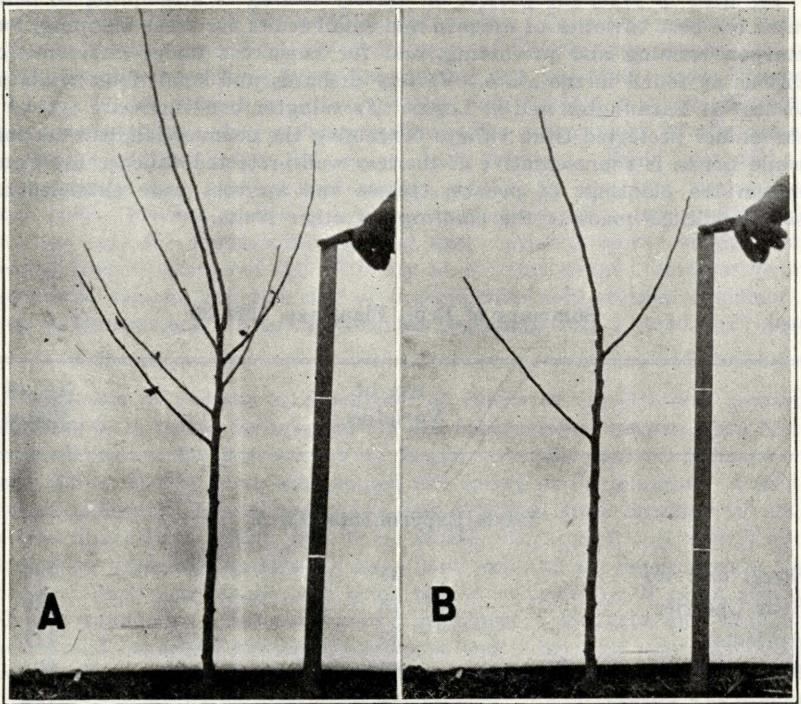


Fig. 12.—A: Ready for first dormant pruning. One-year-old Delicious apple. Note dominant leader and surplus branches.

B: Same tree after pruning. Beginning the modified leader. Note leader left longer to provide additional scaffold branches. Two side branches are all that could be left and be well-spaced.

Trees planted during the past two seasons have made a vigorous growth and some fruit has set on the apricots and peaches. The trees have been trained to the new modified-leader system and are almost entirely free from weak crotches. Some of the new varieties under test which have greatest promise of commercial value are Golden Jubilee, South Haven, Mikado (June Elberta), and Rochester peaches—all firm, yellow freestone shipping peaches ripening before Elberta; Giant, Schmidt Bigarreau, Deacon cherries—all large black shipping cherries promising as pollinizers; Starking, Richared, Dark Red Rome, Staymared, and Blaxstaymen apples; and Cayuga pear. Additional land is needed to adequately carry on these tests. Provision should be made for cooperative variety testing work in those sections of the state where climatic conditions are vastly different. (Project 95.)

Davis County Substation.—Located in the heart of the small fruit and truck-gardening section of the state, this substation is proving its value to growers in this section as well as in all similar sections in the state. Strawberry tests include a variety test as to yield and market value. Be-

cause of lack of ground the strawberry variety test, except for a few of the most promising varieties, was discontinued. Marshall had already proved its worth as the leading variety for local use. Among the bush fruits are included blackberries, dewberries, raspberries, American and European grapes, and currants. The regular planting plan was modified in 1928 to include tree fruits, since which time new plantings have been made each spring and which will continue until all the land allotted has been completely planted. A few varieties of pear trees were added this spring. Tomato work involves chiefly the improvement of canning varieties by selection as to size, color, shape, and is devoted to the two leading varieties—Stone and Baltimore. Onion studies have continued to be one of the most important lines of investigation, with special studies being made on (1) strains of Sweet Spanish varieties, (2) seed production, (3) improvement of pedigreed selection, (4) small or large bulk for seed production, (5) Bermuda onion-growing, and (6) development of the white strain of Sweet Spanish. When celery work was begun many varieties were planted. The results established beyond a doubt that the so-called Utah variety is much superior to all others; therefore, this variety is being grown each year with the aim of improving it by careful selection of mother plants. (Project 59.)

