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Bulletin No. 306 - Report of the Agricultural Experiment Station
Utah State Agricultural College, Logan

R. H. Walker

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AGRICULTURAL RESEARCH IN UTAH

Bulletin 306

Report of the Agricultural Experiment Station
Utah State Agricultural College, Logan

July 1, 1940, to June 30, 1942
President E. G. Peterson,  
Utah State Agricultural College,  
Logan, Utah.

Dear President Peterson:

I present herewith a summary of the research of the Agricultural Experiment Station for the biennium ending June 30, 1942.

Respectfully submitted,

R. H. Walker  
Director.
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AGRICULTURAL RESEARCH IN UTAH

The agricultural experiment stations have contributed in a very material way to the progress of agriculture in the United States not only by the development of better crops and livestock and production practices, but, through basic research on the many and varied problems of agriculture, they have furnished an understanding of those principles upon which progress must depend.

The permanent value of these research centers to the progress of agriculture is no better illustrated than in the present emergency. The ability of farmers to meet the tremendous additional contributions to defense in the way of increased food supplies is dependent in no small way upon the application of knowledge that has been obtained through research in experiment station laboratories over the past decades. As never before, the war production program in agriculture has demonstrated the importance of agricultural research. Without the application of the improved production methods discovered in the research fields and laboratories of experiment stations, the goals set by the Secretary of Agriculture would have been outside the realm of accomplishment. The use of better feeding practices to increase egg, milk, meat and wool production; the control of plant diseases and insect pests; and the breeding of new plant and animal varieties are but examples of the importance of such research.

When emergencies such as the present arise, experiment stations are confronted with many additional tasks that are pertinent to the problems of the moment. In the interest of national welfare the stations have and will continue to lend their full support to the solution of these problems. In doing this, however, they must not lose sight of the fact that basic research in the problems affecting agriculture must be continued. Such research is the best guarantee of preparedness to meet the next emergency. By its very nature much of the research into the principles and practices basic to continued agricultural welfare requires a long time. In order to have facts to meet the problems that will confront the farmers 5, 10, or 20 years hence research should go on as uninterruptedly as possible.

One major service that the stations can render to farmers and the nation in the present emergency is to marshal the facts now available and get these to the people in usable form. This the Utah Station has attempted to do through articles published in the quarterly, Farm and Home Science, as well as by publication in the daily press and by meetings and field trips with farmer groups.

The Utah Agricultural Experiment Station during the past biennium has attempted to reorient its research program to meet the needs of a war economy. Station projects have been examined to find wherein they could be revised to meet the war situation more fully. A number have been dropped and new projects initiated that are more timely.
PROGRESS REPORT ON PROJECTS UNDER INVESTIGATION DURING THE BIENNIAL 1940-42

Much of the work of the Station is conducted in cooperation with various federal, state, and private agencies. The U. S. Department of Agriculture, through cooperative memoranda of agreement, has assigned a number of its scientific personnel to the station to aid in the investigation of various problems. Financial support is also given by state and private agencies, so that much of the work now underway would be impossible were it not for support other than that made by regular state and federal grants. Consequently these various agencies should receive much credit for the progress of the work herein reported.

AN ANALYSIS OF THE ECONOMIC PROBLEMS OF UTAH'S AGRICULTURE

During the biennium, a number of investigations have been conducted on economic problems confronting Utah's agriculture. These studies include: (1) A study of farm organization by farm types and enterprises. The objective is to study farm types as they relate to the use of resources and to determine factors to measure the success of farm business. (2) An economic analysis of agricultural resources by areas as they relate to developments, efficient use, and to the number of people to be supported; also the development of a technique for the economic classification of irrigation and range lands. (3) A study of availability, use and limitations of agricultural credit in Utah. Emphasis has been given to the cause of country bank failures during depression periods, and the change in the agricultural mortgage situation for various periods and by areas. (4) Marketing studies to determine natural channels of sale of Utah agricultural products, competition of other areas, marketing costs, present efficiency of marketing methods, and opportunity of improving marketing conditions in the state.

Economic analyses have also been made of the agricultural price situation, agricultural labor situation during the war emergency, marketing and outlook conditions for special crops, livestock and livestock products, and economic data on Utah's agriculture for setting agricultural production goals for 1942 and 1943.
STUDIES OF FARM ORGANIZATION BY TYPES AND BY ENTERPRISES

FARMS IN SANPETE AND SEVIER COUNTIES

This study presents a description and use of the agricultural resources in Sanpete and Sevier Counties and adjacent grazing areas in Juab, Piute, Millard and Beaver Counties, and a farm business analysis by types of farming. The farm types studied were general irrigated farms, sheep ranches, lamb-feeding enterprises, beef-cattle ranches, and part-time farms.

There is a close relationship between irrigated farms and grazing in Sanpete and Sevier and the adjacent counties. As a result of the available grazing and farm-feed resources, livestock production is the major farm enterprise in the area.

Factors closely related to success of the farm business were: type of farming, size of farm business, efficiency in use of capital and labor, and rates of production.

Availability of resources, size of the operating unit, and rates of production were favorable to sheep production. Of the total feed fed to sheep, 81 percent came from grazing, or sheep were grazed 9.7 months out of the year.

Farms where lamb feeding was a major enterprise had larger and higher crop yields and larger returns than the general irrigated farms of the area. Farms growing cash crops in addition to feed crops and feeding lambs were more profitable.

The small size of the business on general irrigated farms was the major reason for the low income. This could be increased by enlarging the size of farm business, either through additional acreage of farm and range land or through more intensification of enterprises.

The relatively low income on beef-cattle farms was the result of producing beef cattle on irrigated farms under conditions where, because of lack of range resources, cost of production was high. This high cost was the result of a relatively long feeding period, operation of a small unit, and inefficiency in production. Income was considerably higher on the group of farms where cash crops were grown.

Part-time farms were less intensively cultivated than the full-time general irrigated farms. To place these farms on a paying basis or obtain sufficient income to support a family, the size of the farm unit, rates of production, and labor efficiency should be increased. The reorganization of farm business is also needed in order to provide more intensification and a better balance between feed, cash crops, and livestock production (1).
Farms Having Dairy Enterprises in the Ogden Area

This study is based on business records for the three crop years 1937, 1938, and 1939 on farms in the Ogden milkshed area, which includes Weber and Morgan Counties and the southern part of Box Elder County.

The average investment in real estate, livestock, machinery and supplies was $14,207 per farm. The average acreage was 135.6 of which 42 acres were irrigated cropland. An average of 10.2 milking cows were kept. About 20 acres of alfalfa hay were grown per farm. Other important crops were: sugar beets, 5.8 acres; barley, 4.4 acres; irrigated wheat, 4.0 acres; and potatoes and peas, 2.2 acres each. The index of crop yields was 136 (state average 1926-31=100). Butterfat production per cow was 256 pounds.

The labor earnings averaged $881 per farm. The factors most closely related to the amount of the labor earnings were: (1) size of the farm business; (2) crop index; (3) pounds of butterfat produced per cow; (4) efficiency in the use of man labor; and (5) the proportion of farm resources devoted to intensive cash crops.

The farms that were below average in all of the factors mentioned and also in the price received per pound of butterfat, and in man-work-units per $100 of capital averaged but $278 in labor earnings. As the number of factors better than average increased from 1 to 7, labor earnings increased from $286 to $3,596. It not only paid to be better than average, it paid to be from 10 to 20 percent better than average in these factors. The range in average labor earnings for farms with 0 to 5 of these factors at least 10 percent better than average was from $384 to $1,930.

The average returns for man labor from the milking enterprise were $29 per cow or 18.4 cents per hour. The most important factors related to the returns for man labor were: (1) the production of butterfat per cow; and (2) the price at which the butterfat sold, which was largely a matter of whether the milk was sold for distribution as whole milk or for processing.

Economic Analysis of the Weber Central Dairy Association

A business analysis of the Weber Central Dairy Association was completed as a part of a general study made in the Ogden milkshed on dairy production and marketing (2).

In April 1924, the Weber Central Dairy Association was organized, handling at first principally market milk, but later the production of sweet cream butter and milk powder. Seventy-five percent of the butterfat delivered to the association is now used for the manufacture of butter, 13 percent is sold as cream, and 11 percent as market milk.

The association has been successful in putting out high quality dairy products, maintaining an excellent membership, and handling a large
volume. It has played an important role in developing the dairy industry in the Ogden area.

Beginning practically without membership capital in 1924, the association, through a 2 cent per pound butterfat retain plus the retain of a two-week milk check on two occasions, built up membership equity of $136,000 in ten years. At the close of 1939, a plan for revolving membership equity was inaugurated. Instead of the previous practice of distributing patronage dividends in cash, certificates of equity equal to 1 cent per pound of butterfat delivered during 1939 were issued to patrons, and a corresponding amount of outstanding certificates retired.

The association has followed the policy of paying interest (usually 4 percent) on membership equity. The ratio of current assets to liabilities has usually been about 2 to 1, which is a satisfactory ratio for such associations. The financial history of the association has thus been one of consistent progress.

In 1933, there were 1,139 patrons who delivered an average of 1,144 pounds of butterfat, as compared to 1,376 patrons and 941 pounds in 1938. This decreasing volume per patron constitutes a problem, for small quantities increase the difficulty of quality maintenance and entail greater cost per pound of butterfat handled.

The policy inaugurated in 1939, of paying differential cash patronage dividends ranging from one-half cent per pound for patrons delivering less than 600 pounds to one and three-fourths cents for patrons delivering more than 3,600 pounds of butterfat, was a move in the direction of furnishing additional incentive to larger patrons.

Returns to producers have been made on the basis of classes and grades. For the years 1934-38 the average return per pound of butterfat in market milk was 41.44 cents, in milk for manufacture 35.58 cents and in cream 31.17 cents.

The association’s plant has sufficient capacity to handle a considerably greater volume. Additional volume would increase efficiency of operation and thus reduce per unit manufacturing costs.

A cow testing program was inaugurated in 1938. By July 1941, there were 1,200 cows on test, or about 20 percent of those owned by association members. The association has also assisted its members to improve their herds by extending loans for purchase of bulls. Farmers have been assisted in improving their pastures by better cultural methods on the permanent pastures and by seeding cropland to pastures in a rotation system.

**AN ECONOMIC STUDY OF SHEEP PRODUCTION**

Complete financial and operation records for 1939 and 1940 were made on sheep ranches in Washington, Iron and Beaver Counties.

The size of the ranching units varied considerably. The smallest operated
only about 200 stock sheep while the largest operated several thousand. The average of all ranches was 1,405 head. The average investment was $41,485 of which about 10 percent was owned by the operator. In addition, considerable use was made of National Forest and Division of Grazing lands. The average ranch grew 48 acres of crops most of which were for livestock feed. The average labor earnings were $2,790. The return on capital was 9.2 percent. The profit from the sheep enterprise was $2,278 or $2.01 per breeding ewe.

The variation in profits per ranch was large and was closely related to the number of sheep. Ranches with fewer than 250 ewes made profits of $357 while those with more than 1,500 ewes made profits of $4,280. However, the profits per ewe were lowest on the largest ranches.

In addition to the number of ewes operated, some other factors closely related to profits were: (1) percent lamb crop, (2) value of the fleece shorn, (3) percent death loss of the stock sheep, (4) lamb weights at marketing time.

LAND UTILIZATION AND FARM ORGANIZATION BY FARM TYPES IN SOUTHWESTERN UTAH

Farm business surveys have been made on over 350 farms and ranches in Beaver, Iron and Washington Counties. Data on agricultural resources and their proper use have been collected. These data together with those from farm records are being summarized and analyzed to determine: (1) The present farm and ranch situation, including the characteristics and use-capacities of the natural resources, the control and use of the resources, and the types and relationships of farm and ranch operating units. (2) The factors affecting the production and distribution of income and those that determine success of the farm and ranch business. (3) Desirable directions of adjustment in the control and use of resources, and an appraisal of possible means of adjustment, together with changes that might be made in ranch and farm organizations, to increase their efficiency.

BEEF CATTLE PRODUCTION IN RICH COUNTY

The cattle ranching industry developed in Rich County primarily because cattle utilize the forage produced there better than any other class of livestock. Climatic conditions limit the crops grown to the most hardy hays and cereals; almost 90 percent of crops consists of meadow hay. The area surrounding the cultivated land provides good grazing for livestock for about 7 months in the year and native and meadow hay are used to supplement the grazing.

The ranches which were operated most successfully were diversified in their enterprises. They had less capital invested per productive animal unit,
calf crop and pounds of meat produced per animal unit were higher, death losses were lower, and labor was utilized more efficiently.

The following general conclusions can be drawn from the study: (1) Ranchers in this area could increase their net returns by increasing the amount of productive livestock operated. This would enable them to use labor and capital more efficiently and reduce overhead costs of operation. This is particularly true for the smaller ranches. (2) Improved breeding stock and better operation practices on many ranches, some of which are now getting less than a 60 percent calf crop, would increase the returns to the operator. Calf crops of 80 to 85 percent can be obtained economically by most operators. (3) Since the sale of cattle represents the source of most of the income, the amount of beef produced per unit is an important factor influencing returns. Pounds turnoff per cattle unit should not be less than 300. (4) Most ranchers in this area have too small a proportion of their capital invested in productive livestock. It is quite generally accepted that 33 percent or more of the capital should be in livestock. However, the average rancher in Rich County had only 27 percent of his investment in cattle, sheep, dairy and other productive livestock.

**Production and Marketing of Turkeys**

The expansion of the turkey industry in Utah during the past few years has been accompanied by serious problems of production practices, diseases, financing, and marketing. Growers in Box Elder, Cache, Sanpete, and Sevier have been contacted and promised cooperation in a study of these problems. Record books are being kept by the growers and these data will be supplemented with information from feed companies and turkey processing plants.

**Utah's Agricultural Resources and Their Utilization**

**Correlation of Results of Studies of Soils, Irrigation, Range and Economics in the Uinta Basin**

Out of this study a technique has been developed for making an economic classification of irrigated farm lands. As applied to Uinta Basin lands (3), this technique involves the making of two classifications; (1) a classification based on the present use of soil and irrigation water; (2) a classification indicating what might be the most desirable use of soil and water over a relatively long period of time. In the present use classification the following classes of land were set up: A, relatively satisfactory soil and water conditions; B, adjustments in soil and water use desirable; C, adjustments in soil and water use imperative; and D,
land largely not irrigated but good enough to irrigate. Of the total land classified, only 33,763 acres were in class A, while 54,483 acres were in class B, 62,436 acres in class C, and 50,206 acres in class D.

In the classification depicting desirable future use, three classes were set up: Class II which is primarily adapted to grazing; class V which is adapted to extensive irrigated farming, and class VI more intensive irrigated farming. These classes are part of a scheme of classes ranging from I to XI which will cover the entire state. In classes II, V and VI were placed 102,647, 86,643 and 11,602 acres, respectively. In a normal year sufficient water will probably be available with the present storage facilities to provide a full supply for about 77,000 acres. Some additional flood waters will be available which may be applied to pasture lands in classes V and VI and also some in class II.

**Agricultural Credit and Farm Mortgage Debt**

**Farm Mortgage Indebtedness in Utah, Weber, Cache, and Sevier Counties**

In this study, all farm mortgage indebtedness in Cache, Weber, Sevier, and Utah Counties outstanding in 1920 and 1934 was plotted on maps. In addition to these maps the following statistical data were tabulated and compiled: (1) Total outstanding mortgage debt by county for 1920, 1925, 1930, 1935. (2) These totals were broken down to show the senior and junior obligations and the amounts held by the following classes of mortgages: guardians of estates, personal or individual lenders, insurance companies, mortgage and loan associations, State Land Board, federal land banks, national and state banks, and business firms such as lumber companies.

**Farm Indebtedness in Box Elder County**

A study of farm indebtedness in Box Elder County by lending agency, type of loan, and subarea showed the following:

There were, as of May 1940, 2,952 unreleased real estate mortgages recorded on the county records with a face value of $9,184,583. Because face value of recorded mortgages is an overstatement of present indebtedness, an attempt was made to determine present value of mortgage debt from the various mortgages.

The information obtained from mortgage holders showed that the total outstanding real estate mortgage indebtedness for the county was $4,551,349. This amount is approximately $1,000,000 above the 1930 census figure and probably represents a fairly accurate picture of the farm mortgage indebtedness of the county.

There was an average farm indebtedness of $2,610 for each of the
2,327 farmers in the county. This indebtedness was $3,336 in the dry-farm area; $3,306 in the livestock area; $2,984 in the general farming area; $1,148 in the fruit area; and $701 in the Mantua area.

