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Bulletin No. 250 - Summary Report of Progress: July 1, 1932 to June 30, 1934

P. V. Cardon

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Summary Report of Progress

July 1, 1932 to June 30, 1934

P. V. CARDON

Utah Agricultural Experiment Station

UTAH STATE AGRICULTURAL COLLEGE

Logan, Utah
UTAH STATE AGRICULTURAL COLLEGE

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In Cooperation with U. S. Department of Agriculture

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*Deceased (September 22, 1934).
**On leave.
***Part-time U. S. Department of Agriculture.
SUMMARY REPORT OF PROGRESS
From July 1, 1932 to June 30, 1934

President E. G. Peterson,
Utah State Agricultural College.

Sir:

I have the honor to transmit the report of the Utah Agricultural Experiment Station for the biennium ending June 30, 1934. This report includes the reports of the various departments as well as other information pertaining to the work of the Experiment Station during this two-year period.

Respectfully submitted,
P. V. CARDON,
Director, Utah Agricultural Experiment Station.

INTRODUCTION

During the past biennium various members of the Utah Station Staff have been actively engaged in the national and state recovery and emergency programs. P. V. Cardon, the director, served as a member of the National Advisory Committee, Division of Subsistence Homesteads, Department of the Interior, from November 1, 1933 to April 10, 1934, acting as western representative of that division. Effective April 25, 1934, under the Agricultural Adjustment Administration, Land-Policy Section, Planning Division, he was appointed Regional Director of Arizona, California, Colorado, Nevada, and New Mexico. On April 27, 1934, Professor George D. Clyde, Station Irrigation and Drainage Engineer, was appointed by Governor Henry H. Blood as Special State Water Conservator to meet the existing drought situation confronting the state. From December 14, 1933 to April 15, 1934, Mrs. Almeda Perry Brown, Assistant Station Home Economist, was associated on the Farm-Housing Survey conducted by the Civil Works Administration in direct cooperation with the Extension Service of the Utah State Agricultural College.

Sabbatical leaves of absence for further study were granted on July 1, 1932, to Director P. V. Cardon and to Mrs. Almeda Perry Brown, both of whom attended the University of California during 1932-33. Professor G. D. Clyde, formerly Associate Irrigation and Drainage Engineer, was given the rank of Station Irrigation and Drainage Engineer, as of July 1, 1932.

The resignation of William Peterson, Station Geologist since 1915, became effective as of July 1, 1933.

Effective July 1, 1933, Dr. H. J. Frederick, Station Veterinarian since 1905, was retired; Dr. D. E. Madsen, Station Animal Pathologist, was appointed at this time to serve in this capacity.

Due to curtailment of Station funds, the following experimental farms or substations were necessarily discontinued: Carbon, Garfield (Panguitch), Millard, San Juan, and Sanpete. Disposition was made of all farm equipment, machinery, and other Station property, some of which was assigned to remaining Station substations as well as to other Station projects. The sheep and cattle at the Panguitch Farm have been disposed...
of and the farm temporarily leased, pending further arrangements with the United States Indian Service which has a continuing interest in this farm. The men in charge of these respective substations came to Logan at the time the farms were closed and completed their reports and records. Two of these farm superintendents, Mr. George Whornham and Mr. James A. Eagar, on January 16, 1934, were appointed by the Extension Service of this institution as temporary county agricultural agents in the counties (Millard and San Juan) which they had served as Station farm superintendents. These five farms are now officially closed. The men affected by suspension of funds for operation of these farms are I. D. Zobell, Benjamin F. Hulme, George Whornham, James A. Eagar, and LeMoyne Wilson.

SALES

The amount of money realized from sales during the biennium amounted to approximately $28,000. Of this amount, the larger portion of the 1933-34 sales ($19,000) resulted from sales of machinery, equipment, and livestock during 1933-34 when five substations were necessarily closed on account of lack of funds.

OUTSTANDING EQUIPMENT PURCHASED

1932-33

Monroe Calculators (2).
Leitz Binocular Microscope.
Bausch-Lomb Microscope.
Torsion Balance.
Recording Vacuum Gauge.
Typewriters (2 for office; 1 for Entomology Department).
Library Files (10).
Second-hand Typewriter Desk.
Typewriter Tables (2).
Colorimeter.
Soil Thermograph (one-half interest).
Lathe for Shop (one-half interest).
Electric Drying Oven.
Eastman Kodak and Accessories.
Art Metal Files (2).

1933-34

Hood and Ventilating System.
Wiley Mill.
Hamilton Vertical Map Case.
Underwood Typewriters (3).
Filing Cases (2).
Desk and Revolving Arm Chair.
No. 2 Eastman Kodak View Camera.
Kjeldahl Combustion and Distillation Apparatus.
Built-in Incubator.
Hanova Lamp.
General Electric Refrigerator (7-foot).
Spencer Binocular Microscope.
Electric Multiple Furnace.

In addition to these items, all of which were paid for out of Station funds, the Public Works Administration from an appropriation amounting to $1000 made it possible to erect a poultry-feed storage and feed-mixing house.
COOPERATIVE AGENCIES

During the past biennium cooperative relations have been maintained with the following agencies:

1.—FEDERAL—UNITED STATES DEPARTMENT OF AGRICULTURE


6. Relationship of Stream Discharge to Precipitation with Special Reference to Forecasting the Supply of Water for Irrigation from Seasonal Surveys of Snow Cover on Mountain Watersheds. Weather Bureau and Forest Service. (Informal).


15. Peach Irrigation Studies (Boxelder County Experimental Farm). Bureau of Agricultural Engineering. Informal (1931.)

16. The Susceptibility of Cattle to Inoculations with Acid-fast Organisms Isolated from So-called Tubercular Skin Lesions. Bureau Animal Industry. (Informal.)

2.—FEDERAL—MISCELLANEOUS


3.—GENERAL

13. The Susceptibility of Cattle to Inoculations with Acid-fast Organisms Isolated from so-called Tubercular Skin Lesions. State Department of Agriculture. Informal.

In addition to these specified cooperating agencies, the Utah Station is also indebted to various farmers and commercial concerns throughout the state for their cooperation.

LIBRARY

BOUND VOLUMES ON STATION LIBRARY SHELVES, JUNE 30, 1934

State Departments of Agriculture, etc................................................................. 488
State Experiment Stations..................................................................................... 1534
U. S. Department of Agriculture............................................................................ 1510
Department of Interior......................................................................................... 630
Miscellaneous (Technical and Scientific Journals)............................................ 896
Smithsonian Institution (U. S. National Museum)............................................. 209
Bureau of Commerce......................................................................................... 85
Library of Congress.............................................................................................. 34
Foreign .................................................................................................................. 885

Total No. Bound Volumes in Station Library...................................................... 6271
Total No. Bound Volumes in Various Departments
Accessioned in Station Library........................................................................... 236

Grand Total No. Bound Volumes in Station Libraries....................................... 6507
BOOKS PURCHASED FROM STATION FUNDS

Agricultural Economics

"Corporation Finance"—A. S. Dewing.
"Devaluation of the Dollar"—C. O. Hardy.
"The Economics of Recovery"—L. P. Ayres.
"The Economic World Today"—Felix Morley.
"Money Credit and Prices"—J. L. Laughlin (2 Vols.).
" Monetary Stability"—A. Mahr.
"Recent Economic Changes in the United States"—(2 Vols.)
"Federal Farm Board, Department of Agricultural Economics."
"Marketing Utah Fruits and Vegetables."
"Should We Turn to Silver?"—H. M. Brateer.

U. S. Department of Agriculture:

Weather, Crops, and Markets.
Information on Charts, etc.
Statistics on Dairy and Poultry.
Agricultural Situation, 1927-30.
Statistical Bulletins (1-15).
Statistical Bulletins (16-21).
Statistical Bulletins (22-30).
Marketing Activities, Vol. 9.
Marketing Activities, Vol. 10.
Agricultural Economics Bibliographies Nos. (1-17).
Agricultural Economics Bibliographies Nos. (18-25).
Agricultural Economics Bibliographies Nos. (26-32).
Agricultural Cooperation, Vols. (1-3).
Agricultural Cooperation, Vols. (4-5).
Agricultural Cooperation, Vols. (6-7).
Crops and Markets, Vols. (1-2).
Crops and Markets, Vols. (3-4).
Crops and Markets, Vols. (5-6).
Farm Economics, Vol. 3 (Nos. 47-68).

Agronomy

"Outlines of Biometric Analysis"—Pt. I—A. E. Treloar.

Animal Disease Laboratory

"Approved Laboratory Technique"—J. A. Kolmer, F. Boener, et al.
"Principles of Animal Hygiene"—Louis Van Es.
"Recent Advances in Bacteriology"—J. H. Dible.

Botany and Plant Pathology

"Bacteriological Technique"—J. W. H. Eyre.
"(The) Chemical Formulary—H. Bennett.
"History of Staining"—H. J. Conn.
"Introduction to Laboratory Technique in Bacteriology"—Max Levine.
"Handbook of Chemistry and Physics."
"Phytopathological and Botanical Research Methods"—T. E. Rawling.
"Recent Advances in the Study of Plant Viruses"—K. M. Smith and F. T. Books.
"Scientific American Cyclopedia of Formulas"—A. A. Hopkins.
"Virus Diseases of Plants: A Bibliography"—Atanosoff.

Chemistry and Bacteriology

"Hydrogen-Ions"—H. T. S. Britton (2d ed.).
"Root Nodule and Leguminous Plants"—E. B. Fred, I. L. Baldwin, E. McCoy.
"Sulfur Metabolism"—Max Kahn and F. G. Goodridge.
Dairy Husbandry

"The Feeding of Dairy Cows"—James Mackintosh (paper bound).

Entomology

"Animal Ecology with Special Reference to Insects"—R. N. Chapman.
"Handbook of the Mosquitoes of North America"—Robert Matheson.
"Insects and Diseases of Ornamental Trees and Shrubs"—E. P. Felt and W. H. Rankin.
"Locusts and Grasshoppers"—B. P. Uvarov.
"Recent Advances in the Study of Plant Viruses"—K. M. Smith and F. T. Brooks.
"Synoptical Keys to Genera of North American Miridae"—E. P. Van Duzee.

Home Economics

Amer. Child Health Association: "Public Health Aspects of Dental Decay in Children.
"Health Environment"—Edgar Sydenshicker.
"Ultraviolet Light and Vitamin D in Nutrition"—Katherine Blunt and Ruth Cowan.
"Vitamins in Health and Disease"—B. Sure.

White House Conference on Child Health and Protection:

(1) Body Mechanics—Education and Practice.

Horticulture


Human Nutrition


Physics

"Wasserbauliche Stromungelehre"—Paul Nemenyi.

Range Management

"Environment and Plant Development"—H. Lundegardh (Translated by Ashby Eric).

PROJECTS

NEW PROJECTS

Since July 1, 1932, the following new projects have been launched and several projects which had been begun earlier but which had never been definitely approved as projects have been given specific numbers and included in the regular project list. These are:

136. The Chemical and Physical Difference between Soft- and Hard-curd Milk
139. The Tarnished Plant Bug (Lycus pratensis Lin.), the Superb Plant Bug (Adelphocoris superbus Uhl.), and Thrips in Relation to Alfalfa-seed Production.
143. Farm Mortgage, Tax Delinquency, Land Value, and Crop Yield Study.
145. Relative Size of Utah School Children as Determined by Comparing Their Heights and Weights with Baldwin-Wood Norms for the Same Age.
146. Effect of Calcium Phosphorus Ration on Rate and Economy of Gain in Fattening Beef Calves.
SUMMARY REPORT OF PROGRESS


149. Types of Farming in Utah. PURNELL. Agricultural Economics. Authorized: 19 March 1934.


DISCONTINUED PROJECTS

The following projects, by funds, have already been closed during the past biennium or will be closed on June 30, 1934. Included in this statement is given the length of time each project was carried.

**Hatch**

- 78. Injurious Effects on Livestock of Sugar-beets and Their By-Products (1929-33).
- 110. Feeding Value of Alfalfa Hay Treated with Calcium Arsenate for Destroying Injurious Insects (1930-33).

**Adams**

- 17. A Study of Some Factors Which Influence the Reclamation of Water-logged and Alkali Soils (1917-34).

**Purnell**

- 77. Effect of Winter Feed and Shelter vs. Open-range Wintering on the Quality and Quantity of Wool from Utah Range Ewes (1925-34).
- 84. Pasture Studies with Beef Cattle (1927-33).
  - B. Soil Productivity Aspects (1929-34).
  - C. Contributing Sociological Aspects (1929-34).
  - D. Economic Aspects (1929-34).
- 102. Food Habits of Elementary Rural School Children in Relation to Their Physical Well-being (1929-33).
- 103. The Physical Curd Character of Milk and Its Relationship to the Digestibility and Food Value of Milk for Infants (1929-33).
- 103-A. Physical Curd Character of Evaporated Milk (1930-33).

19. Comparative Values of Fleeces from Types B and C Rambouillet Ewes (1929-34).

11. Family Living Expenditures on Utah Farms (1931-33).

State

2. Widtsoe Dry-farm Substation (1917-22).

42. Grain Varieties (1918-33).

64. Cultivation Methods with Sugar-beets (1921-34).

66. Panguiitch Livestock Farm (1920-34).

74. Egg-laying Contest (1924-32).

86. Peach Harvesting Indexes (1925-33).

94. Cherry Pollination Studies (1928-34).

96. Sanpete County Experimental Farm (1927-34).

97. Carbon County Experimental Farm (1927-34).

99. Fattening Lambs in Winter Dry-lot (1928-33).

100. San Juan Experimental Farm (1929-34).

104. High-Altitude Metabolism Studies on Women (1929-33).

111. Swine-Feeding Experiments (1930-34).

112. Alfalfa-seed Investigations in Millard County (1929-34).

113. Types of Greens or Pot Plants Used in Utah Homes (1930-33).


116. Family Living Expenditures in Utah (1930-33).

119. Boxelder County Experimental Farm (1931-33).

120. Washington County Experimental Farm (1931-33).


123. Winter Maintenance of Range Calves (1932-34).

Miscellaneous

152. Part-time Farming Studies (1 January to 30 June, 1934). (C. W. A. Project).

ACTIVE PROJECTS

A brief, comprehensive statement of active projects by fund, leader or leaders, date of beginning, and other pertinent information for the past biennium follows:

Hatch

51. Miscellaneous Insects

A. Miscellaneous Insects Not Related to Alfalfa.
   Date of Beginning—1919 (Revised: 1930; 16 September 1932).
   Leader—G. F. Knowlton.

B. Miscellaneous Insects in Relation to Alfalfa.
   Date of Beginning—1919 (Revised: 1930; 2 July 1932).
   Leader—C. J. Sorenson.

57. Poultry Feeding

A. Methods of Feeding Grain to the Laying Flock.

B. Soft White Wheat vs. Hard Red Wheat as a Feed for Leghorn Hens and Pullets.

C. All-night Light vs. Morning Light for Leghorn Hens and Pullets.
   Date of Beginning—1920 (Revised: December 1931).
   Leader—Byron Alder.

93. Orchard Rootstocks Investigations
   Date of Beginning—1928.
   Leader—F. M. Coe.

95. Fruit Variety Testing.
   Date of Beginning—1928.
   Leader—F. M. Coe.

121. Studies on Fowlpox.
   Date of Beginning—1931.
   Leader—D. E. Madsen.

   B. Value of Dried Molasses Beet Pulp as a Succulent When Added to a Dairy Ration Made up of Alfalfa Hay and Grain.
   Date of Beginning—1932.

132. Corn and Cottonseed Cake as Concentrated Supplements for Wintering Sheep on Desert Ranges of Utah.
   Date of Beginning—1931.
   Leaders—E. J. Maynard, A. C. Esplin, R. J. Becraft, and J. E. Greaves.

138. Grasshoppers and Their Allies in Utah with Special Reference to the Species Which Menace Farm Crops and Range Forage.
   Date of Beginning—1922.
   Leader—W. W. Henderson.

156. The Effect of Iritis of Breeding Hens on Their Progeny.
   Date of Beginning—1 March 1934.
   Leader—W. W. Henderson.

158. Forced Summer Molting as a Method of Increasing Fall and Winter Egg Production of Leghorn Hens.
   Date of Beginning—1 May 1934.
   Leader—Byron Alder.
Adams

   Date of Beginning—1912 (Revised: 1 July 1929).
   Closed—30 June 1934.

17. A Study of Some Factors Which Influence the Reclamation of Waterlogged and Alkali Lands.
   Date of Beginning—1917 (Revised: 1 July 1929).
   Closed—30 June 1929.

22. Factors Influencing the Bacterial Activities of the Soil.
   Date of Beginning—1912 (Revised: 1 July 1929).
   Leaders—J. E. Greaves and K. R. Stevens.

23. Permanent Fertility Studies.
   Date of Beginning—1916 (Revised: 1 July 1929).

   Date of Beginning—1914 (Revised: 1 July 1929).
   Closed—30 June 1934.
   Leader—B. L. Richards.

Purnell

   Date of Beginning—1915 (Revised: 1 July 1929).
   Closed—30 June 1933.
   Leader—William Peterson.

33. Tomato Diseases in Utah: Fusarium and Related Wilts, Bacterial Canker, and Mosaic Diseases.
   Date of Beginning—1916 (Revised: 1 July 1929).
   Leader—H. L. Blood.

61. Range Reseeding Studies with Native Forage Plants.
   Date of Beginning—1921 (Revised: 1 July 1929; December 1933).
   Leader—R. J. Becraft.

88. Studies of Utah Towns and Villages.
   Date of Beginning—1927 (Revised: 1 July 1929).
   Closed—30 June 1934.
   Leader—A. C. Esplin.

89. Nature and Cause of Chlorosis in Utah and Practical Methods of Control.
   1. Treatments of Chlorotic Plants.
      Date of Beginning—July 1929.
      Leader—F. B. Wann.
      Date of Beginning—November 1931.
      Leader—A. L. Wilson.

90. A Study of Factors Influencing the Financial Condition of Certain Utah Irrigation and Drainage Projects.
   A. Engineering and Engineering Economic Aspects.
      Date of Beginning—1928.
      Leader—O. W. Israelsen.
B. Soil Productivity Aspects.  
Date of Beginning—1929.  
Leader—D. S. Jennings.

C. Contributing Sociological Factors.  
Date of Beginning—1929.  
Leader—J. A. Geddes.

D. Economic Aspects.  
Date of Beginning—1929.  
Leader—W. P. Thomas.

Note: Closed 30 June 1934.

91. Effect of Fertilizers on Various Properties of a Highly Calcareous Soil and on the Yield and Quality of Crops Produced.  
Date of Beginning—1928 (Revised: 1 July 1929).  

92. Psyllid Yellows of the Potato.  
A. Disease Aspect.  
Date of Beginning—1928 (Revised: 1 July 1929).  
Closed—30 June 1934.  
Leader—B. L. Richards.

B. Insect Aspect.  
Date of Beginning—1928 (Revised: 1 July 1929).  
Closed—30 June 1934.  
Leader—G. F. Knowlton.

103. The Physical Curd Character of Milk and Its Relationship to the Digestibility and Food Value of Milk for Infants.  
Date of Beginning—1929.  
Closed—30 June 1933.  
Leader—R. L. Hill.

103-A. The Physical Curd Character of Milk and Its Relationship to the Digestibility and Food Value of Milk for Infants.  
Date of Beginning—1920.  
Closed—30 June 1933.  
Leader—R. L. Hill.

105. The Nutritive Value of High vs. Low Calcium and Phosphorus-carrying Wheat.  
Date of Beginning—1929 (Revised: 1 September, 1932).  
Leader—J. E. Greaves.

Date of Beginning—1929.  
Closed—30 June 1933.  
Leader—R. L. Hill.

Date of Beginning—1929.  

Date of Beginning—1929.  
Closed—30 June 1934.  
Leader—A. C. Esplin.

109. Comparative Values of Fleeces from Types B and C, Rambouillet Ewes.  
Date of Beginning—1929.  
Closed—30 June 1934.  
Leader—A. C. Esplin.

113. A Study of Factors Promoting Positive Health in Rural School Children.  
Date of Beginning—1 July 1931.  
Leader—Almeda Perry Brown.

122. Factors Influencing Marketability of Onions.  
Date of Beginning—September 1931.  
Leader—A. L. Wilson.

126. Factors Underlying the Formation of Double Onions and Scallions.  
Date of Beginning—September 1931.  
Leader—A. L. Wilson.

A. Pathological Aspect.  
Date of Beginning—November 1931.  
Leader—B. L. Richards.

B. Agronomic Aspects.  
Date of Beginning—November 1931.  
Leader—R. J. Evans.

Date of Beginning—1 July 1932.  
Temporarily Suspended—1 July 1934.  
Leader—R. L. Hill.

139. The Tarnished and Superb Plant Bugs and Thrips in Relation to Alfalfa-seed Production.  
Date of Beginning—15 July 1933.  
Leader—C. J. Sorenson.

141. Curly-top and Psyllid Yellows of Tomatoes.  
Date of Beginning—15 July 1933.  

143. Farm Mortgage, Tax Delinquency, Land Value, and Crop Yield Study.  
Date of Beginning—27 February 1934.  
SUMMARY REPORT OF PROGRESS

144. Mosquito Control.
   Date of Beginning—27 February 1934.
   Leader—G. F. Knowlton.

145. Relative Size of Utah School Children as Determined by Comparing Their Heights and Weights with Baldwin-Wood Norms for the Same Age.
   Date of Beginning—24 November 1933.
   Leader—Almeda Perry Brown.

146. Effect of Calcium-Phosphorus Ratio, Rate, and Economy of Gain in Fattening Beef Calves.
   Date of Beginning—Fall, 1934 (Authorized: 11 January 1934).
   Leaders—E. J. Maynard and J. E. Greaves.

   Date of Beginning—16 January 1934.
   Leaders—A. F. Bracken and J. E. Greaves.

149. Types of Farming in Utah.
   Date of Beginning—19 March 1934.
   Leader—W. P. Thomas.

150. Cost and Efficiency of Producing Dry-land Wheat in Utah.
   Date of Beginning—1 January 1934.
   Leader—W. P. Thomas.

State

1. Nephi Dry-farm Substation.
   Date of Beginning—1903.
   Leader—A. F. Bracken.

5. Moisture, Soil, and Crop Relations.
   Date of Beginning—1911 (Revised: 1 July 1929).
   Leader—D. W. Pittman.

   Date of Beginning—1910 (Revised: 1 July 1929).
   Leader—D. W. Pittman.