Irrigation, Physics, and Soils

During the first year of this biennium the activity of replaceable bases in soils was studied by the Department of Soils, together with a cooperative study with the Physics Department on the alkalinity and permeability of the soils of the so-called Bell Tract, north and west of Logan. During the past year a series of percolation tanks for a long-time study of the movement of water through various soils have been provided and partly installed; work has continued on the technical studies on the activity of replaceable bases and allied problems heretofore conducted by the Soils Department under Project 11. A considerable amount of work has been done in perfecting apparatus and equipment for the measurement of activity of the replaceable bases. This project now covers some of the work formerly carried under Projects 11 and 17 and all of the work under Project 12. Project 11, under this revision has been discontinued, Project 17 has been revised, and Project 12 is to continue in its present form under the title of "Technical Studies of the Physical and Physico-chemical Properties and Processes in Soils." (Project 12.)

Work formerly carried under Projects 17 and 11 and all of that under Project 17-E was modified and revised. Under this revision, the old Projects 11 and 17-E are discontinued, the revised project carrying the number 17— "A Study of Some Factors Which Influence the Reclamation of Water-logged and Alkali Lands." During the first part of the biennium the work consisted primarily of a study of the soils of the Bell Tract, for which a 20-year lease has been obtained, with particular reference to the alkali content and permeability to moisture. The U. S. Bureau of Public

Roads is cooperating in making a study of the hydrostatic pressure in the gravel stratum underlying the heavy soils in the bottom of the valley. Attention is also being given to the question of reducing the soluble-salt content and alkalinity of these lands. From measurements taken on these pressure wells a hydraulic contour map has been prepared showing in a general way that the artesian flow proceeds through a continuous gravel stratum from the foothills toward the valley in a broad stream, coextensive with the valley itself rather than in well-defined channels. The water-table studies in Cache Valley may perhaps be completed during the coming fiscal year, but it is hoped that the alkali work may continue over a period of years. Reprints Nos. 107, 121, 144, and 146 cover different phases of work on this project. (Project 17.)

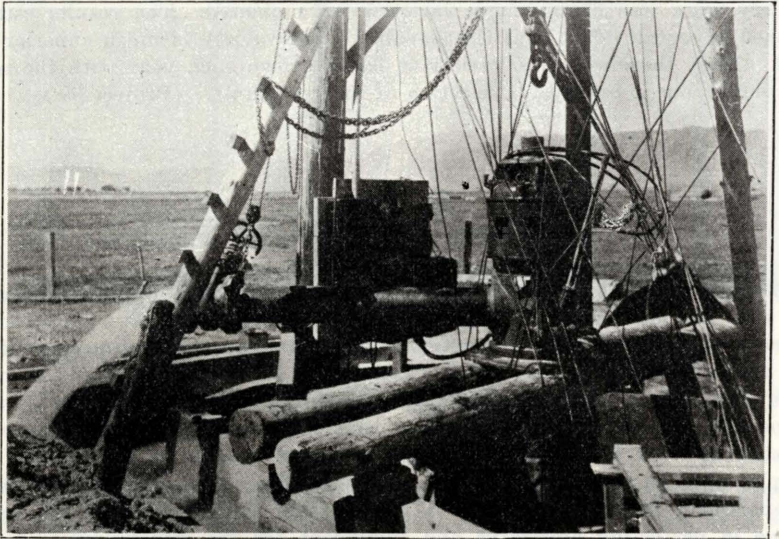


Fig. 13.—Drainage by pumping. By substituting electrical power for gravity and making use of large wells in place of extensive horizontal drainage systems, it is found possible to drain wet lands at a great economic saving. In addition to draining the soil, drain wells furnish excellent irrigation streams.

In a study of factors influencing the financial condition of certain Utah irrigation and drainage projects, Subprojects A and B are carried in this division. Subproject A has dealt specifically with engineering factors influencing the financial condition of the Melville Irrigation and of the Delta Canal Projects, both in Millard County. Work on the former has been completed and the latter is nearly completed. Investigation of engineering factors influencing the several other drainage districts of Millard County is under way, completion of which will require two or more years, the time necessary depending upon the time of completion of the soils and agricultural economic aspects of the study. (Project 90-A.)