Approximately half of the total indebtedness was owed by farmers located in the general farming area; 26 percent by the farmers in the dry farm area; 121/2 percent by the farmers in the western livestock area; 10 percent by the farmers in the fruit area around Brigham City and Willard; and 1 percent by the farmers in the Mantua area.

A little more than half of the farm debt was lent by the Federal Land Bank and Land Bank Commissioner, about one-seventh was held by commercial banks, and about one-seventh by individuals. A check of the mortgagees shown on the records of the county revealed the fact that the Federal Land Bank was the only major lending agency which assumed the responsibility of recording the releases when the mortgage was paid. The general practice of the other lenders has been to place the responsibility upon the borrower, who, in a large proportion of cases, has failed to file the release.

A large sample of the mortgages still on record in the county recorder’s office was checked to determine present status of the loans. Results showed that more than 50 percent had been released by the lender but no release had been filed. The state statutes definitely place this responsibility upon the lender and considerable confusion and expense could be removed if this provision were enforced.

CAUSES OF COUNTRY BANK FAILURES

The study on the causes of country bank failures in Utah showed: (1) Average deposits per bank of the closed banks were approximately two-thirds as great as for the surviving group. (2) Total investments of the open banks were approximately six times as great as for the closed banks. The closed banks had about the same amount invested in stocks but the open group had eight times as much invested in bonds. (3) Prior to the depression, open banks had about 24 percent of their deposits invested in securities compared with 5 percent for the closed group. (4) The closed banks had a much higher percentage of their securities pledged to special creditors than did the open banks. (5) The open banks had greater diversification which was of doubtful advantage because it was gained through investment in foreign and railroad securities. (6) An analysis of the relatively small amount invested in securities by the closed banks is more indicative of a generally more speculative management than it is an explanation of the direct cause of failure. They held a higher percentage of their investments in United States government bonds as well as in common stocks than did the open group. However, since 91 percent of their investment in United States government bonds was pledged to secure special creditors—individual and public—no doubt their greater
investment in common stocks is a more accurate expression of the voluntary investment policy of the management of the closed banks. The less favorable showing of the closed group on the basis of ratings by commercial rating houses, the higher contractual interest rate on the bonds held, the heavier depreciation in the market price of the industrials held by the closed banks, all add cumulative weight to the conclusion voiced above. (7) In 1930 the open banks had one-fourth of their investments in local securities compared with one-eleventh for the closed group. This gave the open banks a distinct advantage in view of the high degree of stability in the price of these bonds during the depression.

**MARKETING INVESTIGATIONS OF UTAH FRUIT AND VEGETABLES**

During 1941 and 1942, studies have been conducted to determine the economic position of Utah fruits and vegetables on various markets, and the efficiency of marketing agencies handling these products.

This information was obtained largely by interviewing brokers, commission men, wholesalers and retail handlers of fruits and vegetables, and by observing Utah products on the markets in comparison with products from competitive production areas. Another phase of the study was analyzing the efficiency of the business organizations which marketed most of the 1941 crop of peaches and cherries. Attention was also given to the volume of Utah's production of fruits and vegetables and its distribution. A brief summary of the findings of these studies follows:

1. The flavor, color, texture and general eating qualities of Utah fruits and vegetables compare favorably with fruits and vegetables from competing areas.

2. Utah fruits are usually smaller in size than the fruits from competing areas.

3. Fruits and vegetables of a specified grade coming from Utah are considered by the handlers in the terminal markets as not equal in quality to those of similar grade coming from most other areas.

4. The limitation to the sale of fruit and vegetables from Utah in many areas is imposed by the quality of the packing—not the quality of the product. The weaknesses of the packing most often cited were:
   
   a. Lack of uniformity in the size and ripeness of fruit that is packed in each package and in each car. (b) The fruit used in facing the package is often much better than that in the body of the package. (c) Packages are not always completely filled, resulting in short weights and a loose pack which destroys the face.
(5) Containers were often inadequately labeled.

(6) Bushel baskets were often used when the trade prefers boxes.

(7) Much fruit, particularly peaches, is damaged in transit through the use of baskets. This results partly from the nature of the basket, partly from improper lidding, and sometimes from improper or inadequate bracing and loading of cars.

(8) Cherry varieties are often improperly labeled. Several other varieties were labeled as Bings.

(9) Too many different sizes of cherry containers are used.

(10) The interval between loading and sale is often too great with the result that the produce has greatly deteriorated before reaching the market.

(11) As measured by grade and quality standards, Utah produce was found to be inferior and, in general, the sale price was lower than that of produce from other areas.

(12) The total production of Utah fruits and vegetables is relatively small and marketing is made difficult because the production is scattered over a wide area with little tendency for concentration of a particular kind of fruit or vegetable in a given area.

(13) The distribution of Utah fruits and vegetables tends to be widely scattered and with little tendency toward concentration in any area. This mitigates against the development on the part of consumers or dealers of any preferential demand for Utah products, and also against efficiency in the performance of marketing services.

(14) There is a definite trend for increased plantings of peaches, pears, apricots, and cherries in the Pacific Northwest. The major portion of these fruits produced in that area is marketed as canned products. This trend is especially pronounced in the case of freestone peaches.

(15) Successful cooperative marketing organizations in other areas are increasing volume by widening the scope of operations and services. This is usually accomplished by handling a larger number of commodities through the same organization. Such a program increases the volume and efficiency of the organization and reduces the number of associations that farmers need to join to market their crops.

(16) The trend is also for cooperative marketing organizations to render more services to members in the way of furnishing supplies, equipment, and credit.

(17) The local market for fresh fruit has been greatly increased during the past two years by reason of increased population resulting from the location of defense plants and other military activities in this area.
Individual consumer purchasing power is also high. These conditions are likely to continue for several years at least, and many will be permanent. Even with some reduction in population in defense sections during the post-war period, the population in Utah and adjacent trade areas will likely be in the neighborhood of one million people.

(18) In addition, at the present time, opportunity is afforded growers to sell large quantities of produce to the military marketing center at Salt Lake City, provided they can meet quantity and grade requirements.

(19) The production of fruit in Utah is insufficient to provide a per capita consumption in the local market equal to the per capita consumption for the United States.

RECOMMENDATIONS FOR IMPROVING THE MARKETING OF UTAH FRUITS AND VEGETABLES

These findings show that fruit and vegetable growers of this state have both production and marketing problems to solve before they can successfully meet competition from other areas.

(1) Production.

It is recognized that the success of a marketing program is in large measure dependent upon the success of the production program. For this reason it is recommended that a definite program be undertaken by producers and state and federal agencies working in this field to improve the quality and grade of produce delivered to the marketing agencies.

(2) General Marketing Policies.

A. Preparation for market.

1. Harvesting of produce should be done at the proper stage of maturity.

2. Small volumes of produce should be concentrated into central packing houses for preparation for market.

3. Uniform grade standards and brands should be used for marketing Utah fruits and vegetables.

4. A few standard types and sizes of containers that will meet the demands of the various markets should be adopted.

5. The produce should be graded and packed according to the demands of the market where it is to be sold.

6. All packages should be properly labeled as to size, variety, and grade, regardless of where they are to be sold.
7. Adequate facilities including cold storage should be provided for the proper handling of the fruit and vegetable crop.

B. Distribution.

1. Under present conditions the local market is the most important one and the primary effort should be directed toward meeting the requirements of this market.

2. The processing of fruit should be considered a definite part of the marketing program. This outlet should not be considered as a market for surplus and cull fruit, but should be a permanent market for first quality fruit.

3. Distant markets should be used only after the needs of the local market have been met fully.

C. Organization.

1. Organization or organizations should be perfected to market Utah's fruits and vegetables in an efficient and orderly manner. In order to do this each marketing organization must have a large volume of business.

2. The marketing organization should have control of the produce from the time of harvest to the time of sale.

3. Producers should be paid for produce according to size and grade.

4. A program for adequately financing both production and marketing should be developed. Grower controlled organizations should provide a program for supplying finances for the production and marketing of the crop.

5. The organization that markets the produce should also provide the grower with the supplies and equipment needed in production.

REFERENCES FOR THE SECTION, AN ANALYSIS OF THE ECONOMIC PROBLEMS OF UTAH'S AGRICULTURE


CROPS AND SOILS

SOILS AND FERTILITY

SOIL SURVEYING

Detail of field work completed under the soil survey is given below:

<table>
<thead>
<tr>
<th>Name of area</th>
<th>Detailed soil survey acres</th>
<th>Reconnaissance soil survey acres</th>
<th>Land classification acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roosevelt-Duchesne</td>
<td></td>
<td>152,000</td>
<td>126,080</td>
</tr>
<tr>
<td>Beryl-Enterprise</td>
<td></td>
<td>26,200</td>
<td>26,200</td>
</tr>
<tr>
<td>East-Millard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorado River-Great Basin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sevier-Gunnison Valleys</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>304,280</td>
<td>66,773</td>
</tr>
<tr>
<td></td>
<td></td>
<td>496,093</td>
<td></td>
</tr>
</tbody>
</table>

The office work was primarily that of determining, section by section, the acreage of each soil type, conservation symbol, and land class shown on recently completed field sheets and summarizing each into tables. This work was completed for reports on the soils of the Roosevelt-Duchesne area and the Beryl-Enterprise area. Manuscripts of the soils reports of the Roosevelt-Duchesne and of the Beryl-Enterprise areas were also completed. Acreage measurements were completed for the upper Duchesne-Blue Bench land classification sheet. This completed the land classification sheets for the Roosevelt-Duchesne area. Three land classification sheets were prepared of the Beryl-Enterprise area, and a tabulation completed of the acreages of the various land classes.

A final check was made of the soil map to accompany the report on the soils of the Virgin River area (1), and on the manuscript of the report of the soils for the Salt Lake area. This completed the work of the Experiment Station on these reports.

During the biennium many land classification maps, some soil type and alkali maps, and many acreage tabulations of the soil types, slope and conservation symbols have been furnished to the War Department, various defense industries, local engineers, county agricultural agents, county commissioners, Farm Security agents, reclamation workers, and many others.

PHYSICAL AND CHEMICAL PROPERTIES OF SOIL TYPES OF UTAH

During the biennium the main efforts under this project have been confined to the chemical analytical work on (1) whole soil, and (2) the clay fraction from the same soil. Samples of both the soil and of the clay fractions have been analyzed for silicon oxide, carbon dioxide, aluminum...
oxides, ferric oxide, calcium oxide, manganese oxide, potassium oxide, sodium oxide, and titanium oxide. In addition, organic carbon, total water, nitrogen and phosphorus were determined on most of the samples of the whole soils. The work was confined to six soil types; three from the Uinta Basin, and three from the Escalante Desert. The determination of replaceable bases was nearly completed on all samples for the three profiles from the Escalante Desert.

An important question which it is hoped this work will answer, or at least throw light on, is: *What are the characteristics of maturity of soil profile development under the environmental conditions in Utah?*

**FACTORS GOVERNING SOIL EROSION BY IRRIGATION WATER**

The fundamental purpose of this study is to obtain a knowledge of the mechanical aspects of the erosion of soil by irrigation water with the view of assisting engineers and farmers in improving methods of handling irrigation water.

When the project was begun small trays were used and various sizes of stream and slopes of eroding surface were studied, and it was found that the erosion tended to increase approximately linearly with the size of the stream and at a more rapid rate with the slope of the surface. Owing to unavoidable "end" effects with the short trays, however, a considerable amount of variability left much uncertainty as to the results.

It was decided, therefore, to make use of larger flumes and to change the plan of attack. A record was kept of the silt content of the eroding stream as a function of the time, and if extreme care is taken to avoid these end effects the time data fall smoothly on a regular curve. Such curves are now being obtained for various slopes and various sizes of irrigation stream. Except when gullies develop, the water is found to become clear with the short flumes. It is possible, then, to compute the total amount of soil removed in an irrigation.

A tentative empirical formula was obtained and it is hoped that the apparatus and equipment may be improved in such a way as to lead to a satisfactory solution of these practical aspects of the erosion problem.

**PERMANENT FERTILITY STUDIES**

In study of the influence of cropping on the nitrogen, phosphorus and organic matter of the highly calcareous, irrigated Greenville farm soil it was found that from 11 to 100 percent of the nitrogen disappearing from the soil was recovered in the crop. Both fallow and continuous oats were found to be wasteful of soil nitrogen.

If the time required for the various crops to remove the equivalent of the phosphorus in the surface foot of soil is used as a basis for comparison the following values are found; continuous beets with 30 tons of manure
annually, infinity; continuous beets with 10 tons of manure per acre annually, 382 years; alternate oats and fallow, 274 years; continuous oats, 192 years; continuous beets, 158 years; alternate oats and beets, 143 years; and continuous alfalfa 108 years. Hence the phosphorus problem in so far as this soil is concerned, is one of rendering available that which it contains and not the addition of more phosphorus.

This soil lost annually the following percentages of the organic matter in its surface foot; permanent fallow 3.9; alternate oats and fallow 1.6; permanent oats 2.6; permanent beets, 10 tons manure per acre annually 0.3; beets, no manure 0.9; and alternate corn and beets 1.3. The soil that was in permanent alfalfa gained 1.9 percent of its organic matter and that which was in beets and received 30 tons of manure per acre annually, 1.2 percent.

FACTORS INFLUENCING THE BACTERIAL ACTIVITIES OF THE SOIL

Nitrogen fixation by Azotobacter chroococcum in the presence of soil protozoa. Protozoa generally when cultured with Azotobacter chroococcum increase nitrogen fixation. This was greatest in liquid media when ciliates were used as the coexistant organism (2). Stimulation was slight but definite in sand culture in the presence of ciliates, flagellates, and amoebae. Nitrogen fixation was stimulated by four coexistant species of protozoa in soil cultures containing mannite, but in many instances it was depressed in soil without mannite.

In both liquid and soil media, Azotobacter was more numerous in the presence of protozoa than in their absence.

The ciliates (Colpoda and Oxytricha), and the flagellates and amoeba to a less degree, produce a substance which favors Azotobacter. Suspensions of Colpoda, heat-killed at 65°C for one-half hour, when introduced into Azotobacter cultures in small amounts, stimulated nitrogen fixation in a manner similar to that of the living protozoan cells. This substance, which is not destroyed by low heat, but is inactivated by prolonged heating in the autoclave, needs to be present in only minute quantities, since the presence of a few hundred cells per cubic centimeter is sufficient to bring about stimulation equivalent to that of 20 to 40 thousand protozoan cells per cubic centimeter. Seitz filtrates of the substance have no stimulating effect, indicating that the substance may be an organic colloid held back by the filter.

Survival of microorganisms in alkali soils. Soils containing approximately 2 percent of soluble salts were kept for 20 years under air-dry conditions (3). At the end of this time the following determinations were made; total number of microorganisms developing on a synthetic glucose agar, and the ammonifying, nitrite-, and nitrate-producing organisms, and nitrogen-fixing powers. From 30,000 to 2,000,000 microorganisms, de-
pending upon the specific salt present, developed. All soils had an active ammonifying microflora which compared favorably with that of fertile soils. Nitrosomonas and the nitrobacter were apparently absent from the soil, for neither nitrites nor nitrates were produced when the soils were inoculated into appropriate media. *Azotobacter chroococcum* was found in some of the soils even after 20 years. These actively fixed nitrogen when seeded into an appropriate medium.

Hence ammonifying and nitrogen-fixing microorganisms can survive for long periods in soil, the water of which is saturated with sodium chloride, sodium sulfate, or sodium carbonate, either individually or in combination. The nitrite- and nitrate-producing bacteria, however, disappear from such soils.

**Inoculation of soil with Azotobacter.** A typical dry-farm soil free from *Azotobacter* was inoculated with *Azotobacter chroococcum* and variously treated with calcium carbonate and organic manure (4). The soil was kept bare in a greenhouse for 17 years, and then was planted to wheat for 2 years. At intervals the nitrogen-fixing powers and the nitrogen of the soil were determined with the following results:

During the first 12 years of the experiment, inoculated soil, when added to a synthetic mannite medium and incubated for 21 days, fixed much larger quantities of nitrogen than did uninoculated soil. At the end of 19 years all soils had become contaminated with *Azotobacter chroococcum*; hence, all fixed approximately the same quantities of nitrogen.

The average annual gain of nitrogen per acre-foot varied from 27 to 38 pounds. The uninoculated soil became contaminated with *Azotobacter* sometime during the first twelve years of the experiment; it cannot be said definitely, therefore, that inoculation of this soil with *Azotobacter* will increase its nitrogen content. There is some definite evidence, however, that the addition of organic manure to the soil increased the quantity of nitrogen gained. It is believed that the gain was primarily the result of the activities of nonsymbiotic nitrogen-fixing microorganisms. It is proved that the absence of *Azotobacter* from this soil is not caused by an unfavorable environment.