10. Miscellaneous Crop Studies.
    Date of Beginning—“Early” (Revised: 1 July 1929).
    Leader—R. J. Evans.

34. Plant Disease Survey.
    Date of Beginning—1913 (Revised: 1 July 1929).
    Leader—B. L. Richards.

36. Breeding for Egg Production.
    Date of Beginning—1907 (Revised: 1 July 1929).
    Leader—Byron Alder.

49. Soil Survey.
    Date of Beginning—1919 (Revised: 1 July 1929).
    Leader—D. S. Jennings.

59. Davis County Experimental Farm.
    Date of Beginning—1919 (Revised: 1 July 1929).
    Leader—A. L. Wilson.

114. Studies of Dairy Cattle Affected with Bang’s Disease.
    Date of Beginning—1929 (Approved as Station Project—7 August 1930).
    Leader—D. E. Madsen.

117. Transmissibility of Bang’s Disease among Dairy Cattle in a Utah Dairy Village.
    Date of Beginning—14 May 1931.
    Leader—D. E. Madsen.

121. Studies on Fowlpox.
    Date of Beginning—6 August 1931.
    Closed—30 June 1934.
    Leader—D. E. Madsen.

123. Improvement of Sweet Spanish Onions.
    Date of Beginning—6 August 1931.
    Leader—A. L. Wilson.

    Date of Beginning—6 August 1931.
    Leader—A. L. Wilson.

125. The Susceptibility of Cattle to Inoculations with Acid-fast Organisms Isolated from So-called Tubercular Skin Lesions.
    Date of Beginning—1931.
    Leader—D. E. Madsen.

127. Miscellaneous Onion Studies.
    Date of Beginning—August 1931 (Approved as Station Project—21 September 1932).
    Temporarily Suspended—1 July 1933.
    Leader—A. L. Wilson.

    Date of Beginning—31 October 1931.
    Leader—A. L. Wilson.

130. Methods of Plant Growing and Plant-growing Structures.
    Date of Beginning—31 October 1931.
    Leader—A. L. Wilson.

Date of Beginning—5 January 1932.
Closed—30 June 1934.
Leaders—E. J. Maynard and J. E. Greaves.

Date of Beginning—24 May 1932.
Leader—W. P. Thomas.

135. The Intermountain Herbarium.
Date of Beginning—14 June 1932.
Leaders—Bassett Maguire and B. L. Richards.

137. Miscellaneous Fertilizer Tests.
Date of Beginning—1926.
Leader—D. W. Pittman.

140. Animal Disease Laboratory.
Date of Beginning—14 June 1932.
Leader—D. E. Madsen.

142. Winter Maintenance of Range Calves.
Date of Beginning—10 December 1932.
Closed—30 June 1934.

153. Miscellaneous Tests on Greenville Experimental Farm.
Date of Beginning—14 April 1934.
Leader—D. W. Pittman.

161. Silage Corn Improvement.
Date of Beginning—24 May 1934.
Leaders—R. J. Evans and D. C. Tingey.

Miscellaneous

152. Part-time Farming Study (Supported by CWA Funds).
Date of Beginning—1 January 1934 (Approved as Station Project—
18 April 1934).
Closed—30 June 1934.
Leader—W. P. Thomas.

No. Miscellaneous Flood-Control Studies.
Date of Beginning—1931.
Leader—R. J. Becraft.

No. Rural Housing Survey.
Date of Beginning—13 December 1933.
Closed—31 March 1934.
Leader—Almeda Perry Brown.

REPORTS BY DEPARTMENTS
AGRICULTURAL ECONOMICS

Study of Factors Influencing the Financial Condition of Certain Irrigation and Drainage Projects: Economic Aspects. Data accumulated from 300 records taken in West Millard County during 1930-33, inclusive, will be used to form the basis for a report to be published during the coming year on the reorganization of the farm business in that section to meet the changing economic conditions. (W. P. Thomas. Project 90-D 2.)

Economic Factors Affecting Production and Marketing of Utah's Poultry Products. This has been a cooperative project with the Federal Bureau of Agricultural Economics, and with that division Utah Station Bulletin 244 was issued in November, 1933. A second publication is now in course of preparation which will contain a more specific analysis of the marketing of poultry products in Utah.


(W. P. Thomas. Project 101.)

Farm Mortgage, Tax Delinquency, Land Value and Crop-Yield Study. This project was initiated by the Federal Bureau of Agricultural Economics as a Civil Works Administration project and is listed by that division as C.W.A. Project No. F-6. A detailed study on farm mortgage or foreclosures and trends in tax delinquency on agricultural lands was made in four representative counties. General tabulations and summaries of data secured have been made and field data on trends in value of agricultural lands and crop yields by districts within the counties have been collected. (W. P. Thomas and W. U. Fuhriman. Project 143.)

2Divisions A, B, and C of Project 90 are reported by O. W. Israelsen, D. S. Jennings, and J. A. Geddes, respectively.
Cost and Efficiency of Producing Dry-Land Wheat in Utah. This study was begun in 1932 when 80 records of the farm business, including detailed data on cost of producing dry-land wheat, were secured for the crop year 1933 in the three principal dry-farming sections of the state: Boxelder, Cache, and Juab Counties. These records have been summarized on the basis of the analysis of the entire farm business and cost and efficiency of producing dry-land wheat. Detailed production costs have been secured on the time and costs of each operation. Costs of operating tractors, combines, trucks, and automobiles have also been secured. The cost of producing wheat has been determined according to the different areas and the kind of power used (tractors or horses). Similar data will be secured for the crop year 1934, which will thus give complete details on the cost of producing dry-land wheat and other efficiency factors for a three-year period. (W. P. Thomas. Project 150.)

Part-time Farming Study. This project was initiated by the Federal Division of Subsistence Homesteads, Department of the Interior, as a Federal Civil Works Administration project, listed by the Washington C.W.A. Office as C.W.A. Project No. 72 and by the Utah C.W.A. Office as Federal Project No. 207. The general outline of the project was prepared by that division while the working out of details has been the responsibility of the Utah Agricultural Experiment Station.

Nine hundred records were secured from persons who had part-time employment and who also operated small farms or gardens; these records have been checked and tabulated. The purpose of this study was to secure information as to the success of operating a small farm, while otherwise employed. Data collected represent information on farm investment, income and expense, quantity of farm produce supplied to the family, amount of time worked on the farm and in other employment, as well as other economic sociological factors which contributed in making a determination of the standard of living for this class of people. (W. P. Thomas. Project 152.)

AGRONOMY

Miscellaneous Crops. That phase of the miscellaneous-crops study pertaining to silage corn studies has been temporarily suspended. However, during the past two years, the demand for information on silage varieties from all parts of the state has been such as to warrant resumption of this investigation on a much broader basis. Silage variety tests have now been started in eight counties of the state, with others to follow in 1935. In most instances, the tests will be run in connection with the uniform cereal variety tests conducted in cooperation with the Office of Cereal Investigations, U. S. Department of Agriculture. Sufficient seed of the varieties now under test has been purchased for two years' planting in order to insure uniform seed for the biennium. A pasture survey was made in Boxelder, Davis, Salt Lake, Summit, Utah, Wasatch, and Weber Counties, from which much valuable information has been obtained. This survey discloses a great lack of artificially seeded pastures; this is hard to understand in view of the fact that in all of these counties were some such pastures with outstanding carrying capacities and with dairymen enthusiastic about their pastures. (R. J. Evans. Project 10.)

Bacterial Wilt of Alfalfa: Agronomic Aspects. The study on various varietal characters, including the varieties grown on plats at the Greenville Farm, in the varietal nursery on the main campus, on the Alfalfa Experimental Farm in Salt Lake County, and on the Uintah Basin Alfalfa-Seed Experimental Farm, has been conducted as this study were: Flower color, size and shape; leaf color, size and shape; stem size, growth habit and texture; and root characters. In the breeding and cross-fertilization test, six plants of each of the following varieties were transplanted from the field nursery to the greenhouse: Turkestan (3 strains), Hardistan, Ladak, Russian, Grimm and Common (2 strains). These plants were grown in the floor of the greenhouse on a regular soil base. Talca plants were grown in large pots; some flowers of these plants were emas-
culated and cross-fertilized and some were cross-fertilized without emas­culation.

Soil samples taken on the Alfalfa Experimental Farm in Salt Lake County in 1932 were further analyzed, the most striking thing being the low lime content in the surface horizon; data also indicate accumulation of lime at the lower or 3-foot depth. Irrigation studies have been con­tinued; weirs were installed under the direction of the Station Irrigation Department. No water was available near the close of the growing season; the land was plowed for reseeding; it was thoroughly worked down, but because of scarcity of irrigation water, seeding was deferred. Treble-superphosphate and ammonium sulphate were distributed to co­operating farmers to use on strips in alfalfa fields to determine the effects of such fertilizers on wilt development.

The plats on the Salt Lake Farm were harvested separately, sampled, and weighed. The borders were removed for yield determina­tions. A special weighing rack was made and attached to Fairbanks-Morse platform scales. The hay from all plats, except the borders, was weighed and yields recorded


(R. J. Evans. Project 128-B.1)

Irrigation and Manuring Studies on Greenville Farm. This project represents a field study of the long-time effects of different rates of ap­plication of manure and of irrigation water in various combinations on land in continuous corn and in continuous fallow. Various irrigation and manuring treatments on corn and fallow land were continued from 1911 to 1931, inclusive. From 20 to 30 inches of irrigation gave a higher yield of corn than either more or less, with or without manure. The maximum amount of manure used—15 tons per acre per year—gave the highest yield of corn with any amount of irrigation. The soil nitrates were highest on the fallow plats, the plats with most manure, and the plats with least irrigation. In 1932 the entire area was seeded to alfalfa and irrigated uniformly without further manuring. Subsequent data show that previous manuring greatly increased yield and phosphorus content of alfalfa as well as available phosphorus in the soil. The previous irri­gation or fallowing seems to have had no appreciable effect on subsequent alfalfa, except that preliminary observations in the spring of 1933 ap­parently indicate that the alfalfa on the previously unmanured plats is holding up better on those plats previously fallow than on those previously in corn. After further checking this last observation, it is planned to plant these plats into sugar beets in 1935 for comparison with plats of other cropping systems in Project 9. After 1935 it is planned to discon­tinue this project.


(D. W. Pittman. Project 5.)

Rotation and Manuring Studies on Greenville Farm. This long-time study of the effect on maintenance of productivity of different manuring and cropping systems on irrigated farms includes our more common irrig­ated crops—sugar beets, alfalfa, grain, potatoes, and peas, which are grown continuously and in long and short rotation with and without both manure and green manure. In a general way, the beets are showing most response to manure and the grain to rotation.

Since it has become necessary through shortage of State funds to discontinue this work shortly, it is planned to crop the entire series of plats uniformly to sugar beets in 1935 so that all plats may be directly compared, there being several plats for each treatment. This will give some good comparisons at the end of the 1935 season. From those plats already in alfalfa in 1934, two early crops will be taken; the plats

*Project 128-A—Reported by B. L. Richards (Botany and Plant Pathology Department).
will then be plowed and fallowed for the balance of the season so that they may be in similar condition to the other plats in the spring of 1935. After the uniform 1935 crop, it is planned to discontinue this project and use the land for other experiments not involving yield data.


(D. W. Pittman. Project 9.)

Cultural Methods with Sugar Beets. In this field study on cultural methods with sugar beets attention has been centered on the problem of thinning and proper spacing. Earlier work on this project has shown the best spacing to be with beets 12 inches apart in 20-inch rows, or about 26,000 beets to the acre. Recent work has shown that it is usually impossible to get as good a stand as this by mechanical blocking, without having an exceptionally thick unthinned stand. A nearly square spacing, 16 x 15 inches, was shown to be somewhat better than closely spaced beets in wider rows of 10 x 24 inches. In the phenomenally early and dry spring of 1934 the advantage of early planting was prominently shown.

Owing to shortage of State funds it is planned to discontinue this project at once, that part of the farm overhead which has been carried by this project being transferred to a newly-created project (No. 153).


(D. W. Pittman. Project 64.)

The Effect of Fertilizers on Various Properties of a Highly Calcareous Soil and on the Yield and Quality of Crops Produced. This is a field experiment on the residual effect of different commercial fertilizers and manure on the highly calcareous dolomitic soil of the Greenville Experiment Farm and on the yield and composition of the crops produced. Phosphorus in the form of treble-superphosphate has given a marked increase in the yield of sugar beets and some increase with barley and wheat. Raw rock phosphate has shown no notable effect. Nitrogen in the form of ammonium sulphate has given considerable increase in the yield of wheat and barley. Manure has increased the yield of these three crops as well as of potatoes. Sulphur, as plaster of Paris or as elemental sulphur, has shown no effect. Preliminary tests on the surface soil show that the superphosphate has considerably increased the available phosphorus and that the ammonium sulphate has increased the nitric nitrogen of the soil. Six years of manuring at 10 tons barnyard manure per acre per year has increased the organic content of the surface soil from about 2.20 to 2.45 per cent. None of the treatments has notably affected the reaction of the surface soil (about pH 7.5) or lime content (about 43.5% calcium and magnesium carbonate).

Since erosion of head ditches is causing some trouble with this experiment when irrigated in small belts, as is now necessary, this problem is being investigated this year with a view to determine whether or not it is sufficiently serious to justify discontinuing the project or making some changes in plans.


(D. W. Pittman. Project 914.)

Miscellaneous Fertilizer Tests. This project has been continued in a small way, testing the effect of unusual fertilizer materials and of standard materials in different parts of the state. Phosphorus deficiency has been shown to be somewhat more widespread than was originally thought. (D. W. Pittman. Project 187.)

Miscellaneous Tests on Greenville Farm. This project was authorized on April 14, 1934, as a State project to handle some of the overhead expense on the Greenville Experimental Farm formerly carried largely by

*Also reported by D. S. Jennings (Irrigation and Drainage, Physics, and Soils).
Project 64, discontinued as of June 30, 1934, and to include such occasional preliminary or auxiliary tests as may be needed from time to time or as may be conducted without additional expense. (D. W. Pittman, Project 153.)

A Genetic Study of the Resistance of Wheat to Physiologic Forms of Loose and Covered Smut. Genetic studies were made of different wheat crosses in F1 inoculated with different physiologic forms of covered smut. These data have not been analyzed in detail; they do, however, suggest that possibly a number of factors for resistance are involved. Somewhat similar studies have been made for resistance to loose smut. A varietal test for loose-smut resistance was made on 62 spring wheat varieties and inoculated with four different collections of loose smut obtained from different regions in Cache Valley. Results showed wide difference in resistance to the different smuts; these data suggest a difference in some of the smuts.

A number of both spring and winter wheat, possessing resistance to either covered or loose smut, as well as some of the spring wheats resistant to both smut covered and loose, are showing considerable promise. One winter wheat (Relief) which is resistant to most physiologic forms of covered smut occurring in Utah and which is especially resistant to *Tilletia tritici* has been introduced to farmers. This new variety is a selection out of the Turkey X Hussar cross.


Weed Control. Studies have been continued on the comparative costs and effectiveness of various tillage and chemical methods of control, with whitetop, Russian knapweed, and morning glory. No one-year treatment was successful in complete eradication on either whitetop or Russian knapweed. Treatments on morning glory were begun at the time the plant came into bloom; consequently, complete eradication could not be expected. Root samples have been obtained on all plats at different times and root-reserves studies are to be made as soon as funds are available.

Previous studies on morning glory, Canada thistle, and perennial sow thistle have shown considerable difference in cost and effectiveness of various tillage and chemical methods of control. The per-acre cost for control with different tillage methods ranged from $7.50 for alternate weekly cultivation to $27 for alternate weekly plowing; effectiveness, however, was practically the same. The chlorates cost from $32 to $120 per acre. The chemical was not as effective as tillage.

Studies made on the comparative effects of sodium chlorate, calcium chlorate, calcium chloron, and ammonium sulfo-cynate on various weeds show the last two chemicals to be of little or no value in weed control. Studies made on the comparative effectiveness of calcium chlorate on morning glory showed no differences. Root samples made before treating, three days after treating, in the fall, and the next spring showed the following percentage reduction in weight (the weight before treating taken as 100): 78, 57, and 36 respectively. (D. C. Tingey. Project 65.)

Bunt Control. In certain fields, soil infection plays an important part in bunt infection, whereas in others little or no soil infection occurs. Satisfactory control was obtained by the following treatments on land where natural soil infection did not occur: Calcium carbonate, formalin, copper sulphate, and Semesan. However, under conditions of soil infection, seed treatment was of little or no value in reducing the amount of smut infec-

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1Division E reported by A. F. Bracken.
tion in wheat. Under conditions of natural soil infection, early seedlings where soil temperatures were relatively high resulted in a higher percentage of smut in the grain than did later seedings under lower soil temperatures; early seedlings also resulted in higher percentage of winter-killing. Under conditions where the soil is naturally infected by wind-blown spores, these conditions make early seeding a hazardous practice. Seedlings made in the spring under the same conditions as those made in the fall showed no smut. This would indicate that overwintering of smut is not an important factor in causing smut infection in wheat.

Eight rather distinct physiologic forms of covered smut have been isolated from smut collections made in Utah. These isolations were made by the use of differential wheat varieties. (D. C. Tingey. Project 115-A.)

Nephi Dry-Land Substation. Established in 1903, the Nephi Dry-Land Substation has for its general purpose the determination of the tillage practices, cropping arrangements, rotations, fertility relationships, cereal varieties, rates and dates of seeding, and other miscellaneous tests which are best adapted to the successful operation of the dry-lands.

The crop seasons of 1932 and 1933 were somewhat unfavorable to growth of dry-land wheat. The approximate average acre-yield for 1932 was 18 bushels (78 per cent of normal); the average acre-yield for 1933 was 16.6 bushels (72 per cent of normal). These poor yields were due to low precipitation and to an unfavorable distribution of that which did fall. The 1932 rainfall measured 10.77 inches; for 1933 it was 9.33 inches; this was 82 and 72 per cent of normal, respectively, for 1932 and 1933.

Yields from the plowing and cultural test for 1932 and 1933, with 18-year averages, show that apparently there is no advantage in fall-plowing over spring-plowing when fallow has been given ordinary tillage; neither did this type of fallow preparation and care give any significantly higher yields than spring-plowing with no tillage of fallow, except that the weeds were pulled. Apparently, frequent harrowing of the fallow reduced yields. Depth-of-plowing yields show that it is not necessary to plow deeper than 7 inches in the fall.

From averages obtained, no significant difference was apparent for the three methods of fallow preparation (disk plow, moldboard plow, and disk harrow). For the seasons of 1932 and 1933, however, yields from disking were lower than for plowing with either the moldboard or large disk plow. The importance of these results is far-reaching, in that when plowing is done by the large disk plow both time and cost are reduced by half.

Results from a 2-year time-of-plowing test show little difference between fall and early spring plowing; they do indicate, however, that for highest returns the spring-plowing period should be no longer than 24 days.

The application of barnyard manure in 1933 had little effect on yield, due to an excessively early vegetative growth which later tended to produce burning. The 1932 application of 10 tons of manure each alternate year had a noticeable effect on yield; the protein content of the grain was increased each season with the larger amounts of manure.

Peas plowed under as a green-manure crop (1932) showed little effect on yield. Yields in 1933 were significantly reduced with the lateness of the stage at which peas were turned under. Eighteen-year averages indicate only slight lowerings of wheat yields when the green manure treatments were compared to the check.

In 1932 experiments where wheat followed wheat plowed under as the green-manure crop only slight differences were observed for the later stages when wheat was plowed under for green manure, because of the late spring rainfall which tended to mark the effect of later plowing. As shown by the 18-year averages and the 1932 yield a progressive reduction in yield occurred with the lateness of plowing for the three last stages; this was also apparent in the 18-year averages. The protein content of the grain appears to be independent of the stage at which wheat is plowed under for green manure.

No significant differences were apparent between burning all or a part of the stubble and plowing under like amounts for the seasons of 1932 and
1933, either in wheat yields or in protein content of the grain. The 18-year averages were slightly favorable to burning, however.

Alternate cropping is shown to be safest and that it will give higher net returns than any other arrangement, especially when precipitation approximates the amount and is similar in distribution to that at Nephi. While these yields show no difference between alternate and one crop in three years with two seasons of fallow, still it is apparent that the system of one crop in three years will outyield alternate cropping by 3 bushels to an acre. This is especially important considering the wheat allotment program of the U. S. Department of Agriculture.

Yields from an eight-course rotation were low for grains and potatoes; they do show, however, that approximately a ton per acre of alfalfa can be produced. In other rotations, where winter wheat appears in rotation with peas, potatoes, or corn, the wheat yield is reduced approximately 2 bushels to an acre, as compared to ordinary fallow. The profitableness of such an arrangement, therefore, depends upon the return of the intertilled crop.

Seven-year averages of 18 varieties of winter wheat show Turkey 26 and Turkey 929 to be highest, with acre-yields of 22.3 and 21.1 bushels, respectively; these two wheats were made at the Nephi Station. Eleven-year averages for seven spring wheat varieties show Baart and Chul to be highest, with 10.5 and 10 bushels, respectively. The 1932 and 1933 seasons were both unfavorable to the growth of spring wheats.

In a rate-and-date-of-seeding test, from 2 to 8 pecks, inclusive, were seeded every 15 days from August 1 to November 1, inclusive. Because of no fall rain, the seeding on November 1 gave a higher yield for 1932 than for any earlier date; for 1933, the seeding just previous to the storm of October 18 gave the highest yields. Averages indicate that seeding should be finished between September 15 and October 15. Yields for the seasons of 1932 and 1933 as well as 15-year averages show that the rate of seeding should be done at the rate of at least 5 pecks to an acre. Less amounts may be drilled when the moisture in the soil is sufficient to force a quick uniform germination.

A close relationship is indicated between moisture percentage and nitrate accumulation, as well as a relationship between these two and yield. The protein content of the wheat is likewise increased by the higher amounts of nitrates.

Leaflet 23. "Meeting the Terms of the Wheat Allotment Contract on Utah Dry-farms." By A. F. Bracken. March, 1934. 4 p.}

(A. F. Bracken. Project 1.)

The 1932 and 1933 yields for wheat not cultivated favored wider spacing of rows than 7 inches; the reverse was true for wheat cultivated. The 7-year averages indicate a loss of 2.1 bushels in yield for wheat cultivated.

Acre-yields for 1932 and 1933 as well as the 10-year averages show a marked advantage of no treatment and copper carbonate over formalin. Sown in a dry soil for both seasons, the seed failed to uniformly germinate, this condition indicating itself in a patchy stand for formalin-treated grain. Copper sulphate somewhat reduced the yield for both seasons. The 10-year averages show that copper sulphate gave a significantly higher yield than formalin and that copper carbonate and no treatment in turn gave a significantly higher yield than copper sulphate.