In an effort to secure quantitative measurements on the important physical and chemical properties of the soil types of the areas represented by the Melville and Delta Irrigation Projects, the profile of each type of soil occurring in these areas has been carefully worked out and samples collected from each horizon in a number of locations of every type. The index of friability, shrinkage coefficient, relative moisture capacities, and determinations of the chemical constituents of the important soil types of these areas are now well under way. (Project 90-B.)

Begun in the fall of 1923 on State funds, this project on seasonal snow surveys was transferred on July 1, 1925, to Purnell funds and its scope broadened. It involves the measurement of winter precipitation on high watersheds, the determination of watershed characteristics, the amount and distribution of early and late fall rains, temperature, evaporation from snow and ground surfaces, ground storage, vegetable cover, and runoff. Satisfactory methods of measuring the winter precipitation on high watersheds have been developed and studies are now being made to determine the factors causing the water loss. There are now available seven years of records on the Logan drainage area which indicates some of the basic principles underlying the stream-flow-precipitation relationships. Snow cover on April 1, temperature during the melting season, early spring precipitation, and watershed characteristics are apparently the major factors to be considered. During the past year a cooperative agreement has been worked out between the Utah Agricultural Experiment Station, the U. S. Forest Service, and the U. S. Weather Bureau, under which a network of snow surveys has been established, covering the principal watersheds of the state. These surveys will form the basis of water-supply forecasts for all streams in the state. This project should continue probably ten years longer to permit the working out of snow-cover runoff relationships for each watershed in the state. Reprints Nos. 124, 135, 139, and 141 represent investigations on this project. (Project 72.)

Plant Pathology and Physiology

Four phases of the potato virus disease problem have received consideration during the past two years: (1) Symptomological studies with an attempt to determine the number and the expression of virus diseases in the different localities, (2) yield tests to determine more accurately the relative importance of the various virus diseases in their effect on yield, (3) dissemination-rate studies to discover areas in the state suitable for seed production, and (4) studies on control, particularly an attempt to check the value of different methods recommended for the control of virus diseases. Seven definite virus diseases have been differentiated: Rugose mosaic, mild mosaic, crinkle mosaic, leaf-rolling mosaic, spindle tuber, leaf roll, witch's broom, and possibly a supermild mosaic. Psyllid yellows, a disease induced by the feeding of the hopping plant louse and peculiar to the intermountain region, may finally prove to be a virus disease. A

description of the symptoms of these various diseases with suggestions for their control is now in manuscript form and will appear as a U. S. Department of Agriculture Farmers' Bulletin under the probable caption of "Potato Virus Diseases in Montana, Oregon, and Utah, and Their Control." Results in the yield test show that all virus diseases are important in yield reduction. In the work under dissemination, plots have been maintained in the potato-growing areas of Cache, Boxelder, Morgan, Weber, and Wasatch Counties, which show that virus diseases, especially rugose mosaic, are spread much more rapidly in some areas than in others. These facts may result in abandoning seed-potato growing in some districts and its concentration in others. This work will be intensified during the coming biennium. Two aspects of the control problem have been emphasized: (1) The value of the tuber unit as compared with mass roguing in the elimination of virus diseases and (2) the determination of value of the early potato areas of Davis and Washington Counties as possible areas for tuber-index work to detect the presence of milder forms of mosaic in certified potato seed. Results for the past two years clearly show that the tuber-unit method is much more effective and that with the application of this method as sufficiently early dates practically all virus diseases can be effectively eliminated in seed stock. Results, in general, indicate that the tuber-unit method of roguing should be employed in all seed-production work, especially where the rate of spread of virus diseases is rapid. That part of this project pertaining to symptomological studies has been carried on in cooperation with the U. S. Bureau of Plant Industry and that part pertaining to control with the State Department of Agriculture. (Project 31.)