**The Influence of Green Manures, Farm Manure and Commercial Fertilizers on the Yield and Quality of Various Crops Growing on the Principal Soil Types of Utah**

There was no significant difference in the yield of either the grain or the straw as a result of planting sweet clover with wheat in a field experiment on an area of Taylorsville silty clay loam near Granger.

A statistical analysis of the individual plot yields showed that ammonium sulfate and treble superphosphate combined induced highly significant increases in yields of both grain and straw, but either of these
materials applied separately failed to increase yields significantly. Manure in all combinations significantly increased yields. Sulfur, gypsum, Soil Aid, phosphoric acid and treble superphosphate alone failed to increase significantly the yield of either grain or straw.

Fourteen fertilizer treatments have been made in four blocks on a pasture on Trenton silt loam near Lewiston. Farm manure did not significantly increase the amount of herbage clipped per plot in May but greatly increased the yields in July. Yields almost double those on the untreated plots were obtained on plots treated with manure and treble superphosphate. Ammonium sulfate greatly increased herbage growth on the pastures in the early spring but in July little benefit was found from such treatment. Treble superphosphate increased the yields but not significantly. It is expected that increases from phosphate treatment may be greater the second year as a result of better growth of the legumes.

THE EFFECT OF FERTILIZERS ON VARIOUS PROPERTIES OF A HIGHLY CALCAREOUS SOIL AND ON THE YIELD AND QUALITY OF CROPS PRODUCED

Experiments on the effects of various fertilizers on crop yields, conducted on the plots at the Greenville Experiment Farm at North Logan, have been concluded. The crops grown were potatoes, sugar beets, barley, wheat, and alfalfa (two years), grown in the rotation in this order. One belt of plots was in each crop each year. The fertilizers used were ammonium sulfate (240 lbs. per acre), treble superphosphate (350 lbs. per acre), potassium chloride (167 lbs. per acre), gypsum (330 lbs. per acre), barnyard manure (10 tons per acre), raw rock phosphate (1000 lbs. per acre used only with manure), sulfur (250 lbs. per acre used only with manure and raw rock phosphate). These fertilizers were applied annually.

The studies have been continued for fourteen years, thirteen years in the rotation and one year in a uniform crop of wheat. From these investigations the following conclusions were drawn:

Gypsum, potash, raw rock phosphate and sulfur had no appreciable effect on the yields of any crops in the rotation.

Ammonium sulfate alone induced average acre increases of 4.67 tons of sugar beets, 0.83 tons of alfalfa, and 5.1 bushels of barley but only small increases of 2 bushels of wheat and 4 bushels of potatoes.

Ammonium sulfate and treble superphosphate combined increased yields of beets 2.43 tons; potatoes, 59 bushels; wheat, 6 bushels; and barley, 4.4 bushels more than those obtained by either of these materials separately. Ammonium sulfate, treble superphosphate, and muriate of potash combined induced no higher yields than the combination of ammonium sulfate and treble superphosphate.

With the exception of potatoes, 10 tons of farm manure per acre induced as high or higher yields of each crop as any combination of com-
mercial fertilizers. Treatment with ammonium sulfate and treble superphosphate combined resulted in about 24 bushels of potatoes per acre more than were obtained with manure.

Finely ground raw rock phosphate and raw rock phosphate with sulfur in addition to manure did not improve crop yields over those obtained with manure alone.

Treble superphosphate added to farm manure resulted in the highest yields of all crops, though these were only slightly higher than with manure alone.

Yield data from a crop of wheat grown on the entire field during the last year seem to indicate that manure is responsible for the greatest yield induced by a single fertilizer and that manure and phosphate induced the greatest yield. The block planted in wheat the year before yielded much less than any of the other blocks.

A Comparison of Different Phosphate Fertilizers

In this investigation an attempt has been made to test and to compare the various fertilizers that appear on the market by cropping in the field and greenhouse and by chemical methods. In addition, the quick test for available phosphorus and the method for determining total phosphorus in plant material have been revised and adapted to the photometer.

The results show that phosphate fertilizers that induce increases in yield of alfalfa also increase the phosphorus content of the plant. "Soil Aid," Anderson's phosphate, and raw rock phosphate had no influence on yield. Potassium metaphosphate (T. V. A.), calcium metaphosphate (T. V. A.), concentrated superphosphate (T. V. A.), fused rock phosphate (T. V. A.), superphosphate, and treble superphosphate all increased the yield of alfalfa forage.

The results of a preliminary test with "Fertile Lime," a product sold to farmers of the state, indicate that it has little or no value as a fertilizer on soils of Utah.

Some Effects of Acid Forming Materials on Utah Soils

The use of acidulated fertilizer materials is being recommended in several states for alkaline calcareous soils. Available data on soil reaction preferences of plants indicate that they should be benefited by the use of such materials on most calcareous soils in this area. Studies during the past two years, however, have failed to show any benefit from the use of acidulated treatments on three Utah soils.

In greenhouse investigations, the following soils have been employed:

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Location</th>
<th>pH</th>
<th>Soluble salts parts per million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodrow clay loam</td>
<td>near Delta, Utah</td>
<td>8.1</td>
<td>3,000</td>
</tr>
<tr>
<td>Millville loam</td>
<td>North Logan, Utah</td>
<td>8.2</td>
<td>1,000</td>
</tr>
<tr>
<td>Salt Lake sandy loam</td>
<td>near Corinne, Utah</td>
<td>7.8</td>
<td>4,000</td>
</tr>
</tbody>
</table>
Soil treatments included sulfur, sulfuric acid and phosphoric acid on the basis of equal potential acidity. These treatments were used with and without manures and treble superphosphate. In addition, tests were included with sulfuric acid and phosphoric acid in irrigation water. The highest direct application of sulfuric acid to the soil and sulfuric and phosphoric acids applied in irrigation water significantly decreased yields of alfalfa. All acidulated materials failed to increase appreciably yields of alfalfa, corn, or barley.

Yields of Federation wheat, growing on Taylorsville silty clay loam, were not significantly increased by sulfur, gypsum, or phosphoric acid. Yields on plots treated with a sulfur-manure compost were nearly the same as on plots treated with manure alone.

Laboratory studies indicate that sulfur is oxidized very slowly in soils. All acidulated materials in any quantities that could reasonably be applied in the field failed to alter appreciably the pH of soil.

**FORAGE CROPS**

**TESTING ALFALFA VARIETIES**

More than 100 varieties and strains of alfalfa are being tested for adaptation and forage production under Utah conditions. These include the best of the old standard varieties, also some strains imported from foreign countries by the United States Department of Agriculture, and some new strains developed in the breeding work of various federal and state experiment stations. Many of the same strains are thereby compared under a wide variety of climatic and soil conditions. Promising strains from the initial test are again tested in an advanced nursery, having large plots and more replications. A final comparison for adaptation, survival of stands, and forage production is made in large plots that are representative of conditions in the important alfalfa growing regions of the state. At present such tests have been located in Cache, Salt Lake and Duchesne Counties. Recommended varieties and strains are given final test by sowing 2 one-half acre strips in each 5 acres planted to the common alfalfa grown on the farms of Utah.

**SEED INCREASE OF IMPROVED ALFALFAS**

New strains of alfalfa are usually developed in a greenhouse or small field nursery. The original seed is often limited to a few grams or ounces which must be increased quickly and under conditions that will preserve its purity and value. With the aid of a special field technique, the original small quantity of seed is increased to from 10 to 50 pounds in the first year, which seed is sufficient to establish the preliminary nursery tests in many cooperating states. Later foundation seed fields of accepted strains
are established on a larger scale from which registered seed is obtained to be used commercially in accordance with the rules of the State Crop Improvement Association. Thus far, one improved wilt-resistant strain known as A-136 has been recommended by the Alfalfa Improvement Conference for trial in wilt infested areas and is about to be released for commercial increase and use. In anticipation of a demand for seed of this new strain several plantings totalling approximately 40 acres have been made in well isolated areas of Utah.

**Breeding Wilt-Resistant Alfalfa**

During 1941 and 1942 there was a highly significant difference in yield between the 25 alfalfa varieties included in the tests for wilt-resistance. Of the 4 highest yielding, three were strains of Utah Station selections. These yield tests were completed in 1942 and the data will be used in future breeding work.

Approximately 20,000 selected seedling plants were inoculated with the wilt producing organism *Phytoponas insidiosum* in the field in 1940. In 1941 about 30,000 seedlings and F₂ hybrids were inoculated and transplanted. A large number of F₂ progenies are showing up well and this material will be carried into preliminary yield tests in 1942-43.

Approximately 2½ pounds of the new alfalfa strain, 262-10, was produced. One pound of this strain was forwarded to Washington, D. C., to be included in the variety tests of the Alfalfa Improvement Conference. This strain gives promise of being wilt resistant, and winter hardy, and of producing high yields.

**Stem Blight of Alfalfa**

Studies during the biennium have established the fact that the general disease condition of alfalfa referred to in Utah as "stem blight" is a confusion of two distinct diseases: A bacterial disease to be designated hereafter as *bacterial stem blight*, which appears to be identical with Sackett's disease caused by *Phytoponas medicaginis* (Sackett) Bergey et al.; and a fungus disease which shall be designated as *black stem*, caused by *Ascochyta imperfecta* Pk. This later disease appears identical with the black stem disease described from Idaho and Kentucky. In the early stages of development the two diseases can be readily distinguished, however in the later stage of bacterial stem blight and in the early development of black stem, confusion in tracing the cause may result. This possibility of confusion is greatly increased by the fact that *A. imperfecta* may completely invade the lesions produced by *P. medicaginis*.

**Alfalfa Seed Production as Affected by Lygus Bugs**

Low production of alfalfa seed in Utah is apparently mostly attributable to heavy lygus bug infestation in previously highly productive areas.
Damage to the alfalfa results from the feeding activities of these insects, during which they leave a poison toxic substance in the plants that is the cause of an abnormal vegetative development highly unfavorable to seed production. Young buds are blighted, excessive flower fall may occur and pods may set that contain a high percentage of brown shriveled seeds of poor quality and low germination value (5).

No completely effective control measures have been developed for combating lygus infestation in commercial seed fields. All known insecticides have proved costly, relatively ineffective and impractical of application often enough to effect worthwhile control. During the growing seasons of 1940 and 1941, field experimental tests were performed to determine the following with respect to lygus-bug control in seed alfalfa: (1) The relative efficiency and comparative costs of 5- and 10-percent strength of pyrethrum (Pyrocide) dusts. (2) The minimum effective dosage of these dusts. (3) The most effective frequency of their application.

Results of the tests in each of the two years were similar in that each showed that: (1) Although the 10-percent dust gave somewhat superior results over the 5-percent, yet the difference was not significant. (2) The difference between applications of 15- and 30-pound per-acre dosages was not significant. (3) Differences obtained with the 2-day and 4-day frequencies of application were highly significant, whereas the mean difference between the 6-day frequency and no treatment was not significant. Seed yields on plots dusted every 6 days were but little better than on those that were untreated.

A test is being made of various cultural practices applied previous to and during the growing of the seed crop. Fall and spring cultivation of the alfalfa seed fields has been found helpful in the destruction of overwintering lygus adults. Cutting of the hay crop prior to starting the seed crop should be so timed as to effect the greatest possible destruction of newly laid eggs and young nymphs of the insect, and followed by shallow cultivation and dragging of the fields. Good results have followed these cultural methods in a few experimental trials, although definite conclusions are not possible at this time.

The weather, soil moisture and fertility, and the health and condition of the alfalfa stands are also important factors affecting the yields of seed. These factors, however, are seldom the cause of a complete failure of a seed crop, such as lygus infestation has produced in many formerly productive areas. Wild bees and other insects that effect tripping and cross pollination of alfalfa flowers are sometimes factors of local importance. They have been the means whereby seed crops have formed under otherwise partly unfavorable conditions.

Since many factors are involved, most of which are beyond the control of seed growers, alfalfa seed production may always be an uncertain crop. The elements of risk and chance should give way slowly to improvement
in methods and practices based on a more complete understanding of the principal factors involved.

**Clover Variety Tests**

An extensive variety test of various clover crops was instituted in the spring of 1940 largely through the request of the Utah and International Crop Improvement Associations. This included all of the available red clover varieties, the four common varieties of white clover, and strawbery clover.

A heavy crop of high quality hay was harvested on the test plots in June, 1941. The dry weight yields ranged from 4.9 to 7.1 tons per acre. A seed crop was also harvested in September, 1941.

A new series of tests was begun in 1941 in Cache, Salt Lake and Duchesne Counties to test the new synthetic varieties and the component strains making them up. There were thirteen red clover varieties and strains and common Alsike clover. A crop of hay was harvested with dry weight yields of from 3.14 to 6.64 tons per acre. Adjacent alfalfa plots yielded from 3.81 to 6.97 tons per acre for the three crops.

Under an agreement with the International Crop Improvement Association and associations of the middle western and eastern states, Utah farmers are growing these synthetic varieties under a contract by which the seed, when produced, is all purchased by these interests at a premium price over common clover seed.

At the request of the U. S. Department of Agriculture and the Utah Crop Improvement Association, two cooperating farmers at North Logan have been asked to grow 4½ acres of Otten red clover produced by the Indiana Agricultural Experiment Station. This seed was planted and good stands obtained in the spring of 1942. The crop was seeded thin to attempt to harvest a crop of seed in one year as this is the only seed available in the United States.

**Grass Breeding and Improvement Investigations**

Selection in smooth bromegrass (Bromus inermis), which began in 1936, has resulted in the isolation and preliminary increase for comparative evaluation of several groups of plants. The principal basis of selection has been sustained high production following clonal propagation into blocks where the opportunity to become sod-bound was intensified. Great differences between plants were noted in these blocks. In the spring of 1942 six selections of B. inermis were included in an experimental pasture planting where they could be accurately evaluated.

Yields have been obtained for four seasons from 100 single-plant selections of slender wheatgrass (Agropyron trachycaulum) grown in replicated rows. Selections differed more than 100 percent in yield but the
relative behavior of each strain throughout the four-year period was fairly consistent. One selection, among the top ten in forage yield, has given preliminary evidence of superior drought resistance.

Plantings made in the spring and fall of 1941 at Benmore, on a dry testing site, suggest that *Agropyron elongatum*, *A. trichophorum*, and *A. popovii* are superior in drought resistance to crested wheatgrass (*Agropyron cristatum*). This appears to be especially evident where the seedlings are in intense competition with *Bromus tectorum* (downy chess).

Studies on the effects of inbreeding in naturally cross pollinated species of grasses have been extensively conducted with smooth bromegrass. One generation of self fertilization led to progenies with significantly lowered vegetative vigor. Self fertility was also seriously reduced. The second inbred generation was further reduced in vegetative vigor and several lines began to break up, giving chlorophyll deficiencies and other abnormalities. There was evidence of segregation for self-fertility. Inbreeding studies are also in progress with *Agropyron smithii*, *A. cristatum* and *A. elongatum*.

Investigations are in progress to develop, if possible, a technique of bulk hybridization of grass (6).

**Physiological Investigations with Grasses**

A method and apparatus for determining the resistance of grasses in the seedling stage to soil drought have been developed. The method consists of growing grass seedlings in newsprint bands (¾ x ¾ x 3¼ inches) for a period of six to eight weeks under greenhouse conditions and then subjecting the plants to a controlled soil drought. The drought treatment is accomplished by allowing the plants to dry out for a period of 6 to 8 days in a chamber constructed to control temperature, light, and humidity. Following the drought, the surviving plants are permitted to recover under optimum growing conditions. Over 70,000 grass seedlings have been tested for their reaction to this soil drought test. The response of grass species to the treatment is similar to their behavior under conditions of critical field drought. This technique also shows wide differences in the survival of strains within most of the species tested. While the soil drought reaction under field conditions is known for only a few of the grass strains tested, the method seems to offer considerable promise as a means of determining relative soil drought resistance of selections within grass species.

A study of the germination, storage qualities, and vitality of seeds of crested wheatgrass, bluestem wheatgrass, slender wheatgrass, smooth brome, mountain brome, blue wild-rye, and green needlegrass has been completed. Seeds of these species were collected in the pre-milk, milk, dough, and mature stages of development in 1937. With the exception of the seeds of mountain brome harvested in the dough stage, all immature seeds
were inferior in field emergence tests to mature seeds. The germination tests showed that most seeds harvested in the pre-milk and milk stages lost viability more rapidly than mature seeds. Mature blue wild-rye seeds decreased in germination from nearly 100 to 2 percent in 58 months of storage. Similar seed of the other species dropped in viability from zero (mountain brome) to 75 (slender wheatgrass) percent during this storage period.