The 1932, 1933, and 10-year average yields show a slight difference in favor of the ordinary drill as compared to the furrow type. Apparently, there is no need to use this new type of drill in this area.

A Genetic Study of the Resistance of Wheat to Physiologic Forms of Loose and Covered Smut: Studies at Nephi Dry-Farm Substation. The purpose of this phase of Project 62 is to develop strains of wheat better adapted to the dry-lands of Utah. It includes a study of lines of Turkey, Kofod, and Sevier, together with a study of hybridized strains of Turkey and Kofod, Kanred and Kofod, Kanred and Alton, Kanred and Sevier, and Kanred and Odessa. Out of an original selection of 500 pure

*Parts A, B, C, and D of Project 62 reported by D C. Tingey.
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lines of Turkey and approximately 500 Kofod selections, 32 Turkeys and 10 Kofods remain. Included in the nursery trials both for 1932-1933 and continued for 1934 were approximately 50 selected hybrids made at Logan for smut resistance. Selected strains Nos. 13A-155, 55A-184, 59B-231, and 60A-157 were especially outstanding for yield. (A. F. Bracken. Project 62-E.)

Analysis of Factors Responsible for Loss of Nitrogen and Organic Matter from the Dry-Lands. The purpose of this project is to measure the difference in nitrogen content between virgin areas and adjacent cropped dry-land and to compare these results with those secured from fields growing alfalfa. If possible, a determination will be made of those factors which are responsible for loss of nitrogen from tilled dry-farms. During the last four years a nitrogen survey has been made of several dry-farms in Juab and Cache Valleys. When results from virgin areas were compared to adjacent cropped fields, it was found that approximately 20 per cent of the nitrogen and organic matter had been lost from the tilled soil. Only one-third of this loss has been removed by the crops, leaving the remaining two-thirds unaccounted for. Comparing land on which alfalfa is grown to virgin areas it was found that legumes maintained the nitrogen of dry-land at approximately the same level as that found in uncropped soil. Since only one-third of the nitrogen lost from the cultivated fields can be accounted for by harvesting of the crops, an effort will be made to determine, if possible, the factor responsible for the additional loss. To check temperature relationships, readings from two thermographs were secured for the 1933 season. Monthly analyses will be made to follow whatever change might take place in nitrogen and organic matter content. (A. F. Bracken and J. E. Greaves. Project 148.)

Uintah Basin Alfalfa-seed Experimental Farm. From data assembled and reported by the Federal Bureau of Agricultural Economics, Division of Crop and Livestock. Estimates, it is evident that Utah has not shown any definite recovery from the decline in alfalfa-seed production following the record high yields from 1919-27, inclusive. While the cause of low yields has not been definitely determined, particular significance is attributed to the fact that since the recorded high acre-yields of alfalfa-seed in Utah were produced during these years, during and immediately following a period when the average annual precipitation was normal or above, it is not less significant that the low acre-yields of record have been produced in a period when the average annual precipitation for Utah as a whole, and particularly in the important seed-growing districts, has been below normal (in some cases as much as 20 to 30 per cent). While moisture relationships are believed to be of fundamental importance in alfalfa-seed growing and the low precipitation of recent years is believed to be an important contributing cause of low yields since 1923, insects also have contributed their share of alfalfa-seed injury. However, studies conducted by the Station Department of Entomology indicate that grasshoppers, alfalfa-weevil, chalcis-fly, and tarnish and superb plant bugs are no more numerous now than during years of high acre-yields of alfalfa-seed. Therefore, there seems to be no reason for believing that insects are chiefly responsible for low yields since 1928. In general, results of completed experimental work and observations lend emphasis to the importance of a proper moisture balance between soil and atmosphere in relation to alfalfa-seed growing. The climate and weather, except for abnormally low annual precipitation, continue to be about the same. In restricted areas, where irrigation and ground-water relationships are favorable and where they have not changed markedly as compared with a few years ago, production and acre-yields of alfalfa-seed have not been seriously affected by the low precipitation prevailing over most of the state. There is reason for believing that alfalfa-seed may again be produced in Utah, as in 1919-27, inclusive.

Because of repeated failures for several years in the alfalfa-seed crop, alfalfa plots in hills and rows were used for growing forage in 1932. Results indicate that alfalfa should not be grown in this manner for forage production. The yield of alfalfa in rows spaced from 14 to 28
inches apart is approximately equal to yields from alfalfa drilled in the ordinary way. For wider rows and in hills it is about equal to yields from thin stands or those obtained when about 2 pounds of seed is sown to the acre. When the alfalfa is spaced widely or is grown in thin stands, a poorer quality of forage results. It is also difficult to gather the low-lying branches with the ordinary harvesting machinery. In 1933, plots in hills and rows were left for a seed crop; due to poor prospects in the early part of the season, however, most of them were cut for hay. The few remaining produced seed and average yields were obtained, as measured on the re-cleaned basis. The shrinkage in re-cleaning was high; otherwise, the yields show a considerable improvement over the two preceding years.

Twenty-four varieties and strains of alfalfa were tested for forage production at the Uintah Basin, Greenville, Millard, Sanpete, and Carbon County Experimental Farms. In 1933, four cuttings were obtained at the Uintah Basin and three at the other farms. Results indicate that Turkestan and Ladak alfalfa have a tendency to go dormant early in the fall and to resume growth later in the spring than Common alfalfa. The average acre-yields in tons for all farms ranged from 5.82 to 4.03 for Hardistan and Peruvian, respectively. Arizona Common and Peruvian show a distinct tendency to winter-injury at the Uintah Basin Farm. In general, the hardy varieties excelled the Common alfalfa in forage yield, but certain strains of Common are equally as good. Most of the selections were made for better seed production, which may account for their comparatively low forage yields.

An attempt has been made to determine the relative effects of natural pollination, self-pollination, and cross-pollination in alfalfa. Plants of known origin have been grown during 1932 and 1933, which will be studied in 1934.

The study of age of alfalfa flowers in relation to pods formed following artificial tripping had for its chief purpose the determination of effect of age of the flower when artificially tripped in relation to the percentage of pods formed. It was found that flowers from 1 to 4 days old gave the highest percentage of pods following artificial tripping. The percentage decreased rapidly and directly in proportion to age from the fifth to the eighth day, after which no pods formed.

Studies in regard to air temperature and relative humidity in relation to seed-setting in alfalfa show that excessively high temperatures and high relative humidity adversely influenced seed-setting in alfalfa. It has been difficult to correlate seed-setting with various conditions of air temperature and humidity. The attempts have given irregular and inconsistent results over several years. However, extremely dry air and extremely humid air have been observed to result both in severe stripping of the alfalfa blossoms and in a low percentage of seedpods.

The uniform varietal tests of small grains (all-state), conducted cooperatively between the Division of Cereal Crops and Diseases and the Utah Agricultural Experiment Station, show the value of Dicklow wheat, Trebi barley, and Markton oats for maximum acre-yields as well as their general adaptability for the Uintah Basin. However, certain of the hybrid wheat varieties may excel in milling qualities and nearly equal Dicklow in acre-yield.

The small-grains variety test (large plats), was conducted on 1/15-acre plats in four replications, the object being to determine the yield of grain under conditions more nearly approximating the average field of the individual grower. Two varieties of oats and barley and four varieties of wheat were grown in 1932, while in 1933 the test was limited to four varieties of wheat. Results confirm those obtained in the all-state rod-row test.

In cooperation with the Division of Cereal Crops and Diseases, U. S. Department of Agriculture, corn is being tested for grain yield. The plan is the same as that used in the all-state test, except that in 1933 a larger number of varieties were included. A group of hardy corn varieties from the Dakotas was included in the hope that suitable varieties for the Uintah Basin might be found. A number of regional strains of Minne-
sota 13 variety were tested to determine the importance of the origin of seed in relation to adaptability to Uintah Basin conditions. In 1933, the corn test was conducted in duplicate and one set was used for determining the silage yield of the various varieties. In general, the early to medium-early hardy flint or semi-dent varieties have been found to excel in grain yield and to be about equal to the improved dent varieties under somewhat adverse growing conditions. Gehu is an excellent extra-early grain variety, but it is low in yield of silage. Falconer semi-dent is probably the best general-purpose variety. It matures earlier than Minnesota 13, exceeding it in yield of grain although it is about equal in yield of silage. These tests are being continued in 1934.

In 1932 a number of forage and pasture crops were tested in an effort to find varieties which might prove valuable as emergency crops as well as those which might be used to supplement alfalfa as feed for livestock. Soybeans, cowpeas, millet, and Sudan grass grew well at the Experimental Farm. Unless the seed of soybeans and cowpeas can be grown locally, these legumes cannot be grown with profit in the Uintah Basin in competition with sweet clover. Sudan grass gave promise of being well adapted as a summer pasture crop. It may be planted in May or June, when irrigation water is plentiful, and produce pasture for the cows during July and August. Due to the poisonous properties of Sudan grass, after freezing weather begins, it is probably advisable to limit pasturing of this crop to July and August.

The tests conducted in 1932 show the potential values of the various crops in terms of dry hay. Oats alone produced 2.92 tons of dry hay to the acre, oats and Canada field peas 2.77, vetch and rye 2.92, vetch and oats, 2.57, and spring rye alone 3.14 tons. These crops are early-spring-planted and may not be well adapted as emergency crops in all parts of the Uintah Basin.

In an effort to determine their values for permanent pasture purposes in the Uintah Basin, sixteen varieties of grasses and clovers were tested in pure cultures. A considerable portion of the Uintah Basin is too dry for most grasses to do well. A few of them (Brome grass, crested wheat grass, slender wheat grass, tall meadow oat grass) may be grown successfully under irrigation. Others (including Kentucky bluegrass, Reed's canary grass, and most of the common clovers) can be grown under medium-dry conditions. Timothy, redtop, and perennial rye grass have not withstood the winters well at the Experimental Farm. Additional tests are required before definite recommendations can be made with respect to pasture grasses for the Uintah Basin.

Practically all of the common varieties of vegetables were found to be satisfactory and can be recommended for the farm gardens of the Uintah Basin. Golden Gem sweet corn is a dwarf variety which matures earlier than Golden Bantam. It is of good quality and yields well. It is believed that this variety would become popular and might be grown generally if it were given a more extensive trial in the Uintah Basin. Most of the hardy annual flowering plants do well, provided sufficient irrigation water is available. The tender sorts may be grown to a limited extent when given extra care. As a rule, the winters are rather severe and too dry for bulb plants. Drying winds in the spring and summer months increase the difficulties for the growers of tender flowers. (J. W. Carlson. Project 75.)

Sanpete County Experimental Farm. Experimental work with general field crops during the past two years has included the continuation of the small-grain variety tests, the corn variety test, and the flax variety test. In addition, a pasture grass and clover test and an alfalfa variety forage test have been conducted. In the uniform-state-barley test, Atlas gave the highest average yield; in addition to being the highest yielder, this variety matures about one week earlier than Trebi. Early maturity is important in this area because of the short growing season and the danger of early fall frosts. During the past three years Markton oats has given the highest average yield in the uniform-state-oat test, although during the past two years Victory has been the highest yielder. In the wheat variety test Dicklow far outyielded five other varieties for the
two-year period. Corn variety tests have shown quite conclusively that corn is not well adapted to this muck soil region. Satisfactory yields of flax were obtained when this crop was planted in clay soil near the edge of the swamp and was irrigated a number of times during the growing season. These tests were conducted in cooperation with the Cereal Office, Bureau Plant Industry, U. S. Department of Agriculture.

Work with pasture grasses and clovers has not been underway long enough to obtain definite results. Varieties which appeared promising on the clay soil, bordering the swamp, were smooth brome grass, Reed's canary grass, crested wheat grass, and alsike clover. The most promising varieties in the high alkali muck soil were smooth brome grass and slender wheat grass.

Experimental work with vegetable crops has shown that long-season non-hardy crops are not adapted to this area because of the short growing season and the occurrence of summer frosts. Tests with celery, cabbage, and cauliflower indicate that these crops can be grown on selected areas of muck soil. Irrigation of these crops is necessary at the time the plants are set out in the field and also at frequent intervals during the growing season. Data obtained on the time to set the plants in the field indicate an earlier planting than is necessary in other parts of the state, best results being obtained with May 25 as the planting date. Pod-pea variety tests conducted during the past two years indicate that satisfactory yields are possible. Dwarf Telephone has given the highest yield each year and apparently is the best variety for this section.

Fall-plowing of muck soil has been found more desirable than spring-plowing or no plowing at all. There is no advantage in preparing the seedbed in the fall. In preparing the seedbed in the spring, to prevent the top soil from drying out, excessive stirring of the soil should be avoided.

The use of a heavy cement roller for rolling the soil immediately after seeding results in increased yields of barley, oats, and canning peas, as compared to unrolled muck soil or to soil rolled with a light steel roller.

Results from cropping tests show that the safest practice is to use short rotations in which each crop is grown for only one year consecutively. Where barley has been grown continuously on the same soil for a number of years, a marked decrease in yield has occurred each succeeding year. Fields in which canning peas were grown continuously for four or five years were badly infested with root rot in 1933.

Plots which had received application of superphosphate as well as plots which had been manured continued to give increased yields of barley. However, the response to superphosphate was not as outstanding as it was to manure. Fertilizer tests were started with other crops in 1932 and 1933, with no significant results. There were, however, indications of increased yields of canning peas, potatoes, and celery on plots receiving either manure or superphosphate. The response to manure as a rule was more pronounced than to superphosphate. (LeMoyne Wilson. Project 96.)

Carbon County Experimental Farm. This period has been the most successful of any since the farm was established (1927). Sufficient irrigation water was available at all times during the growing season for crop production. Heavy winter snowfall tended to cause the soil to be in better physical condition, and the addition of barnyard manure improved its tilth.

The last killing frost in 1932 was on May 6 and on May 13 in 1933, while the first killing frost in the fall was on October 9 and on October 15, for these respective years. The total 1932 precipitation from April to October, inclusive, was 5.74 inches and the 1933 precipitation in the same period was 4.58 inches. The 1932 evaporation for the same period was 38.87 inches and for 1933, 40.49 inches. There were no heavy damaging rains during this period, although there was considerably more wind in 1933 than in 1932.

Alfalfa yields were low because of being grown on poor and unproductive soil. The total acre-yield for the three crops was 2.7 tons in 1932 and 2.54 tons in 1933. The hay was generally of poor quality.
Corn is gradually becoming one of the most important crops in this section. The early-maturing varieties of yellow dents are rapidly gaining in favor. With the trench silo becoming more popular, there is more demand for early-maturing varieties. Ex: ra Early Minnesota No. 13 and Falconer semi-dent are the most promising varieties of any which have been tested. These varieties produce a high yield of both grain and fodder. Corn uses less irrigation water than any crop tested.

Soil and climatic conditions in this area are favorable for potato production. Cobbler varieties have proved to be the best variety of early potatoes tested, giving acre-yields of 290 and 295 bushels for 1932 and 1933, respectively. Rural New Yorkers and Idaho Rurals are the best varieties of late or main-crop potatoes. Rural New Yorkers yielded 268 bushels in 1932 and 327 bushels in 1933. Idaho Rurals yielded 235 bushels in 1932 and 261 in 1933. These varieties can be grown on a wide range of soil types. It is necessary to plant the potatoes close together (12-14 inches) in the rows in order to prevent the development of "over-sized" tubers.

Dicklow variety of wheat has proved to be the best adapted for this section. The commercial fields of Dicklow wheat yielded 63.4 bushels per acre in 1932 and 69.8 bushels in 1933. The formalin treatment gave complete smut control.

Swedish Select and Victory have been the outstanding varieties of oats tested. In rod-row tests, Swedish Select yielded 99.4 bushels per acre in 1932 and 89.5 bushels in 1933. Victory yielded 104.1 bushels in 1932 and 91.5 bushels in 1933.

Trebi has been the highest yielding variety of barley to be tested on the Carbon County Experimental Farm. In 1932 Trebi yielded 101.9 bushels per acre and 90.9 bushels in 1933. An effective method for controlling smut in barley has not been solved for this section. In 1933 approximately 25 per cent of all barley grown in Carbon County was destroyed by smut, while in 1933 less than 11 per cent of the barley was destroyed by smut.

Beans have always done well here and high acre-yields of high-quality beans are produced each year. Pinto beans yielded 2560 pounds per acre in 1932 and 2360 pounds in 1933. Red Mexican produced 2000 pounds per acre in 1932 and 1920 pounds in 1933. Other high-yielding varieties of beans are White Wonder, Robust Pea, Red Kidney, and Great Northern.

Sugar-beets have been one of the outstanding crops in this section. They fit well into the general system of farming, and soil and climatic conditions are generally favorable. Beets respond readily to treble-superphosphate and yield increases are obtained when this fertilizer is used. Curly-top attacks the beets each year in this section. In 1933 a plat of ground was seeded with curly-top-resistant seed, developed by the U.S. Department of Agriculture at St. George. This seed developed less than 1 per cent curly-top diseased beets as compared to 10 per cent disease with the commercial beets. With the introduction of curly-top-resistant seed, the sugar-beet industry should increase in this section of Utah.

A series of 28 tenth-acre plats was used for commercial fertilizers. In addition to the commercial fertilizers used, one-half of each plat was also fertilized with barnyard manure applied at the rate of 10 tons per acre. The following fertilizers were used: Ammonium sulphate, applied at the rate of 160 pounds to the acre, treble-superphosphate, at the rate of 125 pounds, and potassium chloride, at the rate of 125 pounds to the acre. These fertilizers were used separately and in combination. In 1932 corn was grown on the fertilized plats, the phosphorus fertilizers producing the largest yields. When phosphorus fertilizer was used the corn tended to mature earlier, while nitrogen tended to retard the date of maturity. Potassium fertilizer neither increased nor decreased the yield of the corn. Highest yields were obtained when phosphorus was supplemented with barnyard manure. In 1933 wheat was grown on the fertilized plats. The tests of 1933 substantiated those of former years, showing that the soil is deficient in both humus and phosphorus. In each case where barnyard manure and phosphorus were applied either alone or in combination, both yields and maturity were more satisfactory. From the
beginning to the end of the growing season, phosphorus and manure gave marked stimulations, causing the plants to make more rapid growth. Alfalfa plats fertilized in 1929 with treble-superphosphate have continued to give increased yields. The alfalfa shoots start to grow several days earlier on phosphated plats than on check plats; the alfalfa weevil tended to cause less damage on phosphated plats than on check plats. In 1932 there was 32 per cent more calcium, 51 per cent more magnesium, and 16.6 per cent more crude protein in the hay from the phosphated plats.

A series of plats were so arranged that they ran from a region of comparatively little alkali to one which was so heavily infested that ordinary plant-life was impossible. The alkali resistance of several crops was studied throughout the growing season; the chief salt present was sodium sulphate. Asparagus was able to withstand the greatest concentrations of alkali; it seemed to thrive in a concentration of 11,335 p.p.m. of salt. Sunflowers were next to asparagus in their ability to resist alkali. Yellow sweet clover was more resistant than white and barley more resistant than oats.

Several varieties of trees suitable for windbreak and woodlots have been planted on the Carbon County Experimental Farm. All varieties of trees are not suited to Carbon County in spite of the fact that trees are much needed in this locality. Of all species of trees tested, Siberian elm and Russian olive have proved to be best adapted; they are the only varieties which are not seriously affected by soil alkali or by winter-killing. Other varieties which are making good growth are Balm of Gilead, black locust, honey locust, Siberian pea, white ash, and Golden willow. None of these varieties, however, is as satisfactory as the Siberian elm and Russian olive. (I. D. Zobell. Project 97.)

San Juan County Dry-Farm. Agriculture in San Juan under dryland methods is still in its infancy. Many improvements, both in regard to cultural and to seeding methods, will eventually take place. Much time and energy will be expended and many mistakes will be made before these better methods are determined. The possibilities to the farmer in San Juan are innumerable.

Studies conducted on this farm during the past biennium have included: (1) Alfalfa-seed production, (2) alfalfa varietal tests (forage yields), (3) forage crops production (including root crops), (4) cereal crops varietal test (including rate and time of seeding), (5) miscellaneous crops (including vegetables), (6) winter wheat in rotation with intertilled crops, and (7) cropping tests (in cooperation with farmers in various parts of country). In addition, trees planted in 1931 have been further cared for and notes of growth taken.

Utah Common has continued to give the highest yield of alfalfa, which confirms previous results with this crop. Since practically the only expense to producing alfalfa after the first year is that of harvesting, it would appear that this is one of the most profitable forage crops to raise on the dry-farm; no cultivation has been done on the alfalfa during the past year.

Certain grasses were run as pasture crops during the past year. Horses were used in the grazing of these grasses, which were fenced along with several plats of alfalfa. On June 8 the horses were turned loose in the field; in two or three days it was observed that the grasses were eaten close to the ground, the appearance being such as to question whether or not a crop had been planted. The alfalfa was scarcely touched, due probably to the fact that either the horses had never tasted green alfalfa pasture and had not learned to like it or that the grasses were so much more palatable that the horses preferred them to alfalfa. Usually through the winter months the ground is covered with from 1 to 2 feet of snow, thus affording a greater water-supply and affording crop protection from the cold winds. During the winter of 1933-34, however, the high places on this land were swept clean by the winds, thus exposing the alfalfa to the severe cold; hence, results for this period cannot be considered as average. Indications, however, are that in a normal year alfalfa-seed could be produced on the dry-lands of San Juan at a profit.
The seed which has been produced is of excellent quality, with germination of nearly 100 per cent.

Although prospects for wheat crops in the spring of 1933 were discouraging, the final outcome was even better than could be expected. During April and May the wheat did extremely well; during the latter part of May, however, most of the wheat was frozen, resulting in a severe set-back. At this time, most of the moisture had been taken from the soil and it seemed as if the crop were doomed; in June, however, an unexpected rainfall afforded sufficient moisture to carry the wheat along until the usual July rains came; as a result, a fair yield was harvested.

Spring cereal yields were unusual this year. At planting time it seemed as if the lack of moisture would not justify planting spring crops, especially cereals. However, they were planted as usual and later proved to be highly profitable. Oats especially yielded well, due perhaps to the rainfall which came in July and August. The barley was too far along when the rains came and did not respond as did the oats. UTAC, a late-maturing wheat, has yielded well each year and has proved a highly satisfactory variety of spring wheat for San Juan. Bliss Side oats gave the highest total yield in regard to both straw and grain. These oats are about ten days to two weeks later in maturing than the other varieties tried. However, both Kherson and Markton gave a much higher yield in grain.

