Bulletin No. 209 - Biennial Report of Director: July 1, 1926-June 30, 1928

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Biennial Report of Director

July 1, 1926—June 30, 1928

Agricultural Experiment Station
Utah Agricultural College
LOGAN, UTAH
UTAH AGRICULTURAL EXPERIMENT STATION

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*P. V. Cardon, B.S..............................................................Director

WILLIAM PETERSON, B.S......................................................Geologist
H. J. FREDERICK, D.V.M....................................................Veterinarian
J. E. GREAVES, Ph. D............................................................Chemist and Bacteriologist
GEORGE B. CAINE, A.M.....................................................Dairy Husbandman
R. L. HILL, Ph. D.................................................................Human Nutrition
GEORGE STEWART, Ph. D....................................................Agronomist
O. W. ISRAELSEN, Ph. D.....................................................Irrigation and Drainage Engineer
BYRON ALDER, B.S..............................................................Poultry Husbandman
DAVID S. JENNINGS, Ph. D..................................................Soils
WILLARD GARDNER, Ph. D..................................................Physicist
B. L. RICHARDS, Ph. D.......................................................Botanist and Plant Pathologist
KENNETH C. IKELER, M.S..................................................Animal Husbandman
H. J. PACK, Ph. D.................................................................Entomologist
**L. M. WINSOR, M.S..........................................................Associate Irrigation Engineer
E. G. CARTER, Dr. Ph..........................................................Associate Bacteriologist
C. T. HIRST, M.S...............................................................Associate Chemist
D. W. PITTMAN, M.S..........................................................Associate Agronomist
F. B. WANN, Ph. D...............................................................Associate Plant Physiologist
JOSEPH A. GEDDES, Ph. D..................................................Associate Rural Sociologist
R. J. BECAST, M.S.............................................................Assistant in Range Management
GEORGE D. CLYDE, M.S......................................................Assistant Irrigation Engineer
A. F. BRACKEN, M.A..........................................................Assistant Agronomist and Supt. Nephi Substation
**A. L. WILSON, M.A..........................................................Supt., Davis County Experimental Farm
A. C. ESPLIN, B.S.............................................................Assistant Animal Husbandman
CHARLES J. SORENSON, M.A................................................Assistant Entomologist
DELMAR C. TINGEY, M.A....................................................Assistant Agronomist
ALMEDA PERRY BROWN, M.A..............................................Assistant in Home Economics
W. PRESTON THOMAS, M.S................................................Assistant in Marketing
GEORGE F. KNOWLTON, M.S................................................Assistant Entomologist
**H. LORAN BLOOD, M.S..................................................Assistant Plant Pathologist
FRANCIS M. COE, M.S.........................................................Assistant Horticulturist
KATHLEEN L. HULL, Ph. D..................................................Assistant Plant Pathologist
GEORGE Q. BATEMAN, B.S..................................................Supt., Dairy Experimental Farm
JOHN W. CARLSON, M.A....................................................Supt., Alfalfa-Seed Experimental Farm, Uintah Basin
LE MOYNE WILSON, B.S......................................................Supt., San Pete County Experimental Farm
B. F. HULME, B.S...............................................................Supt., Panguitch Livestock Farm
I. D. ZOBERL, B.S............................................................Supt., Carbon County Experimental Farm
RUSSELL E. BERNTSON........................................................Secretary and Purchasing Agent
BLANCHE CONDIT PITTMAN, A.B..........................................Publications and Library
DAVID A. BURGOYNE, B.S..................................................Secretary to Director

In Cooperation with U.S.D.A.

C. M. TOMPKINS, Ph. D..................................................Assistant Pathologist, Sugar-Beet Investigations,

*Bureau Plant Industry

*Appointed Director July 1, 1928.

**On leave.
BIENNIAL REPORT OF DIRECTOR
July 1, 1926—June 30, 1928

JULY 1, 1928.

To the President of the College.

Sir:

I have the honor to submit herewith a report of the Utah Agricultural Experiment Station for the past biennium:

Staff Changes

During the past biennium the following changes in personnel in the Experiment Station Staff have occurred:

Resignations

Dr. I. M. Hawley, Station Entomologist, July 1, 1926
L. F. Nuffer, Assistant Plant Pathologist, July 1, 1926
Prof. T. H. Abell, Assistant Horticulturist, July 1, 1927
Dr. Carrie Castle Dozier, Head of Department of Home Economics, September 1, 1927
W. H. Warner, Assistant Poultryman, April 1, 1928
H. V. Hall, in charge Sheep Experimental Farm, February 1, 1928.

Appointments

Dr. H. J. Pack, Station Entomologist, July 1, 1926
Prof. W. P. Thomas, in charge of Marketing, July 1, 1926
W. H. Warner, Assistant Poultryman, July 1, 1926
G. F. Knowlton, Assistant Entomologist, July 1, 1926
Dr. Joseph A. Geddes, in charge of Rural Sociology, July 1, 1927
LeMoyne Wilson, in charge of San Pete County Experimental Farm, July 1, 1927
Dr. F. B. Wann, Associate Plant Pathologist, July 1, 1927
Francis M. Coe, Assistant Horticulturist, July 1, 1927
C. A. Hymas, in charge of Sheep Experimental Farm, February 1, 1928
I. D. Zobell, in charge of Carbon County Experimental Farm, April 1, 1928
B. F. Hulme, in charge of Panguitch Livestock Farm, June 1, 1928.

Professor R. J. Becraft returned to the Station July 1, 1927, after a year's sabbatical leave spent in study at Chicago University.
On April 5, 1928, Mr. Joseph R. Bateman, in charge of the Panguitch Livestock Farm at Panguitch, died of typhoid fever. Mr. Bateman had been in charge of this farm since its establishment in 1920.

Sales

The sales for the past biennium have approximated $46,000.

Equipment

During the past biennium some of the outstanding equipment purchased by various departments of the Experiment Station is as follows: Set of Fairbanks Scales (value, $250) for use in Purnell project No. 84; Wood Brothers Thresher (value, $700) for the Uintah Basin Alfalfa-seed Experimental Farm; Graham Brothers Truck (value, $1000) for use on the Davis County Experimental Farm; and 1 Frigidaire cooling system (value, $500) for the Department of Botany and Plant Pathology.

Cooperative Research

During the past biennium the Utah Experiment Station has conducted cooperative research with the following agencies:

1. U. S. Bureau of Plant Industry—In cooperation with the Station Department of Botany and Plant Pathology, an exhaustive plant disease survey was carried on in the summer of 1927 by the U. S. Bureau of Plant Industry. In this survey, conducted by Dr. M. B. Linford of the Washington office, eight diseases, not previously known to science, are reported as follows: Celery yellows, delphinium yellows, psyllid yellows of potatoes, bacteria leaf-blight of privet, leaf-spot (*Ovularia pulchella*) of redtop, leaf-spot (*Cylindrosporum shepherdiae*) of buffaloberry, bacterial leaf-blight of strawberry, and sunflower wilt. In addition, twenty diseases were reported in Utah for the first time. A complete report of the work done will be found in the following publication:


2. U. S. Bureau of Plant Industry—The cooperative work in this phase of research has been directly with the Division of Sugar-beet Investigations in which Dr. C. M. Tompkins, Federal representative, is furnished quarters in the Department of
Botany and Plant Pathology. The Federal service has contributed much laboratory equipment. The studies conducted by Dr. Tompkins have to do with stored beets. Research is being conducted with the object of prescribing remedies for diseases which are now causing tremendous losses to sugar-beet companies.

3. Bureaus of Agricultural Economics (Office of Farm Management) and of Animal Industry—During 1927 Mrs. Annie R. Cranford of the Office of Farm Management and Messrs. V. V. Parr and E. W. McComas of the Bureau of Animal Industry, spent much time in Utah, at the expense of their respective bureaus, taking and tabulating records made in a cattle and sheep survey. The U. A. C. Extension Service also cooperated in this survey, the records being obtained through the assistance of county agricultural agents. Approval from the Federal Government was given for the publication of Station Bulletins Nos. 203 and 204 (listed elsewhere), in which the results of the survey are given.

4. U. S. Bureau of Entomology and Idaho Agricultural Experiment Station—In August, 1925, cooperative agreement was entered into with the agencies listed for cooperative research on the sugar-beet leafhopper. This cooperative arrangement still maintains.

5. U. S. Bureau of Agricultural Economics (Division of Hay, Feed, and Seed)—On April 15, 1927, the Experiment Station entered into cooperative agreement with the Division of Hay, Feed, and Seed on a project entitled “Hay Stack and Mow Measurement Investigations”. The object of this project has been to collect measurement and weight data to determine the number of cubic feet of hay necessary to make a ton by weight.

6. Utah Water Storage Commission—This agency provided funds for carrying on investigational soil-survey work on the Colorado River Investigations Project and the Provo Bay Area Project. The data gathered will probably result in a Station publication in the near future.

7. Phoenix Construction Company—Through the financial support given by this company a soil survey was conducted on the irrigable lands contingent to the Cutler Dam. The purpose of the survey was to determine the alkaline content of the soils adjacent to the reservoir.
8. Amalgamated Sugar Company—This company has agreed to contribute financially in the research work on sugar-beet breeding in order to enlarge the project and to stimulate it to earlier fruition.

9. Springville-Mapleton Sugar Company, Columbia Steel Corporation, The Barrett Company, and the Anaconda Copper Company—These companies, together with the U. A. C. Extension Service, are cooperating in a fertilizer-demonstration project in nine counties of the state extending from Cache Valley on the north to Spring Lake, near Payson, on the south. After five years of uniform cropping with the crop yields recorded separately for each of the 84 plats the 6-acre field on the Central Experiment Station Farm received its treatment with the different chemical fertilizer combinations in the spring of 1928. A similar experiment is being run in Utah County financed by the Springville-Mapleton Sugar Company. The fertilizer companies mentioned have very generously supplied, without charge, all fertilizers for the various tracts.

10. U. S. Bureau of Dairying—The Experiment Station is cooperating with this agency on the following project: “A Study of the Relation of the Conformation and Anatomy of the Dairy Cow to Her Milk- and Butterfat-producing Ability” (See Project 73, Animal Investigations Section).

11. U. S. Bureau of Agricultural Economics—M. R. Cooper, in charge of the National Apple Survey conducted by this bureau, during 1926 and 1927 cooperated with the Station in making a detailed economic apple survey of the state. Results of this cooperative study are compiled and will be issued in the near future as Utah Station Bulletin No. 208.

Farms

During the 1927 session of the State Legislature money was provided for the establishment of two additional experimental farms. These farms are as follows: (1) San Pete County Experimental Farm and (2) Carbon County Experimental Farm. A detailed description of these farms is included in the following tabulated account of the eleven farms operated by the Experiment Station at the end of the present biennium. In each case the nature, location, and acreage of each of the eleven farms is given.
<table>
<thead>
<tr>
<th>NAME OF FARM</th>
<th>POSTOFFICE</th>
<th>LOCATION</th>
<th>NO. OF ACRES</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Central Station (Greenville)</td>
<td>Logan</td>
<td>2 miles north of campus</td>
<td>45.5</td>
<td>Irrigation, rotation, fertility, etc. Owned by the state. Established in 1901.</td>
</tr>
<tr>
<td>3. Davis County Experimental Farm</td>
<td>Farmington</td>
<td>Davis County</td>
<td>23.5</td>
<td>Truck-gardening. Bought by state in 1925.</td>
</tr>
<tr>
<td>4. Panguitch Livestock Farm</td>
<td>Panguitch</td>
<td>Garfield County</td>
<td>106</td>
<td>Purebred livestock breeding. Owned by state.</td>
</tr>
<tr>
<td>5. Widtsoe (John's Valley)</td>
<td>Widtsoe</td>
<td>Garfield County</td>
<td>40</td>
<td>Has been dry-farm; proposed to try irrigation. Given to state without cost as long as experimentation continues. Elevation, 7800 feet.</td>
</tr>
<tr>
<td>7. Experimental Sheep Farm</td>
<td>Logan</td>
<td>1 mile north of campus</td>
<td>100.5</td>
<td>Leased from county for 5-year period (1924-29). Sheep and hogs. Also commercial fruit orchard of several acres included in farm.</td>
</tr>
<tr>
<td>NAME OF FARM</td>
<td>POSTOFFICE</td>
<td>LOCATION</td>
<td>NO. OF ACRES</td>
<td>REMARKS</td>
</tr>
<tr>
<td>----------------------------------</td>
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</tr>
<tr>
<td>9. San Juan County Experimental Farm</td>
<td>Monticello</td>
<td>San Juan County</td>
<td>40</td>
<td>Leased for 10-year period (1925-35). Dry-farm. Alfalfa-seed, forage, cereals, etc. Lease taken care of by San Juan County. Special appropriation from Legislature.</td>
</tr>
<tr>
<td>10. San Pete County Experimental Farm</td>
<td>Ephraim</td>
<td>San Pete County</td>
<td>40</td>
<td>Special study made of crops raised on peat soils. Principal crops raised are oats, barley, corn, sugar-beets, canning peas, potatoes, sweet clover.</td>
</tr>
<tr>
<td>11. Carbon County Experimental Farm</td>
<td>Price</td>
<td>Carbon County</td>
<td>40</td>
<td>At present this farm is more of an economic demonstration irrigation farm to demonstrate that farming under this irrigation project can be successful. Such crops as sugar-beets, wheat, barley, oats, corn, potatoes, and alfalfa are being raised.</td>
</tr>
</tbody>
</table>
In publications, the Station activities have distinctly increased. Forty-eight publications have been edited and issued during the past biennium as compared with 26 for the previous 2-year period. There are also thirteen additional technical articles in press, not included in this report.

The findings of the Utah Agricultural Experiment Station are published in three different types of publications: (1) Bulletins, (2) Circulars, and (3) Technical Articles which appear in various scientific journals. In addition to these three general types of publications issued by the Publications Division of the Station, there are numerous popular articles written by the Station Staff members issued elsewhere.

During the biennium a bibliography of all bulletins, circulars, and technical articles by the Station Staff members has been compiled and published as an Annual Summary of Publications in Station Circulars Nos. 62 and 68, respectively. Such a summary for the period from July 1, 1927 to June 30, 1928 is now in process of preparation and will be issued as Station Circular No. 73. The Annual Summary of Publications, issued by the Publications Division, in each case covers the fiscal-year period from July to June of the following year.

A detailed account of the distribution of the three general types of Station publications is given in Station Biennial Report for 1923-24 (Station Bulletin No. 192, pages 8-9).

In addition to the general distribution of each publication as issued, the Publications Division of the Experiment Station maintains a classified mailing list of some 8000 names. During the winter of 1926-27 a revision of the mailing list was made, bringing the list up to date at that time.

A special effort is made to serve the people of the state in the most efficient manner possible. More than 4000 lists of available publications have been mailed during the past biennium. During this period many thousands of bulletins and circulars have been distributed through Utah, the various states, and to many foreign countries. A careful inventory is kept of the number of publications on hand.

Following is a tabulated, concise statement regarding publications edited and issued by the Publications Division during the past biennium:
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Authors</th>
<th>Ordered</th>
<th>Pages</th>
<th>Total</th>
<th>Cost Data</th>
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</thead>
<tbody>
<tr>
<td>198</td>
<td>Biennial Report (18-month Period)</td>
<td>William Peterson</td>
<td>5000</td>
<td>72</td>
<td>360,000</td>
<td>$299.95 $302.45</td>
</tr>
<tr>
<td>199</td>
<td>Mutual Irrigation Companies of Utah</td>
<td>Wells A. Hutchins*</td>
<td>3000</td>
<td>52</td>
<td>156,000</td>
<td>$266.18 $266.18</td>
</tr>
<tr>
<td>200</td>
<td>Maintaining Potato Yields by Selection</td>
<td>George Stewart</td>
<td>3500</td>
<td>22</td>
<td>112,000</td>
<td>$178.36 $19.90</td>
</tr>
<tr>
<td>201</td>
<td>Economic Insects in Some Streams of Northern Utah</td>
<td>J. G. Needham</td>
<td>5000</td>
<td>36</td>
<td>180,000</td>
<td>$254.15 $67.40</td>
</tr>
<tr>
<td>202</td>
<td>Some Observations on Winter Injury in Utah Peach Orchards,</td>
<td>T. H. Abell</td>
<td>3500</td>
<td>28</td>
<td>98,000</td>
<td>$172.55 $41.94</td>
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<td>(December, 1924)</td>
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<td>203</td>
<td>Cattle Ranching in Utah</td>
<td>William Peterson</td>
<td>3500</td>
<td>56</td>
<td>196,000</td>
<td>$280.00 $14.77</td>
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<tr>
<td>204</td>
<td>Sheep Ranching in Utah</td>
<td>A. C. Esplin</td>
<td>3500</td>
<td>60</td>
<td>210,000</td>
<td>$314.00 $9.51</td>
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<td></td>
<td></td>
<td>George Stewart</td>
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<td>$323.51</td>
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<td>P. V. Cardon</td>
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<td>$242.92</td>
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<td>205</td>
<td>The Beet Leafhopper in Utah</td>
<td>George F. Knowlton</td>
<td>3500</td>
<td>24</td>
<td>84,000</td>
<td>$146.00 $21.81</td>
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<tr>
<td>206</td>
<td>Treehopper Injury in Utah</td>
<td>C. J. Sorenson</td>
<td>3500</td>
<td>18</td>
<td>63,000</td>
<td>$98.00 $28.10</td>
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<td>207</td>
<td>Physical Curd Character of Milk and Its Relationship to The Digestibility and Food Value of Milk for Infants</td>
<td>R. L. Hill</td>
<td>4000</td>
<td>32</td>
<td>128,000</td>
<td>$195.90 $7.90</td>
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<td>Total</td>
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<td>380,000</td>
<td>410</td>
<td>1,587,000</td>
<td>$2205.09 $214.00</td>
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</table>

*Associate Irrigation Economist, Division of Agricultural Engineering, Bureau Public Roads, U. S. Department of Agriculture.