**Pasture Improvement Studies**

The results from pasture experimental plots at Hooper show quite clearly that strawberry clover is the best adapted of the legumes to low-lying wet alkali soils. It is gradually crowding out White Dutch clover, alfalfa, and sweet clovers. It is also pressing for survival such grass plants as Kentucky bluegrass, smooth brome, perennial rye, and meadow fescue.

Thirty-six pasture species including grasses and legumes were planted on wet alkali land at Taylor in Weber County. Two mixtures, the first consisting of Morton’s mixture and the second of 20 species of those included in the individual specie test were also seeded in plots.

The following plants were surviving in good condition at the end of the two-year period: Meadow fescue, perennial ryegrass, Reed canary grass, smooth brome grass, strawberry clover, and biennial white sweet clover. Red top, slender wheatgrass, English wild white clover, and Pioneer alfalfa showed considerable resistance to the alkali and excessive water conditions. Red clover seems to be more tolerant to the alkali than either alsike or Ladino clover.

The alkali content of the soils on these plots ranges from approximately 1,000 parts per million to 5,000 parts per million in the first 6 inches of soil, and from 1,800 to 6,800 parts per million in the second one foot of soil. The Strawberry clover plots in Cache County, where the alkali content of the soil was high, show the clover to be well established on practically the entire area.

This experimental work has far reaching significance as there are hundreds of thousands of acres of land in Utah similar to the land in Weber County, and it seems quite probable that a number of these species of plants will be able to replace low-grade species native to these areas.

**Seeding Alfalfa Stubble to Pasture without Breaking**

To determine the possibility of establishing pastures by seeding in alfalfa stubble without breaking, the seed mixture was seeded in the stubble early in the spring after which the field was irrigated and cut three times for hay. Three methods of seeding were checked (1) broadcasting, (2) broadcasting and harrowing the seed into the ground, (3) drilling.

During the summer of 1940 the plots were clipped three times, and
twice during the summer of 1941 to determine the amount of green forage produced.

Based on the amount of green forage harvested for 1940 the drilled plots produced 26.2 percent more forage than the plots where no seeding was made, 3.9 percent increase over plots where the seed was broadcast and harrowed in, and 7.7 percent increase over plots where the seed was broadcast.

During 1941 the seeded plots produced 51.1, 42.2, and 41.4 percent more forage per acre, respectively, for drilling, broadcasting the seed and harrowing it in, than for just broadcasting the seed on the stubble.

The first year dandelion was much more abundant in the alfalfa where no seeding was made. The second year dandelion made up a high percentage of the growth on the unseeded plots, while on the seeded plots it made up only a small part of the forage harvested.

At the first cutting, orchard grass was much in evidence. At the second cutting perennial rye-grass was the dominant forage.

Both years the differences were in favor of drilling the seed. The data indicate that a pasture can be established by seeding with any of the three methods tried. Differences in the stands could not be determined by observation either year.

Even though white clover (Trifolium repens) was sowed at the rate of 3 pounds and alsike clover (T. hybridum) at 2 pounds per acre the percentage of clover established was very low. The results indicate that it is difficult to get a satisfactory growth of clover when seeded in a grass mixture on alfalfa stubble land.

RANGE STUDIES

RANGE RESOURCES

Range appraisal work is conducted by counties and during the past two years investigation has been confined to Utah County.

The plan of this work has been to assemble all known federal survey records on range lands within the county and to locate upon a map the areas already studied. An attempt is made to correlate these records and to compile forage type maps. Field surveys are then made of the remaining areas. This work consists of mapping and appraising the range forage. Mapping is done by use of aerial pictures where they are available and by random sketch in other areas. Appraisal has been done by estimating the quantity of forage of sample plots by individual plant species. This quantitative estimate is then multiplied by a quality evaluation for each species to arrive at an index to the grazing potential for the range as a unit. In addition, observations are made of soil conditions, erosion, season of use, poisonous plants, rodent, big-game and predator populations; and range condition to serve as a basis for recommendations on range utilization.
In an experiment to determine the possibility of starting a pasture by seeding in alfalfa stubble, the growth of grasses was excellent, but clovers failed to grow. Where no seeding took place dandelion was abundant.
Note abundance of dandelion in area where no pasture seed mixture was planted
Utah County has been surveyed in entirety and the forage type map has been completed with the exception of certain areas upon which aerial mosaics are not yet available.

Range Survey Methods and Vegetation Analysis

Range grazing capacity may be determined by two distinct methods, namely, (1) by a study of vegetation, including both quantity and quality, and (2) by a study of performance in which vegetation condition and animal condition are correlated with known use.

The first method is becoming increasingly less relied upon because of evident inaccuracies. Detailed studies under this project were made to determine the reliability of this method. Field work involving 8 trained range appraisers was designed to test (1) accuracy of individual surveyors, (2) variability among surveyors, (3) response of surveyors to training, and (4) variation introduced by different types of vegetation. Preliminary analyses show surveyors to lack consistency which, though benefited, is not overcome by training. Inaccuracy appears so great as to make the method of questionable value.

New range appraisal methods are now being studied which involve rapid general classification of range forage which, in turn, is correlated with known performance.

Determining range potential from vegetation and animal condition is being studied on the Tony Grove experimental pastures in the mountain ranges near Logan. During the past two years these pastures have been stocked with steers at different intensities and vegetation and animal weight responses have been observed. Though the results are strictly preliminary, some interesting facts have been brought to light. (1) Seasonal stock gains, especially in late seasons, seem to correlate quite closely with precipitation. An average daily gain of 2.36 pounds was obtained during one wet fall season, a period during which gains generally are low. (2) Despite unprecedentedly good forage, animal weight gains in 1941 were below long-time averages. (3) Weight studies indicate that intense stocking may results in lesser weight gains even before the range approaches full use. (4) Late season weight losses in 1941 were tremendous. These losses were much greater on heavily stocked ranges. A group of 37 steers lost an average of almost 60 pounds per head during the first two weeks of October.

Animal losses of this nature are of immediate and great practical importance to ranchers, especially where lambs or calves are produced for marketing from summer ranges.

Methods of Revegetating Range Lands

This project was designed to include the study of both natural and artificial propagation of plants under conditions met on dry range lands.
Especial consideration has been given to the practical application of methods used in these studies from the viewpoint of economy and difficult physical conditions existent on range lands. Especially during the current emergency it is important that recommended practices be practical and effective. There is great need for getting information before the ranchers by demonstration and publication since much is now known which would increase the efficiency of range production during the current pressure period.

Experimental range seeding under this project has been characterized by many failures. Practices which have been shown undesirable or inferior include: (1) Seeding too late in the spring, or, indeed, any spring seeding during years when the land cannot be worked until late in the season, or springs followed by dry summers; (2) seeding into stands of dense weeds, especially downy brome grass or "June" grass (*Bromus tectorum*); (3) planting of grain along with grass for use as a so-called "nurse crop" on dry lands; (4) planting on sterile or rocky lands upon which plants previously growing did not thrive; (5) excessive "working" of soil, especially plowing and harrowing until the soil is loose; (6) planting grass seed too deep, a difficulty almost impossible to avoid on loose soil.

Detailed studies on the use of rye nurse crops in reseeding dry ranges have shown average forage yields of crested wheatgrass in grams per square meter to be decreased as follows under various intensities of nurse crop seeding:

<table>
<thead>
<tr>
<th>Year</th>
<th>No. nurse crop</th>
<th>Rye 3 lbs./acre</th>
<th>Rye 10 lbs./acre</th>
<th>Rye 25 lbs./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1939 yield</td>
<td>123.3</td>
<td>30.0</td>
<td>28.0</td>
<td>4.6</td>
</tr>
<tr>
<td>1940 yield</td>
<td>514.1</td>
<td>85.5</td>
<td>57.0</td>
<td>9.1</td>
</tr>
<tr>
<td>1941 yield</td>
<td>417.1</td>
<td>225.8</td>
<td>250.5</td>
<td>132.0</td>
</tr>
</tbody>
</table>

Species trials have included many introduced and native grasses and browse plants. The crested wheatgrass (*Agropyron cristatum*) seems to be the most desirable of these for dry land areas, though less well known wheatgrasses *Agropyron desertarum* and *Agropyron sibericum* also appear promising, as does *Elymus junceus*. Of the browse plants, best success has been obtained with *Atriplex canescens*, *Eurotia lanata*, *Purschia tridentata*, *Cowania stansburiana*, and *Ribes aureum*. Of the native grasses the best success has been obtained with *Agropyron smithii*, *Agropyron subsecundum*, and *Elymus glaucus*. Severe winters in recent years have resulted in winter killing of several species previously looked upon with favor. Included in this group are the annual *Lolium westerworldicum*, *Oryzopsis milceae*, and *Eragrostis abyssinica*.

Experiments on production of seed by native wheatgrass when herbage was removed at various seasons and various frequencies showed a tendency for yields to decrease with heavy clipping. Late season clipping showed lesser influence than did early clipping. Most interesting, however, was the fact that herbage removal failed in any way to influence the percent
of florets which matured seed or the germination percent of matured seed. A fact of great importance in range management is that plants clipped monthly for over 3 years produced seed that germinated over 98 percent.

CEREAL CROPS

BARLEY IMPROVEMENT

Barley improvement in past years has centered around the production of a better adapted smooth-awned spring variety for irrigated sections. Out of this program came Velvon (7), released in 1937, which is a high-yielding, stiff-strawed, covered smut-resistant variety with completely smooth awns or beards. A few hundred head selections from fields throughout the state were grown in single rows in 1938. Many of these were resistant to both loose and covered smut (8). Considerable variation was observed in height, lodging, sterility, or empty kernels, and other visible characters. The best of these are now being tested as single strains and new combinations of the better strains are used in making up Velvon composites. Definite improvement appears possible through this procedure in obtaining improved smut resistance, better straw strength, and higher yield.

A backcross program was begun in 1939 in which a good feathered style is being added to the better Velvon strains. This character insures a higher fertility on the barley spike, which means less sterile or empty kernels. Other promising strains from various crosses are in advanced stages of testing. Some may prove to be superior to Velvon.

Recently an effort has been made to discover a suitable winter barley variety. Many introductions are being tested from which numerous crosses are in the F₁ generation. A preliminary nursery was grown at several localities this past season. Some fairly good varieties appeared so far as winter hardiness is concerned. These are being tested further, along with many others, some of which have come out of Winter Club crosses. Barley is of major importance in Utah as a feed crop as shown by the 1942 estimates of production, which exceed wheat by over one million bushels.

OAT IMPROVEMENT

Oat improvement consisted of testing 74 varieties and strains produced at various stations. No breeding work is being done at this station since suitable material has always been available through government oat breeders from nearly any desired cross. A uniform nursery consisting of 25 varieties was grown this year. None of the recently tested strains have surpassed Uton (9) for desirability as a high yielding, stiff straewed, smut-resistant white oat.
WHEAT IMPROVEMENT

Two spring wheat nurseries were grown, each composed of 24 varieties and strains. One was the regional irrigated nursery, the other was made up of local strains with Federation and Dicklow as checks in both series. No diseases appeared in spring wheat, therefore the rust-resistant varieties did no better than old standards. A number of selections of spring wheat are showing high resistance to loose and covered smut and rust.

In the winter wheats a new selection out of the Relief-Ridit cross is showing resistance to all the races of covered smut. One of these selections was planted in the fall of 1941 to increase seed in quantities to be tried out on a more extensive scale in 1942 with the possibility of its ultimate release.

Genetic study of resistance of wheat to physiological forms of loose and covered smut. Six races of covered smut have been found to occur in Utah and southern Idaho. Of these six races, only three occur in considerable frequency. One race, namely the one affecting Oro wheat, is fairly prevalent. During the past two years the low race of covered smut has not been especially severe except in isolated areas.

Some of the selections of wheat grown in the nursery have shown a high degree of resistance to all known races of covered smut. Inoculation experiments involving varieties and races have shown differential behavior at Logan compared with Pullman, Washington. Some races appearing distinctly different at Pullman behave the same at Logan, or else this is a differential behavior of varieties.

In the loose smut studies, five races have been isolated from collections made in Utah. Genetic studies of resistance of loose and covered smut in wheat have shown marked transgressive segregation.

During the season of 1941 a severe epidemic of black stem rust occurred in this section and a number of selections showed a high degree of resistance in all the nurseries.

Factors influencing the composition of wheat and wheat products. Seventeen varieties of wheat grown on the same soil and under the same conditions were analyzed and found to contain an average of 0.364 percent cystine (10). This corresponds to 0.097 percent of cystine-sulfur and represents 54.4 percent of the average total sulfur. A probable variation in cystine was found between varieties as well as between wheats grown under varying cultural conditions, and a positive correlation was found between cystine and sulfur, as well as between cystine and nitrogen.

Spring wheat grown on the Nephi dry farm carries greater percentages of ash, calcium, magnesium, potassium, iron, phosphorus and sulfur than does winter wheat grown on the same soil (11) (12). A significant difference was found in the calcium content of different varieties of winter wheat grown on the same soil. A highly significant correlation was found
to exist among most of the mineral constituents of wheat. When the wheats of different years were compared, a high variation was found to occur in the various mineral constituents. The addition of green manures to a typical dry farm soil caused a highly significant variation in the ash content and a significant difference with respect to calcium and phosphorus. The use of green manures materially increased the phosphorus content of wheat probably owing to their effect in increasing bacterial activities which in turn increased the available plant food in the soil.

*The nutritive value of wheat.* Five winter wheats, Alton, Kharkof, Kanred, Sevier, and Kofod, together with two spring wheats, were tested on albino rats under controlled conditions. Judged by the quantity required to produce unit gain in live weight and the composition of the blood and bones of the animals fed on the various wheats, Dicklow is the poorest and Alton the best. The addition of calcium or phosphorus to the wheats increased the nutritive value of some of them. When calcium and phosphorus were added to the wheats so that the phosphorus equalled that in Kota, a wheat tested in an earlier study, and there were two parts of calcium to one of phosphorus, all wheats became equally nutritious provided an appropriate protein was fed.

**Hybrid Corn Trials**

During the past two years the tests of hybrid corn have been continued with the hope of obtaining a hybrid equal to U. S. 52 in general adaptation and yield but slightly earlier in maturity. From these trials some slightly earlier hybrids appear promising. Among these are Iowa Hybrid 4206, Wisconsin Hybrids 680 and 645, and one or two other hybrids put out by private seed companies. Some of these hybrids are two to three weeks earlier than U. S. 52, and are adapted to the shorter growing season of the state.

**Production of Foundation Seed Stock**

The following wheat, barley, and oat varieties were grown for the Utah Crop Improvement Association to be distributed to its certified growers:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>4,000</td>
</tr>
<tr>
<td>91a-148-8</td>
<td></td>
</tr>
<tr>
<td>(Hope x Federation)</td>
<td></td>
</tr>
<tr>
<td>Federation</td>
<td>3,000</td>
</tr>
<tr>
<td>Erect</td>
<td>600</td>
</tr>
<tr>
<td>Baart</td>
<td>2,500</td>
</tr>
<tr>
<td>Velvon Comp. 5</td>
<td>700</td>
</tr>
<tr>
<td>Barley</td>
<td>2,500</td>
</tr>
<tr>
<td>Atlas</td>
<td></td>
</tr>
<tr>
<td>Utah Winter</td>
<td>3,700</td>
</tr>
<tr>
<td>Oats</td>
<td>1,400</td>
</tr>
<tr>
<td>Uton</td>
<td></td>
</tr>
</tbody>
</table>
The Pale Western Cutworm, a Pest of Cereal Crops

Because of the almost complete subsidence of the pale western cutworm outbreak by the spring of 1940, the work done on this project has consisted of: (1) Occasional inspections and the operation of light traps in September and/or October for the purpose of ascertaining the density of cutworm population or its probable potentiality. (2) The preparation for publication of the essential data which had been obtained during the investigation of the pale western cutworm problem (13) (14).

Dry-Farm Practices

Tillage Methods

Most of the work at the Nephi Dry Land Station is a continuation of long-time tests (15). The tillage tests show that time of plowing is more important than the subsequent tillage provided weeds are kept under control.

No difference was found where a comparison was made of no tillage of fallow, medium tillage, and frequent tillage. Subsoiling had no advantage over ordinary plowing.

Forage Crops

Of forages, alfalfa and crested wheatgrass gave highest yields, however, common rye, cut early and allowed to reseed, also had high yields. In a rate, date, and depth of seeding test of crested wheatgrass the results showed that fall seeding at a depth of one inch or less at a rate of seven to ten pounds gave best results.