Defiance, a spring wheat, was seeded at the rate of 30, 45, and 60 pounds per acre in three replicates; dates of seeding were from April 15 to June 1. Results are quite conclusive that spring wheat planted late will give better yields than when planted early, as it is not so far advanced when the July and August rains come, thus receiving full benefit from this moisture.

Results from rotation tests have shown the effects of lack of winter snows during the winter of 1932-33 and have tended to prove that continuous cropping of the land is not at all times practical. Had it not have been for the unusual supply of rain during July and August (1933), yields from these crops would perhaps have been even lower. Crops grown on fallow land gave fair yields, while those grown on land following wheat or other crops were extremely low. Since land is cheap in San Juan County and further since land in this section is so easily worked, it would seem unprofitable to rotate wheat with row crops.

An attempt has been made to determine those annual forage crops which are best suited to San Juan County. New crops include soy beans, Improved Learning corn, Reed’s yellow dent corn, and tepary beans; however, none of these gave promise of being better than some of those that have been used in the test from the start. Improved Learning corn produced more forage than any of the other varieties, but because of the high altitude it failed to mature. The stocks of Improved Learning corn are too coarse for animals to eat. Siberian millet is easily harvested, matures early, and furnishes an excellent forage; since it can be harvested with the binder, it is much less expensive to harvest than such crops as corn and cane. Early Red glazo corn, tried at the Station for the first time this year, gave promise of being a satisfactory variety for local forage; the yield was higher than for any of the other varieties and the fodder was fine and seemingly exceptionally palatable. Tepary beans yielded well, but no use could be found for this crop after it was harvested.

Where thinning was properly done both varieties of stock beets yielded well; when allowed to grow too thick in the rows, however, yields were extremely poor. Beets, under local dry-land conditions, should be planted in rows at least 40 inches apart and in hills at least 20 inches apart; they are thus able to live during the dry period of June and part of July, and when the rains occur during the latter part of July and August they attain considerable size and are unusually thrifty.

The difference in yields between Early Amber sorghum and Dakota sorghum was insignificant; however, Early Amber was undoubtedly of a finer texture and much more relished by livestock.
Beans were planted to determine varieties best adapted for yield in San Juan County, varieties that matured earliest, and those having the greatest demand on the market. They were planted in rows 40 inches apart and in hills about 1 foot apart. Since it was necessary to dispose of farm equipment, etc., in the fall of 1934 no results with respect to market value were obtained. Comparing one variety with the other, however, Red Pinto beans gave the highest acre-yield; however, for the past three years the Red Pinto has not been popular on the market. It has also been observed that beans planted on May 20 have not yielded as well as those planted a month later. Although some of the varieties planted on June 19 did not mature, those that did mature gave a much more satisfactory yield than those planted earlier. Hidestra and Martha Washington, when planted late, gave exceptional yields, outyielding the Mexican Pinto, which in San Juan County is considered one of the best varieties.

Gardens, the source of a large part of the living of families on dry-farms, are grown successfully wherever tried on the dry-farms in this section. It is possible to grow most vegetables and the quality is exceptional. Turnips and rutabagas yielded at the rate of 12.7 tons and 9.8 tons, respectively. Rutabagas in particular, when stored until spring, are relished by cattle and sheep. For best results, rutabagas should be thinned to about 20 inches in rows, which should be at least 3 feet apart. Turnips are good feed in fall and winter. On the dry-lands they should be thinned to 16 inches, in rows 3 feet apart. There seems to be no advantage in thinning Amber sorghum, when thinned to hills 15 inches apart, the acre-yield was 9100 pounds; in hills 12 inches apart, 9440 pounds; when not thinned the acre-yield was 13,160 pounds. The unthinned cane was finer and relished more when fed as dry-winter forage.

The average growth made last season for trees procured from the College and planted for windbreak was as follows: Siberian elm, 4 feet 2 inches; Russian olive, 2 feet 6 inches; Siberian pea tree, 2 feet 8 inches; and Balsam poplar, 3 feet, 1 inch. These trees made their second summer's growth in 1933, having been planted as seedlings in the spring of 1932. All seem to possess sufficient winter-hardiness to withstand the deep snows and cold springs. The Siberian elm is acknowledged by all to be the best tree for San Juan County. (J. A. Eagar. Project 100.)

Millard County Alfalfa-Seed-Investigations. The object of this project, started on July 1, 1929, has been to analyze field causes of alfalfa-seed failures in the Millard County alfalfa-seed district. During the first two years irrigation, cultivation, clipping, and spacing practices were studied to ascertain this effect on seed production. A study was also planned as to methods of production on the most successful seed farms in the Millard area as a basis of determining, if possible, the important factors influencing the successful growing of alfalfa-seed. Studies made during the first two years emphasized the fact that certain field practices would increase the yield of seed and that the underlying cause of seed failures was due to factors other than field methods of production. Study made of more than 100 seed farms pointed out the fact that field-method practices were the same on most farms. The yield, however, varied greatly. The records showed that certain farms had been more consistent producers of seed than others.

Special study was made of farms of distinct soil types in the Delta Area and seed records covering an eight-year period obtained. An analysis of these data shows that the average acre-yield varied with the soil type and that there was a difference of approximately 30 per cent more seed on medium-textured soils. A ten-year record of seed yields on more than 100 farms, classified according to type, indicates that in all probability certain farms in the Delta Area have always been better seed farms than others and that in general the better farms are those whose soil is also of a medium texture, which probably indicates that soil properties must be the cause of difference in yield. A significant relationship is shown to exist between the eight-year average yield of seed and the index of friability. Simple correlation coefficients also show a relationship between alkali content and seed yield, between the amount of available soil moisture and seed yield, between the depth of water-table and seed yield,
and between the shrinkage coefficient of the soil and seed yield. However, before definite conclusions can be drawn, a more complete analysis of the data collected on soil properties is needed as well as a statistical study of the alfalfa plant, the soil, the climate, and the biological factors before the factors controlling alfalfa-seed production are definitely known. From data collected, indications are that the alfalfa plant, the soil, the climate, the temperature, the moisture, and insect pests all play a part in causing alfalfa-seed failures.

Uniform varietal tests of wheat, oats, barley, corn, and sorghum have been conducted during the past four years in cooperation with the Office of Cereal Investigations, U. S. Bureau of Plant Industry. Varieties of grains best suited for the Delta Area are now fairly well known.

A large number of pasture grasses and clovers have been planted during the past two years. Several varieties have shown considerable promise, among which are the following: Perennial rye grass, meadow fescue, brome (Bromis polyanthus), Reed's canary, Sudan grass, crested wheat, slender wheat, Early Fortune millet, Turgi millet, and sweet clover. Whippoorwill cowpeas have also shown considerable promise for pasture purposes.

A number of garden vegetables have been grown with fair success. Carrots, turnips, radishes, onions, melons, squash, tomatoes, and sweet corn all do well when the soil is properly tilled.

Some 24 strains of varieties of alfalfa have been grown for two years; the forage possibilities of some of these varieties are quite marked. With the same care and treatment as given the Common variety grown locally, several of these varieties (all of which are hardy) have produced considerable more forage. The bacterial wilt-resistant strains have also been exceptionally satisfactory.

Some study has been made of the damage due to insect pests and while it has been observed that during certain seasons insect damage is greater than during other seasons, it is doubtful if during any particular season they are a controlling factor in seed production. Those insects which seem to do more or less damage to alfalfa-seed are alfalfa-seed chalcis-fly, alfalfa-weevil, grasshoppers, tarnished plant bug, superb plant bug, green stink bug, and blister beetles. Even the native crickets do considerable stripping of ripe burs, if ripe alfalfa-seed is left too long in the piles. (George Whornham. Project 112.)

ANIMAL INDUSTRY

Animal Husbandry

Fattening Lambs in Winter Dry-Lot. A cumulation of data covering four years' work (1928-31, inclusive) at Monroe, Utah, and one year's work (1930-31) at Delta indicates that lambs can be fattened efficiently in Utah on balanced rations composed of small grains, alfalfa, and sugar beet by-products. Although there has been an increase in lamb-feeding activities in the state, no urgent problems are involved at the present time. Bulletin 238. Lamb Feeding Experiments in Utah. E. J. Maynard, A. C. Esplin, and S. R. Boswell. December, 1932. 44 pp. (E. J. Maynard. Project 99.)

Corn and Cottonseed Cake as Concentrated Supplements for Wintering Sheep on Desert Ranges of Utah. A supplemental study was initiated to determine, if possible, the effect of different herders and their methods on the welfare of the sheep throughout the winter. Because of changing herders through the winter, this comparison was lost. During this second trial, heavy losses of sheep were experienced during their trip north from Trout Creek to Timpie in the spring. Out of 14,000 sheep, over 4,000 head perished within a month on the trail; this loss was probably due to low vitality caused by poor grazing facilities, coupled with lack of supplemental concentrates during a winter when forage was extremely scarce as well as to lack of watering facilities en route.
Although all arrangements on this project did not work out satisfactorily, still valuable data were secured for use with the previous material secured. During the fall of 1933 temporary plans were effected for the continuation of the winter-maintenance study on the new range experiment station of the Intermountain Forest and Range Experiment Station west of Newhouse in southwestern Utah. Due to lack of Station funds an attempt was made to hire an experienced man on C. W. A. funds to make customary observations and to collect forage samples. This plan did not materialize; however, herds were located and rations of cottonseed cake, corn, and supplements arranged for; representative sheep were tagged and weighed in the several bands. Weights of sheep and wool were again taken in the spring; these data are now being compiled. Forage samples were collected by a representative of the U. S. Forest Service. (E. J. Maynard. Project 132.)

Winter Cattle Feeding Studies: Phosphorus Supplements with Sugar-Beet By-product Rations for Cattle. Two feeding tests have demonstrated the value of various phosphorus supplements in sugar-beet by-product rations. The beet by-products with beet pulp and sugar-beet molasses are low in phosphorus; the addition of phosphorus (in such carriers as steamed bonemeal, mill-run bran, and cottonseed cake) has materially increased gains and decreased the cost of unit gains. (E. J. Maynard and J. E. Greaves. Project 133.)

Winter Maintenance of Range Calves. During the past two winters an attempt has been made to solve some of the problems of the range beef producer by determining the most profitable way to winter range calves using home-grown feeds and imported protein supplements, when the calves are to be summered on range similar to the Forest Reserve in this section. During the winter of 1932-33 forty head of grade Shorthorn calves, which had been with their mothers during the previous summer and whose average weight was 403 pounds, were divided into four lots of ten head each. The lots were as uniform as possible as to size, breeding, condition, quality, etc. Results indicate: (1) That where calves are to be put on medium to poor range during the summer it is more profitable to feed them during the winter so as to have them gain about 0.5 pound daily than to have them gain more, since a large percentage of the greater gain is lost during the summer on the range; and (2) that, as a supplement to straw in wintering calves, 1 ton of cottonseed cake is equal to about 3.5 tons of alfalfa hay and 0.5 ton of chopped barley. (E. J. Maynard and B. F. Hulme. Project 142.)

Effect of Calcium-Phosphorus Ratio on Rate and Economy of Gain in Fattening Beef Calves. Previous cattle-fattening experiments at this Station have indicated the importance of phosphorus supplements to the sugar-beet-by-product rations. It is planned to study the effect of phosphorus supplements on well-balanced fattening rations composed of grain, alfalfa, and corn silage. It is also planned to secure weights and analyses of all feeds fed per lot, gains in liveweight of all individual steers, and individual blood phosphorus analyses each month during the experiment. This work will begin on November 1, 1934. (E. J. Maynard. Project 146.)

Lamb-Feeding: Fattening Rations for Southern Utah. With the completion of three duplicate tests, covering a comparison of the fattening qualities and relative market value of feeding lambs for grade Rambouillet ewes and sired by rams of different breeds, results have indicated the desirability of continued use of the fine-wool breeds in Southern Utah. Their high relative value in the feed lot as compared with the cross breeds and the added advantage of sale for breeding purposes (grade Rambouillet ewe lambs) seem to give them a distinct advantage over a period of years. (E. J. Maynard. No Number Assigned.)

Panguitch Livestock Experimental Substation. This project, begun in 1920 as an attempt to assist in the production of cattle of better quality by producing purebred bulls for the range cattlemen, has grown to include (1) investigations to determine economical and healthful rations

#Also reported by A. C. Esplin (Animal Husbandry Department) and R. J. Becraft (Range Management Department).
for wintering cattle and (2) tests for hardy varieties of grain and alfalfa. Winter-maintenance studies for dry-beef cows show 10 pounds of oat and pea hay to equal 7 pounds of alfalfa when fed with 2 pounds of chopped barley and straw at will in wintering dry-beef cows. It also shows both rations to be satisfactory in wintering dry cows weighing 1200 pounds, provided they are not too thin at the beginning. Wool varied 4 per cent in weight during the year due to hygroscopic moisture. It was heaviest about February and March and lightest from July to September.

In a uniform variety test, Trebi barley produced 18 to 22 per cent more per acre than the next highest (Sacramento); Dicklow wheat produced 6 to 8 per cent more than the next highest (Federation); Markton oats produced 20 to 24 per cent more per acre than the next highest (Golden Rain).

Hardwood trees cannot be successfully grown in Panguitch Valley. While they do not winterkill entirely much of the new growth kills, leaving the tree each spring in about the same stage of growth as in the previous spring. The year 1934 has proved an exception, the winter being so mild that the trees appeared to be as hardy in the spring as in the previous fall.


**Effect of Winter Feed and Shelter vs. Open-Range Wintering on the Quality and Quantity of Wool from Utah Range Ewes.** The original 5-year study began with "herd-run" ewes; 120 ewe lambs of similar grade and like breeding were evenly divided, 60 being put in with the range herd and 62 trucked to the Panguitch Livestock Experimental Farm. Range ewes were cared for similarly to other range ewes in the state; farm ewes were fed and cared for as are farm sheep on the better farms in the state. Results from both grease and scoured weights are in favor of farm-fed ewes. The 1932 fleeces (lamb fleeces or first-shear wool) are lighter in weight and lighter in shrinkage generally than fleeces from the same sheep after the 1933 shearing and until age has reduced their weight. The grease weight for both years shows the need for feeding for production instead of feeding merely to prevent excessive death loss. (A. C. Esplin. Project 77.)

**Relative Market Value of Crossbred Lambs from Crosses of Purebred Hampshire, Suffolk, Rambouillet, and Corriedale Rams on Utah Range Ewes.** The 1933 lamb crop of ewes at Panguitch for fleece study was used for cross-breeding comparisons. A Rambouillet ram and a Corri­dale ram, each representative of their respective breeds, were used in the experiment, together with 27 ewes in each of two groups. The May (1934) weights show 28 lambs in each group; the sale weights on No­vember 6, however, show 26 Rambouillet lambs and 28 Corriedale lambs. The average weight on this date is identical—76 pounds for each group; buyers made no difference in the grading of the lambs. (A. C. Esplin. Project 108.)

**Comparative Values of Fleeces from Types B and C Rambouillet Ewes.** The 1934 fleeces have been secured from the Panguitch Substation and are being studied in the laboratory. This shearing was completed by April 20. Comparisons of Types B and C Rambouillet ewes show heavier fleeces for Type B than for Type C ewes; fleece difference is less for scoured than for grease weights. Shrinkage is from 2 to 3 per cent less for Type C ewes, although the total scoured weight (clean fibre) for Type C ewes is slightly less than for Type B ewes. The staple for Type C is longer than for Type B ewes, the average difference being 0.2 inch for 1932-33 fleeces. Type B fleeces were 2.15 inches in length and Type C 2.33 inches. All samples represent the side portion of each fleece. (A. C. Esplin. Project 109.)

**Corn and Cottonseed Cake as Concentrated Supplements for Winter­ing Sheep on Desert Ranges of Utah.** In December, 1932, the sheep included in this experiment were weighed and branded in Snake Valley north of the Desert Experiment Station; in April, 1934, these same ewes
were weighed and fleece weights taken at the shearing corral. Continued cooperation with sheep owners has been assured, with the suggestion that weights be taken in October at the time the winter herds are "made up" for desert ranges. All ewes have been branded and ear-tagged so they can be easily handled in the fall weighing. The 5-year-old-group should be discarded and completely replaced by one-year-old ewes. (A. C. Esplin. Project 132.)

Swine Feeding Experiments. All but 91 of the 135 high-grade Hampshire pigs purchased in the summer of 1932 died from a necrotic condition of the intestines before the 1932 experiment got underway; of these 91, 80 were selected for summer-feeding work. All lots were fed on alfalfa pasture and all rations, except the semi-solid skim milk, were self-fed. The semi-solid skim milk was fed in equal amounts twice daily. Results of the pasture work in 1932 were similar to those of 1931.

On January 30, 1933, a second winter-feeding experiment was started. Results of this experiment were similar to those of the previous winter, except that the 50-50 mixture of skim milk powder and tankage did not show up as well in comparison with skim milk powder as in 1932. On June 12, 1933, a third summer-feeding experiment with hogs on alfalfa pasture was started, the hogs used being high-grade Duroc-Jerseys. This work was the continuation of that of the previous summer with the exception that skim milk was substituted for the semi-solid skim milk. The skim milk was fed twice daily as a supplement to grain on alfalfa pasture. The addition of skim milk to a grain-alfalfa-pasture ration materially increased the daily gain and lowered the cost of 100 pounds of gain from $3.90 to $3.58; 303.50 pounds of skim milk saved 63.53 pounds of barley, 0.002 acre of alfalfa pasture, and 0.41 pound of salt, but saved 3.5 pounds less hay, giving the skim milk a feed replacement value of $4.38 per ton, a value which is considerably higher than that at which it can usually be purchased. Skim milk also gave slightly better gain than skim milk powder and at 65 cents less cost per hundred weight. Compared with tankage, skim milk saved 33.96 pounds of grain, 0.002 acre of alfalfa, and 6.73 pounds more hay. It also produced 100 pounds of gain at 90.86 per cent of the cost of gains in the tankage feed lot. Results in the skim milk powder and tankage lots were similar to those of the previous year. No winter feeding work was done during the winter of 1933-1934. (H. H. Smith. Project 111.)

Dairy Husbandry

Production Studies in Dairying. The purpose of this cooperative project is to breed a class of Holstein dairy cattle which will be pure in their inheritance for a high level of milk and butterfat production.

At the present time, the dairy experimental herd is made up of 31 head of cows, 28 heifers, 1 aged bull, and 4 young bull calves. The annual blood test of this herd, taken on May 22, 1934, for abortion, showed all dairy cows and heifers to be negative which makes the third year that this herd has been an accredited abortion-free herd. All feeds fed, with the exception of wheat bran, were grown on Experiment Station land. At the present time there is on hand approximately 15 tons of alfalfa hay, 30 tons of corn silage, 1600 bushels of barley and oats, and approximately 6 loads of straw.

This project has been continued under the following subheads: (A) Standard Method of Management of All Daughters of Proved Sires and (B) Study of Individual Lactation Periods with Holstein Cows to Determine What Production Can Be Expected on Three Different Home-grown Rations. The rations fed are:

- Ration I: Alfalfa hay and pasture.
- Ration II: Alfalfa hay, pasture, and ground barley.
- Ration III: Alfalfa hay, silage, and pasture.

Thirteen cows have completed Ration I, six cows Ration II, and nine Ration III. (G. Q. Bateman and G. B. Caine. Project 73.)

*Also reported by E. J. Maynard and R. J. Becraft.
Effect of Dried Molasses Beet Pulp Added to a Standard Grain Mixture in Milk Production. Value of Dried Molasses Beet Pulp as a Substitute when Added to a Dairy Ration Made up of Alfalfa Hay and Grain. This project was discontinued during 1933-34 because of a reduction in funds. The money that had been allotted this project was used on Project 73. A new project will be drawn up during 1934-35. (G. Q. Bateman and G. B. Caine. Project 181-B.)

**Poultry Husbandry**

**Breeding for Egg Production.** Since the strain of birds developed for heavy egg production over three or more years has been somewhat smaller than the rugged type of Leghorns in popular demand for the farm flocks of this state, a close selection has been made to eliminate from the breeding pens all smaller birds as well as those producing eggs averaging less than 24 ounces to the dozen. Birds from one of the largest and most rugged strains of Leghorns in this section were crossed on some of the pens under this project in an attempt to more rapidly develop a larger type of Leghorn hens which would produce larger eggs. Present indications are that this outcross has made a marked improvement; comparative data, however, will not be available until the pullets raised in 1933 have finished at least one year of egg production. (Byron Alder. Project 36.)

**Poultry Feeding.** In the study of different methods of feeding grain to laying flocks better results were obtained in both health of the birds and average egg production where grain and mash were fed with the grain fed in a straw litter than with an all-mash ration or where the birds were given free choice of all feeds fed in open-type feed troughs.

In testing the feeding value of soft white wheat vs. hard red wheat, there appeared to be no marked advantage in feeding hard wheat and barley, soft wheat and barley, hard wheat and corn, or soft wheat and corn as scratch grains when supplemented with a good laying mash containing the same grains ground to supply the grain part of the mash.

Where different percentages of animal protein made up of meat meal, fish meal, dried milk, and skim milk, were used in the starting and growing rations and continued throughout the first year of egg production, best results were obtained by feeding a ration containing around 15 to 20 percent of the animal protein supplement made up of about 1/3 dried milk and the balance of approximately equal amounts of meat meal and fish meal. (Byron Alder. Project 57.)

**Egg-laying Contests.** Egg-laying contests were discontinued on November 1, 1931. A summary of the data accumulated during the seven years the contests were conducted was made and published as Station Bulletin No. 248. These data show that by selective breeding and good management it is possible to get a fairly uniform distribution of egg production for each month of the year. There appears to be a positive relationship existing between the average yearly size of the hen and the size of the eggs she produces. The weight of the bird about November 1st, or at about the time she commences to lay, apparently is a fair indication of the size of the eggs she will produce, although no indication is given as to the number of eggs she will produce during the following year nor even during the early winter months.

**Veterinary Science**

Studies of Dairy Cattle Affected with Bang's Disease. Ten of the original 22 animals in this experiment continue to remain profitable enough to warrant their retention for milk-producing purposes. Only two abortions have occurred during the biennium, one of which was accompanied by retained placenta. There is a general tendency for serum agglutination titres to lower. Three cows, suspicious in 1930, within a few months became negative and have remained negative. Another cow's serum agglutination titre dropped until the suspicious classification was reached. Subsequently, the titre raised (1 to 1600), thus
placing her again in the positive classification. No animal with a relatively high serum agglutination titre at the beginning of the study has dropped in titre sufficient to be removed from the positive class. Since this project was established (1930), a total of 12 animals free from Bang’s disease have been added to this herd, 11 of these being sexually mature heifers. Judged by the agglutination test, only one animal has shown a positive reaction, and it is possible that this animal was positive before being added to the herd. It is difficult to ascertain why the infection has not spread to these cows since the causative organism was found in the milk of several reacting cows in this herd; it is doubtless present in the uterus in some instances.