**Head, Department of Animal Biology, and Professor of Entomology and Limnology, Cornell University, Ithaca, New York, and graduate assistant in the Department of Zoology and Entomology, Utah Experiment Station, respectively.
<table>
<thead>
<tr>
<th>No.</th>
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<tr>
<td>62</td>
<td>Summary of Publications (Sept. 1, 1925-Sept. 1, 1926)</td>
<td>B. C. Pittman</td>
<td>10,000</td>
<td>4</td>
<td>40,000</td>
<td>$48.22</td>
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<td>$48.22</td>
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<tr>
<td>63</td>
<td>Tomato Culture in Utah</td>
<td>A. L. Wilson</td>
<td>6,000</td>
<td>36</td>
<td>216,000</td>
<td>$283.50</td>
<td>$7.78</td>
<td>$291.28</td>
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<tr>
<td>64</td>
<td>Onion Growing in Utah</td>
<td>A. L. Wilson</td>
<td>6,000</td>
<td>32</td>
<td>192,000</td>
<td>$252.00</td>
<td>$12.80</td>
<td>$264.80</td>
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<tr>
<td>65</td>
<td>The Beet Leafhopper and Curly-top Situation</td>
<td>G. F. Knowlton</td>
<td>3,000</td>
<td>12</td>
<td>36,000</td>
<td>$61.43</td>
<td>$19.55</td>
<td>$80.98</td>
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<tr>
<td>66</td>
<td>Physical Curd Character of Milk and Its Probable Relation to Infant Nutrition</td>
<td>R. L. Hill</td>
<td>4,000</td>
<td>4</td>
<td>16,000</td>
<td>$26.60</td>
<td>$15.00</td>
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<td>67</td>
<td>Rules and Regulations for the 4th Utah Intermountain Egg-Laying Contest</td>
<td>Byron Alder</td>
<td>2,000</td>
<td>4</td>
<td>8,000</td>
<td>$22.83</td>
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<td>$22.83</td>
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<tr>
<td>68</td>
<td>Summary of Publications, Sept. 1, 1926-July 1, 1927</td>
<td>B. C. Pittman</td>
<td>8,000</td>
<td>8</td>
<td>64,000</td>
<td>$77.70</td>
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<td>$77.70</td>
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<tr>
<td>69</td>
<td>Clean Milk and Its Production</td>
<td>E. G. Carter</td>
<td>3,500</td>
<td>16</td>
<td>56,000</td>
<td>$80.00</td>
<td>$22.27</td>
<td>$102.27</td>
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<tr>
<td>70</td>
<td>Agricultural Outlook for Utah, 1928</td>
<td>P. V. Cardon W. P. Thomas</td>
<td>3,000</td>
<td>16</td>
<td>48,000</td>
<td>$84.32</td>
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<td>$84.32</td>
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<tr>
<td>72</td>
<td>Brooding and Feeding Baby Chicks</td>
<td>Byron Alder</td>
<td>10,000</td>
<td>16</td>
<td>160,000</td>
<td>$200.00</td>
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<td>1,096,000</td>
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<td>$97.11</td>
<td>$1546.96</td>
</tr>
<tr>
<td>Reprint No.</td>
<td>Title, Author or Authors, and Source of Publication</td>
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<tr>
<td>80</td>
<td>Blackleaf of Peas Caused by <em>Fusciadium pisiola</em> By M. B. Linford. <em>In PHYTOPATHOLOGY</em>, Vol. 16 (Aug. 1926), pp. 549-558</td>
<td>150</td>
<td>$10.00</td>
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</tr>
<tr>
<td>89</td>
<td>A New Willow Aphid from Utah. By George F. Knowlton. <em>In PAN-PACIFIC ENTOMOL.</em>, Vol. 3 (April, 1927), p. 199</td>
<td>100</td>
<td><em>4</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Graduate Student, Department of Plant Pathology.
2 Graduate Student, Department of Physics.
3 Graduate Student, Department of Agronomy.
4 Bill never received.
5 Cuts included.
6 Graduate Student, Department of Physics.
<table>
<thead>
<tr>
<th>Reprint No.</th>
<th>Title, Author or Authors, and Source of Publication</th>
<th>No. Ordered</th>
<th>Cost</th>
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<tbody>
<tr>
<td>96</td>
<td>Penetration of Ultraviolet Rays through Clothing Materials. By Carrie Castle Dozier and Harriet Morgan. In AMER. JOUR. PHYSIOI., Vol. 84, No. 3 (April, 1928), pp. 603-609</td>
<td>500</td>
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<td>97</td>
<td>A Streak of Tomatoes Produced by a Disturbing Principle from Apparently Healthy Potatoes in Combination with Tomato Mosaic Virus. By H. L. Blood. In PHYTOPATH., Vol. 18, No. 3 (March, 1928), p. 311</td>
<td>150</td>
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<td>98</td>
<td>Predisposition of Sugar-beets to Late Rootrot. By George Stewart and D. W. Pittman. In PHYTOPATH., Vol. 18, No. 3 (March, 1928), pp. 263-276</td>
<td>300</td>
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**COST DATA WITH REFERENCE TO PUBLICATIONS**

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*Associate Agricultural Biochemist in charge Cereal Technology, Minnesota Agricultural Experiment Station.*
Library

No. Bound Volumes ........................................................................................................... 4255
Accessions during biennium .............................................................................................. 533

Purchased ......................................................................................................................... 19
Obtained by Gift or Exchange ............................................................................................ 124
Bound by Station ................................................................................................................ 410

Volumes, complete and ready for binding ........................................................................... 150
Journals subscribed for ........................................................................................................ 27
Agricultural journals, papers, etc., received 
(in exchange for Station Publications) ................................................................................ 275

Projects

The following Purnell projects have been approved by the Washington office since July 1, 1926:

No. 33—Canning Crops Diseases.—This project is chiefly concerned with two tomato diseases: (1) Fusarium wilt and (2) bacterial canker. Prior to February 28, this project was carried as a State project; however, on this date (February 28, 1928) official approval from the Washington office was given to carry it as a Purnell project.

No. 84—Outline to Determine Methods of Handling and Measuring the Carrying Capacity of Beef Cattle on Utah Pastures.—The object of this project is two-fold: (1) To determine the comparative carrying capacity of a rotated pasture as compared with a rotated pasture supplemented with a grain ration for the calves. This was approved as a Purnell project on August 6, 1926.

No. 85—Studies in Marketing Utah’s Apples.—The object, in brief, of this project is: (1) To determine comparative production, price, grades and receipts, (2) to determine factors in orchard management affecting quality and quantity of production, (3) to determine the cost of producing apples in Utah, and (4) to determine the costs and methods in marketing Utah’s apples. Official approval to carry this as a Purnell project was given May 18, 1927.

No. 88—Studies of Utah Village Life.—To determine what comparative advantages in terms of human contacts Utah farm families have who live in towns and villages in comparison with those who live on farms was stated as the object of this project which was officially approved by the Federal office on September 16, 1927.
No. 89—A Study of Chlorosis.—Because of the great variety of plants susceptible to chlorosis, the diagnostic feature of which is a yellowing of the foliage, this problem is of great economic importance. The study includes a general survey of the occurrence of chlorosis, its cause, and the extent of damage caused by chlorosis. Project 89 was approved by the Washington office on January 13, 1928.

No. 91—The Effect of Fertilizers on Various Properties of a Highly Calcareous Soil and on the Yield and Quality of the Crops Produced.—The objects of this experiment, approved officially by the Washington office on June 6, 1928, are as follows: (1) To determine the influence of fertilizers on the chemical, physical, and biological properties of a highly calcareous soil (the soil to be analyzed at the beginning and at subsequent intervals by the best modern methods); and (2) to determine the influence of fertilizers on the yield and on the quality of crops included in the cropping system inaugurated.

No. 92—Psyllid Yellows of Potatoes.—Because of the great economic importance of psyllid yellows to the commercial potato crop of Utah this project was approved in order to make a further study of its distribution and economic importance as well as studies to determine the effect of the contagium on the host or hosts and the type of disease produced. The official approval was given April 13, 1928.

List of Reported Projects For Biennium

The following tabulated list indicates the projects carried for the past 2-year period. Included is given the fund supporting each project as well as the date of beginning and the leader or leaders of each separate project. The projects are arranged by sections:

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Fund</th>
<th>Date of Beginning</th>
<th>Leader or Leaders</th>
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<tr>
<td>1</td>
<td>Nephi Substation (dry-farm)</td>
<td>State</td>
<td>1908</td>
<td>A. F. Bracken</td>
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<tr>
<td></td>
<td>A. Cereal Breeding</td>
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<tr>
<td></td>
<td>B. Plowing and Cultural Tests</td>
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<td></td>
<td>C. Cropping Experiments</td>
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<tr>
<td></td>
<td>D. Fertility Tests</td>
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<tr>
<td></td>
<td>E. Rotations</td>
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<td></td>
<td>F. Varietal Trials of Winter and Spring Wheats</td>
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<td>G. Miscellaneous Tests</td>
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<td>2</td>
<td>Other Dry-farm Stations&lt;br&gt;A. Widtsoe (7800 feet elevation)</td>
<td>State</td>
<td>1908</td>
<td>G. Stewart</td>
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<td>3</td>
<td>Irrigation Practice at Greenville Farm</td>
<td>State</td>
<td>1912</td>
<td>D. W. Pittman</td>
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<td>4</td>
<td>Effect of Different Soil Moisture Contents on Yield and Moisture Requirements of Crops</td>
<td>State</td>
<td>1915</td>
<td>D. W. Pittman</td>
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<tr>
<td>5</td>
<td>Irrigation and Manuring Studies with Corn</td>
<td>State</td>
<td>1911</td>
<td>D. W. Pittman</td>
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<tr>
<td>8</td>
<td>Potato Breeding(^8)</td>
<td>State</td>
<td>1911</td>
<td>G. Stewart</td>
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<td>9</td>
<td>Rotation and Fertility Tests</td>
<td>State</td>
<td>1910</td>
<td>G. Stewart</td>
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<tr>
<td>10</td>
<td>Miscellaneous Field Studies&lt;br&gt;A. Silage Corn Varieties(^9)&lt;br&gt;B. Alfalfa Breeding(^{10})&lt;br&gt;C. Sugar-beet Breeding&lt;br&gt;D. Pasture Plants and Mixtures</td>
<td>State</td>
<td>&quot;Early&quot;</td>
<td>G. Stewart</td>
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<td>42</td>
<td>Grain Varieties</td>
<td>State</td>
<td>1918</td>
<td>G. Stewart</td>
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<td>62</td>
<td>Cereal Breeding(^{11})</td>
<td>Purnell</td>
<td>1920</td>
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<td>64</td>
<td>Cultural Methods</td>
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<td>Weed Control(^{12})</td>
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<td>1921</td>
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<td>75A</td>
<td>Uintah Basin Alfalfa-seed Experimental Farm</td>
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<td>75B</td>
<td>San Juan County Experimental Farm</td>
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<td>A. F. Bracken</td>
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<td>91</td>
<td>The Effect of Fertilizers on Various Properties of a Highly Calcareous Soil and on the Yield and Quality of the Crops Produced(^{13})</td>
<td>Purnell</td>
<td>1928</td>
<td>D. W. Pittman</td>
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<td>96</td>
<td>San Pete County Experimental Farm</td>
<td>State</td>
<td>1927</td>
<td>LeMoyne Wilson</td>
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<td>97</td>
<td>Carbon County Experimental Farm</td>
<td>State</td>
<td>1927</td>
<td>I. D. Zobell</td>
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</table>

\(^8\)Project 8 closed July 1, 1928.

\(^9\)Completes a 5-year variety study on Davis County Experimental Farm.

\(^{10}\)Now a part of Project 75A; transferred July 1, 1927.

\(^{11}\)Approved by U.S.D.A. as a Purnell Project July 8, 1925.

\(^{12}\)Part of project "closed" in 1923. Circular No. 71 on "Weeds" issued in February, 1928.

\(^{13}\)Approved by U.S.D.A. as Purnell Project on June 6, 1928; originally included in Project No. 9.
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<td>Breeding for Egg Production</td>
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<td>Poultry Feeding</td>
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<td>1920</td>
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<td>66</td>
<td>Panguitch Livestock Farm</td>
<td>State</td>
<td>1920</td>
<td>J. R. Bateman, B. F. Hulme</td>
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<td>73</td>
<td>Production Costs in Dairying</td>
<td>State</td>
<td>1924</td>
<td>G. Q. Bateman</td>
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<td>74</td>
<td>Egg-laying Contest</td>
<td>State</td>
<td>1924</td>
<td>Byron Alder</td>
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<td>77</td>
<td>Investigations in Wool and Sheep Management</td>
<td>Purnell</td>
<td>1925</td>
<td>A. C. Esplin</td>
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<td>78</td>
<td>Injurious Effects on Livestock of Sugar-beets and Their By-products</td>
<td>Purnell</td>
<td>1925</td>
<td>H. J. Frederick</td>
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<td>84</td>
<td>Investigations to Determine Methods of Handling and Measuring Capacity of Beef Cattle on Utah Pastures</td>
<td>Purnell</td>
<td>1927</td>
<td>K. C. Ikeler</td>
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<td>87</td>
<td>Miscellaneous Investigations in Veterinary Science</td>
<td>State</td>
<td>1925</td>
<td>H. J. Frederick</td>
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**BOTANY AND PLANT PATHOLOGY SECTION**

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<td>Potato Diseases</td>
<td>B. L. Richards</td>
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<td>33</td>
<td>Canning Crop Diseases</td>
<td>B. L. Richards</td>
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<td>34</td>
<td>Plant Disease Survey</td>
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<td>89</td>
<td>Study of Chlorosis</td>
<td>F. B. Wann</td>
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<td>92</td>
<td>Psyllid Yellows of Potatoes</td>
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**CHEMISTRY AND BACTERIOLOGY SECTION**

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<td>Factors Influencing Bacterial Activities of the Soil</td>
<td>J. E. Greaves</td>
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<td>Permanent Fertility Studies</td>
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<td>24</td>
<td>Survey of Composition of Irrigation Waters</td>
<td>J. E. Greaves</td>
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<td>67</td>
<td>Changes Occurring in Food during Storage</td>
<td>J. E. Greaves, C. T. Hirst</td>
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---

14 J. R. Bateman in charge of Project 66 until time of his death in April, 1928. B. F. Hulme, appointed on June 1, 1928, to continue the work.

15 Approved by U.S.D.A. as Purnell project February 28, 1928. Originally carried under State funds.

16 In cooperation with Department of Entomology. Approved by U.S.D.A. as Purnell project April 13, 1928.

17, 18 Lack of funds has prevented work on these projects during present biennium; "urgent need of carrying on the work".
<table>
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<th>No.</th>
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<td>1919</td>
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<td>80</td>
<td>Chalcis-fly in Alfalfa-seed</td>
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<td>82</td>
<td>Investigation of Sugar-beet Leaf-hopper&lt;sup&gt;19&lt;/sup&gt;</td>
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<td>G. F. Knowlton</td>
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<td>Ground-water Development&lt;sup&gt;20&lt;/sup&gt;</td>
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<td>Factors Affecting Penetration of Ultraviolet Rays of the Sun through Animal and Vegetable Fibers</td>
<td>Purnell</td>
<td>1926</td>
<td>C. C. Dozier&lt;sup&gt;21&lt;/sup&gt; Harriet Morgan</td>
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<td>83</td>
<td>Food Habits of Utah Farm Families</td>
<td>Purnell</td>
<td>1926</td>
<td>A. P. Brown</td>
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<td>Small Fruits</td>
<td>Hatch</td>
<td>1917</td>
<td>T. H. Abell&lt;sup&gt;22&lt;/sup&gt; F. M. Coe</td>
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<td>41</td>
<td>Breeding of Horticultural Plants</td>
<td>Hatch</td>
<td>1918</td>
<td>T. H. Abell       F. M. Coe</td>
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<td>59</td>
<td>Davis County Experimental Farm&lt;sup&gt;23&lt;/sup&gt;</td>
<td>State</td>
<td>1920</td>
<td>A. L. Wilson</td>
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<td>86</td>
<td>Orchard Management Internal Browning and Water Core of Apples Harvesting and Storage</td>
<td>State</td>
<td>1925</td>
<td>F. M. Coe</td>
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<td>Orchard Stocks Investigations</td>
<td>State</td>
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<td>94</td>
<td>Cherry Pollination and Improvement</td>
<td>State</td>
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<td>95</td>
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<td>State</td>
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<sup>19</sup>In cooperation with U. S. Bureau of Entomology and Idaho Agricultural Experiment Station. Approved as Purnell Project September 23, 1925.

<sup>20</sup>Approved by U.S.D.A. as Purnell project August 12, 1925. Originally carried under State funds.

<sup>21</sup>Resigned September 1, 1927.

<sup>22</sup>Resigned July 1, 1927.

<sup>23</sup>Report for this project also includes Project 38 (Canning Crops; Strawberries under Project 40; Celery under Project 41; and Project 67 (Truck Crop Production).

<sup>24</sup>Revision of Project 40; given No. 95, spring, 1928.
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<td>Nutrition of Infants</td>
<td>Hatch</td>
<td>1919</td>
<td>R. L. Hill</td>
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<td>15</td>
<td>Pumping for Irrigation</td>
<td>State</td>
<td>1917</td>
<td>L. M. Winsor</td>
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<td>Relative Elevations of the Water-table and the Plane and Satur-</td>
<td>Adams</td>
<td>1925</td>
<td>O. W. Israelsen</td>
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<td>ation in Fine-textured Soils</td>
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<td>Relationship of Stream Discharge to Precipitation with Special</td>
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<td>1923</td>
<td>G. D. Clyde</td>
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<td>Reference to Forecasting the Supply of Water for Irrigation from</td>
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<td>Seasonal Surveys of Snow Cover on Mountain Watersheds</td>
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<td>Flood and Gravel Control and the Use of Early and Late Water</td>
<td>State</td>
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<td>L. M. Winsor</td>
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<td>Studies in Marketing Utah's Apples</td>
<td>Purnell</td>
<td>1926</td>
<td>W. P. Thomas</td>
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<td>17</td>
<td>Fundamental Soil Moisture Constants</td>
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<td>1917</td>
<td>W. Gardner</td>
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<td>Range Survey</td>
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<td>1921</td>
<td>R. J. Becraft</td>
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<td>Range Reseeding</td>
<td>Purnell</td>
<td>1918</td>
<td>R. J. Becraft</td>
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<td>88</td>
<td>Studies of Utah Village Life (Towns and Villages, No. 1)</td>
<td>Purnell</td>
<td>1927</td>
<td>J. A. Geddes</td>
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<td>Action of Alkali</td>
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<td>49</td>
<td>Soil Survey</td>
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25Approved by U.S.D.A. as Purnell project September 23, 1925. Originally carried under State funds.
26Reported as "inactive" during biennium.
27Projects 48 and 61 approved by U.S.D.A. as Purnell projects August 12, 1925. Both originally carried under State funds.
28Approved by U.S.D.A. as Purnell project September 16, 1927.
29Former Associate Soil Chemist; now Chief Chemist, American Smelting and Refining Company, Salt Lake City.
30The only active work done on soil surveys during biennium has been through funds provided by special sources.
REPORT OF PROJECTS BY SECTIONS

Agronomy Section

Project No. 1—Nephi Dry-Farm Substation.—This project is divided into the following heads, each being a complete project within itself.

1. Cereal Breeding—This project includes a study of pure-line and hybridized strains of wheat. Turkey No. 26, a pure line of Turkey, has been distributed among farmers and has given higher yields than the original parent. Turkey 926, another pure line strain from Turkey combining yield and stiff straw, has given yields in the nursery rows and in the varietal plats higher than anything under test. This year’s harvest will determine the yields of a number of crosses between Sevier, a high-yielding wheat of poor quality for bread-making, and Kanred. Testing of crosses between Sevier and Odessa will also be made.

2. Plowing and Cultural Tests—The results in the cultural tests indicated that for normal tillage following plowing, fall plowing gave higher yields than spring plowing. With no tillage after plowing, the advantage was reversed. In depth of plowing the 8- and 10-inch depths gave higher yields than shallower or deeper plowings. Most of the acre-yields for 1927 in this test were under 19 bushels. Frequent tillage of the fallow, either of fall or spring plowing, gave no higher yields than normal tillage consisting of about two harrowings and a leveling.

3. Cropping Experiments—The highest yield in this test was 18.8 bushels coming from a plat fallowed two years preceding the crop. Alternate cropping plats gave yields between 15 and 16 bushels. Acre-yields from continuous cropping ranged between 3 and 5 bushels.

4. Fertility Tests—This test is divided into three divisions:

A. Barnyard Manure Test—Rather large differences appeared in this test for 1927. In the test in which manure is applied every 4 years the 2.5 tons application gave a yield of 17 bushels, 50 tons 18 bushels, 10 tons 20.6 bushels, and the check gave a yield of 15.2 bushels. Where manure is applied each alternate year, 1 ton gave a yield of 18.1 bushels, 2.5 tons 19.8 bushels, 5 tons 22.2 bushels, 10 tons 23.3 bushels; the average of the checks was 15.7 bushels. In the same test where manure was applied in 1915 with none later most of the plats receiving from 2.5 to 20 tons showed higher yields for 1927 than the check plat.
B. Green Manures—In the first part of this test wheat was plowed under at various stages of growth. When the wheat was allowed to be 6 inches high before it was plowed under for the fallow year, the following year, 1927, the wheat yield was 12.5 bushels, 12 inches high 12.2 bushels, bloom stage 9 bushels, and when the wheat was allowed to go to the milk stage before it was plowed under the yield was 7.5 bushels.