Protein Content of Wheat

With more attention paid to protein content of wheat it has been found that the quality of dry-farm wheat, especially in the older areas, is too low to make good flour. Tests show that this can be corrected by application of moderate amounts of manure and plowing up alfalfa land which has grown this legume crop for four years or more. The latter practice is usually more practical.

Miscellaneous Crops

Tests during the past two years with flax, soybeans, and sorghum show that these crops are not adaptable to dry-farm lands in Utah.

Nitrogen and Organic Matter on Dry Farms of Utah

Twenty fields in Cache Valley and two in Juab Valley have now been sampled to show a comparison of the nitrogen content of wheat land, virgin areas, and land planted in alfalfa for various lengths of time.
The results show that dry-farm wheat land has lost 20.02 percent of the original nitrogen from the first foot, 21.40 percent from the second, and 15.83 percent from the third. Adjacent land which had been planted to alfalfa for 3 to 5 years showed a recovery of nitrogen of 57.23 percent in the first foot, ten years 56.25 percent, and 15 to 30 years 80.16 percent. For the second foot, the corresponding recovery amounted to 38.89 percent for the 3 to 5 year period, 37.35 percent for the 10 year period, and 43.02 percent for the 15 to 30 year period. The third foot showed a recovery of nitrogen amounting to 41.24 percent for the 3 to 5 year period, 33.33 percent for the 10 year period, and 34.78 percent for the 15 to 30 year period (16) (17).

**Weed Control**

Beginning in the spring of 1940 and continuing through 1941 a series of experiments was undertaken to determine the effect of cultivation and cropping on the exhaustion of root reserves in morning glory and whitetop. Both annuals and perennials were used as smother crops in these studies. Likewise, an effort was made to establish perennials following periods of cultivation. The perennials used were alfalfa, smooth brome, Reed canary, and a pasture mixture of both grasses and legumes. The annual crops were corn, sorghum, Sudan grass, soybeans, barley, and winter wheat. It was possible to establish good stands of all these crops with the exception of Reed canary on morning glory-infested lands. During the two-year period these crops have given satisfactory yields, and the morning-glory appears to have been reduced considerably in extent and vigor.

Some of the most promising treatments used in the eradication of morning-glory were the growing of corn and fall wheat—the corn was planted on the square to cultivate both ways. These cropping practices during the two-year period have practically eliminated the morning-glory and at the same time produced satisfactory yields. The plots on which winter wheat was planted are cultivated when not occupied by the crop. This has been one of the most encouraging treatments of any of the cropping practices for the eradication of morning-glory, but not so good on whitetop.

Sugar beets are not a good crop to grow to eradicate morning-glory, but for whitetop they are satisfactory. The reason for this is probably owing to the fact that whitetop makes little growth after the soil is thoroughly worked in the spring, whereas such is not the case with morning-glory.

Growing sorghum, Sudan grass, and soybeans, as annual smother crops in combination with cultivation when the land is not occupied with the crop, have given about equal results. The yields have been satisfactory but the root reserves of the weeds have not been exhausted nearly so well
as where corn and winter wheat were grown. In the control of whitetop red amber sorghum appeared considerably better than soybeans.

Cultivation of the plots at one-week, two-week, and three-week intervals during the two-year period has practically eliminated all morning-glory on the experimental area. The studies on frequency of cultivation showed that cultivation at emergence was not quite as effective as cultivation five days after emergence; but was about the same in effectiveness as cultivation ten days after emergence. The fifteen-day interval between cultivations was not quite as effective as the more frequent intervals. While the twenty, twenty-five, thirty, and thirty-five day intervals all had some effect in reducing root reserves, they were all less effective than the more frequent cultivations.

**Weed Control in Lawns**

In a study of weed control in lawns involving frequency and height of clippings in combinations with different fertilizers, it was shown at the end of the two-year period that there was little difference in the amount of dandelions present on the various plots where frequency and height of clippings were checked; however, there was a significant difference in the fertilizer treatments. Ammonium sulfate used at the rate of five pounds per thousand square feet, applied in either the fall or spring or in both fall and spring, resulted in the greatest reduction of dandelions in the lawn (18).

**State Weed Eradication Program**

As a part of the State Weed Eradication Program the Agricultural Experiment Station, upon request of the county weed committee, has the responsibility of checking the fields which have been in cultivation for weed eradication one or more years. During the biennium 318 farms were checked and of these, approximately 75 percent were recommended to be turned back to cultivated crops. The other 25 percent were recommended to be kept in the weed control program of clean cultivation. In general the demand by farmers for participation in the Weed Eradication Program has increased to the point where the counties are unable to take care of all requests. The control work has proved successful but expensive.

**References for the Section, Soils and Crops**


FRUIT AND VEGETABLE PRODUCTION

VEGETABLE PRODUCTION

TOMATO DISEASES IN UTAH

Bacterial canker (*Aplanobacter michiganense* E. F. S.). The treatment of tomato seed from infested sources with a 0.9 to 1.0 percent acetic acid soak for 24 hours or by extraction from tomato pulp following a 96 hour period of fermentation (1), continues to control bacterial canker effectively under Utah conditions.

The use of fermentation in the extraction of tomato seed and the application of the acetic acid seed soak has occasionally resulted in a considerable reduction in the germinating ability of treated seed. Rapid drying following treatments reduces the harmful effects of the treatment. The addition of tergitol, an organic penetrant, had no apparent effect with the acetic acid treatment but a slight protective effect appeared with bichloride of mercury treatment. It is evident that tomato seed extracted following fruit pulp fermentation or treated with acetic acid after extraction should be dried as rapidly as possible.

Progress is being made in the development of cultural methods for the detection of the bacterial canker pathogen in seed lots before they are planted. This pathogen has survived seven years in a viable condition in air-dried infected tomato tissue.

Verticillium wilt (*Verticillium alboatrum* R. and B.). Single plant selections of tomatoes bearing fruit of approximately commercial size have been made from hybrids of Peruvian Wild (*Lycopersicon esculentum* var. *cerasiforme* (Dun. Gray) with Stone and Century. Canning tests of some of these selections will be made. Single plant selections of these hybrids have been backcrossed and outcrossed in an effort to improve the size and the quality. Backcrossed and outcrossed progenies are highly susceptible to the wilt disease and little progress can be reported from this approach.

The resistant selection of *L. pimpinellifolium* (Jusl.) Mill. is being used in the breeding program but the small size of the fruit makes it less desirable as a parent than the Peruvian Wild which is equally resistant. The highly resistant new species previously reported as *L. species nov*, now designated as *L. glandulosum* C. H. Mull., is being used in the curly-top disease-resistance breeding program. Because of the difficulty of procuring crosses between this species and strains of *L. esculentum* Mill., it is not being used at present in the wilt breeding program.
Resistance of "Riverside" and "Essar" to verticillium wilt under Utah conditions. These tomato varieties were developed in California and showed a distinct resistance to verticillium wilt. In previous tests in Utah they also revealed a certain degree of resistance. In 1940 both varieties showed further improvement with regard to the disease resistance as well as the quality of fruit and earliness.

Curly top (western yellow blight) of tomatoes. This work is being conducted under two divisions. (1) Breeding for resistance to the curly top disease and (2) ecological, physiological and cultural experiments with curly top of tomatoes.

Breeding for resistance to curly top. Large fruited selections from crosses of resistant strains of Ojo de Venado, and Red Peach with commercial varieties of tomatoes, principally Stone, Baltimore, and Century, all within the species Lycopersicon esculentum Mill., were obtained from the Hurricane trial grounds for the first time in 1941. The fruit was sufficiently large to be acceptable for commercial use. The degree of resistance exhibited by the accessions from which the selections were made was low compared with the resistant parent, nevertheless, it was decidedly better than the commercial varieties used as parents and has promise.

Plantings of the same progenies at Hooper, showed a degree of resistance to the disease in general between that of the resistant and the susceptible parent. A few selections appeared to have no resistance, many, however, approached closely the resistance of the disease-resisting parents. These findings indicate that some progress is being made in combining resistance with commercial quality and eventual success may be hoped for.

Strains of L. glandulosum C. H. Hull., peruvianum var. humifusum C. H. Mull., and L. peruvianum var. dentatum Dun. that are highly resistant (approaching immunity) to the curly top disease are being used in an intensive breeding program. Large numbers of pollinations have been made in an effort to combine these species strains with strains of the species L. esculentum and L. hirsutum. The species have been successfully crossed with hybrids of L. esculentum x L. hirsutum. So far the progeny of such crosses have been sterile or almost so. The hybrids that show the slightest tendency to bear fruit are being worked with intensively in an effort to induce them to produce sufficient seed for further studies.

Iodole-acetic acid, indole-butyric acid, thiamin chloride and yeast extract have been applied to stigmas and pistils following pollinations in an effort to increase the percentage of successful crosses but no significant stimulation was obtained.

Ecological, physiological, and cultural experiments with curly top of tomatoes. As in previous years there have been three lines of investigation under this phase of the project: (1) The control of curly top by modifi-
cations in cultural practices consisting of (a) closer spacing of plants (2), (b) direct seeding in the field, (c) varying times of planting, (d) varying times of irrigation, and (e) protection of plants by capping. (2) Studies of the effect of light intensities on curly top expression using (a) cloth shading, and (b) artificial light. (3) The investigation of the effect of nutrition on curly top with special regard to the role of minor elements and the effect of stimulated carbohydrate production.

The control of curly top by modification in cultural practices. The results of the 1940 experiments on the effectiveness of various cultural methods in curly-top control are in accord with those of the previous years. This is especially significant in view of a severe outbreak of the disease in 1940. The infestation of 1941 was not severe, yet the results seem to be indicative and in line with results of previous years.

Closer spacing of plants. The highest percentage of diseased plants in 1940 (81 percent) occurred in checks planted at the regular time (May 10) and with customary spacing (42 inches, one plant per hill) and was accompanied by one of the lowest yields (4.8 tons per acre). The least disease (25.5 percent) occurred with early (April 20) planting, spaced 21 inches apart with one plant per hill, covered with paper caps for frost protection; the yield was also highest (19.4 tons per acre). The next best results (51 percent disease and 14 tons per acre) were obtained from the densest May planting (one plant per hill, 10½ inches apart). With the same number of plants per acre but spaced differently (two plants per hill, 21 inches apart) there was slightly less disease (45 percent) but also a smaller tonnage (12.9 tons per acre). Intermediate densities gave intermediate results. The data definitely show the advantage of a closer spacing than is now practiced. The 1940 closer planting was superior to the standard spacing in the April and May plantings and in directly seeded series.

In 1941 the regularly planted check plots, planted about the middle of May and spaced 42 inches both ways showed 16 percent of the disease and yielded at the rate of 6.1 tons per acre. Those planted at the same time but spaced only 21 inches showed 12 percent curly top and yielded at the rate of 8.3 tons to the acre. As compared with this, the results obtained with corresponding late sowing were as follows:

<table>
<thead>
<tr>
<th>Spaced inches</th>
<th>Seedlings</th>
<th>Disease Percent</th>
<th>Yield per acre tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>14.0</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>11.0</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>10.5</td>
<td>5.0</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3.7</td>
<td>9.7</td>
<td></td>
</tr>
</tbody>
</table>

Direct seeding in the field. Direct seeding in 1940 gave inconclusive results because an early dry spring caused delayed and uneven germination.
However, after the seedlings became established they developed ex­cellently and continued to form new fruit until frost time. The disease in the seeded checks of the standard May planting was considerably below that of the transplants (64 percent and 81 percent, respectively).

Varying times of planting. The effects of early seeding and early transplanting were compared on the basis of 10½ inch spacing which consistently gave better results than wider spacing. Earliness favored higher yields and gave less disease. The results were as follows:

<table>
<thead>
<tr>
<th>Infection percent</th>
<th>Yield per acre tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early seeding covered</td>
<td>4.7</td>
</tr>
<tr>
<td>Early seeding uncovered</td>
<td>3.3</td>
</tr>
<tr>
<td>Transplants covered</td>
<td>7</td>
</tr>
<tr>
<td>Transplants uncovered</td>
<td>7</td>
</tr>
<tr>
<td>Spaced 10½ inches but planted later</td>
<td></td>
</tr>
<tr>
<td>Seedlings, uncovered</td>
<td>3.1</td>
</tr>
<tr>
<td>Transplants uncovered</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Varying times of irrigation. Of all the methods of irrigation tested, the irrigation some time after seeding (depending on the soil moisture), in regular furrows appeared to be the most advantageous.

Protection of plants by capping. There was no killing frost during the growth period in the spring of 1941 and the covers (paper caps) were of no additional value. At the same time they added to the planting cost tremendously, particularly with close spacing which requires covering of entire rows. This is a serious disadvantage of very early seeding or transplanting.

Studies on the effect of light intensities—cloth shading. When the intensity of the sunlight was reduced during the growth period by means of heavy shading, from 10,000 candle feet to less than 2,000 candle feet, the percentage of diseased plants in three tests dropped from 51.9, 53.8, and 73.1 to 3.7, 8.8, and 7.4, respectively. Evaporation, temperature and relative humidity were altered more or less by shading, but the differences were not as great as in the case of light. Light intensity appears to be the chief environmental factor in curly top development.

Investigations of the effect of nutrition. Nutritional studies were conducted in the greenhouse with sand and water cultures, with special emphasis on effects of the excess of various forms of potassium and nitrogen and of the addition of selenium. The results of the four tests conducted during the past year indicate that probably none of these three elements has any arresting effect on the development of curly top, but that nitrogen may have a stimulating influence.

Adding various microchemicals to nutrient solutions in several curly
top inoculation series caused no significant change in the amount of disease.

**Beet leafhopper control.** Beet leafhopper spring populations were moderately high in the local breeding areas of northern Utah in 1940. Greenhouse tests showed that 82 percent of these leafhoppers transmitted curly top to young sugar beets; this is the highest percentage of viruliferousness found in recent years. *Erodium cicutarium* or alfileria appears to be the most important overwintering plant reservoir of this disease in northern Utah breeding grounds.

Following the long-distance and local migrations of the leafhopper, serious damage resulted to susceptible crops, with 65 percent of the sugar beets and 52 percent of the tomatoes being seriously affected by this insect-borne virus disease. Cantaloupes, beans and cucumbers also were affected in some areas.

The beet leafhopper populations in local breeding areas during the spring of 1941 were much lower than those in 1940; also the long-distance migration was 10 days later in reaching the cultivated areas. Only 33 percent of the local surviving leafhoppers carried curly-top virus. The result was a drop to an average of 12 percent curly top in beets and 7 percent in tomatoes during 1941.

**Tomato fruitworm investigations.** In control experiments during 1940 best results were obtained with the use of cryolite diluted to 70 percent sodium aluminum fluoride with corn flour. Such tests averaged 51 percent control with one treatment, 66 percent with two. Cryolite diluted with tobacco dust or talc gave almost equal control. One treatment with undiluted calcium arsenate yielded 29.8 percent control, two treatments 42 percent. When diluted with half lime, one calcium arsenate-lime application yielded but 20.2 percent control. Dilution of calcium arsenate is not recommended for tomato fruitworm control.

In 1941 control experiments, cryolite diluted with talc and undiluted calcium arsenate gave equally effective control. Time of application proved to be an important factor: 1 application on July 15 averaged but 7.28 percent control, 1 application on July 30 averaged 40.55 percent control, and 1 on August 5 averaged 21.26 percent control. Two applications July 15 and 30 averaged 48.82 percent control, treatments July 15 and August 5 dropped to average 30.31 percent control, with dustings July 22 and August 13 yielding 51.18 percent control. Three dust applications were slightly more effective than two, but not enough so to justify the extra expense for material and labor involved.

Seventy-five to 80 percent of the tomato fruitworm eggs were found to be laid on the outer leaves where the worms feed before entering fruits. Because of this it is essential that the entire plant be covered with insecticide if best control is to be attained.
ONION IMPROVEMENT STUDIES

Selections of better keeping sweet Spanish onions have been made. These will be inbred and tested during 1943. Breeding studies are continuing on the inheritance of bulb color and shape, and premature seeding of onions.

Storage tests showed that bulbs stored at 34°F. kept better than those stored at warmer temperatures. When the good bulbs from each lot were planted into the field the bulbs which had been stored at 52°F. began growing first. However, after three weeks no differences could be noticed.

While the bulbs stored at the warmer temperatures showed the greatest number of seed stalks the differences were not significant. The percentage of plants not showing laterals or vegetative shoots was significantly lower for the bulbs stored at a temperature of 34°F.