(D. E. Madsen. Project 114.)

Transmissibility of Bang’s Disease among Dairy Cattle in a Utah Dairy Village. The object of this experiment has been to determine the practicability of an individual dairyman retaining a Bang’s disease-free herd and at the same time allowing his cows to be driven, each day, to and from pasture with herds which harbor this disease. A reduction in community infection was evident for a year and a half following the initial test; subsequently, however, there has been an increase. During the past season there has also been an accompanying increase in abortions—16 abortions in all, 9 of which were from positively-reacting cows and 7 from negatively-reacting cows.

The probable reasons for increase in community infection are:

1. Enthusiasm regarding the practicability of the agglutination test has waned. Most of the reacting cows were having no abortion troubles. Unless experience had taught them otherwise, many were inclined to believe that this disease was of little consequence and no measures were adopted to protect clean herds.

2. A general forage shortage has encouraged more farmers to send their pregnant heifers on the forest range and to other large pastures, where cattle of mixed ownership were grazed.

3. With no thought of consequences, purchases and trades are made without previous testing to determine the Bang disease status of individual animals.

Considering dairy herds (both diseased and disease-free) in a densely populated village, where cattle contact each other en route to and from pasture, the danger of cows contracting the disease under such conditions does not appear to be great. Clean animals pastured with infected cows are placed under far more hazardous exposure.


(D. E. Madsen. Project 117.)

Studies of Fowl Pox. Two flocks have been under observation for traces of fowl pox—a private flock and one owned by the Utah State Agricultural College.

The former has no history of natural pox outbreaks; birds on these premises, however, have been vaccinated for the past three years. On June 8, 1932, 775 birds (age 3½ months) were vaccinated by the follicle method with pigeon-produced vaccine (F.D.). Examinations made seven days later revealed swollen follicles on all except one bird. No spontaneous cases of pox have developed in this flock, however, during the subsequent 12 months of observation.

The second flock has a history of a rather extensive outbreak of pox during November and December, 1931. On July 20, 1932, about 400 pullets (age 2½ to 4 months) were vaccinated by the follicle method with pigeon-produced vaccine (F.D.). All birds were examined eight days later and found to have swollen follicles. During the following winter season approximately 4 per cent of these birds were observed to be affected with comb pox lesions. Those affected showed only mild lesions with apparently no inconvenience to their general health and production.

(D. E. Madsen. Project 121.)
Susceptibility of Cattle to Inoculations with Acid-fast Organisms Isolated from So-called Tubercular Skin Lesions. Utah cattle, slaughtered as a result of reactions to the tuberculin test, belong to one of the three following classes: (1) Those showing gross lesions of systemic tuberculosis on postmortem examination, (2) those showing so-called "skin-lesions," and (3) those exhibiting no lesions at all. A high percentage of reacting cattle which are slaughtered fall into the last two classes. Certain acid-fast organisms are quite regularly isolated from skin lesions removed from reacting cattle, but their identity has not been determined.

Different strains of these organisms have been injected into 17 cattle with the following results:

1. Certain individuals give more characteristic lesion response than do others.
2. Injections of small amounts of suspensions intradermally or subcutaneously are always followed by some hypertrophy of that part.
3. The hypertrophy following inoculation of aqueous suspensions may persist from three weeks to 18 months, while hypertrophy following inoculation of mineral oil or olive oil suspensions may persist from 4 months to 16 months and possibly longer.
4. When the infected organisms are suspended in physiological saline solution, the lesion produced begins to recede at about the fourth week. When suspended in mineral oil or olive oil, the lesion may begin to recede at the third month or it may progress in size to the twelfth month following injection.
5. Histo-pathological examination of lesions produced do not differ from such examinations of skin lesions found in the field.
6. Most animals on which lesions have been produced have shown no allergy to tuberculin. Three out of the 17 animals have shown reactions, varying from highly suspicious to negative. One animal retained for a period of 30 months has been tested with tuberculin 12 different times, with 7 negative reactions and 5 suspicious reactions. Another animal retained for 19 months has shown 8 negative reactions and 1 suspicious reaction. No relation between the time of inoculating the organism and the period of allergy could be established.
7. When these experimental animals have been tested for allergy with a protein filtrate prepared from the organism which produced the lesion, a pronounced reaction was usually observed. Non-inoculated cows do not react to the injection of this filtrate. A limited number of skin-lesion cows in the field likewise have not reacted to the filtrate injection.
8. Seven cows inoculated with Preiss-Nocard organisms produced transitory lesions unlike the skin lesions observed in the field. One of the seven cows showed a suspicious reaction in one out of five tuberculin tests over a period of five months' observation. Blood sera from field cases of skin lesions do not show specific agglutinins for Preiss-Nocard organisms.
9. Four cows injected with non-pathogenic acid-fast organisms, Stercoris phlei and Beronelles margarine, developed (in most instances at the point of injection) nodules which were similar, macroscopically and microscopically, to so-called skin lesions found in the field.

(D. E. Madsen. Project 125.)

Laboratory of Animal Pathology. The diagnostic service offered by this laboratory during the past two years has benefited a larger number of livestock farmers than for any similar previous period. The call for blood-testing service in connection with Bang's abortion disease of cattle and Pulmonary disease of fowls has increased tremendously, and the laboratory finds itself in a position to assist farmers in reducing the losses sustained from these two diseases as well as other diseases of livestock and poultry. During the past biennium the following specimens have been examined:

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry (carcasses and blood samples)</td>
<td>78,525</td>
</tr>
<tr>
<td>Cattle (19 consignments)</td>
<td>29</td>
</tr>
<tr>
<td>Horse (8 consignments)</td>
<td>5</td>
</tr>
<tr>
<td>Swine (2 herds)</td>
<td>16</td>
</tr>
<tr>
<td>Sheep (2 herds)</td>
<td>34</td>
</tr>
<tr>
<td>Fox (6 ranches)</td>
<td>98</td>
</tr>
<tr>
<td>Bovine blood sera for Bang's disease</td>
<td>17,170</td>
</tr>
</tbody>
</table>

Total: 95,890


(D. E. Madsen. Project 140.)

*Cooperative project with State Department of Bacteriology and U. S. Bureau of Animal Industry.
Utah Insects as Vectors of the Virus of Equine Encephalomyelitis. Equine encephalomyelitis first occurred in Utah in epidemic form on July 1, 1933. The first wave reached its height about August 10, when approximately 500 horses succumbed. The morbidity was 27.1 per cent and the mortality 43.9 per cent. The second wave began on September 14, reaching its height during this month and subsiding about November 1; only isolated sporadic cases occurred during the winter months; 1500 horses succumbed in this wave, with an average mortality of 53.2 per cent. This second epidemic was largely restricted to the same territory traversed by the first wave, and there was little tendency to spread to newly uninvaded territory. Hyper-immune serum was apparently beneficial in the first outbreak but apparently useless in the outbreak which followed. Evidence in the second latter outbreak indicated that horses receiving prophylactic doses of serum had a higher incidence of the disease than did non-treated horses. No satisfactory explanation of this phenomenon has been advanced. The symptoms of the second wave of infection differed from those observed during the first wave. The absence of increased temperature was one of the most noticeable differences. During the second wave approximately 10 different horse brains were tested for presence of virus by the usual procedure with negative results. Apparently the virus was located in other body tissues not routinely tested for the presence of this virus. Preliminary studies were made of possible insect vectors as transmitters of the disease, using chiefly mosquitoes, simulids, and horseflies. Results were usually negative, although some simulids injected into susceptible guinea pigs produced typical temperature curves with subsequent death. Filtrates prepared from the brains of such guinea pigs failed to prove infective. Recent tests indicate that mosquitoes may carry the virus, although results of this transmission study are not yet available. (D. E. Madsen. Project 155.)

The Effect of Iritis of Breeding Hens on Their Progeny. Studies of the Station flock in which different degrees of iritis are present indicate that this disease continues to be progressive in pullets and in older hens. Chicks hatched from eggs laid by hens so affected to date have showed no abnormality and mortality has been low. (D. E. Madsen and Byron Alder. Project 156.)

BOTANY AND PLANT PATHOLOGY

Virus Diseases of the Potato and Factors Influencing Their Development and Control. During the biennium two phases of this project have been given attention: (1) Native and imported hosts for crinkle mosaic and (2) further testing in Washington and Davis Counties for indexing of potato lots grown and offered for certification. Crinkle mosaic symptoms have been produced on the following plants: Datura sp., tobacco varieties, and Wonder berry; a considerable number of solanaceous plants as well as common weeds have also been under study in this connection. Results indicate that there are a number of host plants to crinkle mosaic of the potato. Investigation on the second phase of this project confirms previous results, final conclusions indicating that mosaic expression is definite in both Washington and Davis Counties and that these two areas offer special possibilities for testing lots of seed and for early tuber-indexing on a large scale. With the conclusion of the second phase of investigational research, and the publication of methods of control of virus disease, incorporated in U. S. Department of Agriculture Circular No. 271, the general problem of the virus diseases of the potato assumes an aspect in which further progress demands long-time fundamental research effort.


(B. L. Richards. Project 31.)

*Also reported by G. F. Knowlton of Entomology Department.*
Plant Disease Survey. Two distinct phases of this project have been conducted: (1) Disease survey and (2) herbarium work.

The major activity of the disease survey has been devoted to a better understanding of the distribution and economic importance of strawberry roots rots preliminary to the establishment of Adams Project 147 (authorized on January 15, 1934). This disease was located and studied in a preliminary way in Salt Lake, Utah, and Davis Counties where it was found to be of such magnitude as to justify further study on a project basis. During April (1934), a disease of cereal seedlings (designated as frost banding) was studied to the extent of a rather complete understanding of its distribution and possible etiology. This disease is characterized by a peculiar chlorotic banding of the leaves of cereal seedlings, probably produced by low temperatures at the soil surface. Such low temperatures, it appears, are induced by rapid evaporation at the soil line when cold dry winds strike the more exposed areas in fields furrowed for irrigation. It is on these exposed areas on the crest of the ridges that damage occurs.

The herbarium study has included the determination of pathogenic organisms which have been collected, catalogued, and systematically arranged. Such investigation is a continuation of plant-disease survey studies started in 1927 in cooperation with the Plant Disease Survey of the United States Department of Agriculture. Many specimens have been added to the collection during the past two years. A much better understanding of disease problems is apparent.


(B. L. Richards. Project 34.)

Psyllid Yellows of Potato: Pathological Aspects. Results of the research work on this project prior to 1933 were published in the JOURNAL OF AGRICULTURAL RESEARCH, Vol. 46:189-216 (February, 1933). During the present biennium, work has been conducted along the following lines: (1) Recovery in plants affected with psyllid yellows and (2) relation of insect to infective principle.

The study of recovery in plants affected by psyllid yellows was completed during 1933 on both the potato and the tomato. Results indicate that progress in symptomatological expression of psyllid yellows is stopped abruptly when insect-feeding is eliminated and that full expression of disease symptoms results only when nymphs of Paratrioza cockerelli are allowed to feed continuously on tissues of the infected plant. Results show further that recovery generally takes place when feeding is eliminated; however, the degree of completeness of recovery is determined by the extent to which the plant has been modified in its physiology and morphology during the feeding period. The length of time which insects can feed upon potato plants without seriously affecting crop yield is still an unsolved problem. The basic fact of recovery offers great hope in control of psyllid yellows through insect elimination.

Investigation on relation of insects to infective principle is nearing completion. Results obtained indicate definitely that the psyllid nymph cannot be freed from the substance which it injects into the host plant during its feeding processes. The substance so injected is not a virus of known type obtained normally from infected plants; if a virus, of a peculiar nature, it is transmitted through the egg of the insect from generation to generation. Results on recovery and recent researches on the infective principle substantiate the early tentative conclusion that the substance injected by the psyllid nymph is a toxic substance of some sort rather than any specific virus. (B. L. Richards. Project 90-A 11.)

Bacterial Wilt of Alfalfa: Pathological Aspects. During the biennium the following divisions of study have been given attention: (1) Symptomatology, (2) survey, (3) selection, and (4) seed production.

The object of the symptomatological studies has been to determine more accurately the symptoms of bacterial wilt under condition of irriga-

\(^{11}\)Also reported by G. F. Knowlton (Entomology Department) and F. B. Wann (Botany and Plant Pathology Department).
tion and to aid in differentiation of wilt from such diseases as dwarf nematode, stem blight, crown wart, and frost injury. These studies have resulted in the recognition of such symptoms as will make possible detection both by investigator and by the practical grower. In the early stage of nematode stem blight and crown wart, injury differentiation from wilt is an easy problem; however, in later stages when these three diseases have so injured the plant as to permit of rotting of the root, the condition is not so clear and the final stage of root disintegration is so complex as to render diagnosis of wilt particularly difficult, if not impossible. The dwarf disease offers a more difficult problem. The pathological picture of the root is almost identical with that of wilt; the effects of the disease above ground also closely resemble stem and leaf symptoms comparable to wilt.

Survey studies have been continuous over the past two years. A rapid increase of this disease has been noted in the following counties where the trouble has rapidly spread: Boxelder, Cache, Davis, Duchesne, Salt Lake, Tooele, Uintah and Weber. Probably the most surprising rate of spread has been noted in Cache Valley during the past two years. The survey shows that the disease may be so destructive in certain districts as to prevent the obtaining of a fourth year's harvest.

Selections for disease resistance have been conducted along four lines: (a) Field plat work involving a wide range of varieties, (b) field selection work, (c) artificial inoculation, and (d) study of varietal resistance to diseases other than wilt.


Strawberry Root Rots. Since the authorization of this project on January 20, 1934, special attention has been given to the following: (1) Symptomatology, (2) distribution and severity of the root rots, and (3) etiology.

A definite type of lesioning on the adventitious and secondary roots of strawberry plants in various localities throughout the state has been observed. These lesions have been uniform in their location on the roots, in their destructive nature, and generally in their apparent histological nature. This uniformity indicates a common etiology of vital consequence to the strawberry industry of the state. During the fruiting season a definite complexity of symptoms on parts above ground appears to be associated with root destruction, marginal reddening of leaves, purpling of veins, and a general stunting (but less severe) of the plant as a whole where the root lesions persist over a long period. Under severe conditions, wilting and death of the plant result. Dependent upon the severity of the disease, the plant fails to mature its berries, in which case a few or all of the fruits may dry up and become definitely leathery. On diseased plants the strain of fruit production is so severe as to induce wilting of a type seldom seen before the fruiting period or on plants which survive the fruiting process. The genetic connection between the root, leaf, and fruit symptoms remains a problem for further research.

The type of root rots and general leaf and fruit symptoms have been found in Boxelder, Davis, Salt Lake, and Utah Counties, and possibly in Cache County. It is probable that this disease is more generally distributed than the survey indicates. In Salt Lake County and Utah County the disease is so common and so destructive as to become a limiting factor in strawberry production.

During April and May (1934) 250 isolations were made which resulted in obtaining a number of fungi species in approximately the following ratio: Rhizoctonia—3, Fusarium sp.—3, Phytophthora forms—2, Mucors—1, and Aspergillus—1, as well as other miscellaneous fungi with varied frequency. (B. L. Richards. Project 147.)

12Division B (Agronomic Aspects) reported by R. J. Evans.
Tomato Diseases in Utah: Fusarium and Related Wilts, Bacterial Canker, and Mosaic Diseases 13. Among the tomato diseases listed under this project, greatest emphasis has, during the past biennium, been placed on canker diseases. Even though the other diseases are important in the tomato culture of the state, investigations had progressed much further on canker disease than on the other diseases, and since insufficient funds were available to allow investigations of all respective diseases included in this project simultaneously, it was thought advisable to concentrate on bacterial canker until such a time as the work could be completed and attention given to other tomato diseases pressing for investigation. During the past season the growers of Utah suffered a loss of approximately $30,000 from the bacterial canker disease of the tomato. It appears that the disease was more general in most of the tomato-growing regions of the United States during 1933 than in seasons of the recent past.

Bacterial-canker studies have been conducted along two lines: (a) Life history and pathogenicity studies and (b) control studies.

Of the three sources of primary inoculum (field soil, seedbed soil, and the seed), the seed has proved to be of greatest importance in the epidemiology of the disease, followed by seedbed soil and then field soil in order of importance. Infested coldframe or hotbed soil is much more important as a source of canker than infested field soil when used either as a seedbed or in commercial planting. Non-infested seed planted in infected soil in open field seedbeds developed 1.3 per cent diseased plants, whereas non-infected seed planted in an infected coldframe soil developed 33.69 per cent diseased plants. From 40 to 60 per cent of the plants grown from infected seed developed the disease. It is evident that neither the seed nor the seedbed can be neglected when canker infection is threatening, without disastrous results. Field infection is not so serious and may be adequately cared for by a three-year crop rotation. The canker organism maintains itself in the old plant debris in the field, and as this material is decomposed infection from field contamination becomes less threatening. The canker organism gains entrance into the tomato plant readily through wounds of all types and less readily through natural openings. Wounded roots appear to be highly favorable infection courts. Systemic infection develops from infection through natural openings under western conditions only to a limited extent. Incubation periods of from 4 to 90 days have been observed. Accumulating data indicate that germinating conditions influence the percentage of the plants grown from infected seed or infected seedbed soil which develop the disease. Apparently low temperatures during germination and seedling development favor infection. Medium temperatures during the growing season favor the expression of the disease in the field.

It has been found possible to absolutely eliminate bacterial canker from seed obtained from infected sources by fermenting the pulped fruit prior to seed extraction. The process which has proved effective in the control of canker consists of pulping the fruit with an electrically-driven rotary knife and putting aside the pulp, seed, etc., ferment for the required length of time, a fermentation period of 72 to 96 hours being recommended. Varying fermentation procedures are being tried; these substitutions are being attempted in the hope of decreasing a fermentation procedure which will make possible the use of a portion of all of the fruit juice for canning purposes and still be as effective in the control of the disease as the original whole juice fermentation procedure. The adoption of a three-year crop rotation and the careful handling of seedbeds and frames, combined with the fermentation treatment of extracted seed as recommended, has absolutely controlled bacterial canker of tomato in most exacting experimentations. No seed nor root treatment tried during the course of these investigations has proved effective for the control of bacterial canker of tomatoes.

Two wild tomatoes and Lycopersicum pimoiellifolia, a small-fruited

13In cooperation with U. S. Department of Agriculture, Division of Fruit and Vegetable Crops and Diseases, B.P.I. Project 3508: Tomato Diseases in Utah.
relative of our commercial tomato, appear to be quite highly resistant
to bacterial canker. All dwarf varieties of tomato included in these
studies have proved to be highly susceptible to the disease, in fact, more
susceptible than the standard varieties. It appears probable that a tomato
highly resistant to bacterial canker could be developed with comparative
ease from the resistant stocks already available.

Reprint 228. "The Control of Tomato Bacterial Canker (Aplanobacter michiganense
E. F. S.) by Fruit-pulp Fermentation in the Seed-extraction Process."

May, 1934. 4 pp.

(H. L. Blood. Project 33.)

Curly-top and Psyllid Yellows of the Tomato 14. The work on curly-
top disease includes three major divisions: (1) Disease-resistance studies,
(2) environmental and cultural studies, and (3) symptomatological
studies.

During the past two years approximately 676 varieties and strains,
including certain wild strains and 1440 individual plant selections, have
been tested for the expression of any inherent resistance to the curly-top
disease, in addition, last year 103 first-year selections, 113 second-year
selections, and 43 third-year selections were tested for resistance to this
disease. Results secured indicate that while some varieties possess partial
resistance to the disease, none of the varieties tested exhibits a resistance
sufficient to withstand a severe infestation of the disease. The selections
exhibited no greater degree of resistance than the varieties and strains
planted for the first time under diseased conditions. A few varieties and
a few selections showing some resistance, and which appear to possess
promise, are available for continued study.

During the past season, which marked the initiation of environ-
mental and cultural studies, a greater degree of disease development
was secured under reduced light intensity than under full light intensity.
This is not in accord with the findings of previous investigators, to the
effect that shading inhibits the development of the disease. A retarding
effect of more intense shading, however, was observed.

It is evident that curly-top exhibits itself with various degrees of in-
tensity on different varieties of tomato. Due apparently to some slight
structural differences in varieties, they exhibit certain symptoms with
greater intensity. Even though death does not quickly ensue, the altered
metabolism of the infected plant inhibits the development and maturation
of seed. The most marked effect of curly-top is expressed in the pollen
grains which quickly degenerate following infection. The development of
the ovules following fertilization is checked by the inception of the
disease and sterility sets in.

Investigations are under way on the symptomatology of psyllid yel-
lows of tomato as compared with curly-top, the relationship of the insect
Paratrioza cockerelli Sulc to the disease, and the nature of psyllid yellows.

Curly-top and psyllid yellows may be differentiated by the sequence
in disease development, the nature and degree of discoloration, and the
degree of distortion or malformation. Psyllid yellows first expresses itself
by an interveinal puckering of the young leaves; as the leaves develop,
the interveinal tissue accommodates itself to the veinal frame-work and,
while losing some of its puckered appearance, still remains rough and
markedly dwarfed. The veins and leaf margins become purple, two halves
of the leaf tending to fold upward in a V shape over the midvein. Complete
destruction of the tomato plant rarely occurs with psyllid yellows unless
large numbers of insects infest extremely young plants. With older plants
death is usually the result of secondary infection of the weakened yellows-
infested plant.

In regard to the relationship of the insect Paratrioza cockerelli
to psyllid yellows, this disease may be induced on young plants with as few
as two nymphs. As the plants become older, greater numbers of insects

14In cooperation with the U. S. Department of Agriculture, Division of Fruit and Vegetable
Crops and Diseases. B.P.I. Project 3509: Curly-top and Psyllid Yellows Investigations.
are necessary in order to maintain expressions of the disease. Upon the removal of the insects, the plants recover and develop a normal crop of fruit. Seed from such fruit are viable, and no phase of the disease is exhibited either by the parent plant or by any of its progeny. Nymphs from insects' eggs hatched on moist membranes entirely divorced from any plant tissue when placed on tomato seedlings produce the disease as readily as nymphs from eggs hatched on susceptible plant tissue.

All studies indicate that psyllid yellows is associated with the feeding of the insect and is due in some way to the effect of insect excretions on the physiology of the plant.


(H. L. Blood. Project 141 15.)