For the second part of this test peas were plowed under for green manure at corresponding stages of growth with wheat. For 1927 peas plowed under at 6 inches high were followed by a wheat yield of 15.4 bushels, peas at 12 inches high 19.6 bushels, peas in bloom 17.9 bushels, and peas in the pod stage 18.9 bushels, while the check plat gave a yield of 17.3 bushels.

The third part of this test has to do with testing the effect of plowing under stubble as compared to burning the stubble. In each case where stubble was burned either part or all of the amount produced on the land, the yields were slightly higher than where the stubble was plowed under.

5. Rotations—In this experiment 26 rotations are under test, including such crops as wheat, barley, oats, peas, potatoes, corn, and alfalfa. For 1927 the yield of wheat after fallow was higher than the yield of wheat after any of the inter-tilled crops such as peas, potatoes, or corn. Yield of oats and barley in rotation with these same inter-tilled crops showed much lower yields for 1927 than wheat.

6. Varietal Trials of Winter and Spring Wheats—For 1927, Turkey No. 926, a pureline selection bred at the Nephi Substation, gave a higher yield than any other winter cereal, followed by Sevier No. 34. This variety was followed by Turkey No. 26, another pureline developed on the station. Montana No. 36 and Karmont, both new strains from Montana, gave only average yields. Of the spring wheats under test Early Baart, with a yield of 11 bushels, was first, followed by Sevier, then by Chul.

7. Miscellaneous Tests—
   A. Rate and Date of Seeding—This test includes seeding winter wheat from 2 to 8 pecks, inclusive, on August 1, and every 15 days thereafter until November 1. The sowings made on September 15 and October 1, were higher than earlier or later sowings, and with reference to rate of seeding the season favored seeding not less than 5 pecks to the acre.

   B. Cultivation of Growing Wheat—In this test winter wheat is sown the usual distance apart of 7 inches, then 14 inches,
21 inches, and 28 inches. One series of duplicate plats is left uncultivated, while another set is cultivated when the plants are 4 to 6 inches high. Cultivation for 1927 showed no advantage.

C. Smut-control Test—This experiment is divided into two parts, one having to do with the effect of the various disinfectants on the yield of winter wheat, the other testing the efficiency of the disinfectants in control of smut in smutted wheat.

The first part of this test, having to do with yields of wheat variously treated for smut, showed practically no variation when comparing no treatment, treatment with copper carbonate, copper sulphate, and formalin. The results for 1927 were somewhat out of line with results for previous seasons.

The results showed rather wide variations in which several disinfectants were applied to smutted wheat. The data follow:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Smut %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smutted wheat treated with copper</td>
<td></td>
</tr>
<tr>
<td>carbonate</td>
<td>20%</td>
</tr>
<tr>
<td>Smutted wheat treated with copper</td>
<td></td>
</tr>
<tr>
<td>carbonate</td>
<td>50%</td>
</tr>
<tr>
<td>Smutted wheat treated with Dupont</td>
<td></td>
</tr>
<tr>
<td>Dust No. 37</td>
<td>11.8%</td>
</tr>
<tr>
<td>Smutted wheat treated with formalin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4%</td>
</tr>
<tr>
<td>Smutted wheat treated with copper</td>
<td></td>
</tr>
<tr>
<td>sulfate</td>
<td>1.2%</td>
</tr>
<tr>
<td>Smutted wheat not treated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>72.6%</td>
</tr>
<tr>
<td>Ordinary field seed treated with copper carbonate</td>
<td>none</td>
</tr>
</tbody>
</table>

D. Nitrate, Moisture, and Wheat Quality Studies—This test includes testing the soil for nitrates and moisture every 6 weeks during the summer season on a time-of-plowing experiment, and also determining the amount of protein in wheat produced on these same plats. Time of plowing has been found to be a very important factor on the dry-lands in conserving moisture, and this has been found, through the work here at the station, to be directly related to the nitrate accumulation. High nitrate content has also been found to influence the protein content of wheat. For the season of 1927 the nitrate content of most all fallow was low; in spite of this fact yields for 1928 promise to be normal or better. It is likely that the high temperatures of early spring and late winter were responsible for partly making up this deficiency.
E. Delayed Harvesting As Affecting the Quality of Hard Red Wheats—This project is finished. Its results were published in the March issue of Cereal Chemistry:


(A. F. Bracken)

**Project 2A—Widtsoe Farm.**—Located at an elevation of 7800 feet in John’s Valley, east of Panguitch, the Widtsoe farm has for its chief work the finding of varieties adapted to that valley. During 1926 and 1927, Trebi and Colsess barleys were the highest producers, Colsess being the highest yielder in 1926 and Trebi in 1927. Turkey, Baart, and Bluestem wheats have done well. Winter rye did well, but Rosen winter-killed badly in 1927. Excellent yields of peas were grown in 1927.

This farm is greatly handicapped by the limited funds available. Since it has to be nearly self-supporting, only variety work with grains has been possible. Since this is a livestock region, some attention should be given to forages. Possibly certain truck crops might succeed. (George Stewart)

**Project No. 3—Irrigation Practice at Greenville Farm.**—This project has been continued according to the revised plans of 1922. The principal object of the experiment is to determine the effects of different amounts of irrigation water applied to each of our more important field crops when grown under a favorable cropping and manuring system. The crops are grown in 1/25-acre plats provided with flumes and dykes so that a definite quantity of irrigation water may be applied to any plat at any time. The crops are grown in a 10-year rotation consisting of 5 years of alfalfa, potatoes, sugar-beets, canning peas, sugar-beets and wheat with alfalfa reseeded with the wheat. The potatoes and sugar-beets of each rotation receive 10 tons of mixed stock manure per acre each year, making 30 tons of manure on each plot in 10 years. The irrigation treatments consist of different numbers of 5-inch irrigations each year. The results to date show an average maximum yield of sugar-beets with about 30 inches of irrigation water, of potatoes with about 20 inches, and of alfalfa with heavy irrigation. More than 30 inches of irrigation water usually reduce the yield of all crops except alfalfa, although the water-table is 100 feet from the surface on this farm. As a whole, these results are consistent with the previous 10-years’ results with these crops, in so far as the treatments are duplicated. (D. W. Pittman)
Project No. 4—Effect of Different Soil Moisture Contents on Yield and Moisture Requirements of Crops.—In this experiment crops are grown in tanks containing 476 pounds of soil. The moisture content of the soil is maintained at different figures by frequently weighing the entire tank and adding water to replace the loss. The amount of water lost by evapo-transpiration and the weight of the crop produced is recorded for each tank.

In 1926, wheat was grown on the tanks and the soil was maintained at different moisture contents from optimum to quite dry at different periods of the plant’s growth. As the grain started to mature the English sparrows attacked it so that it was necessary to harvest it immature. However, the results showed that a low soil moisture content during the middle period from the time when the plants first started to “joint” till it began to “head” caused the most serious reduction in yield.

Sugar-beets were planted in the tanks in 1927 and the soil was maintained throughout the year at moisture contents, varying from 10 to 30 per cent.

The yield of the beets (in kilograms per tank) and the water cost of the beets (in kilos of water per kilo of beets) are shown below:

<table>
<thead>
<tr>
<th>Percentage Moisture in Soil</th>
<th>Yield Beets (Kilos per tank)</th>
<th>Kilos Water per Kilo Beets</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>4.5</td>
<td>2250</td>
</tr>
<tr>
<td>15</td>
<td>7.0</td>
<td>2000</td>
</tr>
<tr>
<td>20</td>
<td>9.4</td>
<td>1720</td>
</tr>
<tr>
<td>25</td>
<td>8.9</td>
<td>1620</td>
</tr>
<tr>
<td>30</td>
<td>8.0</td>
<td>2300</td>
</tr>
</tbody>
</table>

About 20 per cent moisture seems to be optimum for sugar-beets on this soil. (Moisture equivalent of this soil is 20 per cent.) (D. W. Pittman)

Project No. 5.—Irrigation and Manuring Studies with Corn.—In this project corn is grown on a series of field plats receiving six different quantities of irrigation water and three different quantities of manure in all possible combinations. The average yield of ear corn for the 17 years of the experiment is shown below:
Yield ear corn (bushels per acre—not dried) with different amounts of irrigation water and manure per year.

<table>
<thead>
<tr>
<th>Manure</th>
<th>Water (inches)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td>51.2</td>
<td>57.8</td>
<td>61.3</td>
<td>67.4</td>
<td>64.9</td>
<td>62.0</td>
<td>60.8</td>
</tr>
<tr>
<td>5 tons</td>
<td></td>
<td>71.8</td>
<td>77.9</td>
<td>76.6</td>
<td>81.9</td>
<td>82.0</td>
<td>76.8</td>
<td>77.9</td>
</tr>
<tr>
<td>15 tons</td>
<td></td>
<td>71.5</td>
<td>79.2</td>
<td>83.2</td>
<td>91.2</td>
<td>91.8</td>
<td>89.4</td>
<td>84.3</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>64.8</td>
<td>71.6</td>
<td>73.7</td>
<td>80.2</td>
<td>79.6</td>
<td>76.1</td>
<td>74.3</td>
</tr>
</tbody>
</table>

These figures show a maximum yield of corn with about 20 inches of irrigation water and a lower yield with either more or less irrigation. The maximum yield is with 15 tons of manure per acre per year—the largest application used. The figures also show that manure somewhat lessens the loss due to insufficient or excessive irrigation and that optimum irrigation is especially important where manure is insufficient.

Nitrate tests of the surface soil show very consistently a lower nitrate content with the higher irrigations. Manure increases the soil nitrate. (D. W. Pittman).

Project No. 8—Potato Breeding.—With the publication of Bulletin No. 200 in May, 1927, this project was formally closed.

Bulletin No. 202—“Maintaining Potato Yields by Hill Selection”. By George Stewart and D. C. Tingey, (May, 1927)  
(George Stewart)

Project No. 9—Rotation and Fertility Tests.—This project is a study of different rotation and manuring treatments designed to build up or maintain the productivity of a soil, much of which had been reduced to low fertility by an exhaustive system of farming during a previous series of irrigation experiments. There are represented both short and long rotations, including annual, biennial, and perennial legumes as soil-restoring crops. Some of the rotations are repeated both with and without manure and with green manure. In addition, there are plats of each of the crops used in the rotation grown continuously without manure and with various quantities of manure for comparison. The plan of the experiment as a whole dates from 1922, but many of the plat treatments began in 1911 and in 1916.
Some of the more outstanding results to date are shown in the tables below:

Yield of different crops grown continuously and in rotations with and without manure and in the best rotation.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Avg. Yield Wheat Last 5 Years (bu.)</th>
<th>Avg. Yield Potatoes Last 5 Years (bu.)</th>
<th>Avg. Yield Alfalfa Last 5 Years (tons)</th>
<th>Avg. Yield Sugar-beets Last 5 Years (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous cropping—no manure</td>
<td>18</td>
<td>136</td>
<td>5.3</td>
<td>6.1</td>
</tr>
<tr>
<td>Continuous cropping—manured</td>
<td>28</td>
<td>186</td>
<td>8.6</td>
<td>21.4</td>
</tr>
<tr>
<td>Rotations—no manure</td>
<td>39</td>
<td>149</td>
<td>...</td>
<td>3.4</td>
</tr>
<tr>
<td>Rotations—manured</td>
<td>64</td>
<td>223</td>
<td>7.6</td>
<td>18.8</td>
</tr>
<tr>
<td>Best rotation (10-year including 5 years alfalfa)—manured</td>
<td>78</td>
<td>234</td>
<td>7.9</td>
<td>18.6</td>
</tr>
</tbody>
</table>

Average yield of sugar-beets 1923-26, inclusive, on plats cropped continuously to sugar-beets and given various quantities of manure each year. (Percentage attack by rootrot and curly-top in 1926 included for comparison.)

<table>
<thead>
<tr>
<th>Manure (Tons)</th>
<th>Avg. Yield Rootrot, 1926</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>21.5</td>
<td>0.3</td>
</tr>
<tr>
<td>30</td>
<td>22.2</td>
<td>0.2</td>
</tr>
<tr>
<td>20</td>
<td>21.6</td>
<td>1.5</td>
</tr>
<tr>
<td>15</td>
<td>20.4</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>18.7</td>
<td>3.4</td>
</tr>
<tr>
<td>5</td>
<td>17.5</td>
<td>3.8</td>
</tr>
<tr>
<td>0</td>
<td>6.3</td>
<td>16.6</td>
</tr>
</tbody>
</table>

These results, taken in conjunction with those of Project No. 5, show that manure is essential for the best production of all crops on this soil and more especially for sugar-beets, alfalfa, potatoes, and corn. Rotation of almost any kind is very essential for the small grains, but with sugar-beets only certain rotations are successful, and continuous cropping with plenty of manure gives satisfactory results for at least 10 years, as long as nematode and other pests are avoided.

In 1927 it was necessary to discontinue three of the continuous beet plats because of nematode infestation. These plats had previously received 30 tons, 10 tons, and 0 tons of manure.
per acre each year since 1916. Seeded to alfalfa alone in the spring of 1927 they produced respectively 4.7 tons, 3.7 tons, and 1.9 tons of hay the first year, showing a very outstanding result of the residual effect of the previous manuring on the alfalfa. This effect is also shown on the plats of Project 3 where on land that had been manured every year for 22 years previously an average of 9 tons of alfalfa per acre has been produced with only 15 inches of irrigation water as contrasted with a maximum of 7 tons on previously unmanured land.

Looking at the results of Project 9 in another light, as shown in Table 3, it is seen that both sugar-beets and wheat yield better following sugar-beets than they do following grain with intermediate yields of sugar-beets following potatoes and peas. This probably explains, in part, why the sugar-beets seem to be injured by the rotations employed in this experiment where they must always follow grain, potatoes, or peas. Apparently a better rotation for sugar-beets would be one in which beets succeeded themselves for 2 or 3 years, provided, of course, the soil was free from nematode.

<table>
<thead>
<tr>
<th>Average Yield of</th>
<th>Unmanured</th>
<th>Manured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar-beets</td>
<td>sugar-beets</td>
<td>3.46 tons</td>
</tr>
<tr>
<td>following</td>
<td>potatoes</td>
<td>3.00 tons</td>
</tr>
<tr>
<td>Sugar-beets</td>
<td>peas</td>
<td>4.07 tons</td>
</tr>
<tr>
<td>following</td>
<td>grain</td>
<td>2.13 tons</td>
</tr>
<tr>
<td>Wheat</td>
<td>sugar-beets</td>
<td>30.50 bu.</td>
</tr>
<tr>
<td>following</td>
<td>wheat</td>
<td>17.8 bu.</td>
</tr>
</tbody>
</table>

The green-manure crop used in the 2-year rotation was a crop of peas planted after the grain or earlier peas was removed and plowed under in the fall preceding cropping to beets. In the 4-year rotation the second crop of red clover was plowed under in the fall preceding potatoes which in turn preceded beets. The results show that these green manures were of little or no value, especially when compared with barnyard manure.

While it is yet too early to compare different rotations accurately, the long rotation including alfalfa and manure seems to be the most satisfactory so far. The unmanured rotations, using the annual legumes, peas and beans, have not maintained the soil productivity.

A study of the disease on the sugar-beets shows that the late blight, or rootrot, is largely influenced by the cultural method. Manure greatly increases the resistance of the beets to rootrot, while beets in rotation seem to be more susceptible to the disease than those following a previous crop of sugar-
beets. The attack of curly-leaf in 1926 was only slight and seemed to have no relation to the cultural treatment. These results have been published in the following article:


Laboratory studies of the soil of manured and unmanured sugar-beet plats show a close correlation between the nitrate content of the surface soil in the spring and early summer and the yield of sugar-beets. Later in the summer those manured plats on which the beets are growing vigorously are reduced in nitrate below the unmanured.

Nitrate studies on soils planted to different crops rank them in the following order: potatoes (highest soil nitrate especially in the fall), sugar-beets, corn, peas, small grains, and alfalfa (lowest soil nitrate throughout the season).

Preliminary experiments with the manufacture of straw with chemical reagents continue to show no particular advantage from the use of the reagents. Fearing that the material had not been kept sufficiently moist heretofore, the experiment was repeated this year in pits in the soil but with apparently no more rapid decomposition of the treated than of the untreated straw.  

(D. W. Pittman and George Stewart)

**Project No. 10—Miscellaneous Field Crops.**—This project has been divided into 4 main divisions: (1) Silage Corn Varieties, (2) Alfalfa Breeding, (3) Sugar-beet Breeding, and (4) Pasture Plants and Mixtures.

(1) **Silage Corn Varieties.**—A 5-year variety study has been completed on the Davis County Experimental Farm. As a result of a carefully replicated test it has been concluded that Boone County White excels Improved Leaming on porous soils by about 25 per cent in yield. It produces fully as much grain and matures equally well. These results are thought to be applicable to the silage-growing section from north of Brigham to beyond Payson. On heavy soils, Leaming does about equally as well as Boone County White.  

(George Stewart and A. L. Wilson)

(2) **Alfalfa Breeding.**—In the spring of 1927 this phase of the project was transferred to Uintah Basin Alfalfa-Seed Farm as part of Project 75A.  

(George Stewart and J. W. Carlson)
(3) **Sugar-beet Breeding.**—The breeding of sugar-beets by bagging to control pollination has been conducted with positive results. Definite segregation for leaf size and shape, as well as for growth habits has been obtained. The beets seem to be segregating for various sugar percentages.

This project is to be continued and extended into a genetic search for a strain resistant to “white fly”. This latter phase is in collaboration with the Entomology Department.

(George Stewart and D. C. Tingey)

(4) **Pasture Plants and Mixtures.**—Five combinations of pasture plants are being grown in duplicate plats in order to study the effects of grazing on the plants, and the relative carrying capacity of the combinations. No grazing has yet been done. The plats are being prepared for sheep grazing.

(George Stewart)

**Project No. 42—Grain Varieties.**—Common spring and winter grain varieties were tested in 1926 and 1927, and are being continued in 1928.

Winter wheats were tested on the dry-farm of James C. Jensen at Petersboro. The acre-yields were as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>1926</th>
<th>1927</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kanred</td>
<td>41.9</td>
<td>44.7</td>
</tr>
<tr>
<td>Gold Coin</td>
<td>33.7</td>
<td>40.7</td>
</tr>
<tr>
<td>Kofod</td>
<td>40.8</td>
<td>38.0</td>
</tr>
<tr>
<td>Turkey No. 26</td>
<td>44.1</td>
<td>45.6</td>
</tr>
<tr>
<td>F 68</td>
<td>47.8</td>
<td>45.2</td>
</tr>
</tbody>
</table>

F 68 has stiffer strain than Kanred but lacks somewhat in winter hardiness. The winter of 1925-26 was very mild, whereas in 1926-27 there was some winter-killing of the less hardy strains, such as F 68.

Spring wheats, oats, and barley were tested at Logan. Yields of spring wheats were as follows:

<table>
<thead>
<tr>
<th>Variety</th>
<th>1926</th>
<th>1927</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dicklow No. 3</td>
<td>52.9</td>
<td>20.7</td>
</tr>
<tr>
<td>Federation</td>
<td>53.0</td>
<td>76.4</td>
</tr>
<tr>
<td>Dicklow No. 16</td>
<td>53.9</td>
<td>69.9</td>
</tr>
<tr>
<td>II R 18-5</td>
<td>58.4</td>
<td>90.1</td>
</tr>
<tr>
<td>R. S. 17</td>
<td>60.2</td>
<td>....</td>
</tr>
<tr>
<td>Onas</td>
<td>....</td>
<td>78.0</td>
</tr>
<tr>
<td>Q. 231</td>
<td>....</td>
<td>82.3</td>
</tr>
<tr>
<td>II I 39-3</td>
<td>57.4</td>
<td>77.7</td>
</tr>
</tbody>
</table>
The strains designated by numbers are hybrid productions of the Utah Station.