Treating of bulbs with semesan had no effect on the number of diseased bulbs.

INFLUENCE OF FERTILIZERS, SEED INOCULATION OF PEAS, AND HARVESTING PRACTICES ON THE YIELD AND QUALITY OF PEAS, TOMATOES AND OTHER CANNING CROPS

Data recorded from two years' work on peas show no outstanding differences in yield or quality from the use of the fertilizers, phosphorus and potassium. The fertilizers used alone and in combination were as follows: treble superphosphate, 200 pounds; and muriate of potash, 100 pounds per acre. Inoculation of peas was also tested alone and in combination with the above fertilizers but no differences in yield or quality were found.

In tomatoes the most satisfactory yields were produced by using a combination of nitrogen, phosphorus, and potassium. The following amounts were used: ammonium sulfate, 100 pounds; treble superphosphate, 200 pounds; and muriate of potash, 100 pounds. While some increase in yield was obtained by the use of treble superphosphate alone, so far the differences have not been significant.

It was observed that less cracking of tomato fruits occurred where the plots were treated with a combination of phosphate and potassium.

PEA APHID CONTROL

Aphid populations on peas in 1941 were higher than in any season since the serious outbreak of 1936; on alfalfa the population was highest of any year since the damaging spring outbreak of 1938. Crop injury in 1941 was moderate as a rule, with occasional fields of peas and alfalfa showing conspicuous damage.

Rotenone bearing dusts appear to be the most practical treatment for control of aphids on peas; however, replicated test-plot control results
in Utah have averaged lower than like treatments in several areas where similar materials have been used. Lower humidity and less dew on the plants may be contributing factors. In 1941, 4 percent nicotine dust and 1 percent rotenone and Cubore dusts gave almost equal results. Nicotine-Aresket spray 1 to 1200, Cream of Agicide and a 1 percent Niagara dust all gave higher kills in 1940 than Agicide and Cubore dust.

A number of species of ladybird beetles and their larvae, one species of Melyridae—the two spotted *Collops*—larvae of Syrphidae flies, adult and larval Chrysopidae, several predacious Hemiptera and snowy tree crickets, fed on the pea aphid, in many cases building up high predator populations on this food supply. In addition, two internal hymenopterous parasites, several species of insectivorous birds, and disease organisms attacked the pea aphid.

**FREEZING PRESERVATION OF UTAH VEGETABLES**

The following varieties of peas have given the best results in freezing tests: Teton, Dark-Podded Thomas Laxton, Onward No. 76, Thomas Laxton, and Glacier. Other good varieties are Asgrow No. 40, Morses 2286, Dwarf Alderman, and Stratagem.

The lima bean, sweet corn, and soybean variety trials have been preliminary and only results on small samples have been obtained. The results from lima beans show that the following varieties are better for freezing: Fordhook, Burpees Improved, Baby Fordhook and Henderson Bush. The sweet corn varieties which have shown the best quality are Golden Bantam, Golden Cross Bantam, Ioana, Golden Hybrid 2439, Gold Rush Hybrid and Gold Nugget. The Golden Bantam cannot be recommended because of ear worm damage.

The best garden soybean varieties proved to be Willomi and Bansei. These two varieties gave the highest yields as well as having better quality.

**CELERY IMPROVEMENT STUDIES**

Selections of better strains of Utah celery have been made, and after further trials in 1942, recommendations will be given to growers.

The studies wherein celery plants were spaced in rows at 20, 24, 36, and 60 inch intervals, showed that the closer spacings of 20 and 24 inches not only gave increased yields but gave better quality celery. Blanching of the wider spaced celery was necessary.

The amount of heartburn among fifty different varieties of celery in 1940 varied from 1 to 22 percent. Pascal, Golden Self-Blanching and several hybrids were fairly resistant to heartburn, whereas Masterpiece and Easy Blanching were susceptible. Diseased plants in 1941 varied from 0 to 37 percent at the Davis County Farm. However, in only 9 of the total 140 counts were the diseased plants greater than 10 percent.
Fertilizer trials with minor elements have thus far yielded no evidence that heartburn is a minor element deficiency disease.

Nutrient solution and sand cultures have shown that celery grows best at a pH of 7.5 or above. In the continuous drip culture in sand, severe heartburn was found in the three nutrient solutions minus manganese, and minus manganese and zinc, and complete. Celery grown in sand with a continuous flow of water supplying a water level of different heights developed severe heartburn symptoms. The culture with the highest "water table" was the least affected.

TUBER INDEXING OF SEED POTATOES

The major objective of this project is to produce seed free from virus diseases through tuber indexing under critical greenhouse procedure as a basis for foundation seed stock. During the biennium a total of 10,919 tubers from 197 growers were indexed. Of these, 2,830 or 26 percent were found to be diseased. These diseased tubers were segregated out and the others were returned to growers as a basis for foundation seed stock.

UTILIZATION OF POTATOES IN D-LACTIC ACID FERMENTATION

The findings of these investigations indicate the possibility of profitably using potatoes in dextro-lactic acid fermentation. Burbank Russet potatoes were used in this study and the work completed justifies the following conclusions:

1. The potato carries ample accessory growth-promoting material for the lactic acid fermentation. This was shown by the rapid growth in the potato medium which compared favorably with that obtained from the artichokes.

2. The percentage of the sugar resulting from hydrolysis and transformed into dextro-lactic acid was as great as that resulting from the artichokes.

3. Large quantities of small unmarketable potatoes are available in the state, hence this fermentation process provides a market for a product already being produced; whereas, if artichokes are used their utilization will depend upon the profitable establishment and production of such a crop.

Earlier work reported in the biennial report for 1939-40 showed that Jerusalem artichokes could be utilized in the production of d-lactic acid by fermentation.

SOYBEAN TESTS

Soybean varietal tests were extended to Duchesne, Hurricane, Murray, and Salina during the biennium as well as the plantings at Logan and
Cedar City. The season of 1941 was slightly shorter than usual, and some varieties failed to mature satisfactorily.

The two varieties which appear to be highest in yield are Illini and Mukden. These varieties are rather late, however, and in some years even in the sections of the state similar to Cache, Box Elder, and Salt Lake Counties, there would be difficulty in getting them to mature.

Of the earlier varieties which have matured each year without difficulty are Cayuga and Minsoy. One or two other varieties were added to the test for 1942, but they failed to be as desirable as some that have already been grown for a number of years.

Again the yield of soybeans as compared with barley, for example, was not sufficient to warrant their being grown in this section. The acre returns for barley under the same conditions were about twice those for soybeans.

FRUIT PRODUCTION AND PROCESSING

TESTING AND IMPROVEMENT OF FRUIT VARIETIES

Breeding for hardiness. Considerable work has been done on the breeding of hardier stone fruits during the biennium at the new Terry trial grounds where the seedlings are being tested for hardiness and other characters. A total of 7,644 seedling trees were planted. These trees were divided as follows: cherries, 3,670; apricots, 2,754; plums and prunes, 486; peaches and nectarines, 134. Nearly one thousand larger seedlings, some of fruiting age, were transplanted from the campus trial ground to the Terry trial grounds in the spring of 1941 to make room for a parking area. A fair stand was obtained considering the size of the trees transplanted.

At Farmington, 525 seedling apricots from hand crosses made in 1939 were planted out in spaces where older seedling trees had been removed. Most of these have made good progress, and should fruit during the next two years.

The severe winter of 1941-42 killed back a large majority of the sweet cherry seedlings to the snow line, making possible selection of the hardier seedlings.

New variety test blocks of peaches and nectarines containing a total of 300 trees were planted in 1941 and 1942 at Farmington and at Logan. These trees included over fifty selections for hardiness made from Utah orchards, in 1937, together with promising new varieties introduced by peach breeders, experiment stations and nurserymen which had not previously been tested in the Station variety test orchards. As a result of this replanting, and the severe winter of 1941-42, many of these trees were killed out and many others received severe setbacks.

Peach varieties. Of the newer peach varieties, the following appear promising from studies made during the biennium: Golden Jubilee,
Halehaven, South Haven, Candoka, Rio Oso Gem, Palora x Tuscan, White Hale, Klondyke, Valiant. The Palora x Tuscan, an unnamed seedling from the U. S. Fruit Breeding Station at Palo Alto, California, is the best of the canning cling type of peach tested, being large, good quality, attractive in appearance, and later than Elberta. Halehaven is large when well pruned and thinned, but requires good thinning and general care. Candoka is the largest and finest peach in the orchard, but the tree is weak and a shy bearer. Rio Oso Gem, a late Hale-type peach appears promising, but set a high percentage of doubles in 1941. Hardee introduced a few years ago as an Elberta with hardy buds, proved to be of Early Elberta type and season, differing in the fruit being long and flattened. Klondyke Elberta has proved to be a good type of Early Elberta, differing in having higher color.

Plums. In plums, Methley x Wickson proved to have hardier flowers and set fruit following a heavy frost. The fruit is of the Santa Rosa type, but the tree is more productive and the fruit smaller. It appears to be an excellent variety for jams, jellies, and freezing. Other varieties of plums which appear worthy of testing by growers are: Yakima, Imperial Epineuse, Pacific, Stanley, Hall, Elephant Heart, Flaming Delicious, Methley, Duarte, Sugar, California Blue, Burton Champion. Varieties which do not appear promising are: Simon, Tragedy, Clyman, Bradshaw, Apex, Burbank, Standard, Beauty, Climax, Sapa, Waneta, Gaviota, Elliot, Burwood, Tonka, La Crescent, Underwood, Loring Prize, Winona, Chicasaw, Purple Flame, and Grand Duke.

Cherries and apricots. Of the sweet cherries, Deacon, Victor, Early Burbank, and several new seedlings which fruited for the first time this year appear promising. No outstanding new sour cherries or apricots have fruited during the biennium, although a number of the new sweet-pit, first-generation seedlings of the Large Early Montgamet apricot are being propagated and crossed for further testing and improvement. The new Riland apricot appears to be too soft and uneven in ripening for commercial culture in Utah.

Apples. Of the new apples, the early new varieties, Early Red Bird, U.S.D.A. 49 and 50, Wilson June, Early McIntosh, and Lodi appear promising, while Black Mack, Macoun, Blaxtayman, Sweet McIntosh, Richared, Starking, Sweet Delicious, Turley, and Cortland appear to be the most promising. Starking, Richared, and Cortland have been planted for commercial use for several years. Apple varieties which do not appear worth testing by growers are: Dr. Matthews, McIntosh 3609, Medina, Milton, Orleans, Ranier, Seeando, Winesap, Texola, C.P.C. 312, U.S.D.A. 15.

Pears. Among the new pear varieties, Cayuga, Pulteney, Phelps, and Gorham are showing up well although Phelps and Gorham have blighted
rather badly in the Station orchard during the biennium, and appear little if any more blight resistant than Bartlett. Because of their later season and high quality, they appear to be worthy of testing by commercial growers even though not blight resistant. Conference and Bosc appear to blight as badly as Flemish Beauty, and so are hardly worthy of further testing.

**Variety testing and improvement of berries and grapes.** A number of outstanding new varieties of strawberries, raspberries, and grapes have been found through the variety testing work of the Station conducted on the Davis Experimental Farm during the biennium.

**Strawberries.** In 1941, Red Heart and Corvallis strawberries appeared especially promising for fresh market and freezing, while Dorsett, Fairfax and Catskill also appeared worthy of trial by growers. Of the everbearers, the Rockhill, Green Mountain, and Twentieth Century appeared best. In 1942, under unfavorable weather conditions with repeated spring frosts, the Catskill and Claremont showed up better than the other varieties, and heavily outyielded all of them, including the standard Marshall strawberry. Narcissa appeared promising as an early sweet home or market berry. Camden also appeared worthy of further testing.

Varieties which were discarded in 1941 as being inferior in the tests were: Aberdeen, Blackemore, Big Late, Big Joe, Gandy, Gem, Orem, Pearl, Premier, Superb, William Belt.

In a new planting on the Terry trial grounds, the following new varieties looked promising in addition to those tested at Farmington: Maytime, the earliest of the June berries, Dresden, Red Star, and Starbright. Best everbearers were Twentieth Century, Rockhill, and Green Mountain. In trial plots near Millville, Cache County, the new Dresden strawberry from the New York Experiment Station was outstanding in yield of large berries in spite of frost, outyielding Dorsett approximately three to one. While the berries appear high in quality for freezing or preserving, they may be too tart for fresh table use. Maytime also appeared promising in these plots, although not as heavy a yielder and not as early as Dresden. Shelton, Big Joe, and Macy appeared to have no particular value. Fairfax had the best quality, but yielded poorly.

**Raspberries.** In 1940, approximately half of the red raspberry varieties under test were discarded and removed. Varieties discarded were Ontario, Cayuga Red, Chief, Colossus, Herbert, Melrose, St. Regis (Ranere), Utah Red, Victory, Marlboro, Owasco, and three New York Station seedlings.

Of the new red raspberries under test, Taylor and Newburgh appear most promising of the varieties available for planting, and Indian Summer the best of the everbearers for home use and local market.

Red raspberries which proved to be tender in severe winters, hence
unsuitable for culture in the colder valleys were: Cuthbert, June Red, Newburgh, Marcy, Lloyd George, Marlboro, Taylor. Monson purple raspberry winter-killed badly, Sodus purple was moderately injured. Evans and Dundee blackcaps were moderately to severely injured, as were Lucretia dewberry, evergreen blackberry, and Boysenberry where the canes were not covered.

Grapes. Among the new grape varieties under test the most outstanding appears to be the new Golden Muscat grape from the New York Agricultural Experiment Station at Geneva. This is a large green variety of high dessert quality which is the nearest approach to a vinifera fruit on a native vine yet tested in Utah. Bunches and berries are large and well flavored, but too tender for commercial handling. The vine is vigorous, hardy, and productive. The variety appears well worth planting for home and roadside stand use. The ripening season is about two weeks after Concord, so it would likely be too late for the shorter season upland valleys of Utah.

INFLUENCE OF COVER CROPS, FERTILIZERS AND MOISTURE SUPPLY ON THE YIELD AND GRADE OF FRUIT IN ORCHARDS

Soil management studies were conducted on two Elberta peach orchards and one Lambert cherry orchard. Three soil cover treatments were employed in combination with five fertilizer treatments on each. The cover crops used in the peaches were hairy vetch, alfalfa, and clean cultivation, with ammonium sulfate, treble superphosphate, ammonium sulfate plus treble superphosphate, barnyard manure, and no fertilizer, on each of the covers. The set-up was the same for the cherry orchard except that winter barley was used in place of alfalfa.

The results from the cherry orchard have been valueless because of spring frosts and unfavorable pollination weather during bloom.

Preliminary results on the peach orchards indicated more uniform and earlier ripening on trees to which treble superphosphate had been applied in early spring. Yields were heavier and the fruit was later and ripened less uniformly on trees on which ammonium sulfate or barnyard manure had been applied. The color of fruit on the trees treated with treble superphosphate was better from the point of view of marketing, showing more red blush and a more brilliant and desirable undercolor. Although the size of fruit was variable more fruit was larger in size on trees treated with manure or nitrogen.

FRUIT TREE ROOTSTOCKS INVESTIGATIONS

The marked superiority of sweet cherry trees on the mahaleb rootstock (Prunus mahaleb) as compared to the trees on mazzard (Prunus avium), and the Stockton morello (Prunus cerasus) noted in the previous report
on this project, becomes more evident as the trees grow older, and are subjected to more of the hazards of orchard trees in Utah. In September 1941 the rootstocks test orchard was subjected to winds of hurricane intensity which blew down or broke off several dozen trees in the test orchards. Most of the trees on the Stockton morello root and several on mazzard root were blown over, while none on the mahaleb rootstock were blown down.

When this difference is considered in connection with the greater distress and wilting of the trees on morello root in periods of hot weather it is evident that trees on morello root do not have as well developed or well anchored root systems as those on the mahaleb rootstock. Trees on the morello root lose vigor and tend to overbear much earlier than those on mahaleb root, unless they are pruned heavily and given extra cultivation, fertilization, and irrigation. They tend under favorable pollination conditions to set crops heavier than they can mature to good size, the fruit becomes small and of poor flavor and color, and the tree is weakened and liable to winter-kill or die from root failure the following season.

Dwarf trees on morello root could be used in home gardens where they are given extra care providing they are kept well pruned to keep them vigorous. Unless these precautions are taken it would seem advisable from the results in this experiment to prefer the mahaleb root for home orchard trees, certainly for commercial orchard planting. The only advantages of the morello stock which would warrant its use are the smaller size of the tree and the earlier and heavier bearing as a young tree, both the result of the dwarfing effects of the stock on the vigorous scion. It is possible that the morello stock would give better comparative results on heavier, less open soils, where drainage is not so rapid and the soil has a higher average moisture content, since the mahaleb rootstock is notoriously intolerant of poorly drained soils.