Nature and Cause of Chlorosis in Utah and Practical Methods of Control.

1. Treatments of Chlorotic Plants.
2. Soil Studies.
4. Economic Aspects.

1. Treatments of Chlorotic Plants. While intensive work in this division has been terminated, a number of injection experiments have been carried out in an effort to determine the rate of movement of the injected iron and the tissue concerned in the translocation as well as to test the effect of compounds other than iron. By removing leaves or twigs of treated pear and apple trees at various intervals following treatment or from various distances from the point of injection of the iron salt and maintaining these in a living condition, it was hoped to obtain data on the rate of movement of the iron in the tree. Ringing experiments were employed for the purpose of determining whether or not the phloem issues were involved in the transport of the iron. In both of these types of experiments, however, the results were quite conflicting and thus inconclusive or negative. In connection with the effect of other compounds, definite beneficial results were obtained with acidified zinc or manganese sulphates, but not with dilute acid alone.

2. Soil Studies. Soil samples are being obtained for a detailed study of the seasonal fluctuations in soil nitrogen, pH, and soluble iron.

3. Biochemical Studies. Chief emphasis has been placed on this division of Project 89 during the past year, the following aspects being studied: (a) Nitrogen relations, (b) hydrogen concentration tissues of healthy and chlorotic stems, (c) micro-chemical tests for iron, (d) iron analysis, and (e) shading.

Further data on chlorotic and healthy raspberry, apple, peach, and grape leaves substantiated preliminary results of last year, indicating as high or higher total nitrogen content in chlorotic leaves as in normal ones. The soluble nitrogen content of chlorotic plants, especially nitrates, is higher and the coagulable nitrogen lower than in green plants. Thus far it has not been possible to demonstrate that the increase in nitrates in chlorotic leaves is associated with a decrease in reducase activity.

The determinations of the pH of healthy and chlorotic tissues were extended to grape, pear and several additional varieties of raspberry of varying degrees of susceptibility to chlorosis. In all cases the pH of the xylem and cortical tissues have been found to be acid (pH 4-5) enough to hold iron in solution. The phloem, on the other hand, is nearly neutral or only slightly acid (pH 7.5-6.5) in both chlorotic and healthy plants. At this pH value, soluble iron might readily be precipitated from solution. These data appear to eliminate differences in the internal pH as a possible explanation of the diseased condition.

The precipitation of iron within the tissues of the chlorotic plant

Biochemical and Physiological Aspects reported by F. B. Wann.
has been suggested in connection with explanations of the cause of the disease. In an effort to obtain evidence of such deposition, sections of leaves, stems, roots, and underground stems of chlorotic and green raspberry plants, and stems, leaves, and petioles of chlorotic and green grape plants have been examined after treating with iron reagents. In practically all cases observed all tissues appeared to be free from iron deposits.

Quantitative determinations of the soluble and total iron content of normal and chlorotic tissues have been extended to several varieties of raspberries and grapes. Contrary to expectation, there appears to be as much soluble iron in chlorotic leaves as in the normal. An increase in soluble iron in the leaves of treated grapes has been demonstrated. As has been known for many years, the total iron determinations frequently show a higher value in chlorotic tissues.

Thus far, shading experiments have shown no marked response in chlorotic plants to this type of treatment.


(F. B. Wann. Project 89: 1, 2, 8, 4.)

Psyllid Yellows of the Potato: Physiological and Biochemical Studies. These studies have been directed toward the determination of: (1) The biochemical changes induced in the potato by the psyllid contagium and (2) the effect of light intensity on the expression of the disease.

The biochemical analysis of the tissues and juices of several varieties of potatoes have shown that in the leaves the disease results in an increase in dry matter, solids, reducing and total sugars, and freezing-point depression. Diseased stems are likewise higher in dry matter, solids, and starch but lower in soluble sugars. Diseased tubers showed a decrease in dry matter and solids. This disease is characterized by an increase in the C/N ratio in the leaves and a decrease in the stem. Data indicate that this disease probably prevents the normal translocation and utilization of both carbohydrates and nitrogen constituents, resulting in an accumulation of soluble nitrogen and starch in the stem tissues. During the past winter the work was projected on the effect of light intensity on the expression of the disease. Attempts to obtain disease-free plants for inoculation with psyllids were repeatedly frustrated by the appearance of mosaic. Inoculations of two series of plants failed to produce symptoms of the disease in the normal greenhouse light intensity of mid-winter and early spring. (F. B. Wann. Project 92-A.)

Curly-top of Tomato. Analysis of healthy plants of many tomato varieties at various stages of growth has shown that there is a rather consistent increase in dry matter, solids, ash, freezing-point depression, and sugar content with age and that, in general, the varieties differ in biochemical characteristics. These differences however, are slight in the early stages of growth but become greater as the plant matures. The values for the characteristics studied appear to drop slightly in the early-growth stages but rise sharply following this brief "lag" period. When these biochemical characteristics are compared on the basis of resistance to curly-top exhibited by the several varieties, a certain amount of correlation appears possible. In the 1932 series the more resistant varieties were those with lower values in the biochemical characteristics; in the 1933 series the correlation was directly the reverse, the more resistant varieties being those of higher values.

Analysis of healthy and diseased plants of many tomato varieties indicates in general that curly-top plants are higher in dry matter, pulp, weight, solids, sugars, freezing-point depression, but lower in ash and pit than healthy plants. There was apparently little, if any, correlation between the magnitude of the changes induced by the disease and the degree of

[18]Division 5 reported by A. L. Wilson (Horticulture and Vegetable Crops Department).

[31]Also reported by B. L. Richards (Pathological Aspect) and by G. F Knowlton (Insect Aspect).
response to curly-top inoculation in the several varieties. Of 16 varieties analyzed for total nitrogen, all but one showed a decrease in nitrogen content in the diseased leaves, while in none of the varieties an increase in nitrogen content of the diseased stems was observed. An effort to establish a correlation between these nitrogen changes and reducase activity has proved unsuccessful.

Various degrees of shading produced marked decreases in dry matter, pulp weight, solids, and ash in the single variety tested. Slight increases in pH were found under shade, but the effects on sugar content and freezing-point depression were slight.

A progressive increase in biochemical values was established in the bean as well as in the tomato. Differences between strains, however, were slight and there did not appear to be any correlation between the biochemical values obtained and the known resistance of the strains to curly-top. (F. B. Wann. Project 141.19)

The Intermountain Herbarium. The function of this project is to determine by extensive collection of plants any data relative to their life histories, abundance, and distribution, and the composition and character of the flora of Utah. This work is carried on only in Utah, by necessity of the proximity to the field and the close interrelation of native plants to specific state problems. To date the collection in this herbarium represents a total of 18,220 specimens, with 10,599 mounted and filed sheets. (Bassett Maguire and B. L. Richards. Project 135.)

CHEMISTRY AND BACTERIOLOGY

Factors Influencing the Bacterial Activity of the Soil. Since nitrogen fixed in soil and in soil extract media by Azotobacter chroococcum is considerably greater than that fixed in the synthetic media used at the present time for the culturing of this microorganism, a culture medium of known constituents was devised in which the nitrogen fixation affected by A. chroococcum was as great as that accompanying the growth of the same species in Ashby's basal solution. In all cases, media of the new type permitted also luxuriant growth of the organism. As a result of extensive experiments with elements which have been found in soil solutions, it was found that boron, aluminum, copper, bromine, zinc, titanium, selenium, and tellurium are nonessential to Azotobacter, and even when used in small quantities in liquid media, fail to stimulate A. chroococcum. Copper and zinc were found to be toxic when present in minute quantities. Manganese, iron, and iodine greatly stimulate nitrogen fixation when added to liquid cultural media. No evidence was obtained that they act by absorption or that they render oxygen more available. The results point to the conclusion that they are essential elements used by this microorganism in its growth or metabolism.


(J. E. Greaves. Project 22.)

Permanent Fertility Studies. Rather consistent differences are apparent between cropped and fallow soils in regard to respiratory and decomposing powers. In practically every instance cropped soils show higher respiratory and decomposing values than do fallow soils; this occurred both in the manured and irrigated soils. Two more complete crops have been harvested of each of the legumes from both inoculated and non-inoculated soils. These crops are being analyzed to determine the influence of inoculation upon the legume proteins.

19Also reported by H. L. Blood.
Analyses of soils collected in Cache Valley showed that only 78 per cent as much carbon occurred in the first foot of cropped soil as in adjacent virgin soil and 83 per cent as much nitrogen in the cropped as in the virgin. Consequently, it appears that these soils, when cropped, are losing their carbon more rapidly than their nitrogen. The Juab County soils lost their nitrogen more rapidly than their carbon, due to cultivation. The carbon-nitrogen ratio in both soils was wide, indicating highly fertile soils. (J. E. Greaves, C. T. Hirst, K. R. Stevens. Project 23.)

The Nutritive Value of High versus Low Calcium- and Phosphorus-carrying Wheat. When fed to albino rats high-calcium wheat (Kota) yielded bones higher in ash than low-calcium wheat (Turkey). When calcium and phosphorus were added to the ration along with Turkey wheat, the bone ash was the same as when Kota was fed. A normal calcium and phosphorus blood content also resulted. Turkey and Kanred wheats carried similar quantities of calcium, but Kanred contained approximately twice the phosphorus of Turkey wheat. Animals fed on Turkey had bones with less calcium and blood with less phosphorus and required more food to make unit increase in weight than those animals fed on Kanred. The addition of phosphorus to the diet made Turkey equivalent in nutritive value to Kanred. Data thus far obtained point to the conclusion that one of the main differences in the nutritive values of the various wheats is variability in calcium, and especially in phosphorus content; this difference, apparently, can be made up by the addition of inorganic phosphorus and calcium to the diet.


The Mineral Content of Different Varieties of Wheat. Some thirty varieties of wheat, grown under the same conditions at the Nephi Dryfarm Substation, have been analyzed for mineral constituents. Averages for four years show a marked difference in the ash, calcium, magnesium, iron, and sulfur content of the different varieties. Although there is a yearly fluctuation, those wheats carrying high mineral content for one year show a relatively high mineral content for other years. Turkey is uniformly low, whereas Kota is uniformly high as is also Regenerated Defiance. Hence, while yearly variation may occur, it is not as great as is varietal variation.

The quantity of the various minerals removed from the soil by the grain varies widely with the variety. Turkey, Kofod, Sevier, Black Hull, and Kanred remove nearly three times the quantity of minerals from the soil as is removed by Kota, Hard Federation, and Regenerated Defiance. Low-yielding wheats usually carry higher percentages of the minerals than do high-yielding wheats, which points to a correlation between available mineral constituents and the chemical compositions of the grains. All wheats analyzed were found high in calcium, phosphorus, and sulphur when compared with wheats grown in many other sections of Juab County. (J. E. Greaves and C. T. Hirst. Project 107.)

ENTOMOLOGY

Grasshoppers and Their Allies with Special Reference to Species which Menace Farm Crops and Range Forage. One part of this investigation has been done in the summer and has consisted of making trips through fields, pastures and more accessible foothills of the state, collecting samples of all species of grasshoppers found and taking ecological notations and other data which might be useful in laying a substantial foundation for future methods of control. Samples collected have been properly preserved and stored and brought to the laboratory. For handy reference and for permanent storage, the insects collected have been
placed in cabinets. During this first biennium, collections include more than 3000 specimens in mounted, labeled, and classified form. It is planned to continue this same procedure for a few more years, varying the time of making collections so as to include as wide a seasonal variety as possible and making an effort to reach all parts of the state so as to have a fair representation of geographical distribution of destructive species in the state.

Inasmuch as the species with which this project is concerned constitute such a menace to agriculture in the state, it is recommended that this project be given as much encouragement as may be consistent with present economic policy.


(W. W. Henderson. Project 138.)

Miscellaneous Insects Not Related to Alfalfa Production.38 Lizard food-habit studies have shown that a number of insectivorous lizards occur in Utah. Only one herbivorous lizard, the chuckwalla, has been encountered. These studies are being made to determine the benefits derived from lizards in the control of injurious insect pests of range, forest, and farm plants. Each lizard collected is preserved and its stomach contents examined microscopically in the laboratory. The examined stomachs have contained large numbers of grasshoppers, tarnished plant bugs, false chinch bugs, aphids, ants, caterpillars, and many other injurious forms. Studies to date have shown that native lizards are highly beneficial, consistently aiding the farmer and livestock men in their struggle against insect pests.


(G. F. Knowlton. Project 51-A.39)

38Nearly all of the work carried on under Project 51-A has been reported in Bulletin No. 243, in Leaflets Nos. 1-4, 6, 9, 21, 22, 27, 28, and 33, and in Reprints Nos. 227, 229, 230, 235 and 238.
39Project 51-B reported by C. J. Sorenson.
Beet Leafhopper Investigations. During 1932 and 1933 beet leafhoppers varied from scarce to moderately abundant in most sugar beet growing areas of northern Utah. As a result, curly-top damage was severe in but a few scattered, more heavily infested localities; in other areas damage was moderate to negligible, being least injurious during 1933. Fall host-plant conditions could hardly be classed as normally favorable during these two years in the Tooele and Boxelder County breeding areas, and fall populations were below normal. Due to the unusually mild winter of 1933-34, mortality was unusually low, resulting in high spring population. Beet leafhoppers survived in greater abundance in agricultural and desert areas than ever before. A number of males were found to have survived in Tooele County breeding grounds, an unusual condition in northern Utah. By mid-May, large numbers of beet leafhopper nymphs had matured on the breeding areas lying to the south and north of the Great Salt Lake. In the evening, about sunset, the newly-emerged adults were often found to be active, lighting upon the highway and parked automobiles and hopping and flying about actively over the host-plant covered areas. The spring dispersal was noted to have reached northern Utah on April 25, 1932; May 1, 1933; and April 17, 1934; it was much heavier during the spring of 1934 than during the two preceding seasons. The combination of early beet leafhopper abundance and drought suggested the possibility of curly-top injury in many parts of Utah.

A study of beet leafhopper predators further emphasized the importance of the small desert lizard, *Uta stansburiana stansburiana* (B. and C.), as a natural control factor of the beet leafhopper. Several other lizards play less prominent parts in reducing leafhopper abundance in northern Utah desert breeding grounds. Several thousand lizards have been collected and their stomachs examined. Studies of internal parasitism during this period included the dissection of 28,088 beet leafhoppers, which were found to contain 345 parasites, of which 288 were Pipunculum maggots, 45 dryinid larvae, and 12 stylopids.


(G. F. Knowlton. Project 82.)

Psyllid Yellows of the Potato: Insect Aspect. A survey conducted during this period showed that the potato psyllid, *Paratrioza cockerelli* (Sulc), occurred in practically all agricultural areas of Utah. Daily microscopic measurements of potato psyllid nymphs revealed only five nymphal instars in specimens developing under favorable laboratory conditions. Biological-control studies failed to reveal any internal parasites of the nymphs, but a number of insect predators were found to attack the adult and nymphal psyllid. These included the damsel bug, *Nabis ferus* (L.), the big-eyed bug, *Geocoris decoratus* Uhler, and anthocorid bug, predacious syrphid fly larvae, chrysopid larvae, adults and larvae of the convergent ladybird beetle, *Hippodamia convergins* Guerin, adult *H. americana* Cr., *H. lecontei*, var. *uteana* Csy., *H. quinquesignata* Kby., and *H. tredecim-punctata* (L.). A number of insecticides, including nicotine sulphate, pyrethrum, miscible oils and calcium cyanide A-dust, were found to be useful in controlling the nymphs of the potato psyllid; thorough coverage, especially on the underside of the potato leaves, however, was essential to successful control by use of liquid-spray materials.


(G. F. Knowlton. Project 92-B.)

21Disease Aspects reported by B. L. Richards and F. B. Wann.
Mosquito Control. A survey of the more important mosquito-breeding areas of Utah was undertaken during November and early December (1933), in anticipation of the Federal C. W. A. Pest Mosquito Control Project. The purpose back of this project was (1) to drain mosquito-breeding land, thus resulting in certain social benefits and (2) to usefully employ needy and unemployed men. Authorization for this work was received from Washington on December 5, and supervisors and the first of the laborers commenced work on December 8. The setup for Utah allowed 1000 laborers and 19 supervisors. All wages, except those of the project director, were paid from Federal C. W. A. funds. The government also provided a budget to equip the men for carrying on this type of work. Work on this project continued until February 15, 1934, without loss of time because of unfavorable weather conditions.

More than 10,000 acres of wet, mosquito-breeding marsh, slough, and swamp land were drained, resulting in the elimination of large mosquito breeding areas. To drain such a large area of wet land, it was necessary to dig over 550,000 linear feet, or more than 104 miles of open drain, varying in depth from 1 to 17 feet, the average depth being approximately 3 feet, the average bottom width being 3 feet, and the approximate yardage of dirt moved in digging open drains being 268,000 cubic yards. In addition, 20,000 feet of trench was dug for tile drains; gravel and rock were hauled to properly install these drains, the trenches having an approximate average depth of 6 feet and a width of 2½ feet. The 20,000 feet of tile laid varied in size from 6 inches to 24 inches, inside diameter. All tile drain trenches were filled in after the tile was laid and the graveling completed. In addition to the tile, over 300 culverts were installed, which totaled approximately 5000 feet in length and which varied in size from 12-inch iron or wood culverts to 42-inch reinforced concrete pipe, the sections of which weighed 3 tons each. One of these culverts which used such large sections of reinforced concrete pipe, extended for 100 feet under the North Point Canal, west of Salt Lake City. The total man hours represented on the project was 200,000. The total payroll for labor and supervision was $110,500. The tools, equipment, supplies, and other project costs amounted to approximately $12,000. Considering the project as a whole, it was of great benefit not only to those who were able to earn a living from the work, but to the citizens of Utah who will enjoy its benefits. It improved the productivity and real estate value of much land and its benefits reach out in many directions.


Insect Transmission of Equine Encephalomyelitis Studies. The project was first undertaken in September, 1933, when a severe outbreak of brain fever was killing large numbers of horses in various northern Utah localities. The suspicion that insects might be responsible for much or all of the rapid spread of the disease received additional confirmation from Kelser's report that the yellow fever mosquito, Aedes aegypti (L.), readily transmitted this disease from diseased to healthy guinea pigs and from diseased guinea pigs to horses. Native blood-sucking Diptera, including several species of mosquitoes, horseflies, and the black fly, Simulium vittatum Zett., were collected upon horses suffering from brain fever and later fed upon healthy guinea pigs. In other cases the same species were collected, caged upon diseased horses, and then allowed to feed upon healthy guinea pigs. The results of these tests were inconclusive and this work is being continued. Certain taxonomic studies have been necessary in order to recognize the different species with which experiments are being conducted as well as other species of blood-sucking arthropods which feed upon horses and to classify the species used in the experiments.

(G. F. Knowlton. Project 155.)


Also reported by D. E. Madsen, of Veterinary Science Department.
Miscellaneous Insects in Relation to Alfalfa. Problems receiving special attention during the past biennium are as follows:

1. Effect on flower and seed development in alfalfa of the application of insecticidal dusts.
2. The alfalfa-weevil situation and its control.
3. Extent and degree of parasitism occurring in the alfalfa weevil during its current outbreak in Western Millard County and in the Uintah Basin.
4. The degree of hyperparasitism occurring in the alfalfa weevil parasite (*Bathyplectes curculionis* Thoms.) and the species involved.
5. Sporadic and serious outbreaks of injurious insects.

Owing to the necessity of applying calcium arsenate for the control of alfalfa-weevil in first-crop seed fields, the question arose as to the probability of its effect on seed development. As a result, some tests were made in which different plots of alfalfa were dusted with calcium arsenate, nicotine dust, dusting sulphur, and calcium cyanide during bud and full-bloom stages of the plants. Following these treatments observations and record were made of the behavior of buds, flowers, and pods.

In connection with the bi-monthly insect surveys which have been made during the past two summers in alfalfa fields of Western Millard County and the Uintah Basin under Projects 80 and 139, observations and records were also made of the alfalfa-weevil situation relative to extent and amount of damage and of the weevil population in its various stages of development. Serious weevil injury to first-crop alfalfa occurred in 1932 in most of the alfalfa fields of Millard County and the Uintah Basin. In the Uintah Basin where the first crop is customarily left for seed, weevil damage was so serious and widespread in 1932 that little seed was produced.

Record was also made of the number of alfalfa weevil parasites (*Bathyplectes curculionis* Thoms.) which were taken by net. In addition to this, 2836 alfalfa weevil cocoons were collected from 15 sample alfalfa fields in the Uintah Basin during June and July, 1932. In these samples, parasitism by *B. curculionis* was found to range from 55.55 to 100 per cent, with a weighted average for the 15 fields of 70.84 per cent.

While making studies of the degree of parasitism occurring in the alfalfa weevil, in June, 1932, it was observed that *Bathyplectes curculionis* was itself parasitized by certain small chalcid hyperparasites. Of 706 *B. curculionis* puparia, 7.79 per cent were found to be hyperparasitized. The number of hyperparasites emerging from each *B. curculionis* puparium ranged from 1 to 6. All of the hyperparasites bred from *B. curculionis* puparia belong to the Superfamily Chalcidoidea of the Order Hymenoptera. For further identification, these insects were sent to the U. S. National Museum, which reported that in this insect material three different species had been found which were new to science and that a fourth species in the same material appeared to be identical with a new species which was then being described as a parasite of the Hessian fly.

In mid-June the "warrior" grasshopper hatched in vast numbers in the Uintah Basin on the pasture lands situated about a mile east of Hayden. When about half-grown, these insects attracted considerable public attention because of their immense numbers and because their migrations were in the direction of cultivated crops. When the adult stage was reached, the swarm divided into three parts, one of which entered a district consisting mostly of alfalfa fields. The other two portions of the swarm remained in the grasslands. All three portions of the swarm became quite generally scattered so that later in the season some of them could be picked up in most of the area within a radius of 15 miles. On the grasslands where they hatched the adult hoppers remained in a more or less concentrated swarm until October 1, when the last observation of the season was made. No concentrated oviposition was seen during the bi-monthly observations. On May 20, 1933, no newly-hatched hoppers nor egg-pockets were observed in a limited search for them. About June 1 a smaller swarm of these insects made their appearance in the meadows near Hayden. These were mostly destroyed by the applications of poison bran mash. During the summer of 1933 grasshoppers were generally less numerous in the Uintah Basin than in the preceding five or six years.
During the first week of July, 1932, the sugar beet webworm, *Loxostege sticticalis* Linn., made its appearance almost simultaneously in a few alfalfa fields in the Vernal, Roosevelt, North Myton Bench, Lapoint, and Ouray Valley districts. The larval forms occurred in such numbers in each infested field as to threaten serious damage. The alfalfa was destroyed on areas varying from 5 to 20 acres in each field. In all fields the outbreak occurred in association with Russian thistle infestations where the eggs had evidently been laid. As the thistle-food of the insects became depleted, the larvae moved on to and devoured the alfalfa. In most instances control of the pest was obtained by cutting and immediately removing the hay, followed by wire-dragging of the fields. Calcium arsenate dust, applied at twice the amount used for the alfalfa weevil, had little effect on the larvae. Paris green sprayed on the foliage gave fairly good control. As food became scarce in the infested areas the larvae moved on to and devoured most any vegetation which they encountered, including potatoes, leaves of cottonwood trees, willows, and plum bushes, etc. Pupation began about July 15, and after 10 days the emergence of the adult moths was near its height. For nearly a month after July 25 sugar beet webworm moths were numerous in many alfalfa fields and some moths were present in all fields. No eggs nor larvae of the July brood of moths were observed during August and September. During the summer of 1933, while making insect surveys, sugar beet webworm larvae and moths were occasionally observed and collected in the alfalfa fields. However, no injury was observed.