In oats tests Swedish Select, the standard variety, was out-yielded by Markton by 4 bushels. Markton, however, lodged much more than did Swedish Select.

Several barley varieties were grown in 1927 with the following results:

<table>
<thead>
<tr>
<th>Variety</th>
<th>1927</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>75.0</td>
</tr>
<tr>
<td>Atlas</td>
<td>105.5</td>
</tr>
<tr>
<td>Coisess</td>
<td>85.6</td>
</tr>
<tr>
<td>Melay</td>
<td>87.1</td>
</tr>
<tr>
<td>Trebi</td>
<td>98.4</td>
</tr>
</tbody>
</table>

Atlas, a California selection by Foleelli, is the only variety that has ever outyielded Trebi in plat tests in Utah. As yet this is only a one-year test and should be tried more thoroughly.

(George Stewart and D. C. Tingey)

**Project No. 62—Cereal Breeding.**—Cereal breeding as conducted for the last several years at the Utah Station consists of an effort to produce superior strains of wheat by hybridization and also of a genetic analysis of the inheritance of certain characters.

The outstanding crosses studied are as follows:

1. Kanred x Sevier of which about 400 strains are being tested at Newton and at Nephi.
2. Odessa x Sevier of which about 200 strains are being tested at Newton and at Nephi.
3. Turkey x Federation, still in the segregating stages.
4. Hussar x Turkey, and Ridit x Turkey in an effort to get bunt-resistant strains. In F₃ generation in 1928.
5. Federation x Sevier of which about 200 strains are being tested at Logan.
6. Federation x Marquis of which about 60 strains are being tested at Logan.
7. Dicklow x Federation, and Dicklow x Hard Federation, of which about 50 strains are still in test at Logan. Three of these are very promising, Q 231, Q 227, and II I 39-3.
A series of genetic studies has been completed, some with striking results.

1. A rust-resistant progeny was secured from Federation x Sevier, both parents of which were susceptible to blackstem rust.

2. Awn inheritance in Sevier x Federation wheats was found to be due to two linked factors.

3. Strong correlations were found between length of spike and length of awn in Kanred x Sevier Cross. Some progenies also had more compact heads than either parent,—a new and very interesting recombination of genetic factors.

4. Two awnless wheats, Marquis and Federation, produced when crossed truebreeding awned progenies in about 25 per cent of the strains tested.

5. A cross involving Federation and a different pureline of Sevier gave a two-factor difference for awns, with the factors behaving independently. The more compact heads again occurred to an augmented degree.

This work is being continued in 1928. Kota x Hard Federation cross will be in the F₃ generation.

(George Stewart and D. C. Tingey)

Project No. 64—Cultural Methods.—This project aims to study the effect of different cultural methods on the yield of crops. The details of the experiment must necessarily vary somewhat from year to year to meet different weather and soil conditions.

In 1926 with a scant snowfall and an early spring the sugar-beets planted earliest (March 17) gave the highest yield, with a steady decrease in yield for progressively later plantings. Beets planted in the fall (November 27) did about as well as those planted in the middle of May and developed few seed plants but were not really successful. In 1927 with a heavy winter snowfall and late, backward spring following an early thaw, the early planted beets were not successful, but those planted about the middle of April gave the highest yield.

In the experiment with different distances of thinning sugar-beets (in 20-inch rows) the stand was not sufficiently good to admit of leaving beets actually closer than 12 inches apart, but the 12-inch distance gave a higher yield than wider spacing.

In experiments with the Mammoth French White Jerusalem artichoke no appreciable difference was observed between fall
and early spring planting, or between early winter and spring harvesting. Planting small sets gave fewer and larger stalks per hill than planting large whole tubers, but the yield of tubers was not noticeably different. Where the tops were cut for silage the acre-yield of the tubers was 7.6 tons as compared with 11.4 tons per acre where the tops were not cut for silage. The material put into the silo came out in good shape and at the same moisture content as the corn silage. The material, when taken from the silo, was readily eaten by the dairy stock; however, when given a free choice those animals that had previously had corn silage and those that had not preferred the corn silage ate it first.

Tubers stored over winter in small piles on the surface of the ground with a little soil sprinkled over them kept better than those carefully pitted and protected with a considerable cover of straw and soil. (D. W. Pittman)

Project No. 65—Weed Control Experiments.—Weed control experiments have not been active since 1923, but it would be highly desirable to study weed control of common field pests and also of lawn pests. Some survey work is highly desirable.

During the biennium the following publication has appeared:

Utah Experiment Station Circular No. 71 "Weeds" (May, 1928). By William Peterson and D. C. Tingey.

(George Stewart, D. W. Pittman, D. C. Tingey)

Project No. 75A—Uintah Basin Alfalfa-seed Experimental Farm.—During the first year of the biennium a stand of alfalfa of the varieties to be used for the various lines of investigation was secured. The first crop of seed was obtained from these plantings during the season of 1927. The investigational work with alfalfa has been done along the following lines: (1) Alfalfa-seed production as related to physical conditions of the environment; and (2) Technical studies of the alfalfa plant as related to its improvement for seed production.

Data on the yield of seed have been secured from 10 different treatments as to the time clipping or sheeping-off the alfalfa before letting it make the seed crop. The information secured would show that either no clipping or a clipping given not later than the beginning-of-bloom stage is most favorable for the production of seed.

Seven different treatments as to type of cultivation given
Alfalfa before it makes seed have been tested. The data secured show that cultivation is for weed control and results in a higher purity test of the seed produced. So far the type of cultivation treatments given has not influenced greatly the yield of seed.

Three different treatments in the application of manure to alfalfa before producing a seed crop have been used. The application of manure has a residual effect, and the results must be measured over a period of years.

Nine different treatments in the practice of applying irrigation water to alfalfa before or while producing a crop of seed have been tested. Under the conditions of the experiments, the best yield of seed was secured from the plats receiving no irrigation water. An application of 4 to 5 inches of water, during the previous fall or very early in the spring before the alfalfa had made much growth, reduced somewhat the yield of seed. The growth of weeds and an excessive vegetative growth of plant were the most conspicuous results produced by irrigation water.

Twelve varieties and strains of alfalfa have been tested for seed production. There was found to be no significant difference in the value of Utah Common, Grimm, Hardigan, and Cossack alfalfa in this respect. Peruvian alfalfa was found to winter-kill to a great extent, but the surviving plants yielded a heavy crop of seed. The varieties differ considerably in seed- and hay-producing qualities as well as in winter hardiness.

In the technical studies of the alfalfa plant, considerable work has been done in the study of the seasonal behavior of alfalfa flowers as related to seed production. The results of this study are given in detail in the following publication:


A good beginning has also been made in the search for superior strains of alfalfa and testing them for seed-producing qualities. Some headway has also been made in an attempt to develop by breeding or selection new superior strains of alfalfa. During the summer of 1928 self-fertilized seed that has been produced under cages or enclosed in paper bags will be planted.

During the biennium the most promising varieties of wheat, oats and barley have been tested. Dicklow has proved to be the high yielder, but it is not in demand as a milling wheat. Defiance excels in milling quality but does not yield extremely well.
Of the corn varieties tested Gehu (Yellow Flint) has so far proved to be the best. An acre-yield of 60 bushels may be expected from this variety, and it matures well under the conditions in the Uintah Basin. Minnesota No. 13 and Australian White Flint are also good but do not equal Gehu.

It is proposed to continue the investigations along the lines followed at the present time. (J. W. Carlson)

**Project No. 75B—San Juan County Farm.**—This project may be divided into three divisions: (1) Alfalfa-seed production; (2) testing forage and root crops; and (3) testing winter and spring cereals.

1. **Alfalfa Seed Production.**—The primary purpose for the establishment of the San Juan County Experimental Farm was to determine the possibility of alfalfa-seed production for that territory. The test includes about every row width; hill distance; method, time, and kind of tillage for the crop; also time of cutting the first crop with the second crop left for seed. For 1927 no seed formed on any of the plats of this experiment. It is likely that the high July and August rainfall was responsible for this. The crop produced an excessive vegetative growth, and this is usually not associated with seed production.

2. **Forage and Root Crops.**—The rainfall which hindered the formation of alfalfa seed stimulated the growth of crops listed in this project. Carrots gave yields up to 15.15 tons per acre. The yields of stock beets ranged between 1.05 tons for a poor stand to 17 tons for a good stand. The yield of field peas varied from 15.5 bushels per acre to 22.0 bushels. Sorghum gave acre-yields around 3400 pounds of dry fodder. Corn gave field dry weights of near 3000 pounds as an average for several plats. Beans were first frozen then were later badly damaged by hail. This crop, however, showed promise. For selected seed potatoes in rotation with wheat an acre-yield of 230 bushels was produced.

3. **Winter and Spring Cereals.**—Seven winter wheat varieties, four spring wheats, two spring barley varieties, and two spring oat varieties were included in this test for 1927. In addition, a rate-of-seeding test for winter wheat has been added.

Of the winter wheats Minturki, with an average acre-yield of 32.2 bushels, was highest, followed by Odessa with a yield of 31.3 bushels; the next variety in order was Turkey No. 26 with a yield of 30 bushels. In the rate-of-seeding test with winter wheat 4 pecks gave a higher yield than higher or lower
rates of seeding. Regenerated Defiance with an acre-yield of 20.7 bushels was first of the spring wheats, followed by Kubanka, then Early Baart. Coast Barley gave a yield of 27.2 bushels and Trebi gave a yield of 23.5 bushels. One plat of Kherson produced 79.4 bushels to an acre followed by Swedish Select with 71.8 bushels. Averaging the replications, Swedish Select gave a yield of 50.3 bushels and Kherson 51.5 bushels.

(A. F. Bracken)

Project No. 9131—The Effect of Fertilizers on Various Properties of a Highly Calcareous Soil and on the Yield and Quality of the Crops Produced.—A few preliminary studies have been run in an effort to determine the response of the soil to chemical fertilizers. In the greenhouse sugar-beets and wheat gave an increased growth with added nitrogen, but subsequent studies showed that the conditions in this greenhouse were favorable to rapid bacteriological nitrate consumption, so this may not be significant. In the field only ammonium sulfate and sodium nitrate have shown noticeable results on lawn and only superphosphate on alfalfa.

After five years of uniform cropping with the crop yields recorded separately for each of the 83 plats the 6-acre-field set aside for fertilizer experiments received its first treatment with the different chemical fertilizer combinations in the spring of 1928. Last fall the soil of the plats was carefully sampled. Five holes, 10 feet deep, were bored on each plat, and the soil samples from different horizons saved for future analyses. The data of the 5-year crop yields of uniform cropping furnish not only a good basis for comparison of future yield with different fertilizer treatments but also some interesting scientific data on the heterogeneity of the soil which it is hoped to publish soon as a scientific article. The fertilizer treatments in this experiment, as now started, include the more common chemical fertilizers singly and in various combinations, together with manure for comparison. The treatments are replicated on a 6-year rotation including the more common crops and so arranged that the experiment may be continued an indefinite number of years without trouble from plant diseases or other difficulties that might arise from continuous cropping. It is hoped to study the effect of the fertilizers not only on the crop yields but also on the structure and composition of the soil and of the crops.

31Approved by U.S.D.A. as Purnell project on June 6, 1928. Work had been done formerly under Project 9 (Rotation and Fertility Tests). In cooperation with Fertilizer Committee.
Cooperation with the Extension Service.—In cooperation with the Extension Service a cooperative experiment, or demonstration, of the effect of fertilizers on crop yields is being started this year. Under the supervision of the county agents 34 farmer cooperators (besides the various experimental farms) are trying out the common fertilizers on different crops on fields distributed from near the Idaho line south to Spring Lake below Payson, in Utah County.

(D. W. Pittman and George Stewart)

Project No. 96—San Pete County Experimental Farm.—By a special act of the 1927 State Legislature, the experimental farm in San Pete County was established. The farm site was chosen April 1, 1927. The farm, located on a peat land drainage district, is about three miles west of Ephraim in San Pete County, Utah. The soil on the farm for the most part is raw peat and is typical of over 7000 acres in the vicinity. The reclamation of peat lands in this region is practically a new step in the agricultural development of the state.

Information on the management of peat soils and of crops adapted to such soils in our arid region is very meager. The solution of the following problems are therefore under way: (1) Proper methods of soil management and (2) crops that are adapted to the soil and climatic conditions. During the summer of 1927 the experimental work consisted of crop and variety tests and sod-treatment tests. Crops that showed promise were barley, oats, canning peas, sweet clover, sugar-beets, potatoes, celery, cabbage, and asparagus. No results are as yet available on sod treatment.

In the spring of 1928 crop and variety tests and sod-treatment tests have been continued and the work has been enlarged to include rotation, fertility, and alkali tests of the soil and the ground-water. At the close of the season data will be compiled from these experiments.

(LeMoyne Wilson and George Stewart)

Project No. 97—Carbon County Farm.—By a special act of the 1927 State Legislature, an experimental farm was created in Carbon County. This farm was located in April, 1927, on a new irrigation tract south of Price River. Forty acres of land about four miles south of Price was rented. One-half of this acreage was broken out of old alfalfa and sown to wheat, oats, barley, sugar-beets, potatoes, and corn. One-half of the plowed land was manured. This part yielded about 50 per cent
more potatoes, corn, oats, and sugar-beets than the unmanured land. On account of the washing out of canal flumes, no water was available for irrigation for about 6 weeks in June and July, but fair crops were obtained. County Agricultural Agent O. P. Madsen superintended the work on the farm during 1927. On April 1, 1928, I. D. Zobell was appointed superintendent.

In the fall of 1927 the other 20 acres were broken out of old alfalfa. Part of this was manured. By July 1, 1928, the farm was seeded to sugar-beets, potatoes, wheat, oats, barley, corn, and new alfalfa. About half the farm is platted in 1-10-acre plats and a part of these treated with commercial fertilizer were being grown to barley and sugar-beets. On June 8, good stands of all crops had been obtained save potatoes which had not then been planted long enough to have come up. At this time (June 8, 1928) the farm was examined carefully and site for buildings chosen. Altogether, the crops on this farm seem to indicate high productive powers of the better soils on the project. (I. D. Zobell and George Stewart)

Animal Investigations Section

Project No. 36—Breeding for Egg Production.—During the past two years the work on this project has been carried on as in former years, i. e., to develop a strain of fowls that would be high producers over a period of 3 years or more. However, greater emphasis has been placed on size of hen, and the whiteness of the eggshell, and size of egg in the selection of individual breeders than in former years. From the standpoint of production, this project has brought out some exceptional Leghorns. Hen No. 4754 finished her fourth year of production October 31, 1927 with a 4-year record of 870 eggs. This hen’s dam finished her seventh year on the same date with a 7-year record of 1271 eggs. These are the highest 4- and 7-year records made in the Station flock to date. (Byron Alder)

Project No. 57—Poultry Feeding.—During the first year of the present biennium the following lines of research were continued: (1) A study of the comparative value of calcite, (2) other limestone deposits, and (3) oyster shell as a source of calcium carbonate in the ration of laying hens. The results of these experiments and a study of results of the use of calcite on large commercial flocks justifies the conclusion that pure deposits of calcium carbonate limestone, provided they contain little or no magnesium, may be used to entirely replace oyster shell in the poultry ration.
In the study of skim milk and dried milk (milk powder) as a supplement for meat meal in the laying mash, the first year's results indicate that there is little, if any, difference. Where three-fourths of the meat meal was replaced by dried milk, no better results were obtained than where only one-fourth of the meat meal was replaced by the milk. (Byron Alder)

Project No. 66—Panguitch Livestock Farm.—This project has been devoted wholly to certain phases of the beef cattle business, one of the main purposes of which has been to produce an improved and more efficient type of beef bulls suitable for use in the range herds of the area.

During the years that the College Station has had control of the farm, an effort has been made to build up the soil fertility by the application of manure, to improve the pastures by manure and reseeding, to work out a desirable system of crop rotation, to rebuild the fences and to straighten the ditches, and to place the buildings in good condition by repair and paint. The entire farm is now in the best condition that it has been since its inception.

The farm now produces sufficient crops for the adequate feeding of approximately 35 head of pedigreed Shorthorns. This herd has been constructed by careful breeding into one of the best herds of beef cattle in the state and the surplus has been in strong demand by the ranchmen of the area. The pastures and cattle on the farm are now being used by the Station as a basis for Purnell Research Project No. 84.

Mr. J. R. Bateman, who had served continuously and efficiently as Superintendent of the farm since it was acquired by the Station, died early in April, 1928. He was largely responsible for the progress of the farm and herd. Mr. Ben F. Hulme, who has had much experience with beef cattle, was appointed June 1st, to fill the vacancy created by the death of Superintendent Bateman. (K. C. Ikeler)

Project No. 73—Production Costs in Dairying.—The general purpose of this project has been to arrive at: (1) Costs of production of milk and fat; (2) amounts of feed consumed during a lactation period; and (3) amounts of feed needed to raise a heifer up to freshening. In addition to these three general headings, an attempt is being made to determine the total feed consumed and milk and fat produced during the life of an individual in the herd.
Results obtained during the past two years have been a continuation of the keeping of records of production, breeding, etc., as well as a continuation of the two groups of cows on the feed test being made on corn silage and wet sugar-beet pulp.

During the past year the following phases of new investigational work have been undertaken:

1. Two groups of Holstein heifers were selected, ten head being placed in each group and both groups being made as uniform as possible. The object of this work was a feed test of corn silage against wet sugar-beet pulp for growing out heifers during the winter period with alfalfa hay as a basis for the ration.

2. During the winter of 1926 it was noted that there was considerable loss in weight between the time the pulp was weighed over the sugar factory scales and the time the pulp was weighed out to the dairy cows, the loss being largely due to a runoff in water. To check this, a bin was built and factory weights of pulp in the bin were checked against pulp weighed out of the bin.

3. Starting October 8, 1927, a third group of cows was started on a feed test, this group being known as the hay-and-grain group. They were fed all the alfalfa hay they would eat and grain at the rate of \( \frac{3}{4} \) of a pound a day for each pound of butterfat produced a week; when a cow dropped to 207 pounds of butterfat or less a month grain was discontinued. The purpose of this group is to compare the hay and grain ration with the other two rations being fed.

The records indicate that the corn silage group made an average daily gain of 1.14 pounds per head, as against a gain of 1.54 pounds per day for the pulp group.

No measurements were taken to determine growth in body scale of the two groups, but it is felt that just as rapid growth was obtained on the corn silage group in growth of skeleton and frame as on the pulp group, and that the advantage pulp gave in gain in weight over silage was due to a greater accumulation of fat on the body in the pulp group.

Much valuable material is now available showing the production of one cow over another on the same feeds.

The Utah Experiment Station is cooperating with the Bureau of Dairying in the project: “A study of the relation of the conformation and anatomy of the dairy cow to her milk and butterfat producing ability”. Cows Nos. A-18 and W-8 were killed and posted during the year in connection with this work.
This project is being operated upon 86 acres of land, a 6-year rotation being followed, all feed produced being consumed by the dairy herd. (G. Q. Bateman)

**Project No. 74—Egg-Laying Contest.**—The object of the egg-laying contest has been to stimulate a greater interest in breeding and the selection of high-producing strains and to give each breeder an opportunity to compare the records of his birds with those of other breeders.

In the second contest there were 24 entries, all S. C. White Leghorns, and 40 entries in the third contest; of these latter 36 were S. C. White Leghorns, 2 Barred Plymouth Rocks, and 2 Rhode Island Reds. The entries have come from breeders located in 8 different states.