In the twelfth year of the test orchard, which was planted in 1931, the Napoleon and Bing trees on the mahaleb root were so much larger that they outyielded the trees on mazzard and those on morello many times over, even allowing for the pruning back necessary to offset the wind damage.

Trees on the mazzard root continued to lag behind trees on the mahaleb root, and in many cases were even inferior to those on morello root. Some trees on the mazzard stock are large and comparable to those on mahaleb, but most of them in the test orchard appear to be permanently dwarfed. Many more trees on the mazzard root have been lost from winter-killing than on the mahaleb root. Little leaf trouble appears to be more prevalent on the mazzard root.

The apricot rootstocks test orchard suffered severely from the windstorm in the fall of 1941, also from injury in the winter of 1941-42
when parts or all of several additional trees were killed. As a result, it will probably be impossible to procure further statistically significant data from this block comparing Chinese apricot on peach root with trees on apricot root for lack of sufficient numbers of undamaged trees. Observations and data to date indicate a small advantage for the trees on apricot root. Certain individual comparisons strikingly favor apricot root under conditions on the Davis Experimental Farm.

CHLOROSIS OF HORTICULTURAL CROPS IN UTAH

The distribution of chlorosis in individual orchards or fields has frequently been found associated with distinct differences in soil profile characteristics. Chlorosis is most prevalent in areas with restricted internal drainage. Although the restricted drainage is frequently not great enough to bring about any apparent differences in soil characteristics, chemical analysis of soils in two areas has shown that where chlorosis is severe, soils are higher in carbonate and readily soluble calcium; they have a higher hydrolyzable pH and less iron soluble in oxalic acid solutions than adjacent soils where chlorosis does not occur (3). Readily soluble calcium and hydrolyzable pH were found to be closely correlated with iron solubility. These facts, together with observations in the field, indicate that chlorosis can be avoided in many instances by better methods of irrigation. In some cases drainage ditches to carry away waste irrigation water from orchards would undoubtedly assist in decreasing chlorosis.

Soil treatments with various acid-forming materials and minor elements have in general failed to give satisfactory control of chlorosis in fruit trees. Iron sulfate sprays or injection of iron phosphate have caused some improvement but in some instances many leaves dropped from the trees after spraying. The injection treatments showed more promise than either the soil or the spray treatments. Some trees injected with iron phosphate in late spring dropped a few leaves but in most instances the recovery was satisfactory and growth during the summer was comparable with normal trees nearby. The injection treatments appear to have little influence after one season, however, because trees so treated become chlorotic the second summer after injection.

The problem of chlorosis in peach trees is now being approached by an attempt to develop resistant rootstocks. Many different seedling rootstocks are now growing in a highly chlorotic soil to test their response. Chlorosis in grapes. The grape rootstock selection study demonstrated that Concord and other susceptible labrusca grapes could be grown successfully in chlorotic soils by grafting on vinifera rootstocks (4). The study is being continued with phylloxera-resistant stocks.

In studies of the respiration of grape roots it has been found that labrusca varieties excrete more CO₂ than vinifera varieties. It would appear that
the resistance of viniferas to chlorosis is not owing to their greater CO₂ excretion.

**Little Leaf Studies**

All cases of severe little leaf investigated have occurred on noncalcareous soils. These soils have been derived principally from either granite, gneiss, quartzite, or sandstone and have varied in texture from loam to gravelly loam.

Granite, gneiss, and quartzite rocks were found to contain about the same content of total zinc as limestone rocks. Soils derived from limestone, however, were found to contain approximately two to three times as much zinc as soils derived principally from the more siliceous rocks.

In noncalcareous soils, total zinc was found to be closely correlated with the organic matter content. In calcareous soils, no definite relation between organic matter and total zinc was found. No significant relation was found between zinc solubility and soil pH, or between total zinc and soil pH, except that noncalcareous soils had a lower pH than calcareous soils, and also had more soluble zinc and less total zinc than calcareous soils.

Soil treatments with various acid-forming materials and minor elements have in general failed to give satisfactory control of little leaf. Little leaf was controlled in peach, cherry and apple orchards by the use of zinc sulfate sprays or by injecting zinc sulfate or zinc tacks into the trunk. In some instances symptoms reappear the second summer after treatment.

The zinc content of little leaf leaves was found to be about one third that of normal leaves, thus substantiating the belief that little leaf in Utah is a zinc deficiency disease.

**Western “X” Disease of the Peach**

The Western “X” disease of the peach, resembling the x-disease (yellow-red virosis) of the East was first observed in the western chokecherry, *Prunis demissa*, in 1937 and in the peach in 1939. Artificial transmission from peach to peach and from chokecherry to chokecherry has been procured by bud graft inoculations. Intercommunicability of the disease between western chokecherry and the peach has not been established, however, but is under investigation. The incubation period of the virus in the peach may vary from 5 weeks to as much as 2 years. The shortest period noted in the chokecherry is one year.

The Western “X” disease has been found in high concentrations in 6 counties in Utah: Cache, Box Elder, Weber, Davis, Salt Lake, and Utah, varying from a fraction of a percent to as high as 80 percent of the living peach trees in the orchard. In 1939 a critical survey of 22 orchards of all ages gave an average of 23.8 percent diseased trees, in 1940, 36.7 percent in 14 orchards varying from 6 to 20 years and in 1941, 47 percent in 15 orchards of this same age range.
Inoculation and survey studies indicate that nursery stock may be a definite means of disease distribution. The long incubation period and the retarded expression in young shoots from diseased buds greatly increase this possibility.

Affected peach trees are seldom if ever killed by the virus. On the other hand they remain permanently diseased and serve as a reservoir for infectious virus material. Fruit on diseased trees is found under Utah conditions to ripen early, is undersized, misshapen, and drops from the tree before normal maturity.

Leaves on diseased trees remain apparently normal until late June or early July, after which time specific symptoms may continue to develop throughout the remainder of the season until late autumn. These leaf symptoms fall essentially into two groups either of which may become dominant, dependent apparently upon the season or upon the variety of peach affected.

In group 1 irregular pale-green areas varying in size and pattern first appear in the blade of the leaf. During the early part of the season, and especially in leaves on rapidly growing shoots, these irregular “paling,” necrotic areas may separate from the more normal tissue and fall away. These more severe symptoms in the early part of the season are usually accompanied by decided leaf falling resulting frequently in complete defoliation of affected twigs.

Later in the season, in older trees, and under conditions apparently less favorable for growth the characteristic “paling” progresses with little or no abscission of affected tissue until the entire leaf assumes a characteristic golden yellow color. Leaves so affected may remain on the tree until late season in the absence of frost, dropping some ten days to two weeks earlier than normal leaves. In Utah these golden yellow leaves, frequently with reddish spots and with inward curling of the leaf, may provide the most characteristic mid and late season feature of the Western “X”. In late fall the golden yellow is replaced in the leaves with a brilliant orange.

In group 2, symptoms are first observed as irregular “water soaked” appearing areas in the blade of the affected leaves. Leaf casting and dropping out of necrotic tissue is rarely pronounced, and lesions quickly become highly colored appearing usually with light brown or tan colored centers surrounded by a purplish border which varies both in thickness and in color intensity. The remaining veins may be so dispersed as to give the leaf a reddish or purplish cast, which in its final expression is distinctly different from the striking golden color of group 1.

Data collected during the past 2 years have established the fact that Western “X” is of major economic importance in Utah and in the Pacific Northwest and offers a definite threat to the peach industry of the region. Control will be difficult and expensive.
COXCOMB (ENNATION OR RASP LEAF) OF THE SWEET CHERRY

This peculiar disease, characterized by a proliferation of the under side of the cherry leaf, was first discovered in Utah in June, 1941. It is now known to occur in a severe form in three orchards in Davis County, however no detailed information is available as to its exact distribution or potential economic importance. Artificial transmission has been obtained by bud graft inoculation during 1941-42 indicating its infectious or virus nature.

RING SPOT OR LACE LEAF OF CHERRY

This disease of the cherry, wherein practically all of the mesophyl tissues of the leaf become necrotic and falls out leaving a lacy skeleton, was first observed in Utah in 1939. In August of the same year 20 young healthy Bing cherry trees were inoculated with buds from trees with ring spot; 18 of these inoculated trees developed ring spot in 1941. Ring spot is generally distributed in Utah.

CONTROL OF PEACH TWIG BORER

With the cooperation of owners of young peach orchards heavily infested with the peach twig borer, three in Box Elder and three in Utah County, experimental tests were conducted in 1940 and 1941 to ascertain the relative efficiency and economy of each of the following sprays.

(1) Those applied in the delayed dormant stage: (a) Liquid lime sulfur (b) Liquid lime sulfur plus lead arsenate (c) Emulsible oil (d) Emulsible oil plus lead arsenate (2) Lead arsenate applied upon the emergence of first twig-borer adults of the season: (a) On plot trees that had received no previous treatment (b) On one-half of the plot trees that had been sprayed in the delayed dormant stage with one of the above sprays.

The only significant difference found was with emulsible oil, which was less effective in the control of the overwintered brood of twig borer and gave less protection to the fruit crop than did any of the other sprays.

Results of studies made in the Hurricane-Toquerville district during 1941, indicated the likelihood that the cause of bud destruction on one-year-old peach twigs was either late summer broods or the over-wintered brood of the peach twig borer. Further study of this problem is necessary, however, because previous work began too late in the spring and had to be discontinued too early in the fall.

CATFACING OF PEACHES

Preliminary investigations in the North Ogden district during the summer of 1941 were unsuccessful in determining the cause of excessive "cat-facing" of peach fruits.
Strawberry-Root Weevils

The strawberry-root weevils, *Brachyrhinus ovatus* L., *B. rugosostriatus* (Goeze), and in Cache Valley also *B. sulcatus* (Fabr.), are the most injurious insect pests attacking strawberries. Raspberries also have been damaged by the root-feeding larvae of these beetles.

In experimental tests (5) sodium fluosilicate gave more effective control than calcium arsenate or sodium fluoride in the various bait mixtures used. Baits consisting of 50 pounds of a dried fruit (apples, raisins or prunes), 45 pounds bran, 5 to 6 quarts of water and 5 pounds of sodium fluosilicate, calcium arsenate or sodium fluoride gave better control than a bran bait consisting of 100 pounds straight bran, 6.5 pounds molasses, approximately 5 gallons water and 5 pounds sodium fluosilicate or sodium fluoride. Two bait applications, the first approximately two weeks before the end of strawberry harvest and the second immediately after picking ends, using 60 to 85 pounds of bait per acre at each application, have given better control than one application only, using 100 to 115 pounds for the treatment.

Freezing Preservation of Utah Fruit

A new laboratory building for the processing of fruits and vegetables has been built at the Davis Experimental Farm at Farmington by the Station and furnished with equipment for freezing work by the U. S. Bureau of Agricultural Chemistry and Engineering.

Fruit freezing experiments have been confined to freezing of samples of strawberries and raspberries for ice cream tests. Quality tests and judging of the samples frozen in 1939 and 1940 have also continued.

Varieties of strawberries which have shown up well in the judging as whole frozen berries for short cake, sundaе toppings, or direct dessert use are: Red Heart, Marshall, Corvallis, Dorsett, Fairfax, Grand Champion, Catskill, and Green Mountain. Red Heart and Corvallis were outstanding in appearance as whole frozen berries. For dessert use, the Red Heart was considered rather tart. For the commercial preserving trade, these two varieties were considered too dark in color, a lighter berry such as Marshall or Dorsett being desired. Sliced or partly crushed berries have been found superior to whole frozen berries for sundaе topping, ice cream and short cake filling purposes.

In red raspberries, Cuthbert, Marcy, and Taylor were superior when frozen whole in sugar or sugar syrup.

Taylor was judged to be definitely superior to the Cuthbert for freezing. Marked differences between the various varieties in acidity were indicated. High acidity was found to accompany better and more intense flavor. Grade A fruit was found to have an acidity of 1.0 percent or better.

Because of the shortage of tin and steel freezing preservation of fruits
as a substitute for canning has increased rapidly. Substantial quantities of Utah apricots and pie cherries were frozen this season. A large pack of Chinese apricots was frozen in corn syrup and packaged in paper for the manufacture of baby food. Additional information on freezing preservation of fruits is being called for as a result of this war-stimulated expansion.

REFERENCES FOR THE SECTION, FRUIT AND VEGETABLE PRODUCTION

IRRIGATION, DRAINAGE AND GROUND WATER

SNOW SURVEYING

DURING the past biennium snow surveys have been made over the key courses at the end of the months of December, January, and February, and annual snow surveys over the entire cooperative network at the end of March. From these surveys the seasonal water supply for Utah has been forecast.

Soil moisture measurements on the watershed in the fall and spring were continued. No quick, inexpensive method of determining the moisture condition of the soil has yet been developed. Because of war emergencies, the research on a radio method of determining soil moisture was discontinued.

Precipitation data at all stations in Utah and daily hydrographs of streamflow have been kept up to date. Snow-cover-runoff curves have been readjusted in light of additional records.

A snowmobile for transporting men and equipment over snow cover has been developed and constructed. Tests made during the spring of 1942 were highly satisfactory.

Summary of conclusions reached during the biennium:

1. Abnormally heavy rains during April, May, and June can completely upset the annual water forecast based upon the April 1 snow surveys. 2. Deficient spring rains have less effect on the forecasts. 3. All water-supply forecasts should be corrected at the end of April and May in the light of the spring precipitation. 4. The rate of melting has an important effect on the yield from snow cover. 5. Studies to date indicate that many snow courses now being measured can be eliminated without affecting the accuracy of the forecast.

WATER-APPLICATION EFFICIENCIES IN IRRIGATION AND THEIR RELATION TO IRRIGATION METHODS

During the biennial period attention has been given to cooperative research work in Utah and Salt Lake Counties.

The Utah County data on water-application efficiencies collected during the period 1937 to 1940, inclusive, have been analyzed and prepared for publication.

It was found that low water-application efficiencies are caused by unfavorable irrigation conditions which the irrigator can usually change to his own advantage. For instance: the application of excessive amounts of water in single irrigations; the use of obsolete, poorly kept irrigation
systems; the irrigation of irregular, rough land surfaces; and the practice of irrigating because the "turn" for the water has come even though the soil has sufficient moisture—these and related factors within the control of the irrigator caused low water-application efficiencies.

Studies of water-application efficiencies were conducted on nine cooperative farms in Salt Lake County, owned and operated by irrigators; they represented lands under five irrigation companies. Forty water-application efficiency measurements were completed. These were based on 5,300 soil moisture determinations and 218 apparent specific gravity tests. Soil properties including field water capacity and permeability were given particular attention.

**WATER CONVEYANCE AND DELIVERY EFFICIENCIES IN RELATION TO METHODS AND COSTS OF LINING CANALS**

Many irrigation canals lose, in conveyance and delivery, from one-third to one-half of the amounts of water taken into the canals. The object of the experimental work, reported herewith, is to find low cost materials and methods of canal lining, which will enable irrigation companies to save water economically.

In the Delta area the inflow and outflow of water in seven experimental canal sections were measured. Losses in two canals were too small to justify lining of the canals. The length of the other five canals studied ranged from 3,468 feet to 9,392 feet. The average inflow ranged from 23.1 second-feet up to 71.5 second-feet. The canal that was lined lost 4.6 second-feet in 1940, whereas in 1941 after lining it lost only 0.4 second-feet. This canal was lined early in the year 1941 with a blanket of clay three inches thick (when compacted). A layer of gravel one inch thick was placed on the clay lining.

If it is assumed that the loss in 1941 would have been the same as that in 1940 without lining, the saving of 4.2 second-feet amounts to 252 acre feet per month, or 1,512 acre feet during the irrigation season of six months. Irrigation authorities estimate the value of an acre foot of water at $1.35. On this basis the value of the water saved in six months by lining would be $2,041, which is 40 percent of the cost.

The results of canal lining experiments can be applied not only in the Delta area, but throughout the state and in all of the states where irrigation is practiced and where natural materials are available for lining canals to prevent seepage losses. It is noteworthy that the cost of annual maintenance of lining of this type as yet is undetermined. This is a factor of major importance in the experimental work. If it is found that the clay lining is reasonably permanent, as it is believed to be when covered with gravel, then it will be economically feasible to line all earth canals which
sustain excessive seepage losses and thus conserve water, and also conserve soil productivity by prevention of alkali injury.