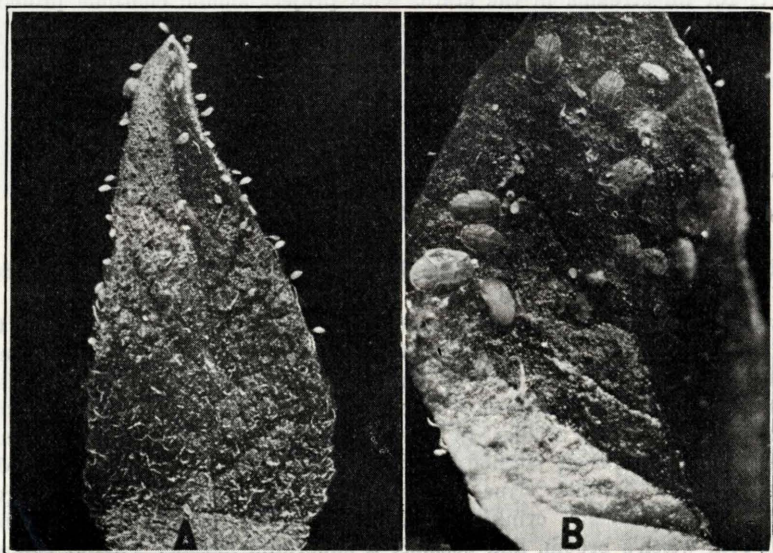


Fig. 14.—A: Eggs of *Paratrioza cockerelli* Sulc. (Leaf and eggs, x 91.)
B: Young nymphs of *Paratrioza cockerelli* Sulc. (x 91.) Note eggs on margin of leaf.

Bacterial canker, caused by *Aplanobacter michiganese*, was found in 1927 to be the most important disease of the tomato in the state, causing a loss of from 12 to 14 per cent of the tomato crop. During 1928 the disease, while less prevalent than in 1927, undoubtedly ranked first for the season, causing a loss of approximately 8 per cent of the crop. Between August 26 and September 2, 1929, bacterial canker was found in 59 of the 66 fields

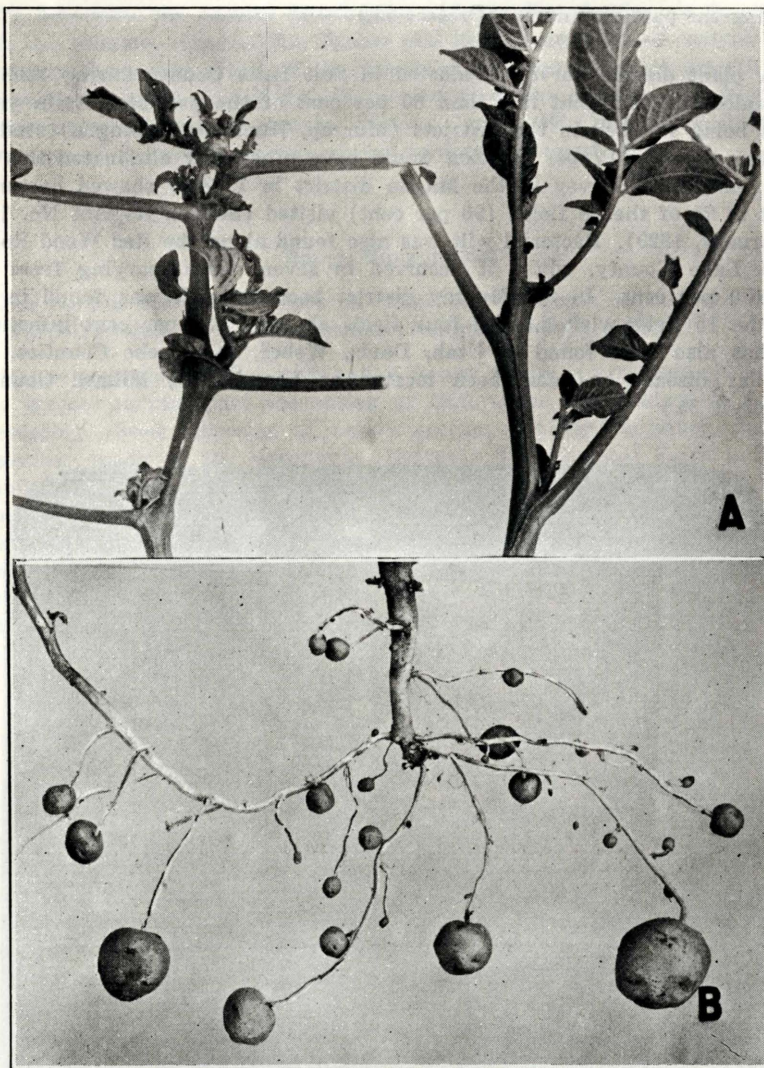


Fig. 15.—A: Left—Diseased potato plant from psyllid yellows. Right—Healthy plant. Note axillary angle of diseased plant as compared with that of healthy plant.
B: Effects of *Paratrioza cockerelli* Sulc. on potatoes where excess tuberization is induced by the feeding of the insect.