About June 20, 1932, two or three large swarms of Mormon crickets, *Anabrus simplex* Hald., migrated from the mountains or foothills in the vicinity of Jensen, Uintah County, to the banks of the Green River, which formed a barrier to the crickets, preventing their migration to the farm area near Jensen, with the exception of less than a half-dozen ranches located on the same side of the river as the crickets. Upon these ranches all crops, including alfalfa, corn, potatoes, and most varieties of garden vegetables, were completely eaten off to the surface of the ground. On July 9 most of the crickets had laid their eggs in sandy knolls and had then died. On July 17 a few crickets were observed in the same area along the east bank of the Green River. Poison bran mash was used, on a small scale, at the ranches which were being invaded by the crickets. Few of the insects were killed by the poison as their chief purpose seemed to be to migrate rather than to feed, and their numbers were far too great to be fed with the poison baits available at that late date. In 1933 the crickets did not migrate from the mountain and hill areas into the valley.

In July, 1932, great swarms of green stink bugs (Pentatomids) made their appearance in the fields of Western Millard County, including the Snake Valley. According to reports of local farmers, these insects were apparently migrating but would settle down on grain and alfalfa crops, inflicting serious damage to the grain and lesser apparent damage to the alfalfa. From September 22 to 25, 1932, in many alfalfa fields these insects were present in unusually large numbers in comparison with those found during any one of the past six years. Pentatomids did not appear in excessive numbers in the fields of Millard County in 1933.


(C. J. Sorenson. Project 51-B.24)
Chalcis-fly in Alfalfa-seed. During the past biennium studies have been continued on the following phases of the original chalcis-fly investigation:

1. Field populations and seasonal distribution of the alfalfa-seed chalcis-fly and its major parasites as they have occurred in representative alfalfa-seed fields of the Uintah Basin and of Western Millard County.

2. Amount of chalcis-fly infestation in the annual alfalfa-seed crop.

3. Parasites of the seed chalcid, including the degree of parasitism occurring and the species of parasites involved.

Field populations of the alfalfa-seed chalcis-fly and its major parasites, together with their seasonal distribution as indicated by the sweep method of taking an insect census, were ascertained by periodically sweeping during the growing season representative alfalfa-seed fields in Western Millard County and in the Uintah Basin.

Chalcid populations, particularly of overwintering broods in the alfalfa fields of both Western Millard County and the Uintah Basin, were conspicuously less during the summer of 1933 than in any one of the preceding seven summers. Reduced acreage of first-growth alfalfa, left for seed, and the consequent shorter season remaining for seed formation on second-growth alfalfa has greatly curtailed opportunities for multiplication of chalcids. The thorough cultivation of alfalfa-seed fields has destroyed more of the overwintering chalcids in shattered seed which has fallen on the ground during cutting and gathering of the seed crop. Chaff stacks have not been left in the fields over summer during the past two or three years, and this has also undoubtedly been a factor in reducing field populations of chalcids.

From 111 of the field samples collected in the fall of 1932, and an overwintering brood of 15, 116 chalcids emerged in the laboratory; 90.56 per cent were the alfalfa-seed chalcid (*Bruchophagus funebris* How.), 1.88 per cent were the parasite *Eutelus bruchophagi* Gahan, and 7.56 were *Liodontomerus perplexus* Gahan, also a parasite of the seed chalcis-fly. From 48 of the 53 field samples of seedpods collected in 1933 remaining after drawing off 1000-seed samples, 9065 chalcids emerged from the box-cages in the laboratory. Of these, 93.18 per cent were the alfalfa-seed chalcid (*B. funebris* How.), 2.67 per cent were *E. bruchophagi* Gahan, and 4.15 per cent were *L. perplexus* Gahan. A few specimens of *Habrocytus bruchophagi* Gahan and occasional specimens of *Eupelmella vesicularis* (Retz.), both of which species are also parasites of the seed chalcis-fly, were reared from the “fly”-infested pods.


(C. J. Sorenson. Project 82.)

Tarnished and Superb Plant Bugs and Thrips in Relation to Alfalfa-seed Production. Investigational work during this period has included:

1. Studies to ascertain the nature and amount of injury inflicted by *Lygus* (tarnished) and superb plant bugs and thrips to alfalfa plants with particular reference to its effect on seed yields.

2. Life-history studies of *Lygus* and superb plant bugs and of *Frankliniella occidentalis* (Perg), the latter of which is the predominant species of thrips occurring in the alfalfa-seed fields of the Uintah Basin.

3. Studies of field populations and seasonal distribution of the three species of insects as given under (2).

4. Experimental tests for the prevention and control of these insects.

In studies to ascertain the nature and amount of injury inflicted by *Lygus* and superb plant bugs, alfalfa (in prebud, bud, blossom, and pod stages) was caged and infested with plant bugs in various ratios of bugs to plant parts and for varying periods of time. Different stages of alfalfa development were selected in order to ascertain, if possible, in which stage greatest injury was inflicted and the minimum length of exposure necessary to affect the seed productivity of alfalfa. Numerous replications of the tests were made during each growing season. Data obtained in these experiments give evidence that significant injury was caused in nearly all cases.

During the growing seasons of the past two years, life-history studies of *Lygus* and superb plant bugs have been made on caged alfalfa plants
in the fields. Life-history studies of thrips were made during the growing season of 1933; only these were carried on in both field and laboratory.

An annual census of the principal insects infesting sample alfalfa-seed fields in Millard County and in the Uintah Basin was taken by the sweep method at intervals of 10 days or two weeks during the growing season. Included in this work was the census of the two species of plant bugs considered, each species being segregated with respect to nymphal and adult stages.

Various cultural and chemical tests were made during July and August of each year for the prevention and control of Lygus and superb plant bugs and thrips. Early cutting of the alfalfa for hay gave evidence of more effective prevention and control than any other cultural treatment tried. Dusting with black colloidal sulphur, commercial and homemade nicotine dusts, and calcium cyanide dust were all tried in various concentrations. None of those was found effective in destroying either the plant bugs or the thrips. The colloidal sulphur indicated some repelling action against the plant bugs.


GEOLOGY

A Study of Underground Water. The purpose of this project has been to determine the relationship between the annual recharge to an underground basin and the appropriated water now being used through annual discharge. A large number of wells have been measured to determine whether the water-table is rising or lowering. Artesian wells have been measured in the form of static head. An attempt has been made to measure all well water in each valley for the purpose of computing the amount of water drawn from the artesian basin each year. This total amount, correlated with the relationship to the water-table, gives some valuable data as to the safe amount which might be drawn on the average as a dependable water-supply. The field work of this project has been closed and results have been tabulated for early publication. (William Peterson. Project 25.)

HOME ECONOMICS

Study of Factors Promoting Positive Health in Rural School Children. While this project was authorized on September 9, 1931, because of the difficulty in the winter in reaching those farm homes located off main highways, field work was not started until May 1, 1932. The intervening months were spent in completing the selection of children for study, selection and training of three field workers, perfecting forms, and accumulation of necessary equipment. Field work terminated on August 31, 1932. Records of factors under investigation were secured from 56 children, of whom 52 were found to be complete and suited to the need of the study. Since July 1, 1933, food values of all three-day weighed dietaries secured from 56 children have been computed; final checking of this work is still in progress. Tabulations have been made of the other factors studied preliminary to the tracing of relationships. (Almeda P. Brown. Project 118.)

Relative Size of Utah School Children as Determined by Comparing Their Heights and Weights with Baldwin-Wood Norms for the Same Age. Height-weight-age data taken in 1932-33 have been tabulated, and averages, arithmetic mean, and measures of dispersion have been computed. Comparison of averages with the Baldwin-Wood tables showed the following: For all ages the average height of the boys was between Baldwin-Wood averages for short and medium-tall boys. Average heights for girls at ages 6, 7 and 13 were the same as Baldwin-Wood averages for those
ages; heights of girls of other ages were between the Baldwin-Wood averages for short and medium-tall girls. In weight, both boys and girls were between medium and small.

Because of this situation, the present project was organized for the purpose of determining whether urban children of Utah are also below Baldwin-Wood norms, and if so, how much below. The procedure was similar to that followed in obtaining height-weight data from rural children. In order to draw a distinct line between rural and urban children only those school officials in the four largest cities of the state were contacted. After approval of Project 145 (November 24, 1933), all possible speed was made to get winter measurements so that any possible differences due to seasonal variation in growth of children might be eliminated. Officials in three of the cities contacted (Salt Lake City, Provo, and Logan) cooperated satisfactorily, supplying a total of 7472 height and weight measurements for boys and 7118 for girls from 6 to 20 years of age. These data are now being classified according to age groups preparatory to making comparisons with Baldwin-Wood norms and with similar data from rural schools. (Almeda P. Brown. Project 145.)

Rural-Housing Survey.26 Out of 6569 farm homes reported (1930 census), a total of 6020 were surveyed. Of these 6020 homes, 5056 were owned and 964 not owned. All homes visited, in the opinion of the occupants, needed some repair or improvement; 9 per cent wanted to replace the old homes with new ones. The engineers estimated that $11,-575,426 would be required to make improvements desired by these 6020 families. The houses surveyed averaged 5.2 rooms per house, with .99 person per room. Each person had .45 of a bedroom to himself. Although most Utah villages have community water-systems, only 50 per cent of the homes surveyed have kitchen sinks with drains, 35 per cent have bathtubs; 33 per cent have flush toilets. Ninety-one per cent of the 6020 farm homes surveyed have electric lights; 83 per cent have power washers, but only 15 per cent have electric ranges.

Even though all families where homes were surveyed expressed a desire for home improvement of some kind, only 2949 (or 49 per cent) expressed willingness to borrow money for that purpose, even though it were available for long-time loans at a low rate of interest. (The average rate of interest, as expressed by 4693 families, was 3.4 per cent.)

In offering suggestions as to ways in which farm-families might be helped to the enjoyment of better housing conditions, the following is given:

1. The most effective and satisfactory way would be to increase the farmer's purchasing power by assuring him a satisfactory price for his products. There appeared to be a widespread fear of borrowing among the families surveyed.

2. Enlarge the functions of community service agencies. For example, why should a community water commission pipe city water only into the yard of a taxpayer who has helped to construct the system, instead of piping it into his house?

3. Find some means of assisting farmers on unproductive farms, as well as those on farms who are manifestly unsuited to farming, into some industry where they can become self-respecting producers.

(Almeda P. Brown. No No. Assigned.)

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Cooperating Agencies in Utah: Extension Service, Agricultural Experiment Station, and Department of Engineering (Utah State Agricultural College), and State Civil Works Administration and local Civil Works Administration service organizations in areas covered by survey.
HORTICULTURE AND VEGETABLE CROPS

Orchard Rootstocks Investigations. Because of limited time and funds required for variety-testing work, little new work has been undertaken.

The cherry rootstocks orchard at Farmington, although suffering some winter injury in December, 1932, which may tend to obscure the comparisons between the three rootstocks under test, made a good recovery last season, in spite of the fact that a few trees had been killed outright and others had to be cut back to sprouts. This season the trees were pruned heavily to reshape them and they are making a vigorous growth.

Studies in the after-ripening and germination of cherry seed indicate that Mahaleb seed can be after-ripened immediately after maturing in from 12 to 14 weeks. At 33\(^\circ\) F. the seeds were dormant but ready to grow, while at 40\(^\circ\) F. germination was more advanced. Satisfactory germination was obtained by storage in an outdoor coldframe and in a fruit cellar. Seed stored dry until November 1 and then after-ripened gave fair germination, but inferior seed stratified immediately. Seed after-ripened satisfactorily at 45\(^\circ\) to 50\(^\circ\) F. but required 14 weeks and germinated less well than that after-ripened at 33\(^\circ\) and 40\(^\circ\) F. Mazzard seed from certain sources proved to have poor germinating power under all treatments, although that from other sources germinated well but less well than Mahaleb. Mazzard seed required 16 weeks to after-ripen and did not give satisfactory germination then.


Variety Testing. Most of the trees in the variety test orchards at Farmington and Logan were affected in some degree by the unusually early and severe cold weather of mid-December, 1932, when the temperature reached \(-18^\circ\) at Farmington and \(-23^\circ\) at Logan. Many peach trees were killed outright, and the new varieties from the U. S. Department of Agriculture at Palo Alto which had been top worked and which had made a vigorous growth the preceding season were nearly all killed. Fortunately, however, these varieties had been propagated and a new planting was made in 1934. While significant differences in hardiness of tree were observed, none of the hundred-odd varieties of peaches or nectarines under test, with two exceptions, were hardy enough to withstand the low temperatures.

Three new plum varieties proved to be tender; Beauty, Gaviota, and Satsuma, the last being one of the most popular local market plums. Of the new plum and prune varieties, the most promising to date are President, Stanley, Standard, Hall, Duartex, and Waneta.

Of the apricot varieties under test, Cutler, Royal Blenheim, and Derby Early Royal showed winter injury. Tilton, Sophia, and Early Golden bore fair crops, while Moorpark and Large Early Montgamet (Chinese, Jones), the leading varieties in Utah, bore light crops. Of the new varieties two appear to be worthy of wider cultivation in Utah—Tilton and Shense (Acme, Yakimine, "Peach."). Tilton appears to be harder in bud, later blooming, and a more reliable annual bearer than the Large Early Montgamet, which is practically the only variety grown for shipping in Utah.

Of the sweet cherries, Black Tartarian, Napoleon, Early Purple, Chapman, Centennial, Early Burbank, and Lyons appeared to be particularly tender under prevailing conditions. Windsor, Yellow Spanish, Major Francis, and Lambert appeared to be harder than average, with Bing, Giant, Seneca, Black Republican, Abundance, and Gold being average in hardiness. A variety grown to a limited extent at Centerville under the name "Black Oxheart" has been identified as Elkhorn. As grown here, the fruit is fully the equal of Bing and Lambert in size, color, and firmness.
Of the sour and Duke cherries, May Duke and Reine Hortense proved to be somewhat tender. Montmorency Sweet appears to be identical with Early Richmond, which with Dyehouse appears to have the most vigorous tree of the sour cherries.

On the whole, the variety test orchard at Hurricane, in Southern Utah, made an extremely vigorous growth and is bearing a light crop this year, its third season. About 40 new varieties were topworked there last fall, bringing the total number of varieties to over 250 under test.

At Logan, many of the trees suffered severely from winter injury, particularly apples and plums. Many apple trees had to be removed, while others were cut back nearly to the ground. Even such standard varieties as Delicious, Winter Banana, Jonathan, Rome Beauty, Winesap, and Black Twig were severely injured.


Boxelder Experimental Farm. After two seasons’ experimental work in the irrigation and pruning of a bearing peach orchard on stony loam soil, this work was discontinued at the close of the 1932-33 crop season when failure to reappropriate State funds by the State Legislature made necessary the closing of this experimental farm. No data have been published, as there is some question as to whether experiments were continued sufficiently long to permit the drawing of accurate conclusions. Because of the outstanding importance of these problems to the peach industry of the state, however, it is hoped that provision will be made as soon as possible for resumption of research on these and other pressing problems, particularly those relating to orchard soil management. (F. M. Coe. Project 95.)

Washington County Experimental Farm: Orchard Heating and Variety Testing. This experimental farm has been discontinued because of lack of State Funds and orchard heating and vegetable and small fruits work has been discontinued. The variety testing of orchard fruits work has been transferred to Project 95 (Variety Testing of Tree Fruits). The orchard-heating experiment was set up for three seasons, but no actual results from heating tests were obtained because it failed to freeze hard enough to kill the blossoms during these years. The variety test orchard planted in 1932, which now contains over 250 varieties, has made an unusually vigorous growth and will bear a light crop this year. About 40 new varieties were top-worked in the orchard in 1933. (F. M. Coe. Project 119.)

Davis County Experimental Farm. Since this is largely an administrative project, only miscellaneous or preliminary studies are conducted here. Under this project during the past biennium three such studies have been conducted: (1) Tomato Improvement Studies, (2) Sweet Corn Earworm Studies, and (3) Onion Standardization.

The work on tomato improvement of the past two years has consisted entirely of testing out selections made previous to 1931. This work has uncovered several selections of Morton, Livingston Stone, and Indiana Baltimore to be considerably above the average in canning quality and producing power. Because of reduced budgets, it has been necessary to entirely discontinue tomato work.

For several years, sweet corn ear worms have been highly damaging in Utah and information on control measures has been requested. In 1932 several strains of Golden Bantam corn were planted largely as an accommodation to a Federal variety project. Some of those were less suscep-

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26Vegetable and Small Fruit Tests reported by A. L. Wilson.
tible to corn ear worm damage than others. In 1933, 65 strains of the leading varieties were planted, in an attempt to find a non-resistant strain. While there were some differences in respect to the seriousness of worm injury, no strain was outstanding.

The work on onion standardization is one unit of a national variety standardization project under the direction of the Division of Vegetable Crops and Diseases, of the United States Department of Agriculture. In addition to this unit, work is being done at Massachusetts, Indiana, Texas, California, and at Washington, D. C. In 1932 18 varieties, totaling 72 strains, were grown for observation. Notes on growth habits, date of maturity, and bulb characters were made and forwarded to Washington, D. C., for coordination with data from other states.

In addition to these three divisions, the Davis County Farm budget furnishes supervision, land, and facilities for:

1. Fruit Variety Testing—under direction of F. M. Coe.
2. Tomato Disease Studies—under direction of H. L. Blood.
3. Studies in Vegetable Crops and Small Fruits—organized as separate projects but budgeted under Davis County Farm.
4. Other Studies in Vegetable Crops—organized and budgeted as separate projects but carried on in part, at least, at Davis County Farm.

Because of decreased budgets, work at Davis County Farm has been considerably reduced. At present Projects 122 and 126 and the Federal onion standardization work are being carried on in full force. Other projects have been either discontinued or placed on a maintenance basis. Approximately two acres of land was lent in 1933 to the State Emergency Relief Organization for the transient camp garden. About six acres were reduced to alfalfa.


Nature and Causes of Chlorosis in Utah and Practical Methods of Control: Development of Chlorosis-resistant Varieties of Small Fruits. Chlorosis does considerable damage to most kinds of small fruits on limestone soils. It has been observed that some varieties vary in the degree of susceptibility to this disease. It is the object of this study to discover possible resistant varieties and to isolate resistant strains from marketable varieties. Thus far the work has been done mostly with raspberries, strawberries, and grapes. Some currants and some gooseberry varieties have also been included, although neither of these is badly damaged by the disease.

From the 1932 cuttings but 116 vines were obtained; of the 4800 cuttings made in 1933, 80 per cent were alive on June 1. The vines obtained from the 1932 cuttings vary considerably in their resistance. While no single strain was entirely free from chlorosis, 41 vines out of 116 were apparently free from chlorosis on June 1, 1934. Out of 17 varieties of strawberries and 19 varieties of raspberries, no strain was entirely free from chlorosis. However, Premier, Bouquet, Harvest King, Bellman, and Jupiter strawberries give promise of partial resistance. Out of more than 600 Marshall strawberry plants not one was free from chlorosis. Marlboro, Latham, Cuthbert, London and Lloyd George varieties of raspberries contain few to several non-chlorotic plants. (A. L. Wilson, Project 89: 5.2)

Washington County Farm: Vegetable and Small-fruit Tests. Due to lack of funds this project was officially closed at the end of the 1932-33 fiscal year. Consequently, this report includes only the first year of the biennium, when the following studies were under way: (1) Date of planting of vegetable crops, (2) use of plant-forcing devices, and (3) variety tests of vegetables.

None of these studies had advanced far enough to warrant definite conclusions. (A. L. Wilson, Project 120-C.2)

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2Division 1, 2, 3, 4 of Project 89 reported by F. B. Wann (of Botany and Plant Pathology Department).
3Parts A and B reported by F. M. Coe.
Improvement of Sweet Spanish Onions. This project has been practically suspended because of lack of funds. Stocks already isolated are being carried over without any attempt to measure possible improvements. The white selection of Sweet Spanish was almost lost, due to seed crop failure in 1933. It is being built up again from a small quantity of reserve seed. (A. L. Wilson. Project 123.)

Factors Influencing the Keeping Quality of Onions. Two groups of factors are involved in the storage of any perishable agricultural commodity: (1) The inherent properties of the produce and (2) the condition of the storage house. While records have been kept relative to the temperature and humidity of the storage houses, the work of this project thus far has been chiefly to determine the influence of growing and harvesting factors on the storage value of onions. Comparable lots of onions grown or handled in more than 30 different ways were stored in three warehouses, located at Ogden, Farmington, and Bountiful. The Ogden storage is a third floor, well-aerated, and well-lighted warehouse. The Farmington storage is a concrete basement built in a well-drained gravelly constructed onion-storage house. Experimental work was conducted in the basement of this storage house.

Two years' data are now available. Storage losses were much higher in the 1933-34 season than in the 1932-33 season. Both temperature and humidity are important in onion storage; in 1933-33 loss was highest at Ogden, where the temperature was high and the humidity low; during the warmer year of 1933-34, however, loss was heaviest at Bountiful, where the humidity was highest. Apparently the lower temperatures of 1932-33 inhibited the development of decay organisms and reduced losses due to this factor.

Several groups of growing and harvesting conditions were studied as they affect storage. (A. L. Wilson. Project 122.)