Monthly progress reports have been issued, giving the egg record of each entry for the month as well as the egg record from the beginning of the contest. In the report published at the close of each contest (November 1st) have been included the amount and cost of feed consumed by each pullet, the average feed cost of one dozen eggs, and the average feed, egg, and cost record for each bird. (Byron Alder)

**Project No. 77—Investigations in Wool and Sheep Management.**—The purpose of this project during the past biennium has been: (1) To study the effect of winter feed and shelter vs. winter range feed upon quantity and quality of wool, and (2) to determine yields of wool and shrinkage by scouring whole fleeces, to compare yields on farms with yields on ranges of Utah, and to compare shrinkage percentage of fleeces by samples and by whole fleece-scouring.

The cooperation with range men L. N. Marsden and H. L. Adams, Parowan, Utah, began in October, 1925, and continued to May, 1928. Three clips of wool were secured and three crops of lambs compared during the cooperation.

Fleeces of wool of the range sheep were bought and freighted to the Experiment Station. These fleeces, together with the fleeces produced at the Station, were weighed, scoured, measured, and sampled, after which they were sacked and shipped to the U. S. Bureau of Agricultural Economics for a complete scouring and grading.

Sample scouring at the Station and whole-fleece scouring at Washington, D. C., is incomplete. Records for fleece weights in the grease, fleece-scouring, and measurements for staple are complete for the 3-year wool production period and are on file.
Lamb weights, market, time-percentage production, and sale prices are also on record. On completion of scouring, material for publication will be available to the cooperators and to the public.

The sheep of the Station have been fed and cared for as is customary on farms. One peculiar incident is noted, i.e., seven of the Marsden ewes died during the 31 months at the Station and only one of the Adams ewes died. Death loss has been caused by alfalfa bloat in five cases, one death by dogs, and two by mammitis. In May, 1928, the Station sheep were sold with the idea of buying from other sections of the state in October, 1928.

The Experiment Station flock carries Rambouillet and Hampshire purebred sheep in the ewe flocks as well as a Suffolk ram. Fleece weights have been noted carefully during three shearing periods—May of each year. Fifteen 1-year-old Rambouillet ewes sheared 205 pounds of wool, the lowest being 12 1/4 pounds, and the highest 17 1/2 pounds, with an average of 13. The highest shearing (3-year-old) in the herd for 1928 has been 23 1/2 pounds.

Project No. 78—Injurious Effects of Sugar-beets and Their By-products when Used for Feeding Livestock.—The work of this project has been a continuation of observations and effects on livestock from feeding beet top silage, beet pulp, and beet molasses or syrup.

Many animals, over a large area where beet by-products were being fed, were carefully observed and a request was made of those feeding such material to report at once any detrimental effects. All complaints investigated showed that the troubles were due to some other cause than beet by-products.

The effect of beet-top silage has been observed principally in cattle and sheep, while beet-pulp feeding has been tested and observed on nearly all domestic animals and over a large area near sugar-beet factories in Cache County, Boxelder County, and Weber County. The work done and the observations noted warrant the conclusions that many of the ill effects from feeding beet by-products have been largely due to bacterial poisons forming on improperly handled feeds rather than poisons involved from the feeds themselves.

The action of bacteria on foods is many-fold. Some are the source of rapid destruction of albuminous substances, others like those of the lactic acid group, live principally on carbohydrates and produce acids, thus inhibiting the development of albumin-
destroying bacteria. Some saprophytic bacteria are capable of producing very violent toxins as the *Bacillus botulinus*, which is the cause of botulism. It appears that the *Bacillus botulinus* is often responsible for detrimental results to animals being fed on such feeds.

It was noted that some of the beet-pulp contained a high percentage of acetic acid. This would have a tendency to produce ill effects. The addition of calcium carbonate and calcium sulfate to such feeds has been recommended. The plan is to more thoroughly investigate this problem as well as the effects of the botulinus organism on foods.

**Project No. 84—Pasture Studies with Beef Cattle.**—The preliminary plans for this investigation were perfected early in 1927. The purpose of the investigation is three-fold: To determine (1) the hay-making capacity of irrigated pastures, (2) the carrying capacity of rotated pastures as compared to non-rotated, and (3) the relative effect of rotated and non-rotated pasture upon pasture improvement.

The investigation was started June 15, 1927, and will continue during successive pasture seasons. One 6-acre, fenced irrigated pasture is carrying 4 purebred beef cows and their suckling calves. A second 6-acre irrigated pasture is subdivided into two 3-acre pastures upon which four purebred cows and their calves are carried. This second lot of cattle is rotated every two weeks upon the two 3-acre pastures. Similar quadrants have been staked off in each of the two 6-acre pastures. To determine the relative increase or decrease in the pasture plants, a count of the number and kind of plants contained therein is recorded each year.

The first year's data show that both the cows and the calves on the rotated pasture have made larger average gains than those on pasture not rotated. The investigation promises to cast considerable light upon which cows in the lots are the most efficient beef producers on pasture. This information is of much value in the breeding program that is being followed to work constructive improvement in the herd. (K. C. Ikeler)

**Project 87.—Miscellaneous Veterinary Science Investigations.**—This project has been conducted along the 2 main heads: (1) Diseases among Cattle, and (2) Poisonous Plants on the Range.

**Diseases among Animals**—Investigations on skin lesions of dairy cattle reacting to the tuberculin test have continued. One cow that reacted to this test was carefully examined post-
mortem where only skin lesions were visible. These lesions were carefully taken and suspensions of them inoculated on guinea pigs. These pigs were examined and killed at different intervals to note if such lesions can be transmitted to other animals. In the past it has been impossible to transmit affections from condemned cows to cattle, sheep, or pigs. Out of 23,039 cattle tested in Cache County, Utah, 255 reacted to the tuberculin test, and on postmortem examination most of them showed only skin lesions. The agglunination test for infectious abortion in cows is being carried out and will be continued. No results are yet available.

Botulism among horses was further investigated and the botulism antitoxin applied with fairly good results.

According to the complaints received, poultry diseases seem to be on the increase. Many of the birds sent in for examination contained internal parasites. Roup, pox, diphtheria, neuritis, blackhead, and nutritional troubles are among the poultry diseases investigated and treatment and prevention outlined. More work on poultry diseases is necessary.

Investigations on progressive pneumonia, or lunger disease, among sheep have been continued. It has been impossible to transmit this affection from affected to healthy sheep, either through inoculation or contact. Conclusions deduced from observation and experiments performed show that this affection is not infectious but seems to be contracted by sheep through rough handling. Stercoremia, or pre-parturient paralysis, among sheep was further investigated. It occurs among farm flocks which are highly fed and have little exercise. This trouble is due to absorption of toxin during pregnancy, near the time of parturation. Cutting down the feed and enforcing exercise largely eliminated this trouble.

Poisonous Plants on the Range—Work has been continued on this part of the investigation. The ranges where animals have died were kept under observation, but losses were not encountered. This is possibly due to an abundance of other forage plants. The suspected poisonous plant, Ast. agelus hylophelus was not extensively eaten. No cases of plant poisoning were reported by stockmen. Further work is being done on this plant. Extracts prepared by the chemist have been tried out. No definite results have been obtained. The sheep used for this experiment have been kept in the pens and fed nothing but alfalfa hay and allowed what water they wanted. They have lived in this way for over 18 months and are doing nicely, making good gains and producing good wool, comparing favorably with sheep
kept in the open, on pasture and supplements. It is generally conceded that sheep reed considerable common salt. However, the sheep under observation have received nothing but alfalfa hay and water. More work should be done on this method of handling sheep. (H. J. Frederick)

Botany and Plant Pathology Section

Project No. 31—Potato Diseases.—The two phases of this project are here considered: (2) Rhizoctonia Studies\(^{32}\), and (3) Virus Disease Studies.

(2) Rhizoctonia Studies—The work on potato Rhizoctonia has been suspended during the past four years. However, there exists a very definite need for testing out the relative efficiency of a number of new mercury compounds in the control of this disease.

(3) Virus Disease Studies—Work in this division has been continued for the past two years to determine: (1) The various types of virus diseases prevalent on the potato in the intermountain region; (2) the symptoms of these various types of diseases on the different potato varieties; and (3) the effectiveness of control methods in the various local conditions. During the past biennium (1926-28) in addition to the rugose mosaic, mild mosaic, leafroll, and spindling tuber, two diseases—the leaf-rolling mosaic (an apparently new type of mild mosaic) and an entirely new disease, Psyllid Yellows—have been differentiated out and the characteristics determined. During 1927 the latter disease spread throughout Utah, the western slope of Colorado, and penetrated Idaho, Montana, and Wyoming. It became so destructive as to indicate that it may become economically the most important disease of the potato in the west. The progress in the studies on this disease is discussed under the report for Project No. 92 entitled “Psyllid Yellows” which was approved as a Purnell project by the U. S. Department of Agriculture on March 26, 1928.

The work on control methods is essentially a continuation of the work started in 1925, consisting in hill selection and roguing chance seedstock in various parts of the state. In the spring of 1927 choice seed from stock tubers indexed in 1925 and 1926 was selected and planted in seed plats in Clarkston, Mantua, Eden, Morgan, and Logan. These plats were rogued five times during the season of 1926 and selections made for similar seed

\(^{32}\)Part 1 (Physiological Studies) was continued at the time Dr. George R. Hill resigned from the Station on July 1, 1925.
plats in 1927. During 1927 roguing was again commenced, but the plats (with the exception of the one at Clarkston, Utah) were entirely ruined by the new potato disease, Psyllid Yellows.

The results up to 1927 indicate quite conclusively that under conditions of isolation and with careful roguing and selection potatoes can be kept free from most virus diseases and that good seed potatoes can be produced in various parts of Utah. There is need to continue this work during the coming biennium. (B. L. Richards)

Project No. 33—Canning Crop Diseases.—Under this project detailed attention has been given to four tomato diseases: (1) Fusarium wilt, (2) Mosaic, (3) Western Yellow Blight, and (4) Bacterial Canker. Emergency work with reference to celery heart rot, the Verticillium wilt of the eggplant, and white-spot of alfalfa has also been included.

Fusarium Wilt—This work, commenced in 1924, has continued during the past two years along the various lines as follows: (1) Selection of strains resistant to the wilt-producing organism, *Fusarium lycopersici*, (2) field tests of resistant strains, and (3) survey. The first two divisions of this work have been carried on in the field plats at Layton, Utah. During the summer of 1926 a Stone selection was made which appeared to manifest a high degree of resistance. Other selections were made during the season of 1927. Tests during 1927 indicate that the selection has value both in resistance to wilt and in high quality and possible earliness. It is yet too early to draw any definite conclusions. Field tests for resistance were continued during 1926-27 with 14 varieties: Norton, Norduke, Livingston Stone, Melchers Stone, Greater Baltimore, Morrel, Columbia, Louisiana Red, Landreth, Marglobe, and one strain selected in greenhouse tests in 1924. Resistance was shown in approximately the same degree as in 1924 and 1925 with the exception of the Norton variety which showed a high degree of susceptibility during 1926. This apparent decrease in resistance was probably occasioned by the use of seed produced on diseased soil. During 1926-27 the 1924 greenhouse selection proved to have little, if any, resistance, and will therefore be discarded. This phase of the project will be continued during 1928 and possibly during 1929.

The survey conducted during 1926-27 shows Fusarium wilt to be increasing in the state. It also discovered the presence of Verticillium wilt of the tomato (caused by *Verticillium albo-atrum* which has undoubtedly complicated the wilt problem.
Mosaic of Tomato—Survey work conducted two summers ago (during 1924-25), preliminary to an investigation of the weeds of the state responsible for the overwintering of tomato mosaic, revealed the presence of what appeared to be different types of mosaic on tomatoes. Early in the year of 1926 work was started on the most severe type of mosaic found in the survey. A yield test plat was planted in 1926 to determine the effect of the time of infection upon the crop. The plat was destroyed before positive data could be taken. A study of the plat indicated that under favorable conditions for spread the disease may become of serious economic importance. Plants, infected with the disease prior to blossoming, failed to set fruit, and plants infected while in the process of setting fruit ceased as soon as symptoms of the disease appeared. Another yield test plat was planted this spring (1928) in the hopes that definite data on the effect of the disease upon the crop might be obtained.

Inoculation work conducted in the greenhouse during the winter months proved the disease to be what T. C. Vanterpool describes as “Streak” or “Winter Blight” caused by combining tomato mosaic virus and rugose potato mosaic virus on the tomato. The combination of these two viruses produced the same set of symptoms on the tomato and the tobacco as the virus of the severe mosaic obtained from infected plants in the fields throughout the state.

A survey of the tomato fields of Davis and Weber Counties the summer of 1926 pointed out that the disease had increased in prevalence over the previous year and was responsible for a heavy reduction in yield up to 65 per cent of the crop in a number of fields. Definite data on reductions in fruit setting and yield will be obtained during this season. The results of three years’ research with this disease are now in process of publication.

Western Yellow Blight—The severity of this trouble during 1926 demanded an extension of the project to include a more detailed study of the disease. Only preliminary results, however, have been obtained. The work has consisted in more careful study of the etiology and has resulted in connecting up the disease with the curly-top of the sugar-beets. This work is wholly conclusive, and it is quite evident that the virus causing curly-top of sugar-beets transmitted by the leafhopper is also responsible for the production of western yellow blight. This problem has been carried on in conjunction with the Entomological Division.
Bacterial Canker—Bacterial canker, caused by *Aplanobacter michiganensis*, was first noted in Utah in 1923. Since that time the trouble has slowly increased, until in 1927 it reached epidemic proportions and proved to be the most destructive disease of the tomato in the state. It was particularly severe in the canning crop, resulting in a decrease of approximately 12 per cent of the state crop. The survey conducted jointly by the United States Department of Agriculture and the Station Department of Plant Pathology showed the disease in nine of the 17 counties in which tomatoes were examined and in 37 of the total of 82 fields and garden plats visited, or 45 per cent of the plantings. An average infestation of these 82 fields equalled 10.5 per cent of the plants. In the five counties 41 fields were investigated, and of these 32 fields, or 78 per cent, showed the disease. In these five major tomato-growing counties the plantings examined contained an average of 18.2 per cent of affected plants. Several fields were visited in Utah and Salt Lake Counties in which from 75 to 95 per cent of the plants were diseased and with a corresponding loss in yield.

Studies made during 1926 and 1927 indicate that the disease is probably seed-borne, and hope for control appears to be in the planting of clean seed in clean seedbeds.

Bacterial canker appears as the most outstanding disease of the tomato needing immediate and intensive investigation. Mr. H. Loran Blood has been given the responsibility of this problem and will continue his researches, commenced in Utah, at the University of Wisconsin during 1928-29.

The results of the survey on this problem during 1927 are now published in the following publication issued by the Bureau of Plant Industry (U. S. Department of Agriculture): THE PLANT DISEASE REPORTER Supplement No. 59—"Plant Diseases in Utah in 1927" (issued May 15, 1928) by M. B. Linford.

Heart Rot of Celery—During the time that celery has been growing in Utah there has been noted in increasing quantities a peculiar blackening of the heart of celery followed by a definite heart rot which, in some cases, has been responsible for the complete loss of the crop in numerous fields. A rather careful study of the conditions under which this disease occurred has led to the conclusion that the trouble is very closely related to irrigation and is probably due to over- or excessive watering of the plants. The trouble, therefore, is physiological and later may result in definite rot due to bacterial invasion.
Eggplant Wilt—During the summer of 1926 a definite wilt of eggplant was discovered in Salt Lake County. The disease was so severe as to justify immediate investigation. Work done has shown conclusively that this trouble is caused by *Verticillium albo-atrum*. The symptomology of this particular Fusarium wilt is now being studied in detail. Other phases of the trouble will also receive attention during next year.

White-spot of Alfalfa—White-spot frequently becomes a serious factor in alfalfa production in Utah and in certain areas (as in Farmville, Utah) appears as a limiting factor. The nature of this disease has remained obscure, and although various theories as to its etiology have been advanced, no experimental data have been presented in support of any of them. Studies conducted during 1926 and 1927 indicated clearly that the trouble is in some way associated with an unbalanced water relationship in the plant which may be readily induced, under certain conditions, by the application of irrigation water. During these two years white-spot was experimentally produced over considerable acreage and to an extent of from 75 to 80 per cent of the plants in certain fields. These experiments were so controlled and were repeated in such numbers as to justify the definite conclusion that while other factors might be responsible under local conditions for the production of white-spot, the improper application of irrigation water is by far the most important cause of the disease in the west. Surveys conducted preceding and subsequent to the experimental work confirmed this conclusion and indicated that heavy rains may also be responsible for this disease.

The production of similar, if not identical, lesions in the leaves of sweet clover, *Melilotus albo*, in the same field and under the same experimental conditions responsible for the white-spot of alfalfa, indicates that such localized mesophyll destruction as characterizes white-spot is not peculiar to the alfalfa.

The results of this work, conducted primarily in Cache Valley, are now in process of publication and will appear in an early issue of *PHYTOPATHOLOGY*. Recommendations for control are now before the public. (B. L. Richards)

Project No. 34—Plant Disease Survey.—During the summer of 1926 casual survey data were collected on a number of diseases as Fusarium wilt, mosaic, and western blight of the tomato, as well as on white-spot or leaf blotch of alfalfa, on eggplant wilt, heart rot of celery. Even on these particular diseases the data
were entirely inadequate and no information was obtained regarding the numerous other diseases of the agricultural and ornamental plants. The necessity for a more intensive survey of the various diseases has for a long time been felt as an outstanding need of Utah's agricultural program.

This more intensive type of survey was carried out in cooperation with the U. S. Department of Agriculture during the summer of 1927. During this survey the major portion of the 218 diseases reported for Utah was studied. Twenty-three of the 29 counties were surveyed, and all of major and minor crops of the state, totaling 64, were included in the observations. Specimens numbering 192 were collected and a definite disease herbarium of Utah Plant Diseases was established at the Utah Experiment Station. Duplicates of these disease specimens are also on file at Washington, D. C.

Eight diseases\(^{33}\) not previously known to science are reported in this survey are as follows: (1) Celery yellows, (2) Delphinium yellows, (3) Potato psyllid-yellows, (4) Privet bacterial leaf-blight, (5) Redtop leaf-spot (\textit{Ovularia pulchella}), Buffaloberry leaf-spot (\textit{Cylindrosporium shepherdiae}), (7) Strawberry bacterial leaf-blight, and (8) Sunflower wilt. In addition, 20 diseases were reported in the survey for the first time from Utah.

\(\text{B. L. Richards}\)

**Project No. 89—A Study of Chlorosis\(^{34}\).—**The method of attack planned for the study of chlorosis has involved: (1) Surveys for extent and distribution of the disease, (2) a study of the causes of chlorosis directed chiefly toward soil studies and remedial treatments, and (3) a study of the actual effects of the chlorotic condition on growth.

An intensive and exhaustive survey is not contemplated in this project, but enough of this type of work will be carried out to give a general idea of the extent of the disease and to correlate the occurrence with soil conditions if possible. Although the condition is extremely scattered it has frequently been found on well-drained gravelly soil, especially where this is a rather shallow layer over clay. The conditions suggest that possibly lack of nitrogen is one of the contributing factors. The disease may be extremely sporadic even in local areas, at times only one


\(^{34}\)Approved by U. S. Department of Agriculture as a Purnell Project, January 13, 1928.
or two trees of an orchard being affected, in other cases 50 per cent showing yellowing. It is the plan to make a general survey this spring (1928) of the most important fruit regions in connection with the treatment experiments, and to repeat this in the fall when results of the experiments will be obtained.

The work on soil studies has thus far been confined to an investigation of the H-ion concentration of the soil around normal and chlorotic apple or pear trees. The determinations have been made with the colorimetric method, but will be checked and extended with the simple quinhydrone electrode.