(89 per cent) of the tomato plantings visited; infections, however, were generally light and only in a few cases were fields found with infections equal to many in 1927. The disease was found in the selections of tomato varieties to be used as a seed source for most of Utah's 1930 crops; these selections were discarded. Results on virus diseases of tomatoes are now ready for publication. The Department of Plant Pathology, Wisconsin Agricultural Experiment Station, has cooperated in the tomato-disease work during the past biennium. (Project 33.)

A plant disease survey conducted in Salt Lake County during 1928-29 revealed the fact that less than 60 per cent of the possible alfalfa yield was being realized in the districts (Murray, Hunter, and Magna) studied in this county. Proper rotation would have practically eliminated this 40 per cent loss. Survey in the Magna district in 1928-29 showed bacterial wilt in 25 of the 28 fields (90 per cent) visited (Station Reprint No. 123, February, 1929). Bacterial wilt was also found along the Red Wood Road, Salt Lake County, where it occurred in severe form, varying from 40 to 100 per cent. In the Murray district bacterial wilt was found in 13 of the 15 fields visited, with four fields showing 100 per cent infection. It has also been found in Utah, Davis, Weber, and Cache Counties. A similar disease has also been located at Leamington, Millard County. (Project 34.)



Fig. 16.—Chlorotic pear tree three years after injection of iron into right side. Left side untreated.

While the disease, **psyllid yellows**, is definitely known to be produced during the feeding of **Paratrioza cockerelli** Sulc., the exact nature of the disease and just how the disease is produced remain obscure. There is much evidence that the etiological agent is not a distinct virus but rather a toxin injected during the feeding process of the insect. However, this view is not clearly established. (Project 92-B.)

To determine the general distribution and severity of chlorosis, to establish the primary cause of the disease and perfect methods of control, and to study the actual effect of the chlorotic condition on plant growth are the main objectives in regard to the project on **nature and cause of chlorosis and practical methods of control**. Station Circular 85 (May, 1930) includes a resume of the results on this project to date. (Project 89.)

Range Management

For various reasons the work on **range survey**, begun in 1918 and listed as Purnell Project 48, was discontinued beginning July 1, 1929.

Range reseeding studies with native forage plants is a revised outline of the project carried since the spring of 1921 under the heading of Range Reseeding. Seed collection of native species is being continued, and of plantings made on the Greenville (Central) Experimental Farm a large number are now successfully established. Life-history studies have been centered on mountain brome grass, **Bromus polyanthus**. Greenhouse and field tests on depth of planting showed successful establishment in light from the surface to 1.5 inches depth. Laboratory tests on soil moisture necessary for germination of **Bromus polyanthus** showed a minimum requirement of 8 per cent and a maximum of 18 per cent moisture. (Project 61.)

Rural Sociology

An effort has been made to determine the differences, with respect of both quantity and quality of social contacts, between (1) those farm families living on farms, (2) those living in both towns and on farms, and (3) those who live in town and who farm outside of town. In this study of towns and villages—some contacts among farm families—over 1000 individual records from 80 farm families have been obtained which cover all social contacts over a period of four months, that is, one month in each season of the year. The attendance of all the people of each of the three farm groups at public gatherings during this period has been tabulated and information concerning the social service agencies constituting the sources of supply for social contacts has been assembled. (Project 88.)

Cooperation has been given in a study of factors influencing the financial condition of certain Utah irrigation and drainage projects. This phase of the problem will be continued during the next biennium. (Project 90-C.)

RECOMMENDATIONS

With its financial status greatly strengthened as the result of (1) a slight increase in appropriation, (2) some additional revenues from co-operative agencies, and (3) business-like administration of its budgeted funds, the Utah Agricultural Experiment Station closes the biennium, 1928 to 1930, in an unusually satisfactory condition. And with all of its research projects revised to meet the more recent needs of the state, the Station's program of work at the close of the biennium is in line with what the producers of Utah require. Moreover, a highly qualified staff is eager to carry forward this program, which is founded on the sound result of four decades of Station service to the commonwealth.

In order for it to meet successfully problems now confronting farm and rural life interests, however, the Station not only must not suffer reduction in its present status but should be strengthened through the provision of additional equipment.