The Use of Plant Protectors and Paper Mulch in Vegetable Production. Only one year's data are available on this project. The experimental crops used in this study were tomatoes, eggplants, peppers, cantaloupes, and cucumbers. The following seven types of protectors were used for one or more of the crops: Germaco Hotkap, Saco Hi-Hotkap, Sunray Cap, Homemade Closed caps made from 40 pounds dry waxed paper and 30 pounds stock of Glassine paper, Homemade caps with a \( \frac{3}{4} \) -inch opening at the apex also made from the paraffine paper, and Cylinders made from Celoglass. All types had some frost-protective value, although Glassine and Closed Wax caps were more efficient in this respect than the others. Although most of the plants under some protectors were injured by frost, none of them were killed; 90 per cent of the plants in the open were killed outright by frost. Protectors had considerable value in the successful planting of eggplants. All crops grew more rapidly under protectors than in the open. Larger early yields of tomatoes, eggplants, and cucumbers were obtained from protected plants. Peppers and cantaloupes responded less to the stimulation of the protectors than did the other crops.

From this one year's work it appears that plant protectors have value in forcing tomatoes and eggplants. Whether or not increased yields were sufficient to pay for extra costs was not determined. (A. L. Wilson. Project 124.)

Factors Underlying the Formation of Double Onions and Scallions. The consideration of data thus far assembled in connection with this project warrant the conclusion: (1) That "doubling of onions" occurs in response to relatively high soil nitrate-nitrogen supplies and a favorable environment for photosynthesis and (2) that as nitrate-nitrogen supplies decrease in the soil, bulbing takes place in response to the accumulation of carbohydrates. In one case, the nitrogen-carbohydrate relations (ample soluble nitrogen and abundant carbohydrates) stimulate vegetable growth, causing the plant to branch (double), while in the second case, deficient soluble nitrogen inhibits vegetable growth and stimulates the development of storage tissues. (A. L. Wilson. Project 126.)

Miscellaneous Onion Studies. The expansion of other onion projects in 1932 made it necessary to suspend this miscellaneous project until
some of the other projects were closed; consequently, no work has been done on this project during the past biennium. (A. L. Wilson. Project 127.)

Variety Tests of Small Fruits. During the past biennium this project has been largely on a maintenance basis. The following varieties of strawberries were planted in 1932 and came into bearing in 1933: Blackemore, Bellmore, Corvallis, Rockhill No. 26, Fruitland, Mastodon, World's Wonder, Red Heart, Washington, Jupiter, and May Queen. Of these varieties, Washington, Corvallis, Rockhill No. 26, Red Heart, and Mastodon have promise, and of these Washington is the best. It has a fruit similar to Marshall but is slightly earlier; it is a heavy cropper in its first year. Red Heart is also a good berry but later than Marshall.

The new State Highway crossed over the strawberry plantation, making it necessary to abandon this phase of the project.

The collection of blackberries, raspberries, gooseberries, and currants is being maintained until budgets can be increased. (A. L. Wilson. Project 129.)

Methods of Plant Growing and Plant Growing Structures. The object of this project is to study (1) the relative efficiency of various sources of heat for hotbeds, (2) the value of pots, and (3) the role of transplanting in plant-growing. Thus far, only the first phase has been considered. A comparison has been made of the relative value of manure, electricity, and hot water for heating hotbeds. From the standpoint of the plant itself there is no difference in the ultimate value. This, of course, assumes proper methods of preparation and management of the manure hotbed. Seeds will germinate about two days earlier when hot water or electricity are used than when manure is used. They might grow slightly faster at first. However, there seems to be a nitrogen problem involved in the hot water and electrically heated beds which does not occur in the manure beds. As a result, the rate of growth is then reduced unless nitrogen fertilizer is supplied. Part of this difficulty was eliminated by removal of the cinder insulation beneath the soil. It is still necessary, however, to apply nitrate to the beds in order to maintain green color and a fair rate of growth.

From the standpoint of convenience, safety, and cleanliness the electrically heated hotbed is superior. But from the point of view of operation costs, manure hotbeds are cheaper. (A. L. Wilson. Project 130.)

HUMAN NUTRITION

Effect of Physical Curd Character of Milk on the Quality, Yield, and Physical Texture of Cheese. This project was carried to as near a conclusion as was deemed advisable and the results published in Bulletin 236. The project was closed on June 30, 1933.


(R. L. Hill. Project 106.)

The Chemical and Physical Difference Between Soft- and Hard-Curd Milk. An effort has been made to determine the chemical reasons for the difference between soft- and hard-curd milk. Five samples of soft-curd milk were taken, each one of these from a different cow. Casein in all of these samples was coagulated, purified, and analyzed. The same treatment was given three samples of hard-curd milk. Analyses have been made of samples of casein for the percentage of moisture, percentage of total protein, percentage of ash, total nitrogen, ammonia nitrogen, humin nitrogen, nitrogen in the form of arginine, histidine and lysine. Analyses have also been made to determine the amount of nitrogen present in the total basic amino acids and the total mono-amino acids and the amino acids present in the filtrate after these other amino acids have been removed, as well as for the non-amino acid nitrogen content of the filtrate.
While there are individual variations between all of these determinations, yet there is no change that is characteristic with soft-or hard-curd milk. Results would indicate that curd character of milk is not due to differences in these constituents. (R. L. Hill, Project 136.)

**Relationship of Soft-Curd Milk to Subclinical Mastitis.** This project has recently been submitted to the Office of Experiment Stations for official approval, yet permission was granted to carry on preliminary work under Purnell Project 136. In this preliminary work, 949 tests were run on the relationship of soft-curd milk to subclinical mastitis. The accuracy of the various chemical tests for indicating mastitis was determined and the chloride determination was found to be the most sensible. Taking 14 milligrams of chlorine per 100 cc, as the upper limit for normal milk, it was found that 78 per cent of all cows tested should be classed as having some form of subclinical mastitis; 61 per cent of these cows had a curd test of about 30 grams and would not be classed as giving soft-curd milk; 17 per cent of the 78 per cent were classed as soft-curbed cows; and only 21.8 would have been classed as normal (free from subclinical mastitis). There was a greater prevalence of subclinical mastitis among the soft-curbed cows than was found with hard-curbed cows. Soft-curbed cows, however, were not invariable reactors to subclinical mastitis.

This project will supplant Project 136, which will be temporarily suspended. (R. L. Hill, Project 157.)

**IRRIGATION AND DRAINAGE, PHYSICS, AND SOILS**

**Relationship of Stream Discharge to Precipitation with Special Reference to Forecasting the Supply of Water for Irrigation from Seasonal Surveys of Snow Cover on Mountain Watersheds.** This project involves the measurement of winter precipitation on high watersheds, the determination of watershed characteristics, amount and distribution of early spring and late fall rains, temperature, evaporation, ground storage, and runoff. The measurement of the precipitation and the determination and valuation of the factors causing the water loss constitute the major problems which must be solved before water-supplies can be forecast with any degree of accuracy. During the past biennium the collection of data on snow cover, summer precipitation, and stream-flow has been continued. There are now eleven years of record available on the Logan River drainage area and four years of record on most of the other principal watersheds of the state. The runoff during the entire eleven years of record on the Logan area has been below normal, with a 1930-31 record reaching a record low of 50 per cent of normal. Measurements of snow cover in 1934 indicate that the runoff during 1934 will reach an unprecedented record low of not more than 35 per cent of normal. In spite of the fact that the period of record is short and that it covers a continuous dry cycle, the accuracy with which forecasts have been made indicates that many of the basic principles underlying stream-flow precipitation relationships have been determined.

During the past biennium the network of the statewide snow courses has been properly marked with permanent iron markers set in concrete. The markings on the snow courses were carried out by the Civilian Conservation Corps working under the direction of the Forest Service. The record of snow cover on the Logan, Blacksmith Fork, Ogden, Weber, and Provo Rivers is now sufficiently long to form the basis of fairly accurate stream-flow forecasts. Normals have been established for all of these basins, upon which the forecasts of stream-flow are based.

The high correlation between the snow-cover approaches 8000 feet elevation, and the July-September runoff has been obtained on all of these streams. The low snow-cover (below 8000 feet elevation) and spring rains have been found to affect materially the relationship between the snow cover and the April-September runoff. Forecast accuracy within 10
per cent is the rule for the July-September runoff, but further refinements in modifying factors will be necessary before a high degree of precision can be obtained in the April-September forecast.

The snow cover of 1932-33 indicated a runoff of approximately 70 per cent of normal, and the actual runoff during the summer of 1933 approached that figure. The fall of 1933 was extremely dry and the winter which followed was mild. The unusually mild winter made it desirable to make special observations on the watersheds. On February 1 a snow survey on the Provo River watershed indicated: (1) A light snow cover with extremely dry soil at 10,500 feet elevation; (2) winter melting up to 9000 feet elevation; and (3) an almost complete absence of snow below 7000 feet elevation. February and March precipitation did not alter this condition on the watersheds, as was indicated by the annual survey made on April 1.

The water-supply forecast was issued immediately upon the completion of the April 1 snow survey. This forecast has played an important part in crop-planting for the 1934 season; it emphasized the seriousness of the pending water shortage and was largely responsible for setting in motion, by the Governor, the Water Conservation and Drought Relief program which has been so effective in reducing the serious effects of the worst water shortage in the history of the state. (George D. Clyde. Project 72.)

A Study of Some Factors Which Influence the Reclamation of Waterlogged and Alkali Lands. During the past biennium considerable time has been devoted to the presentation of technical articles concerning the movement of underground water. Hydrodynamic theory leads to the conclusion that the pumping of water for irrigation or drainage from small-diameter wells involves an expense due to friction loss in the water-bearing gravel. Experimental studies covering a period of years have suggested the possibility of effectively enlarging the well diameter by constructing a so-called well battery. The determination of the effective diameter of such a battery is a matter of hydrodynamic theory, and the solution of this problem has led to some interesting results. A comparative study of the saving in power cost and its general bearing on the design of structures aiming at the control of underground water has led to considerable amount of theoretical work.

A special phase of this work has been conducted cooperatively with the Botany Department. Capillary potentiometers and special double-walled auto-irrigators have been installed for plant studies requiring control of the capillary potential.

A special meter has been designed, constructed, and tested out for the direct measurement of the flow of moisture in the soil.

Some work has been done on the use of the photo-electric cell for measuring the turbidity of soil suspensions with the ultimate aim of completing by this means an effective method of making mechanical analysis of fine-grained soils. A laboratory study is now being made to give an experimental test of the theoretical performance of a well battery.

Since the theoretical phases of the broad question of groundwater, and its control and development, are not thoroughly understood, it is proposed to continue to make applications of hydrodynamic theory to the solution of practical problems. It is particularly desirable that methods of rehabilitation of sodium-saturated soils be given careful study. It is apparent also that the development of underground water for irrigation should form an important coordinated problem for study and research with the farmers throughout the state. It is difficult to realize that in the face of a shortage of irrigation water for the tillable soils of our state, large quantities of underground water are permitted to go to waste, at the same time water-logging and rendering alkaline many thousands of acres of otherwise valuable soils.


(O. W. Israelsen, Willard Gardner, and D. S. Jennings. Project 17.)

A Study of the Factors Influencing the Financial Condition of Certain Utah Irrigation and Drainage Projects. During the past biennium attention has been given to the organization and financial activities of each of the four Millard County Drainage Districts as well as to the four irrigation companies located in this section. A manuscript entitled "Financial Problems of Certain Utah Drainage and Irrigation Enterprises," has been prepared for proposed publication. (O. W. Israelsen. Project 90-A.29)

Water-application Efficiencies in Irrigation and Their Relation to Irrigation Methods. The object of this project is two-fold:

1. To make a survey of irrigation conditions, practices, and methods in Salt Lake and Utah Counties on lands supplied with irrigation water from the Utah Lake.

2. To make extensive studies of water-application efficiencies and their relation to irrigation methods.

Under (1) it is planned to measure water delivered to canals, conveyance losses, canal wastes, farm deliveries, runoff losses, irrigated areas, size of farm streams, length of irrigation runs, time rates of water-application, depth of water at each irrigation, and other important farm irrigation practices. Under (2) it is planned to select typical farms and to measure at each irrigation: water delivered, runoff, water stored in soil, deep percolation loss, and water-application efficiency.

In broad perspective, this project represents a cooperative effort to apply scientific methods and research procedure to the solution of pressing irrigation problems on lands irrigated with water from the Utah Lake and the Jordan River. It is hoped that the project will demonstrate the practicability and the wisdom of making a thorough study of irrigation practices and methods and requirements in advance of, and in part as a basis for, far-reaching court decisions relating to water-rights. (O. W. Israelsen and George D. Clyde. Project 151.)

Technical Studies of the Physical and Physico-Chemical Properties and Processes in Soil. During the past biennium work has been continued on (1) the activity of the replaceable basis in soils and (2) base-reaction studies. It was essential in the work on activity to know precisely the amount of chlorine retained by the finer portions of soil material after that material had been treated with a neutral chloride of the base and washed free of soluble salt. For this purpose the silver-silver-chloride electrode was used to develop the technique of preparing these electrodes. Progress in this technique has been satisfactory and electrodes can now be prepared that are both constant and reproducible; the minute quantities of chlorine retained by the soil colloids have also been measured. These measurements, together with those of several years past on the activity of the replaceable bases in soils, as determined by the sodium electrode, have been partially assembled in tables and parts of a technical paper prepared.

Data on base reaction in soils in this study show that calcium enters the soil ten to fifteen times as readily as does sodium; therefore, a calcium salt even in the presence of large quantities of a sodium salt will remove replaceable sodium from the soil. Equilibrium studies with potassium salts have been made; it has been found that potassium also enters the soil four or five times as readily as does sodium. Calcium enters the soil one and a half or two times as readily as potassium. If the exchange complex of the soil is high in calcium, the soil is in much better physical condition than if the exchange complex is mainly sodium. Evidence has been obtained which shows that friability is greater for calcium colloids than for sodium colloids. (D. S. Jennings, Willard Gardner, and O. W. Israelsen. Project 12.)

Subprojects B, C, and D reported by D. S. Jennings, J. A. Geddes, and W. P. Thomas, respectively.
Soil Survey. At the urgent request of state officials, a soil-survey party consisting of one representative from the U. S. Bureau of Chemistry and Soils and one representative from the Utah Agricultural Experiment Station began a detailed soil survey of Carbon County early in December (1933). About December 20, bad weather necessitated a change of location. Accordingly, the party began work at Hurricane in Washington County on December 29, continuing until January 31, 1934. During this time the field work for approximately 20,000 acres was largely completed. This area (which lies in Township 41 South, Range 13 West, and in Township 42 South, Range 13 West) as well as several small areas adjacent at the south and at the southwest corner of Township 42 South, Range 13 West, was mapped on a scale of 2 inches to the mile. On February 1 the party returned to the Carbon County area; a detailed soil map covering most of the agricultural area of this county is nearing completion. The scale of this map is also 2 inches per mile.

In both the Washington and the Carbon County Areas soil-mapping is in sufficient detail to furnish the necessary field data, from the agronomic point of view, for a land-use classification map. A good beginning has also been made on detailed soil classification and crop-mapping work in Salt Lake County. (D. S. Jennings. Project 49.)

A Study of Factors Influencing the Financial Condition of Certain Utah Irrigation and Drainage Projects: Soil Productivity Aspects. During the early part of the biennium, in cooperation with the subproject leaders of A, C, and D, a crop map was made of the Delta Area, the detail of which is comparable to one made in 1918 in cooperation with the Bureau of Chemistry and Soils. These maps show the use made of the land during those years as indicated by the following classification: Alfalfa, grain (small), corn, beets, abandoned (old), abandoned (new), and virgin. During the latter part of the biennium the crop-map data were reduced to tables which will make possible any correlation that might exist between the use of the land as indicated by this crop classification and the soil type.

The physical and chemical measurements of the samples of soils collected from the profiles of the various soil types of the area were completed during the biennium and the data partly arranged in tables. Determinations of the types of alkali salts found in several different localities of the area have also been completed. Laboratory and field work has been completed. (D. S. Jennings. Project 90-B.)

RANGE MANAGEMENT

Range Reseeding and Native Forage Plants. In a spacing test with mountain brome grass (Bromus polyanthus), plants in their third season yielded less volume than in the second year. The greatest decline was with 6-inch spacing, which appears to be too close to maintain thrifty plants. A slightly higher yield of the 18-inch spacing in comparison with the 12-inch also suggests an advantage of the greater space with advancing age of the plants. These yields were a reversal of second-year results.

Seed of Karroo bush (Atriplex halimus), supplied by the Forest Service, gave low germination in the greenhouse and almost none in the field, but a few plants established. The largest grew to a height of 2 feet in the one season and produced 12 branches. Plants left outside were winter-killed. Two bushes that were cut back and transplanted into kegs in the greenhouse produced some 30 inches of new growth over winter. Propagation by cuttings was demonstrated in the greenhouse. This species is not hardy in the Upper Sonoran Zone.

Cliff rose (Cowania stansburiana) produced fair germination in the greenhouse and a few plants from field plantings. Average height growth the first season was about 8 inches, with an additional 20 inches during the second season.

Subprojects A, C, D reported by O. W. Israelsen, J. A. Geddes, and W. P. Thomas, respectively.
Bluestem wheatgrass (*Agropyron smithii*) was used in planting rootstocks of 1-, 2-, 3-, and 4-inch lengths at depths of 1, 2, 3, and 4 inches in the greenhouse. Satisfactory growth was secured from the 3- and 4-inch lengths at 1- and 2-inch depths. Check tests under dry-farm conditions were a failure in 1933 which was an extremely dry year. However, small chunks of sod established successfully. Range plantings of miscellaneous species in Transition and Canadian Zones were also practically eliminated by the drought of 1933. (R. J. Becraft. Project 61.)

**Corn and Cottonseed Cake as Concentrated Supplement for Watering Sheep on Desert Ranges of Utah.** A second season of winter field work was conducted at Troutcreek, Utah, from December, 1932, to March, 1933. A second series of forage samples for chemical analysis was collected, these practically duplicating the collection of the previous year. The list follows:

<table>
<thead>
<tr>
<th>Species</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Brigham tea</td>
<td>6</td>
</tr>
<tr>
<td>2. White sage</td>
<td>4</td>
</tr>
<tr>
<td>3. Rice grass</td>
<td>3</td>
</tr>
<tr>
<td>4. Shadscale</td>
<td>6</td>
</tr>
<tr>
<td>5. Russian thistle</td>
<td>6</td>
</tr>
<tr>
<td>6. Blue sage</td>
<td>6</td>
</tr>
<tr>
<td>7. Rabbitbrush</td>
<td>4</td>
</tr>
<tr>
<td>8. Curly sage</td>
<td>4</td>
</tr>
<tr>
<td>9. Brown sage</td>
<td>6</td>
</tr>
<tr>
<td>10. Curly grass</td>
<td>6</td>
</tr>
<tr>
<td>11. Yellowbrush</td>
<td>6</td>
</tr>
<tr>
<td>12. Fourwing saltbush</td>
<td>3</td>
</tr>
<tr>
<td>13. Matchweed</td>
<td>6</td>
</tr>
<tr>
<td>14. White cedar</td>
<td>5</td>
</tr>
<tr>
<td>15. Salt sage</td>
<td>3</td>
</tr>
<tr>
<td>16. Bud sage</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>75</td>
</tr>
</tbody>
</table>

These forage samples were delivered to the Chemistry Department for chemical analysis; a small sample of each species was retained in a display bottle.

Data were reported on plant types, species habitat, and palatability, grazing capacity, general range conditions, and sheep movements.

Collection of herbarium specimens for accurate identification of plants was made in 1932 and in 1933. This material has been identified and the mounted specimens have been incorporated in the Intermountain Herbarium (Project 135). Photographs of herbarium sheets of the 16 important species have been made. (R. J. Becraft. Project 132.)

**Miscellaneous Flood Control Studies.** This project, continued during the summer of 1932 as the "Utah Flood-Erosion Survey," was in cooperation with the Utah State Land Board and the Intermountain Forest and Range Experiment Station (U. S. Forest Service). Examination of flood drainages has been completed, a classification of land ownership on these critical watersheds being obtained from records of the U. S. Land Office, Utah State Land Office, and various counties. Additional work in 1933 was conducted by the Forest Service in connection with State C.C.C. camps. (R. J. Becraft. No Number Assigned.)

**RURAL SOCIOLOGY**

**Studies of Utah Towns and Villages.** During the past biennium, work has involved a study of: (1) Mobility of population in Plain City and (2) comparative use of community agencies of the home town and of other towns by the four groups under study at Plain City, Tremonton, and Lewiston.


(J. A. Geddes. Project 88.)

**A Study of Factors Influencing the Financial Condition of Certain Utah Irrigation and Drainage Projects: Sociological Aspects.** In view of

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^1Project 132 also reported by E. J. Maynard and A. C. Esplin.
the fact that the four project leaders have agreed that 90-C should be the latest of the four studies to be published and that a pyramiding of results be attempted through each leader taking account of the data in the preceding unit, active work on the completion of this project has been delayed pending the completion of the units which precede it. However, the field studies of 90-C have been partially tabulated. The division dealing with mobility of population of the areas has been completed and reduced to manuscript form. (J. A. Geddes, Project 90-C.2)
LEAFLETS

25. **Short-hole Borer or Fruit-tree Bark Beetle.** By C. J. Sorenson. April, 1934. 3 pp.
31. **Peach Tree Borers.** By C. J. Sorenson. April, 1934. 3 pp.
32. **Seed Potato Treatment.** By B. L. Richards. March, 1934. 4 pp.
33. **Chlorosis.** By F. B. Wann. May, 1934. 3 pp.
44. **Common Diseases of Baby Chicks.** By D. E. Madsen. May, 1934. 4 pp.
45. **Control of Damping-off Disease of Seedlings.** By H. H. Smith. May, 1934. 4 pp.
RECOMMENDATIONS

The Agricultural Experiment Station as a research agency has a distinct function to perform with respect to the rural problem of Utah and it is anxious to have that function generally recognized as a guide to its own activities and also as a suggestion to other agencies of how Station activities may be most effectively coordinated with theirs.

During the biennium, and particularly during the last year, it has been possible to extend effective cooperation with various state and federal agencies in assembling data of basic value as a background against which to project the Station's research program. This cooperation is being continued, and it is recommended that it be continued indefinitely not only as a means of securing basic data, but also as a means whereby the closest possible relationship and coordination of interest with other agencies may be maintained.

The funds made available to the Experiment Station by the last Legislature represented a reduction of 60 per cent from those available during the preceding biennium. This has clearly limited the research program, but, by exercising every precaution, the Station was able to operate within its curtailed budget. In doing this, however, it has had to abandon some projects and to refrain from activity in fields demanding attention. The inadvisability of continuing on such a reduced scale should be generally recognized. Hence, it is recommended that every effort be made, consistent with state needs, to restore the Station budget as rapidly as possible.

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