A few preliminary treatments of chlorotic pear and apple trees were carried out in the fall of 1927 in which solutions of iron sulphate were injected into certain limbs of severely affected trees. This treatment caused burning and premature exfoliation, but the following spring the treated limbs produced deep green foliage, in sharp contrast to the light green or chlorotic leaves on the untreated branches. Experiments have also been conducted in a preliminary way, on plants of raspberries, strawberries and grapes.

A few data have been obtained on reducing sugar and total sugar content of normal and chlorotic leaves in blackberries. Both types of leaves were collected from individual plants, dried, ground to a fine powder and the sugars extracted by the Soxlet method. The few results thus far obtained indicate a much higher reducing and total sugar content in the normal leaves, the chlorotic leaves being 25 to 50 per cent lower.

(F. B. Wann)

Project No. 92—Psyllid Yellows of Potatoes. This project has for its prime purpose the study of a new disease of the potato which appeared suddenly in 1927 and which purports to become the outstanding disease problem in the intermountain states. In its rate of spread and in its degree of destruction it would seem that nothing has been more startling in American agriculture.

In the one year, 1927, the disease spread throughout Utah, the western slope of Colorado, reached well into southern Idaho, and established itself in Montana and Wyoming. It was observed in 23 of the 29 counties in Utah and in every field visited in 16 counties. The trouble was most severe on the early crop, and in Washington, Davis, Weber, Utah, and Boxelder Counties practically the entire early plantings were destroyed. The loss for

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the state is estimated between $500,000 to $800,000. Many fields in the various counties did not return the seed planted; others were left unharvested; Washington County reported a total failure.

An idea of the loss is seen in the estimates from Weber County. Based on average yield and acreage planted, the county would have shipped 740 cars; but 110 cars were actually shipped, and with a return upwards of $30,000 below cost of seed planted. Grand Valley, Colorado, estimated a shipment of 600 cars; two cars were actually shipped out of the entire region. The later potato areas were much less affected.

The studies conducted during the season have resulted in a clear recognition of the disease symptoms and have related the disease in its etiology to the sucking process of a small insect, the jumping plant louse or psyllid (*Paratrioza cockerelli* Sulc.). The correlation of the occurrence of the insect with the disease in the field is complete, and numerous greenhouse experiments have confirmed its etiological connection. Just how the insect causes the disease remains as a problem for the future.

A scientific paper on the occurrence, economic importance, symptomology, cause and nature of the disease, together with a discussion of the insect responsible for its spread, is now in preparation. This paper will include the results of field and greenhouse studies during the period from June 20, 1927, to May, 1928.

Surveys conducted during May and June, 1928, show the trouble distributed throughout the state seriously damaging the 1928 crop in Washington, Utah, Salt Lake, Davis, Weber, and Boxelder Counties. It is difficult to predict the outcome of the disease in 1928; however, if failure comparable with 1927 results, potato-growing in certain areas will be indefinitely suspended. (B. L. Richards)

**Chemistry and Bacteriology Section**

**Project No. 22—Factors Influencing Bacterial Activities of the Soil.**—A study has been made of the microflora of natural and artificially-produced alkali soil both before and after leaching, and it was found that sodium chloride, sulfate, and carbonate all reduced greatly the numbers and activity of the microflora of the soil. After leaching, and especially after inoculating with the requisite organisms, the bacterial activities were high, in some cases even above those in the normal soil. The results indicate that organic manures are essential for
the restoring of alkali soil to a high state of productivity even after having been drained. At times the unproductivity period after draining may be shortened by inoculating. This has been pointed out in the following article:


Various substances such as arsenic, sodium chloride, sodium sulfate, sodium carbonate, manure, and the mere leaching of some soils increase the bacteria in the soil as well as their activities. Often this increase can be attributed to an increase in the available plant-food. There are cases in which this will not account for the observed phenomenon. Consequently, the question is raised: Is not this limiting factor a bacteriophage substance ultramicroscopic in size and having the characteristics of either a virus or a ferment which limits the number and activity of the various microflora of the soil and which is inactivated or removed from the soil by the various stimulants studied? The data in favor of this view are given in the following article:


(J. E. Greaves)

Project No. 23—Permanent Fertility Studies.—The limiting element of plant production, in most soils of the arid west, is nitrogen. Many of them have a rich active nitrogen-fixing microflora. This is due in no small measure to their composition. They are usually high in calcium and magnesium carbonate, and contain a good supply of phosphorus and potassium, but have a low nitrogen content. They are low in organic carbon; consequently, their native supply of energy is limited. Work has shown that many of these soils gain annually approximately 30 pounds of nitrogen per acre due to non-symbiotic nitrogen fixation. Studies have been in progress for a number of years, the aim of which is to increase this gain. Work indicates that the optimum moisture content for maximum nitrogen fixation is around 70 per cent of water, measured in terms of water-holding capacity, and that organic manures (barnyard and plant residues) greatly increase the nitrogen-fixing powers of the soil.

These results, however, were obtained in pot experiments under greenhouse conditions. Soils under field conditions were
found for an 11-year average to make an annual acre gain (where 5 tons of manure had been applied yearly) of 45 pounds in addition to that carried to the soil in the manure and that which might have been carried from the soil in the drain waters. The results of this investigation have been summarized in the article:


Although these soils were so active in nitrogen-fixing powers, yet they were devoid of azotobacter. A systematic study of the microflora of this soil has yielded 27 new species and varieties, all but one of which were nitrogen fixers. A study of their morphological characteristics shows 10 actinomyces, 8 bacilli, 8 micrococci, and 1 pencillium. Their nitrogen-fixing powers ranged from 0.25 to 8.1 milligrams when inoculated into soil. Most of the organisms hydrolize starch; 24 out of 27 tested hydrolyze starch rather rapidly; 22 liquefy gelatin; 7 form indol; and 10 reduce nitrates to nitrites with varying ability. Nine cultures have optimum temperatures between 35° C. to 37° C., 18 from 30° C. to 34° C., and 5 have optimum temperatures below 30° C.

The results of this investigation are reported in the following publication:


Project No. 24—Composition of the Irrigation Waters of the Intermountain Region.—Lack of funds has prevented active work in this project during the past biennium; consequently, only those samples which have been sent in by water users have been analyzed. However, as soon as funds are available it is desirable that a thorough survey of the composition of the irrigation waters of the state be made so that intelligent advice can be given the water users. (J. E. Greaves)

Project No. 67—Changes in Vegetables During Storage.—In this work a study has been made of the chemical changes occurring during the storage of potatoes. However, it is premature to attempt to draw conclusions from the limited data available. (J. E. Greaves)
Entomology Section

Project No. 51—Miscellaneous Insects.—This project comprises the following subdivisions:

Insectivorous Reptiles—This work consists of a systematic study of the snakes and lizards of Utah and a study of their food habits. During the past year some data were obtained on food habits. The work will soon be ready for publication. The bulletin will be illustrated by pen drawings and photographs, the latter having been obtained through the courtesy of the California Academy of Science.

Sugar-beet Root Maggot, *Tetanops aldrichi* Hendel—There are no new data in regard to this pest. It is periodic in appearance, doing no damage last year but doing a little damage this year. If the injury is extensive, control measures will be started.

Ants—A few observations were made on field ants in cooperation with Mr. A. C. Burrill of Missouri, who spent the summer of 1926 at the Utah Agricultural College. The two materials which gave most effective control of field ants were: (1) Used engine oil and (2) calcium cyanide.

Squash Bug, *Anasa tristie* De Geer—Numerous tests for the control of the squash bug were conducted in Ogden, Farmington, and Hooper. The only effective insecticide found was calcium cyanide, “A-Dust”. Additional work is being done with calcium cyanide, and the life history of this insect is being studied.

Strawberry Root Weevil, *Otiorynchus ovatus* Linn—Various poisoned baits for the destruction of the adult of this insect were tested in Ogden and Provo and on the Experimental Farm in Davis County. Magnesium arsenate was very effective when dried apples were used as a carrier. Calcium cyanide, “A-Dust”, gave very effective control on heavy vines in absence of wind.

Wheat Jointworms, *Harmolita grandis*, *H. vaginicolo*, *H. tritici*—Studies were made on the extent to which wheat was infested by the jointworms and conditions under which infestation was most severe. Almost without exception volunteer wheat was infested. Careful fall plowing and good agronomic practice are the main factors in reducing jointworm infestation. This investigation is being continued.

Gooseberry Fruit Worm, *Zophodia franconiella* (Hulst)—This insect is becoming very serious in the state, taking 50 to 75 per cent of the crop in some regions. Life history and control studies have been started.
Tomato Psyllid, *Paratriozona cockerelli* Sulc.—This insect is apparently responsible for transmission of the yellow blight of potatoes. Life history studies were begun in the greenhouse in the fall of 1927 and are being continued in the field at the present time. In recent experiments calcium cyanide so far has given almost complete control. These experiments will be continued on a larger scale during the summer. (See Report for Project No. 92 under Botany and Plant Pathology Section.)

(H. J. Pack)

Project No. 80—Chalcis-fly in Alfalfa Seed.—Field work on this project began in the spring of 1926. During the present biennium investigational work has dealt chiefly with the following phases of the chalcis-fly problem: (1) The annual fly infestation of alfalfa seed, (2 and 3) natural and life history studies, (4) parasitism, (5) seasonal distribution of the fly population, and (6) means of control.

1. Annual Fly Infestation of Alfalfa Seed—An index to this problem has been obtained by ascertaining the percentage of alfalfa seed that was fly-infested. Seed samples have been collected from representative alfalfa seed fields, mostly in the Uintah Basin and in western Millard County. In 1927 seed samples were taken also from the Milford district, Emery, Sevier, Utah, Boxelder, and Cache Counties. Determinations were made from 67 seed samples in 1926. Infestation was found to range from 2 to 38, average 9.41 per cent, a loss of $254,285. In 1927, the infestation in samples collected from 90 representative seed fields ranged from 0.76 to 36.84 and averaged 9.67 per cent.

2. Natural History Studies—These have included the question of over-wintering of the flies; their spring emergence and date of beginning of emergence, and the length of the period; mating and feeding habits and the length of adult life; time of emergence of second brood adults and its relation to seed development.

3. Life History Studies—Data have been obtained by means of breeding-cage work, concerning the time and manner of oviposition; the number of eggs produced by individual flies; the length of the incubation period; feeding habits of the larvae, their growth period and hibernation; pupal development and length of the period.

4. Parasitism—Some data have been secured concerning the natural parasites of the chalcis-fly. During the past two years the species and percentage of parasites have been determined.
5. Seasonal Distribution of the Fly Population—The chief purpose of this study was to ascertain whether or not there were fly-free periods during the summer, and if so if the setting of the seed could be correlated with them so as to prevent fly infestation.

6. Means of Control—Experiments have been performed in the field for the purpose of finding out what effect cultivation would have upon the spring emergence of flies from infested seed which had shattered and fallen to the ground during harvest. Results which have been obtained during the past two years indicate that an important degree of control may be had by cultivation.

Investigations have shown that great numbers of chalcis-flies pass the winter in infested seed which was blown over into the chaff stacks during threshing and that these chaff stacks when left standing in the fields after about May 15th are responsible for increased numbers of chalcis-flies in the seed fields during the summer.

Volunteer alfalfa which grows along ditch-banks and fence lines in stock yards and other waste places usually produces new seed continuously throughout the summer and forms very suitable conditions for the multiplication of chalcis-flies. In view of this fact, volunteer alfalfa should be prevented from going to seed as a factor in fly prevention.

There are no indications, thus far, of fly-free periods during the summer season. The flies occur in the seed fields from May until harvest time, and their numbers increase as the season advances. Investigations indicate that when seed is grown from first- and second-crop alfalfa in different fields of the same district, the first crop becomes a source of fly infestation for the second crop. It appears that whichever crop is left for seed it should be uniform in a district if fly control is considered. Control of the chalcis-fly is a cooperative district problem.

(C. J. Sorenson)

Project No. 82—Investigation of the Sugar-beet Leafhopper.
—A survey has been made over the greater part of the state to determine the distribution and abundance of the beet leafhopper. Particular attention has been given to the most important breeding grounds. Seasonal abundance of leafhoppers in the beet fields and the development of curly-top throughout the season have received considerable attention. Practically all of the important beet areas of Utah have been examined, and beet leafhoppers and curly-top have been found to occur in all cases,
at least during bad curly-top years, such as 1926. Some data on the life history and habits of the leafhopper have been obtained as well as information on the most important host plants. Enormous numbers of leafhoppers each season develop on Russian thistle, the most important host plant in this state.

Curly-top damage was very severe in 1926, and fewer than half of the Utah factories were operated. Beet leafhoppers were abundant from early spring in many parts of Utah during 1927, and some areas suffered badly. However, in most areas the damage did not occur until late in the season, after the beets had obtained fair size, and a fair tonnage was usually obtained. During the spring of 1928, beet leafhoppers were slightly more numerous in the beet fields of Boxelder County, and at Hooper, but less abundant in most parts of Davis, Salt Lake, and Utah Counties.

General information on the beet leafhopper problem is contained in the following publications issued during the biennium:

Utah Experiment Station Circular 65—"The Beet Leafhopper and Curly-top Situation in Utah" (May, 1927). G. F. Knowlton.


(G. F. Knowlton)

Farm Economy Section

Project No. 79—Influence of Cropping Systems on Production Costs36.—The studies thus far conducted pertain primarily to two crops: (1) Dry-farm wheat and (2) apples.

The cost studies pertaining to dry-farm wheat production cover two full crop years, and records are available from more than 10,000 acres of dry-farm land in four counties of Utah. The data contained in these records have been assembled for analysis with a view to early publication. It seems desirable, however, to continue the studies another year in order to secure additional information on costs and to secure also a better understanding of some of the factors found to be influencing important changes in dry-farm wheat production in this state.

The cost studies with apples constitute a part of the apple survey conducted under the leadership of W. P. Thomas, in charge of marketing investigations. The results of these studies

36Approved by U. S. Department of Agriculture as Purnell Project on January 13, 1926.
will appear in a bulletin, soon to be published, which will in-
clude a detailed report of each phase of the survey.

Additional cost studies were made also in connection with
the ranch survey, reported in Station Bulletins 203 (November,
1927) and 204 (January, 1928).

The additional publication has appeared:

Utah Experiment Station Circular No. 70—“Agricultural
Outlook for Utah for 1928” (February, 1928). By P. V.
Cardon and W. P. Thomas.

(P. V. Cardon)

Geology Section

Project No. 25—Ground-water Development.—The work on
the problem of ground-water development during the past two
years has been confined to the following projects:

(1) Completing a map of the state wherever records indicate
a possibility of ground-water development.

(2) Gathering data necessary to estimate the recharge to
all valleys depending on underground water either for culinary
purposes or for irrigation and for watering stock. The work
in recharged data has been materially handicapped for lack of
rainfall data in the hills and surrounding areas. In the future
there will be no attempt to correlate this work with snowfall
and surface runoff.

(3) Measurements have been kept on artesian wells at
Fillmore, (Millard County), Utah County, and Cache County.
All of the wells have been used for measurement at Fillmore
and only enough in the other localities to form an index for
interpretation. The records in and around Fillmore show a
decrease in pressure and in flow compared with previous yearly
records. Measurements showed 50 second-feet flowing from
the group of wells in the first week of April, 1928. The users
have agreed to change their methods to seven months closed
and five months open to determine whether or not this will build
up the static head and increase the flow and the pressure. Seven
months closing season, or even a longer period, will not interfere
with the successful growing of crops in the locality. One prac-
tice has in a small way developed in the locality, which seems
counter to an existing law. Small tracts have been purchased
and a series of wells put down on a small tract and the water
thus developed conveyed through a ditch more than two miles
away to be used for irrigation on lands where ground-water is
not available. Better legal protection should be given this terri-
tory, both from the standpoint of established rights and in new development.

Careful records are being kept on a series of wells in Cache County to determine the flow and pressure, and while the total measurement of water flowing from all the artesian wells aggregates more than 40 second-feet, the records do not indicate a decrease in the static head. Careful work is being done to determine whether wells developed for irrigation are affecting a series of small wells on higher ground used only for culinary purposes. These data have not gone far enough to make report.

Study is being made on the pump wells in Boxelder County with an attempt to correlate the total amount of water being pumped with a possible annual recharge to the valley. This work will be continued and enlarged into other areas.

(William Peterson)

Home Economics Section

Project No. 81—Factors Affecting Penetration of Ultraviolet Rays of the Sun through Animal and Vegetable Fibers\(^{37}\).—Methods of procedure were developed in order to measure biologically the ultraviolet ray transmissibility of clothing material. The albino rat was chosen to be the experimental animal, approximately 200 rats being used. To assure a constant source of ultraviolet light a Hanovia A.C. air-cooled quartz lamp run at 220 volts and 2.5 amperes was used throughout the experiment. The cloth to be tested was interposed between the light source and the cottonseed oil which was to be irradiated. The rachitic potency of the oil was detected by McCollum’s line test. To insure a permanent record of results obtained, microphotographs were taken of the bones studied.

The following aspects of the problem have been studied:

1. The screening action of artificial silk, cotton, wool and silk fabrics on ultraviolet rays.
2. The influence of weave and weight upon the ultraviolet ray transmissibility of clothing material.

The results of these experiments are published as follows:

"The Penetration of Ultraviolet Rays through Clothing Materials", Pt. 1\(^{38}\). By Carrie C. Dozier and Harriet Morgan. \(\text{In AMER. JOUR. PHYSIOLO.}, \text{Vol. 84, No. 3 (April, 1928)}, pp. 603-609.\)

(Harriet Morgan)

\(^{37}\)Project was begun January 1, 1926, under direction of Dr. Carrie C. Dozier who resigned September 1, 1927.

\(^{38}\)Part II of "The Penetration of Ultraviolet Rays through Clothing Materials", by Harriet Morgan, is now in press (AMER. JOUR. PHYSIOLO.).
Project No. 83—Food Habits of Utah Farm Families.—This project was begun January 1, 1926. Securing cooperators began late in February and was concluded the first week in June (1926). On July 1, 1927, there were in the project files 34 year-long records, collected from farm housewives in four different types of farming communities located in 11 different counties of the state. These records gave kinds and quantities of farm-furnished foods consumed by cooperating families during the year. One hundred and twenty-four women began the work of record-keeping; 34, or 27.4 per cent, continued throughout the year. An additional 14.6 per cent kept records for approximately six months.

During this period the following phases of the project have been studied: (1) Food varieties, and (2) quantities of farm-furnished foods.

Food consumption records received from four kinds of farming communities show that for home use at least 23 kinds of vegetables are raised on Utah farms, 18 kinds of meat, 5 dairy products, eggs, and 4 kinds of cereal products. Quantities of farm-furnished foods per household compare favorably with quantities reported from some other states.

So far as the records show, proximity or remoteness of markets does not affect either variety or quantity of home-furnished foods on Utah farms, unless nearness to markets might have a stimulating effect both on variety and quantity production, since communities so located have a slight lead in both respects over other communities studied. However, the dry-land wheat communities produce the same variety in vegetables and the general farming communities remote from markets have a slight lead in variety of meats. The dry-land wheat communities produce a larger quantity of dairy products and beef and mutton per household than do the others; however, this is probably due to proximity to grazing lands rather than to remoteness from food markets.

The records do not show that either variety or quantity per family of home-furnished foods is affected by type of farming. They do suggest a number of factors, however, which may affect both. These factors are to be made the basis for special investigation to be conducted during the fiscal year 1928-29.

In addition to the above investigations, the following studies were made during the biennium:

(1) Storage of Home-produced Foods—Each family agreeing to cooperate in Project No. 83 was asked to give information
on kinds and quantities of farm-furnished foods stored by them for use during the non-growing season. All reports, except those from alfalfa-seed farms, showed a fairly general storage of fruits and vegetables both in the fresh state and preserved in various ways. In the communities of alfalfa-seed farms, few vegetables or fruits are produced or stored, apparently due to shortage in irrigation water.