The chief need of the Agricultural Experiment Station is a central experimental farm near the college. For more than forty years the Station has had only a pitifully small tract of owned land upon which to conduct its major crop and livestock investigations. In more recent years it has had to lease additional tracts to satisfy its requirements. But leased tracts are not suitable because on such land the making of permanent improvements is not advisable, even though such improvements are essential to the proper conduct of experimental work. Besides this disadvantage, the annual rental charge is a cost item that could be eliminated if the land used were owned by the institution.

Recognizing this obvious need for an experimental farm it cannot too strongly be urged that it be called to the attention of the Governor and the State Legislature with a view to having the need satisfied. This land requirement probably could be included in any general land program that the institution may formulate, but it is hoped that the next biennium will find the Station with a suitable farm.

Another need, which was emphasized during the last legislative session but remained unsatisfied, is the need for additional research greenhouses. A number of departments of the Station are seriously handicapped because of inadequate greenhouse space in which to conduct important investigations. It is recommended, therefore, that provision be made in the next budget presented to the Governor for at least two more greenhouses for research purposes.

A continuing appropriation is needed for the Animal Disease Research Laboratory created by the last Legislature. This laboratory is now equipped and ready to render the great service expected of it as the time it was established. The next Legislature should make possible the rendering of that service by providing for the maintenance and operation of the laboratory.

Besides lands, greenhouses, and a continuing appropriation for the Animal Disease Research Laboratory, the Station needs additional scientific appa-

ratus in all departments and it must, of course, take care of normal maintenance costs.

A rapidly increasing and a very broad interest in fish and game, apparent in all parts of the state and reflected by the activities of protective associations, has suggested the desirability of the Experiment Station inaugurating a research program in this field. Financial support of such a program is recommended in the belief that the results would be of inestimable value to the state not alone from the standpoint of fish and game culture and protection, but from the relationship of fish and game to range and stream use as affecting livestock and agricultural interests.

The State of Utah has displayed as generous an attitude toward the Agricultural Experiment Station as circumstances would permit, and it is felt that this attitude will continue and the needs of the Station will, if possible, be met.

LIST OF AVAILABLE PUBLICATIONS

BULLETINS

- 121—Soil of the Southern Utah Experiment Station.
- 128—Blooming Periods and Yields of Fruit in Relation to Minimum Temperatures.
- 132—Minor Dry-land Crops at Nephi Experiment Farm.
- 137—Quality of Home-grown Wheat vs. Imported Wheat.
- 144—Water Table Variations—Causes and Effects.
- 150—Further Studies on Nitric Nitrogen Content of Country Rock.
- 152—Effect of Soil Moisture on Certain Factors in Wheat Production.
- 159—Soil Moisture Studies under Irrigation.
- 160—Important Factors in Operation of Irrigated Farms.
- 161—Orchard Heating.
- 163—Composition of Irrigation Waters of Utah.
- 165—Labor Costs and Seasonal Distribution of Labor in Irrigated Crops.
- 173—Duty of Water in Cache Valley, Utah.
- 178—Irrigation of Barley.
- 181—Duty-of-Water Investigations on Coal Creek, Utah.
- 183—Water-holding Capacity of Irrigated Soils.
- 184—Farm Management Study of Great Salt Lake Valley.
- 185—Influence of Nitrogen in Soil on Azofication (Technical).
- 186—Irrigation Experiments in Sugar-beets.
- 187—Irrigation Experiments in Potatoes.
- 188—Maintaining the Productivity of the Soil.
- 189—Ridding the Land of Wild Morning Glory.
- 190—Corn Silage in the Dairy Ration.
- 191—Oedipodinae of Utah (Technical).
- 192—Biennial Report of Director, 1923 and 1924.
- 193—Cache County Water Conservation District No. 1.
- 194—The Influence of Storage on the Composition of Flour (Technical).
- 195—Field Studies of Sugar-beet Nematode.
- 196—Fruit Tree Leaf Roller.
- 197—The Pear Leaf Blister Mite as an Apple Pest.
- 198—Report of Director (for 18-month Period from Jan. 1, 1925 to June 30, 1926).
- 199—Mutual Irrigation Companies in Utah.
- 200—Maintaining Potato Yields by Hill Selection.
- 201—Economic Insects in Some Streams of Northern Utah.
- 202—Some Observations on Winter Injury in Utah Peach Orchards.
- 203—Cattle Ranching in Utah.