(2) Places of Storage—From the questionnaires received the indication is that the general method of storing potatoes and root vegetables is in a pit, or in cellars under the house. Canned foods were stored in basements, in pantries, in closets, and in unused rooms.

A questionnaire was also sent to the cooperators regarding unpopular home-produced foods. Among the 40 cooperators replying, it was found that among the unpopular home-produced foods were included 14 common vegetables with carrots, cabbage, parsnips, spinach, and other greens heading the list in the order named. Milk and rhubarb were also classed as unpopular foods.

The work for 1927-28 included not only a record of farm-furnished foods but also kinds and quantities of all purchased foods. Ninety-four began the records. To date there are on file 25 completed records. These records are being analyzed with the idea of securing the following information:

1. Kinds and quantities of foods purchased on Utah farms.
2. Percentage of food furnished by the farm.
3. Adequacy of farm home diet. (Almeda P. Brown)

Horticultural Section

Project No. 40—Horticultural Survey.—Those phases of this project pertaining to Small Fruits (Strawberries and Bush Fruits) and Ornamentals are now a part of the general project for the Davis County Experimental Farm (See Project 59).

Winter Injury of Orchards—This phase of the project, dealing with the effects of the severe winter of 1924-25 on the orchards of the state, was closed with the publication of Station Bulletin 202, entitled “Some Observations on Winter Injury in Utah Peach Orchards” (June, 1927), by T. H. Abell. (F. M. Coe)

Project No. 41—Breeding Horticultural Plants.—This project has been inactive during 1927-28, except that portion pertaining to tomatoes and celery which is included in the general report for the Davis County Experimental Farm. (F. M. Coe)
Project 59—Davis County Experimental Farm.—During the past biennium the work of this farm has been conducted along practically the same lines as previously reported. The chief emphasis has been placed on tomato, strawberry, and onion investigations. The silage-corn variety test was concluded with the 1926 harvest. In the spring of 1928, the program of the Station was extended to include stone-fruit investigations. The following paragraphs indicate briefly the progress and the present status of the various projects under consideration.

Strawberries—The strawberry studies consist of a variety test and cost of production.

Variety Test—Fifty-three varieties were under observation during 1926. In that year the old plantation was plowed up and a new plantation set out. Out of the original number of varieties only 36 were retained. Ten new varieties were added, making a total of 46 varieties in the second plantation. In the spring of 1927, 16 additional varieties were added to the plantation. These, together with those discarded in 1926, make a total of 79 varieties that have been investigated. Howard 17 is synonymous with Premier and is easily the best early variety, from the standpoint of yield, for Utah. From the standpoint of dessert quality the Marshall variety is the best. However, it is adapted to only local use.

Cost of Producing Strawberries—This work was commenced in 1923. The first set of records was completed in 1925 and the second set in 1927. Each plantation was kept for three years. Two crops of berries were harvested from each. A third plantation was set out during the past spring. The Marshall variety was used in each case. The data from the second planting, including land rental, cultural operations, harvesting, and containers, are summarized briefly as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost per ½ acre for 5 years</td>
<td>$465.81</td>
</tr>
<tr>
<td>Average cost per 12-pint case</td>
<td>81.86 cents</td>
</tr>
<tr>
<td>Total costs—less containers</td>
<td>$392.11</td>
</tr>
<tr>
<td>Average cost per 12-pint case</td>
<td>68.9 cents</td>
</tr>
<tr>
<td>Total costs less harvest and container costs</td>
<td>$238.94</td>
</tr>
<tr>
<td>Average net production costs on basis of berries</td>
<td>40.2 cents</td>
</tr>
</tbody>
</table>

No allowance has been made for overhead costs nor for marketing costs.

Formerly carried as Part A of Project No. 40.

This item represents the net production costs. Harvesting and container costs vary widely, depending upon size of the crop. The net production costs should not vary much whether the crop be large or small.
Bush Fruits—A number of varieties of several kinds of small fruits is being accumulated in preparation for a variety test. At the present time there are being grown 35 varieties of blackberries and dewberries, 36 varieties of red and black raspberries, 33 varieties of European and American grapes, 3 varieties of gooseberries, and 4 varieties of currants. Some blueberry plants were imported from New Jersey in 1927 in the hope that they might be adapted to certain types of soil in this state. The plants have made a rather promising growth.

Stone Fruits—In order to initiate some of the more pressing problems relative to stone fruits, the general program was modified in 1928 to include deciduous fruit tree plantings. The more important varieties of sweet and sour cherries, peaches, apricots, plums, and prunes were planted in 1928. This work is under direction of the Department of Horticulture and will be considered in more detail in the report of that department (See Project 95).

Tomatoes—The tomato investigations involve chiefly the improvement of canning varieties by plant selection and wilt studies. Of minor importance is the improvement of marketing tomatoes. Hundreds of strains of almost all varieties have been under observation during the course of this project. At the present time only the six most important canning types are receiving any consideration, and of these the Stone and Greater Baltimore varieties occupy at least three-fourths of the area devoted to tomatoes.

In 1926 western yellow blight was so severe that tomato studies were practically a failure. In 1927, 84 strains were planted, from which 425 individual plant selections were made. Due to the lack of both time and land, only 170 of the best of these selections were planted in 1928. The remainder are reserved for subsequent planting.

The wilt investigations are being conducted in cooperation with the Department of Botany and Plant Pathology. A more detailed statement of this work will be found in the reports from that department (See Project 34).

However, it might be stated that selections have been made from Livingston's Stone, a variety of local popularity, which show a great resistance to Fusarium wilt.

41Formerly carried as Part A of Project 40.
Onions—Onion studies are being carried on along the following lines:

1. Strain studies of the Sweet Spanish varieties.
2. Seed production.
3. Improvement by pedigree selections.
4. Small or large bulbs for seed production.
5. The effect of continuous selection of double onions for seed production.
7. Development of white strain of Sweet Spanish.

1. Since the adoption of the Valencia onion as the variety to be grown in Utah, several growers have laid the foundation for individual strains of this variety. The State Department of Agriculture has arranged to make official inspections and certify strains of these stocks meeting certain requirements. In order to insure the stability of the Utah Valencia, nearly all of these individual stocks are being grown on the Davis County Experimental Farm. It also offers an excellent opportunity for comparing our own selections with commercially known strains. Thus, every strain studied is acceptable and can be planted with safety; however, some strains are much better in certain respects than others.

2. When onion-seed growing was first undertaken in Utah it soon became apparent that the Sweet Spanish was a low seed producer. This project was initiated in order to increase the seed production of the variety. A large number of typical bulbs was selected and divided into four groups without prejudice. The first group was planted whole; the second was cut through the neck and about half way down the bulb; the third received two right-angle cuts similar to group No. 2. The upper one-third of the bulb was cut from each onion in the fourth group. In 1924, 1925, and 1926 groups Nos. 2 and 3 yielded practically the same amount of seed, while group No. 1 produced only one-half as much, and group No. 4, three-fourths as much; however, in 1927 the order was reversed. The wounded bulbs showed top growth about a week to ten days before those planted whole. The group with top half removed are slower than those cut down through the bulb. The reversal in 1927 was probably due to the fact that the earlier plants were injured by severe April frosts, while the slower-growing whole bulbs came up later. The present prospects are much in favor of the groups, cut once and twice, with the poorest outlook for the whole bulbs.
(3) The Sweet Spanish onion still contains some undesirable types, especially from the standpoint of color, texture, and shape. In order to isolate the more desirable types, almost 700 individual plant selections have been made. Each onion thus selected is provided with sufficient space in the field so that individual attention may be given it. Just before the blossoms open each seed ball is covered with a paper bag to prevent cross-pollination. The seed from each selected bulb is planted separately and accurate observations recorded as to its behavior and desirability; only a few of the many selections have been retained as being in some respect superior to the average of the variety.

(4) The mother bulbs constitute the greatest item of cost in the production of onion seed. If small bulbs could be used with safety, this cost might be considerably reduced. In order to determine the effect of continued selection of small bulbs for seed production, a group of bulbs, under 2 inches in diameter, was selected from one of the best strains. The first year's progeny outyielded any other strain in the field. From the first crop, a group of large bulbs and a group of the smallest bulbs were chosen to head a line of small and a line of large bulbs, with a common origin. Each line will be continued for several generations, using each year the largest and smallest bulbs, from their respective lines.

(5) In order to determine whether the tendency to form double onions is a heritable character, a number of double onions were planted for seed. The first generation indicates rather definitely that double onions tend to produce double onions. Double bulbs will be selected from this same stock each year for a number of generations.

(6) In spring of 1928, 12,000 Bermuda onion plants were purchased in Texas. These were set out in wet furrows about March 1. The first bulbs were harvested on June 26. On the whole, the onions were of large sizes, 2 to 4 inches in diameter, and the quality very good. There are limited possibilities for Bermuda onion-growing in Utah. They may well replace the growing of onions from sets, for local market during July and August.

Celery Improvement.—During the past few years a rather extensive variety test of celery has been conducted. The outstanding results of this work established beyond a doubt the superiority of the so-called Utah variety. Splendid results were obtained from some strains of Golden Self-Blanching, Emperor, and Easy Blanching, but in every case they lacked the table quality of Utah celery. Utah celery is far from perfect as a
market variety because of a mixture of types. The present objective is the elimination of undesirable mixtures. Imperfect winter storage has retarded the work some; however, several selections have been made which offer promise of improvement.

Miscellaneous Studies.—In addition to the major activities listed above the following minor investigations have been carried on:

1. Variety test of sweet corn
2. Variety test of cucumbers (this includes the American, English, and hybrid varieties)
3. Adaptability of sweet potatoes to Utah conditions
4. Adaptability and yield of okra

(A. L. Wilson)

Project No. 86—Orchard Management.—

Fruit Thinning—This phase of Project 86 has been inactive during the biennium.

Internal Browning and Water Core of Apples—This work was started in 1925 to determine the factors which are associated with internal breakdown or browning and water core diseases of apples in storage. Both of these troubles have caused considerable loss in Utah, especially with the Jonathan variety. Preliminary work in 1925 indicated that late harvesting and lack of sufficient soil moisture during the growing and ripening season is conducive to damage by these troubles.

In 1926, experimental work was conducted to find, if possible, a means to determine the best time of picking to secure maximum storage quality and color as well as minimum loss from breakdown and water core. Factors which were considered were color of seeds, ease of separation from spurs, pressure test, red color and ground color (color on unblushed side). While work was carried on most extensively with the Jonathan variety, some Romes and Winesaps were also included.

It was found that serious water core and breakdown was most prevalent in fruit from orchards deficient in soil moisture. This is significant from the point of view of soil management. It was also found that serious water core and breakdown was evident only in the later pickings. Harvesting as early as is consistent with good color development would seem to be the best practice for Jonathans intended for storage.

In regard to indexes of maturity, the pressure tests showed a wide range between the different orchards; consequently, as yet no rule for its general use can be given. Ground color of
the fruit was found to be the best index of maturity. Fruit whose unblushed cheek was green tinged with yellow corresponding to color No. 3 of the U. S. D. A. color chart was found at the best stage for maximum storage quality. Ease of separation from the spur was found to be variable and unreliable as a picking guide. Color of seeds was found useful in conjunction with ground color. This phase of work has been inactive during 1927-28. Cold-storage equipment at Logan is needed to continue this as well as the work on peach harvesting indexes in an accurate and efficient manner.

Indexes for Harvesting Peaches.—This line of work was started in 1925 to find a means of accurately determining the proper time to harvest peaches for distant shipment. Lack of uniformity in ripeness of Utah peaches varying from green fruit of poor quality to overripe bruised fruit has occasioned much loss to the peach industry.

Studies were limited to the Elberta and Early Elberta varieties. Fruit was harvested in three or four pickings from seven orchards in Boxelder, Weber, and Davis Counties to represent different conditions. Notes were taken on pressure test, color, size, and freedom of pit. A half bushel sample was placed in storage at 44° to 45° F., which approximates temperatures in the lower layers of an iced car in transit. Samples were taken and tested 7, 10, and 14 days, as representing elapsed time to midwestern and eastern markets.

Results indicate the color test and the pressure test for firmness to be the most reliable harvesting indexes. In general, the best picking time was when the peaches had acquired a distinct yellow color on the unblushed side. Spoilage became high when a distinct orange color became evident. Peaches showing green color with little yellow did not develop good quality.

This line of work was inactive during 1927-28 because of the lateness of the change in personnel in the Horticulture Department. It is planned to continue it during 1928-29 in an effort to formulate workable recommendations.

Additional problems under this project (Orchard Management) which should be investigated are orchard crowding, orchard fertilization, and orchard soil management. Crowding of trees is the most common defect in Utah orchards, causing low yields, small fruit, and poor color. Methods and results of tree thinning in crowded orchards and planting distance should be studied to remedy this situation. Experiments with fertil-
izers, tillage, and cover crops are also needed to lay the foundation for better methods of soil management for the fruit industry of Utah. (T. H. Abell\textsuperscript{42} and F. M. Coe)

Project No. 93—Orchard Rootstocks Investigations.—The object of this work has been to determine the most satisfactory rootstocks for orchard fruits under diverse soil and climatic conditions prevailing in Utah as well as to improve fruit tree rootstocks through selection, propagation, and testing. Special emphasis is being paid to sweet cherry and pear rootstocks. This work is made necessary by the frequent complaint concerning early death of cherry trees in Utah and the losses caused by ravages of the fire blight disease of pears which results in severe loss. Problems of rootstocks are directly concerned in remedying both of these difficulties.

Rootstock materials are being assembled and grown in a nursery at Logan. It is planned to test as many of the promising kinds of seedling stocks of cherry and pear as can be secured, as well as some apple, peach, and plum stocks. Seedlings will be budded to commercial varieties and grown under diverse soil and climatic conditions to determine the best species and seed sources.

In order to eliminate lack of uniformity characteristic of seedling rootstocks, efforts are being made to select superior seedlings and propagate uniform stocks from them by use of root cuttings and layering. The selected characters will be hardiness, adaptability, vigor, congeniality to commercial varieties, and resistance to diseases and insect pests.

Stocks now growing in the nursery include Mazzard (\textit{Prunus avium}) Mahaleb (\textit{P. mahaleb}), Morello (\textit{P. cerasus}), French pear (\textit{Pyrus communis}), Japanese pear (\textit{P. serotina}), Ussurienis and Calleryana Oriental blight-resistant (\textit{P. ussurienis} and \textit{P. calleryana}), Myrobalan plum, peach, and apple seedlings.

Several hundred Mazzard and Morello seedlings were propagated by the root-cutting method which has proved successful with plums and apples. Early observations on these root cuttings indicate that the method is not successful with cherries.

Additional land at Logan and Farmington is needed to test the rootstocks selected and developed in the nursery. It is hoped that longer-lived, more uniformly vigorous and productive orchards will result from this work. (F. M. Coe)

\textsuperscript{42}In charge Horticultural Investigations up to July 1, 1927.
Project No. 94—Cherry Pollination and Improvement.—The purpose of this project, initiated in the spring of 1928, is to determine the following: (1) The best varieties and strains to use as pollinizers for Bing, Lambert, and Napoleon for Utah; and (2) what strains of these varieties exist in the state and which are most desirable. The lines of work initiated this season were: (1) Hand-pollination experiments and (2) study of varieties and strains now grown in Utah. New varieties and strains are being introduced under Project 95. It is planned to continue this work for several years to so extend it as to insure its accuracy and completeness. A survey of varieties and strains as grown in Utah is planned in conjunction with the study of cherry rootstocks under Project 93. (F. M. Coe)

Project No. 95—Variety Testing.—Work on this project, initiated the past winter, has for its purpose the testing of new and promising varieties of fruits to determine their value under Utah conditions. The plan of work under this project is to secure, plant, and test varieties which come under the following groups: (1) Varieties promising for commercial purposes; (2) those promising for local market and home use; (3) commercial varieties standard in other regions whose reputation leads to frequent planting here. It is planned to test varieties at Farmington for the Salt Lake and Utah Valleys, and at Logan for Cache and Morgan Counties and districts with similar conditions. The latter test will include principally hardier and shorter season varieties. Test orchards were planted this year at Farmington. The orchards at Farmington are located on the more gravelly portions of the Davis County Experimental Farm. About four acres have been made available for this work. Testing of apple and pear varieties must await the provision of additional land for this purpose. No suitable land has been made available for the variety testing work at Logan. A start has been made, however, toward pear, plum and peach variety orchards on a small plot of rocky bench soil on the Experimental Sheep Farm. (F. M. Coe)

Human Nutrition Section

Project No. 52—Nutrition of Infants.—During the past biennium the work of the Department of Human Nutrition has been directed primarily on further research work with the milk curd test previously developed at this station. More than 1000 cows of different breeds of dairy cattle have been tested and results summarized in Bulletin 207, just published. Cooperation has been obtained from doctors and nurses in the feeding of soft-curded milk to infants. Results of this work are also sum-
marized in the above bulletin. Further work has been done on the effect of boiling and pasteurization of milk on its curd character. A more simple test for determining the hardness of curd of milk has been developed and described in Circular 66. This test requires no special equipment but is less accurate than the test described in Bulletin 207.

Utah Experiment Station Circular 66—"Physical Curd Character of Milk and Its Probable Relation to Infant Nutrition" (June, 1927). By R. L. Hill.

Utah Experiment Station Bulletin 207—"The Physical Curd Character of Milk and Its Relationship to the Digestibility and Food Value of Milk for Infants" (June, 1928). By R. L. Hill.

(R. L. Hill)

Irrigation and Drainage Section

Project No. 15—Pumping for Irrigation.—During the biennium an extensive study has been made covering the entire west with the aim of ascertaining the best practices in pumping for irrigation and to study in particular the economic phases of the problem. The field study was made at the expense of the U. S. Bureau of Public Roads. Manuscript for a cooperative bulletin on the subject has been completed and submitted for approval.

Further observations have been made pertaining to the subject of ground-water development in Utah, and manuscripts prepared in 1926 are being revised into form for a cooperative bulletin. (L. M. Winsor)

Project No. 17E—Relative Elevations of the Water-table and the Plane of Saturation in Fine-textured Soils.—During the summer of 1926 an effort was made to saturate completely the soil in plats which were surrounded by a deep trench, with the view to lowering the water-table to a depth of about 8 feet, permitting the water to drain to a state of equilibrium, and then determining the elevation of what has been designated the "saturation plane".

The plats were located near a canal in which the level of the water escaped through the somewhat sandy subsoil at a depth of approximately 4 to 5 feet. Owing, furthermore, to the presence of large quantities of gas in the underground water, the special equipment designed for determining the saturation plane was found inadequate. It was found impossible to complete the investigation along the lines planned without entailing an expenditure that was not thought to be wise at this time. However, it may be said that the outcome of the work has led
to a modified plan with a modified objective of a more comprehensive character the results of which are discussed in a preliminary theoretical paper now in press, which has been prepared as a joint publication of the Department of Physics, the Department of Irrigation and Drainage, and the Division of Agricultural Engineering of the Bureau of Roads. The paper will appear in an early issue of SOIL SCIENCE under the title of “The Drainage of Land Overlying Artesian Basins” by W. Gardner, O. W. Israelsen, and W. W. McLaughlin.

Measurements of the water-table and of the moisture distribution in the plats have continued at intervals with the hope of attacking the problem at some future time when funds may be made available for a considerable expenditure that will be required48.

(0. W. Israelsen)

Project No. 76—Flood and Gravel Control and the Use of Early and Late Water in Irrigation.—This project was begun for the purpose of finding an economical method of placing mountain streams under control at flood time and during the spring high water so that the surplus runoff might be used. It was intended that the investigation should continue to the end that the waters thus placed under control should be used and that the effect on increased crop production should be recorded.

During the past 2-year period the project has progressed as follows:

1. Two additional streams have been placed under control, one at Payson and one at Santaquin.

2. At Mount Pleasant a flood control barrier was begun in 1923, but was not completed because of failure of agreement between the City Council and the owner of the land on which the structure was laid out. During May, 1928, the entire City Council spent a day with the project leader, looking over similar structures in Salt Lake and Davis Counties and a unanimous decision was reached to push the structure on to completion. This structure is being carried forward to completion while this report is being written.

3. During 1927 a flood control works near Garfield in Salt Lake County was completed at a cost of a little less than $175,000. By special arrangement this work was done by the

48 Note: Further detailed information will be found in a recent report prepared by O. W. Israelsen and submitted to the Experiment Station and to the U. S. Bureau of Roads.
American Smelting and Refining Company under the direction and plans of the project leader.

(4) Additional studies have been carried forward at Farmington and at Willard by which it has been determined that a high-water stream, laden to capacity with sand and gravel, can be made to build its own marginal dyke around the barrier basin above the spillway.

(5) Contemplating the continuation of the project, additional studies were undertaken to determine whether or not there is need for early irrigation in parts of northern Utah. One of the senior students in irrigation engineering took this subject for his thesis. His investigations were conducted under the direction of the project leader. It was learned that the soils under alfalfa fields in parts of Cache Valley, and at Snowville in Boxelder County, and also at Stone, Idaho, contained less than one-third their capacity of moisture in early spring. This condition was limited to fields which had not been irrigated after early August. Winter precipitation had not penetrated to the fourth, fifth, and sixth foot in depth under such conditions. Similar results were obtained on other lands which had not been irrigated just before or just after the end of the growing season.

A copy of the complete report is placed on file in the Director's office. (L. M. Winsor)

Project No. 72—Relation 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.—The object of this project has been to extend the science of mountain hydrology in the arid regions of the United States so as to form a basis for forecasting the amount of water available for irrigation, power, and municipal purposes in advance of its utilization.

This project was begun in the fall of 1923 on State funds. Snow courses were established for measuring the winter precipitation and standard rain gages were set up for measuring the summer precipitation on the high watersheds. These snow courses and precipitation stations have been maintained and data collected continuously since that time. In addition cooperative agreements have been carried out with water commissioners and others throughout the state for collecting data on snow-cover and runoff. This cooperation has greatly advanced the collection of data so necessary in the determination of the snow-cover runoff relations.

In the spring of 1925 this project was transferred from State to Purnell funds and its scope broadened. The work dur-
ing the period July 1, 1926, to June 30, 1928, has been confined to a study of the following factors affecting the relationship between the precipitation and runoff:

(1) The collection of data on winter precipitation by means of seasonal snow surveys and summer precipitation by means of high level rain gages has been continued on the Logan drainage area and through cooperation with water commissioners and irrigation companies on the other principal watersheds of the state.

(2) Other field work consisted of collecting physical data on stream flow, vegetable cover, absorption, surface mantle, geology, and topography. An effort is being made to determine the effect of these factors on the precipitation-runoff relationship.

(3) A study of existing weather bureau records of snowstake readings, together with a field study of the snowstake locations, has been completed. This study indicated very conclusively that the greater portion of the existing snowstakes are located too low in elevation to be of any value and that snowstake readings of depth along without water content determinations are very misleading. In the Uinta mountains it is believed that only those stakes above 10,000 feet bear any relation to runoff.

(4) Daily hydrographs of principal Utah streams are being studied in connection with temperature and daily precipitation for the purpose of determining the stream-flow characteristics.

(5) Observations on Ricks Spring show that its flow fluctuates in step with the Logan River. Its source is in the higher snows because the low snow is gone before the spring starts flowing.

(6) The snow surveys to date indicate a uniform snow cover from Franklin Basin on the north of Mt. Logan on the south.

(7) Preliminary studies have been made to compare the watershed characteristics of different streams to see if wide-area forecasting is possible.

(8) Attempts to measure the evaporation from the snow cover from the end of the precipitation season until the snow is gone have not resulted in any definite results.

(9) A study of summer precipitation high watersheds is being continued, but as yet the data are too meager to give any results.
A detailed study of runoff and snow-melting characteristics has just been completed on the Gooseberry watershed in central Utah. The data collected in this investigation have not yet been completely analyzed, but the following points were clearly established:

(a) The density of snow increases up to a maximum when melting begins and decreases after melting begins. The maximum is different for different years, depending quite largely upon temperature and soil moisture conditions.

(b) There is a very definite lag in time from when snow starts to melt and water appears as runoff. This lag is dependent upon temperature and moisture in soil when melting begins.

(c) Sufficient water from snow must go into the soil to saturate it before runoff begins. Fall precipitation and the physical condition of the surface soil determine quite largely the character and extent of runoff.

The studies to date indicate a very close correlation between the snowcover on the Logan drainage and the runoff of the Logan River for the period April to September, inclusive. By measuring the snow cover at Franklin Basin, Tony Grove, and Mt. Logan along the forepart of April it is possible to predict within 10 per cent what the seasonal runoff will be.

It is expected to have data on this problem ready for publication during the next year. (G. D. Clyde)

Marketing Section

Project No. 85—Studies in Marketing Utah’s Apples.—Inasmuch as there had been little work done previously on marketing research by the Utah Experiment Station, the 6-months’ period from July, 1926, to January, 1927, was largely spent in analyzing the marketing problems of the state. After giving consideration to the outstanding economic projects and the methods to be used in attacking the various phases of the work, it was decided to make studies of individual agricultural commodities. Making the commodity the unit and studying the economic factors from production to consumption was thought advisable, for by so doing better results could be secured than by studying independently production, marketing, and other factors.

The first project undertaken was the economic study of the apple situation in Utah. Trends in production, competition with
other apple districts, price analysis, geography of Utah's apple markets, determining of the varieties of apples that have given the highest returns in Utah, the cost of producing and marketing apples, the relation of apple production to other farm enterprises, methods and efficiency in marketing the product, and the future outlook for the industry have been the factors considered in the analysis of the apple situation for Utah. A report of the project is being prepared for publication as a Station bulletin. This project has been conducted under a cooperative agreement with the Bureau of Agricultural Economics and is a part of the national study of the apple situation.

A price study to determine the relation between the prices paid for farm products in Utah and the prices of non-agricultural commodities, or the products which the farmer has to buy, has been under way during the past two years. The price index for Utah farm commodities, with 1910-14 equalling 100 as a base period, has been made covering the period since 1910. The average purchasing power of all Utah farm products rose to 261 in 1920 and dropped to 104 in 1921. The average purchasing power of all Utah's agricultural products stood at 68 cents in 1921 and at 94 cents in 1927.

The survey of skimmilk powder production and marketing in the Pacific Coast States was made in March and April of 1928. A report showing the trends in production and consumption, costs of manufacturing skimmilk powder, and the returns to the producer for his skimmilk through the manufacture of this product, was prepared and submitted to the Station Director and to the people interested in the installation of a skimmilk powder plant.

Assistance was given toward the following publication:

Utah Experiment Station Circular No. 70—"Agricultural Outlook for Utah for 1928" (February, 1928). By P. V. Cardon and W. P. Thomas.

(W. P. Thomas)

Physics Section

Project No. 17—Fundamental Soil Moisture Constants.—During the biennium 1926-28 work has continued in technical studies of the movement of water through soils and of the various physical characters which have to do with the important soil properties and processes associated with the production of agricultural crops.

The work connected with the rate of germination and rate of growth of plants as determined by the availability of moisture
has been assembled and in a short time will be presented for publication. The unique feature of this work is the use of the capillary potential function as a measure of the availability of moisture.

Some new information on the angle of contact for water and metallic surfaces has been obtained. This problem is still under way, and it is hoped that results may be available for publication at an early date. Soil moisture phenomena require for their explanation new experimental data regarding the various equilibrium configurations of the soil and water complex and it becomes necessary to seek for this information first on some of these intricate relations by investigating systems somewhat less complex.

The results of preliminary work on the properties which have to do with the friability of soils have been discussed in the following article:


This work is also being continued with promising results.

A considerable amount of attention has been given to field work on problems connected with the drainage of lands which are water-logged as a result of artesian water. A discussion of the problem is now in press and will appear shortly in SOIL SCIENCE under the title “The Drainage of Land Overlying Artesian Basins”. (See report for Project 17E, under Irrigation and Drainage Section). It will suffice to say here that the outlook for controlling the water-logged condition by means of wells for such areas as the Cache Valley region is very favorable. It appears that the cost for relief, aside from certain overhead costs for installation of equipment, is in direct proportion to the amount of water available from the artesian source and that this in turn becomes a new and important asset heretofore neglected.

A new type of Weignen-Gessner apparatus for measuring the dispersion of soils has been devised and is being installed at the present time.

Incidental and miscellaneous studies in cooperation with other departments have been continued. Straight lines have been fitted to potato yield data, for example, for the various states reported in the U. S. Department of Agriculture publications for the two periods, 1867-1888 and 1888-1926. The trend is shown to be consistently downward for all the states reported
during the first period and consistently upward during the second. The average annual acre decrease for the first period is 0.95 bushel and the average annual acre increase for the second period is 0.86 bushel. Other studies of this character have been undertaken with the help of students at a nominal cost.

A considerable portion of the work of the department has been conducted cooperatively with the Department of Irrigation. The Office of Irrigation Investigations of the U. S. Bureau of Public Roads has also been associated with the two departments in the drainage work. (Willard Gardner)

Range Management Section

Project No. 48—Range Survey.—During the past biennium only incidental attention has been given the survey, meager data being obtained on trips made for other purposes. (R. J. Becraft)

Project No. 61—Range Reseeding.—This project was held in abeyance during 1926-27, while the writer was on sabbatical leave, but has been continued since July 1, 1927. The distribution of native species has been worked out locally, though certain associations will be given further study. Seed collection is being continued. The minor plantings at the Greenville farm have not been successful, but repetitions and new species will be tried this coming fall and spring. The half-acre lot of mountain brome grass (*Bromus polyanthus*), from seed supplied by the Great Basin Experiment Station of the U. S. Forest Service, has demonstrated its adaptability to valley lands and made a luxuriant growth. The smut infestation has continued about the same for three consecutive years, namely 30 to 40 per cent, and presents a problem of control.

Because of demand for early spring feed, the problem of suitable species for this purpose has been studied. A survey was made of foothill dry-farms and range lands. A 2-acre tract has been leased, fenced, and divided into plats 2 by 4 rods (1/20 acre). These were planted to promising species for which seed was obtainable. Germination showed best for alfalfa, sweet clover, perennial and Italian rye grasses (*Solium*), and western rye grass (*Elymus glancus*). Further plantings will be made, and species judged on establishment, drought resistance, and early forage production. (R. J. Becraft)
Rural Sociology Section

Project No. 88—Studies of Utah Village Life (Towns and Villages, No. 1)44—This project, begun in 1927, has considered human contacts, quantitatively and qualitatively, among farm families. The purpose of this project has been to determine the difference with respect to both quantity and quality of social contacts between farm families who live on farms and farm families who live in town and who farm outside.

The original plan was:

(1) To select 4 distinct types of Utah villages which are reasonably representative of the class to which they belong:

(a) A village isolated from the main currents of human intercourse. No nearby railroad or highway connection and therefore forced to provide its own social service agencies.

(b) A small “strung-out” community with only a few service centers but near enough to a large town so that a variety of high grade contacts is available.

(c) A thriving, small town with highway, interurban, and railroad connections but sufficiently far from large centers to be under the necessity of providing its people with most of their social service.

(d) A village of moderate size, neither highly isolated nor close to urban communities.

(2) To formulate record-books covering the principal kinds of contrasts.

(3) To develop community interest in the project by enlisting support of leaders.

(4) To select cooperator families to keep records. These families are to represent the various economic levels and also the geographic situation of the different farm groups being studied.

(5) To keep a record by a local assistant of the attendance of the groups being studied at all group gatherings.

(6) To examine school records in order to determine the standing of the groups with respect to scholarships, attendance, time of beginning in the fall, and punctuality.

44Work on this project was begun July 1, 1927. Official approval by the U.S. Department of Agriculture as a Purnell project was given September 16, 1927.
Because of inadequate funds, it was necessary, for the first year, to confine the inquiry to but one type of village instead of the four, as originally planned. However, some preliminary work was done in Lewiston and Clarkston. It was also necessary to confine the record-taking to one month (October) instead of during one month of each season.

It is the intention to continue the project during 1928-29. Preliminary work is now being done at Tremonton, Utah.

(J. A. Geddes)

Soils Section

Project No. 11—Action of Alkali.—Under Project 11 and Part 1 (Vapor-pressure Studies) of Project 12, the following articles have recently appeared:


In addition to the above papers, a fifth part of Aqueous Vapor Pressure of Soils is in process of preparation by the same author.

In these papers it is shown: (1) That when the replaceable bases are displaced by a single base of calcium, magnesium, or sodium, and then leached with successive quantities of distilled water, there is a nearly constant solubility of the sodium, and (2) that the concentration of sodium is on a high level as compared with the other bases.

Frequent reference has been made to the fact that a high content of replaceable sodium is attended by a high degree of dispersion of the fine material of the soil, while a granulating effect generally accompanies a high content of calcium, magnesium, and potassium. An explanation of this fact may be found in the activities, or ionic concentration, of the bases. Energy, therefore, has been centered in the measurement of the activity of the replaceable bases in soils.

Formerly Associate Soil Chemist.
data have been tabulated and a copy of the results submitted to the representative of the company through the Station Director's office. The power company paid the salary of the men detailed to do this work. However, the men received constant help from members of this department. The field and laboratory data are valuable to this project since they add a large amount of detail to the 51 soil profiles.

Provo Bay Area—During the present biennium, at the request of the U. S. Reclamation Service and of the Utah Water Storage Commission, a representative of the Federal Bureau of Soils made a classification of the soils of the Provo Bay Area. The same institutions extended an invitation to this department to continue this study by collecting samples of soil from the different classes and determining their physical and chemical properties. Members of the staff visited the area and collected 66 samples of soils representing 18 profiles. The necessary analytical work was completed and a report rendered in September, 1927, to the Utah Water Storage Commission. It is shown in this report that the content of organic matter of approximately 4000 acres, or 50 per cent of the total area, ranges from 9 to 40 per cent; consequently, the area may be developed into an important truck-gardening section. The prosecution of this work was made possible by a grant of $400 from the Utah Water Storage Commission. If proper arrangements can be made with interested parties, it is planned to publish the results of this work in the near future.

Colorado River Investigations—During the past biennium, at the request of the Utah Water Storage Commission, a member of the department conducted a reconnaissance soil survey of the Price River-Huntington-Castlegate-Ferron Area. Funds for this work were furnished by the Utah Water Storage Commission from a special fund provided by the last State Legislature. The immediate object of the survey was to determine the character of the irrigable soil of representative areas of that portion of the Colorado River Drainage System. The soils of more than 160,000 acres were classified and mapped into four general types. All the help and much of the equipment of the Department were for a time used to prosecute this work. Detailed reports with soil maps were sent to the Secretary of the Utah Water Storage Commission the latter part of 1927.

Since the data upon which these maps and classifications were based are all in the files of this department, they will not have to be duplicated when more detailed maps and classifications of the soils of these areas are surveyed.

(D. S. Jennings)
RECOMMENDATIONS

The control of plant diseases is becoming economically more and more important. During the summer of 1927 losses, aggregating more than a half a million dollars, came to the farmers of the state through diseases on potatoes, tomatoes, and sugar-beets. In addition to these, great losses in grain crops were suffered. More money should be spent in experimental plant-disease work. The disease, known as psyllid yellows of potatoes, can be looked upon as an emergency, and it is very urgent that research for control should be expanded and cooperation should be procured through Federal Bureaus to aid in what at present is looked upon as being a real menace in the growing of these crops.

Closely associated with the diseases found in plants is the work of the insects. Injurious insects seem to be growing more and more destructive. There is no reason for believing that any insect injurious to plants that can thrive in this environment will not sooner or later be present. The work for the control of insects should be increased and cooperation with agencies in surrounding states should be secured in an effort to gather data to control this scourge.

The work in these two lines is several years behind what it should be, and even if started immediately it will take many years to have sufficient data to be in advance of the effect of diseases and insects as it is now approaching.

Future plans should also include additional work in research in dairy manufacture and in the feeding and handling of dairy cattle. Especially should more work be done to give the dairy-men a better knowledge of how to control contagious abortion. The poultry industry of the state has grown to a large industry but additional research is demanded in the control of diseases and parasites of poultry.

The work of range management is important, and it is especially urgent that a solution to the problem of grazing between the feedlot and the forest reserve be attacked. Some work has been already started, but this should be increased and extended.

Respectfully submitted,
WILLIAM PETERSON,
Director, Utah Agricultural Experiment Station, 1926-28.

July 7, 1928.

(College Series No. 264)

46Director, Utah Agricultural Experiment Station from September 1, 1921 to June 30, 1928.
LIST OF AVAILABLE PUBLICATIONS

BULLETINS
121—Soil of Southern Experiment Station.
122—Nature of the Dry Farm Soil of Utah.
124—Fruit Variety Tests on Southern Experiment Farm.
128—Blooming Periods and Yields of Fruit in Relation to Minimum Temperatures.
131—Variety Tests of Field Crops in Utah (1914).
122—Minor Dry-land Crops at Nephi Experiment Farm.
134—Nitric Nitrogen Content of Country Rock.
147—Alkali Content of Irrigation Waters.
150—Further Studies on Nitric Nitrogen Content of Country Rock.
151—Freezing of Fruit Buds.
148—Minor Crop Studies at Nephi Experiment Farm.
152—Effect of Soil Moisture on Certain Factors in Wheat Production.
153—Soil Moisture Studies under Dry-farming.
160—Important Factors in Operation of Irrigated Farms.
137—Quality of Home-grown Wheat vs. Imported Wheat.
154—Soil Moisture Studies under Irrigation.
161—Orchard Heating.
162—Movement of Soluble Salts with Soil Moisture.
149—Summer Pruning of a Young Bearing Apple Orchard.
156—Soil Moisture Studies under Dry-farming.
157—Soil Moisture Studies under Irrigation.
140—Variation in Minimum Temperatures due to Topography of a Mountain Valley in Relation to Fruit-growing.
144—Water Table Variations.
145—Soil Alkali Studies.
163—Composition of Irrigation Waters of Utah.
157—Labor Costs and Seasonal Distribution of Labor in Irrigated Crops.
164—Irrigation of Oats.
165—Use of Alkali Water for Irrigation.
170—Duty of Water in Cache Valley, Utah.
171—Irrigation of Barley.
168—Duty-of-Water Investigations on Coal Creek, Utah.
132—Irrigation of Barley.
133—Water-holding Capacity of Irrigated Soils.
182—Irrigation Experiments in Sugar-beets.
183—Irrigation Experiments in Sugar-beets.
184—Irrigation Experiments in Potatoes.
185—Irrigation Experiments in Sugar-beets.
186—Irrigation Experiments in Sugar-beets.
187—Maintaining the Productivity of the Soil.
188—Ridding the Land of Wild Morning Glory.
189—Corn Silage in the Dairy Ration.
190—Oedipodinae of Utah (Technical).
191—Beet Leaf Hopper in Utah.
192—The Beet Leaf Hopper in Utah.
193—Cattle Ranching in Utah.
194—Sheep Ranching in Utah.
195—The Physical Curd Character of Milk and Its Relation to the Digestibility and Food Value of Milk for Infants.
197—Biennial Report of Director, July 1, 1926 to June 30, 1928.