BULLETINS—Continued

- 204—Sheep Ranching in Utah.
- 205—The Beet Leaf Hopper in Utah.
- 206—Treehopper Injury in Utah Orchards.
- 207—The Physical Curd Character of Milk and Its Relation to the Digestibility and Food Value of Milk for Infants.
- 208—An Economic Study of the Apple Industry of Utah, 1926 and 1927.
- 209—Biennial Report of Experiment Station, 1926-28.
- 210—The Mineral Contents of Grains.
- 211—Silage Corn Varieties for Utah.
- 212—Studies on the Morphology of the Beet Leafhopper.
- 213—Food Habits of Utah Farm Families.
- 214—An Economic Survey of the "Dixie" Section, Washington County, Utah.
- 215—Cost Reduction in Dry-farming in Utah.
- 216—Notes on Miscellaneous Insects of Utah.
- 217—Prices of Farm Products in Utah.
- 218—The Alfalfa-seed Chalcis-fly in Utah, 1927-29, Inclusive.
- 219—Twenty-eight Years of Irrigation Experiments near Logan, Utah, 1902-29, Inclusive.
- 220—Biennial Report of Utah Agricultural Experiment Station (July 1, 1928 to June 30, 1930).

CIRCULARS

- 12—Thinning Apples.
- 18—Better Horses for Utah.
- 21—Dry-farming in Utah.
- 22—Some Sources of Potassium.
- 23—Seed Situation in Utah (1916).
- 26—Storing Vegetables for Winter.
- 29—Control of Rodent Pests.
- 30—Codling Moth.
- 31—Alfalfa Weevil.
- 41—Soil Alkali.
- 44—Agriculture of Utah.
- 48—Rural Credits in Utah.
- 49—This Public Domain of Ours.
- 51—Foot-and-Mouth Disease.
- 54—The More Important Insects Injurious to the Sugar-beet in Utah.
- 57—Economy in Harvesting Sugar-beets.
- 58—Potato Production in Utah (Revision of Circular 40 now out of print)
- 60—Seed-Potato Treatment.
- 63—Tomato Culture in Utah.
- 64—Onion Growing in Utah.
- 66—Physical Curd Character of Milk and Its Probable Relation to Infant Nutrition.
- 69—Clean Milk and Its Production.
- 70—The Agricultural Outlook for Utah, 1928.
- 71—Weeds.
- 72—Brooding and Feeding Baby Chicks.
- 75—Selecting Dairy Cows.
- 76—The Utah Agricultural Experiment Station—What It Is, What It Is Doing, etc.
- 77—Measurement of Irrigation Water.
- 78—Annual Summary of Publications.

CIRCULARS—Continued

- 79—Rules and Regulations for the Sixth Utah Intermountain Egg-Laying Contest.
- 80—Domestic Slaughtering, Cutting, and Curing of Pork.
- 81—Beef Slaughtering and Cutting.
- 82—Lamb Slaughtering and Cutting.
- 83—Planning, Planting, and Caring for the Young Orchard.
- 84—Building Young Deciduous Fruit Trees.
- 85—Chlorosis: Yellowing of Plants.
- 86—Coccidiosis of Chickens.
- 87—Raising Dairy Calves.
- 88—Annual Summary of Publications, July 1, 1929 to June 30, 1930.
- 89—Rules and Regulations for Seventh Utah Intermountain Egg-laying Contest.

Address:

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Utah Agricultural Experiment Station,
Logan, Utah.

CONTENTS

	Page
Staff Changes	3
Resignations	4
Appointments	4
Sales	4
Equipment	5
Substations	5
Establishment of Animal Disease Laboratory	5
Cooperative Research	6
(A) U. S. Department of Agriculture	6
(B) Miscellaneous	7
Library	8
Publications	8
Projects	16
Summary of Results of Investigations	21
Agricultural Economics	21
Agronomy	22
Animal Husbandry	33
Chemistry and Bacteriology	39
Entomology	40
Geology	42
Home Economics and Human Nutrition	43
Horticulture	45
Irrigation and Drainage, Soils, and Physics	49
Plant Pathology and Physiology	51
Range Management	55
Rural Sociology	55
Recommendations	56