**SOIL EROSION AS INFLUENCED BY IRRIGATION**

This project was initiated at the beginning of the biennium with the object of finding the best methods of control of erosion under irrigation practices. Studies have been conducted on the South Logan Experimental Farm and on the Utah State Prison Farm. The experimental plots of each farm consisted of 10 furrows, having different slopes.

On the South Logan Experimental Farm the soil consists of 22 percent sand, 66 percent silt, and 12 percent clay. Streams of 5, 10, and 15 gallons per minute were run into each furrow for one hour. Samples of the stream at the furrow outlet were taken every 15 minutes and the amount of soil in each determined. On slopes from 0.2 to 0.6 percent erosion was negligible; on slopes from 0.6 to 1.5 percent it was small, while on slopes above 1.5 percent it increased rapidly. With a stream of 5.8 gallons per minute on a 0.5 percent slope when the soil was irrigated promptly after furrowing, the erosion in one furrow was only 2 pounds per hour; whereas with the same stream on a slope of 3.0 percent it was 122 pounds per hour. These amounts of eroded soil are equivalent, respectively, under ordinary irrigation practices, to 0.76 and 46.4 tons per acre per annum.

For the 0.5 percent slope, at this rate of erosion it would take nearly 1,400 years to remove the 7-inch layer of top soil, whereas with 3 percent slope and the 5.8 gallon stream this top layer of 7 inches would be removed in only 23 years.

On the State Prison Farm the erosion was found to increase appreciably with the increase in flow of stream at a particular slope. For instance, on a 3 percent slope with a stream of 6.12 gallons per minute, the erosion was 50 pounds of dry soil in one hour; whereas with a stream of 17.13 gallons per minute, the erosion was 220 pounds. Also, on a slope of 4 percent with a stream of 6.12 gallons per minute, the erosion was 100 pounds in the first hour, whereas with a stream of 17.13 gallons per minute, it was 360 pounds.

Three types of soil have been studied in a special 30-foot adjustable laboratory flume having five channels. In addition to soils taken from the South Logan Experimental Farm and the State Prison Farm a study was made of a fine sandy soil from Box Elder County having 80 percent sand. This work shows that erosion is negligible with small streams having slope of less than 1 percent, but that for slopes exceeding 3 percent the erosion becomes serious.
The Application of Hydromechanics to the Design of Structures for Controlling Ground Water

During the past two years the work of this project has been devoted essentially to an experimental study of the movement of water into drains (1, 2, 3, 4). Previously attention was given to analytical studies based on the Darcy velocity law. In some respects the results thus obtained seemed to contradict popular concepts and for that reason it was decided to conduct laboratory studies. The method of study is essentially what is called model testing. Miniature drainage systems are constructed in such a way as to make it possible to observe the direction of flow of the water in the soil. This is done by means of coloring matter that is introduced at various points, and from these points it follows the direction of flow. One side of the apparatus is bounded by a plate glass window fitting against the soil and the coloring matter marks out paths that can be observed through this window.

Numerous cases were studied and photographs taken and in every case the patterns were found to conform, at least qualitatively, with the patterns predicted by theory. The experimental studies furnish convincing evidence confirming the soundness of these previous studies. Because of the fact that they are somewhat contradictory to popular opinion regarding drainage, the influence of these studies on drainage practice will no doubt be far-reaching.

References for the Section, Irrigation, Drainage and Ground Water


ANIMAL INDUSTRY

THE NUTRITIONAL VALUE OF RANGE FORAGE IN UTAH

Data collected during the past five years from analyses of plants on summer ranges of northern Utah indicate that these plants should supply an adequate diet for grazing animals without supplementary feeding.

Because of apparent inconsistencies in these data, however, it was concluded that the method of collection might be an influencing factor in the results, and a study was initiated to determine just what factors did affect chemical composition in native vegetation. Collections of plant material were made at various dates from various soils and habitats. The plants so collected were analyzed and the results subjected to statistical analysis. It was concluded from these studies that in collecting range forage for analysis, attention must be given to date of collection, soils, and location; and that, in collecting to sample seasonal variation of plants it is important to collect within the same site and soil type, or so to composite the material as to make it representative of these two variables.

A major problem influencing forage value studies on heterogeneous range lands is the difficulty of determining the animals' exact diet in terms of species ratio. Numerous methods of determining this have been tried including estimation of range use, observation of grazing animals, and studies of protected plots.

Investigations have been conducted upon the feasibility of animal stomach analysis for determining forage consumption. Nineteen sheep were first starved for 24 hours, then fed a weighed amount of various plants and then slaughtered. Stomach contents were removed, washed through screens, and segregated into species. From this study it was concluded that previous feeding and the difference in the rate of digestion of different plant species so influence stomach contents as to make this method undependable. Results from these experiments are of great interest in view of the reliance that has been placed in this method in past studies, especially in studying wild animal diets.

In addition to the above studies, plant collections have been made from both summer and winter ranges to determine chemical constituents. Six different range plants were gathered at two stages of development, (1) from late flower to early fruit, and (2) dry and seeds gone. It was found that there was a small but definite loss of protein as the result of drying.

Studies were continued on the blood phosphorus levels of sheep that had been fed various phosphorus supplements during the breeding season. These animals were turned onto the open desert range and the supplement discontinued. Then it was possible to study the effect of supplementation during the breeding season and early gestation. After 2½ months
on open range, all animals, whether previously supplemented or not, had blood phosphorus levels below the normal level of safety. However, the animals that had been given phosphorus supplements showed a better lambing performance.

Phosphorus supplementation of sheep kept the blood phosphorus at a normal level and this increased the number of conceptions, and although the blood phosphorus value later fell below normal, the benefits of phosphorus supplementation were carried over to lambing.

**SHEEP STUDIES**

**FACTORS AFFECTING THE LAMB CROP IN RANGE SHEEP**

In a study conducted at the Desert Range Station of the U. S. Forest Service west of Milford to determine whether supplemental feeding on desert range would affect the lamb crop, 170 ewes were divided into 5 groups to receive a protein and/or phosphorus rich supplement (except those ewes in the two control groups which received no supplement). Cottonseed cake was used for the protein supplement and one lot of ewes received phosphoric acid and another bone meal for phosphorus rich supplements.

More ewes lambed, more twins were dropped, and the ewes conceived more promptly in those groups that received the phosphorus rich supplements before and after breeding.

Ewe lambs slaughtered in January after being on feed 12 weeks had somewhat larger reproductive organs and showed more follicular development in the ovaries than did those grazed on the range.

Four out of 17 ewes carried on the range their first winter as lambs failed to show estrus during the succeeding fall breeding season as compared with 1 out of 16 ewes that received extra feed their first winter.

There has hardly been a sufficient number of observations to warrant final conclusions. Probable applications are: (1) Phosphoric acid containing supplements (about an ounce a day per ewe) fed to ewes on Utah desert ranges during the breeding season result in ewes conceiving more readily and a larger number of lambs produced per 100 ewes bred. (2) Under Utah desert range conditions, a higher percentage of ewes will come into heat the fall they are yearlings if those ewes have been fed supplements during the first winter of their lives.

**MEASURING PERFORMANCE IN SHEEP AND DEVELOPING INBRED LINES**

This project was set up in 1936 to procure data to measure performance (meat and wool) in the college sheep. The work during 1940 and 1941 was a continuation of that previously conducted.
A statistical study of two methods of determining wool density has been conducted (2).

Fleece weights of the sheep were procured. Each fleece was sampled and scoured to determine the wool production of individual sheep. For the 1941 season the Rambouillet ewes averaged 14.8 pounds grease weight, 6.5 pounds scoured weight, with a staple length of 2.6 inches; the Corriedale ewes 14.1 pounds (grease), 7.2 pounds (scoured), 4.1 inches staple length; Columbia ewes 11.1 pounds, 5.9 pounds, and 3.4 inches, respectively; Hampshire ewes 8.3 pounds, 4.5 pounds, and 2.5 inches; Southdown ewes 6.9 pounds, 3.0 pounds, and 2.2 inches, respectively.

Wool production records of the progeny of Rambouillet rams used at the college from 1936 to 1941 have been tabulated. The data show a rather uniform grease weight production from the different sires, but scoured weight varied from 5.96 pounds to 4.73 pounds. These figures emphasize the need for the testing and use of rams with high levels of wool production.

WOOL GRADING AND SCOURING

Wool has been sampled and scoured by grades from range and farm flocks. Four cooperators have worked with the Experiment Station so that composite samples were taken from their 37,000 sheep each of the two years of the biennium. Side samples were taken from four purebred herds, including those of the Utah State Agricultural College and of the Branch Agricultural College (3).

In the 15 range herds sampled the shrinkages were:

11 herds—grade fine ...............53.23 to 67.23 percent
3 herds—grade ¼-blood ...........49.33 to 59.32 percent
1 herd—grade ½-blood ............45.23 percent

Variations in shrinkage among individuals, among herds of the same grade and between grades is the most significant characteristic of the work done. This indicates the urgent need of making shrinkage tests to determine the value of the clip rather than the present system whereby the wool buyer purchases on the basis of his estimate of the shrinkage.

In four purebred Rambouillet herds consisting of 352, 169, 24, and 47 ewes, the average fleece weight in the grease was 9.70, 9.56, 15.2, and 14.83 pounds, respectively. The average scoured weight on these was 4.61, 3.86, 6.96, and 6.50 pounds, respectively. The average shrinkage was 52.54, 59.24, 54.26, and 56.17 percent, respectively. The range in shrinkage was from 41 to 69.7 percent. The staple length for each herd was 2.24, 2.21, 2.07 and 2.64 inches, respectively.

Composite samples were drawn from 25 ewes of a herd of 169 purebred Rambouillet sheep to compare with side samples from each of the same
ewes. From the following figures it will be seen that both methods of determining shrinkage proved fairly reliable. Composite sample shrinkage was 59.10 percent, and side sample shrinkage 60.49 percent on these ewes, a difference of only 1.39 percent. Side sample shrinkage on the whole herd of 169 ewes was 59.24 percent.

On 22 purebred Corriedale ewes the average grease weight of wool was 14.1 pounds, scoured weight 7.16, shrinkage 49.35 percent (range 38.27 to 58.9 percent), staple length 4.07 inches. In 20 Columbia ewes grease weight averaged 11.12 pounds, scoured weight 5.89, shrinkage 47.21 percent (range 37.47 to 59 percent) staple length 3.37 inches. (Columbia ewes were old ewes and may not represent average weights of the breed.)

The very fact that there is so much variation among herds and individuals emphasizes the need for careful selection of sheep with desirable characteristics with respect to wool shrinkage, net yield and staple length. Culling plus selection will speed up the improvement program. The management of the herds has proved to be an important factor with respect to relation of grease weight to clean weight.

**The Value of Molasses**

**In the Rations of Growing and Fattening Hogs**

The feeding of large amounts of beet molasses to young hogs causes a condition that is characterized by a wobbly gait, and that is frequently fatal. Some farmers have also reported breeding failures and abortions when beet molasses was fed to brood sows.

The Station has been carrying out experiments on how to feed safely this relatively cheap carbohydrate feed in swine rations (4). The following are the findings to the present:

Hogs weighing 100 pounds or more may be fed as much as 40 percent of their rations as beet molasses and still make as rapid and cheap gains as hogs fed similar rations without molasses. A satisfactory ration is barley, 44 parts; tankage, 10 parts; molasses, 40 parts; alfalfa meal, 5 parts, and common salt, 1 part. The alfalfa can be fed as hay, free choice, and the salt, with due precaution, can also be fed free choice. It is usually easier to feed the grain, tankage and molasses mixed into a slop with water.

Weaner pigs will not thrive on the above ration, but will develop a disease involving the nervous system. However, 40 percent of the ration can be molasses if the pigs receive the equivalent of 5 percent of hay as fresh cut green alfalfa or 5 percent of dried brewer's yeast. A satisfactory ration for weaner pigs is barley, 41 parts; tankage, 13 parts; molasses, 40 parts; fresh cut green alfalfa, 5 parts, and common salt, 1 part. The green alfalfa can be furnished as pasture and the salt fed free choice. It is usually most satisfactory to feed the barley, tankage and molasses as a slop.
Costs of Various Feeds for Dairy Cows

Since 1938 detailed data have been kept on the items pertaining to the cost of production of total digestible nutrients in pasture, alfalfa hay, corn silage and barley. This data is summarized in table 1.

These data show that pasture is one of the cheapest feeds for dairy cows. Butterfat produced from pasture cost 8 cents per pound, while from corn silage the cost was $0.261 and from barley $0.192.

In comparing the production per acre from pasture and other crops it should be noted that no fertilizers were applied to the pasture during the first three years of this experiment in order to determine what yields could be obtained without their use. These pastures have now been fertilized and yields will be compared with those obtained without the use of fertilizer.

Mastitis of Dairy Cows

During the past year, all cows (approximately 30) in the experimental herd have been tested monthly for mastitis by the following methods: strip cup, bromthymol blue, udder palpation, Hotis test and bacteriological examination (agar plate test).

The purpose of this experiment is to determine the presence of bovine mastitis streptococcus or other organisms infectious to the cow’s udder, and to attempt to free the udder of these organisms by injections of certain germicidal substances.

During this period 15 cows (38 quarters) were found to show clinical evidence of mastitis. Fourteen of the quarters were infected with Streptococcus uberis, 11 with with Streptococcus agalactiae, 6 with atypical streptococci, and the infection in 7 was not classified.

Twenty-five quarters (10 cows) were injected with colloidal silver oxide suspension in oil (Novoxil). Injections were made just prior to drying up the cows. Of the 14 quarters infected with Streptococcus uberis, organisms could be demonstrated in only one of the quarters following treatment. Five quarters infected with Streptococcus agalactiae, 2 quarters infected with atypical streptococci, and 4 quarters whose infection was not classified all proved free from organisms following treatment.

Four quarters (1 cow) infected with atypical streptococci and 5 quarters (2 cows) whose type of infection was not determined, were injected with acriflavine dye solution. One cow with one infected quarter was freed from infection. The remaining 8 quarters (2 cows) continued to harbor infection.

Nine quarters (5 cows) were injected with Tyrothricin solution. Seven
Table 1—Time required, costs of production and returns per acre of pasture, alfalfa, corn silage and barley

<table>
<thead>
<tr>
<th></th>
<th>Pasture</th>
<th>Alfalfa</th>
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<tr>
<td><strong>Yields</strong></td>
<td></td>
<td></td>
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<tr>
<td>Per acre</td>
<td>183.7 days</td>
<td>4.53 tons</td>
<td>15.33 tons</td>
<td>88.96 bushels</td>
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<tr>
<td>Total digestible nutrients (lbs.)</td>
<td>2,922</td>
<td>4,876</td>
<td>5,398</td>
<td>3,360</td>
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<tr>
<td>Straw (lbs.)</td>
<td>131.3</td>
<td>203.2*</td>
<td>224.9*</td>
<td>140.0*</td>
</tr>
<tr>
<td>Butterfat (lbs.)</td>
<td>10.61</td>
<td>7.45</td>
<td>10.33</td>
<td>26.77</td>
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<tr>
<td><strong>Items of production</strong></td>
<td>6.78</td>
<td>24.01</td>
<td>67.06</td>
<td>32.07</td>
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<tr>
<td>Man hours required</td>
<td>3.97</td>
<td>12.05</td>
<td>34.28</td>
<td>14.43</td>
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<td>Horse hours</td>
<td>2.75</td>
<td>2.75</td>
<td>2</td>
<td>1.75</td>
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<tr>
<td>No. of irrigations</td>
<td>5.18</td>
<td>3.31</td>
<td>14.04</td>
<td>155.</td>
</tr>
<tr>
<td>Seed planted (lbs.)</td>
<td>5.18</td>
<td>3.31</td>
<td>14.04</td>
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<td><strong>Costs</strong></td>
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<tr>
<td>Production costs per acre (dollars)†</td>
<td>10.73</td>
<td>16.69</td>
<td>58.63</td>
<td>28.26</td>
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<tr>
<td>Production costs per 100 lbs. total digestible nutrients†</td>
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<td>.342</td>
<td>1.086</td>
<td>.841</td>
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<tr>
<td>Feed production cost per lb. butterfat†</td>
<td>.082</td>
<td>.082</td>
<td>.261</td>
<td>.192</td>
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<tr>
<td>Gross returns per acre when butterfat sells for $.50 per pound</td>
<td>65.65</td>
<td>101.60</td>
<td>112.45</td>
<td>70.00</td>
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*Calculated.

†The feed production cost does not include real estate tax, interest on the land and overhead such as labor for repairing fences and ditches.
of these quarters were infected with *S. agalactiae*. Three quarters continued to show infection following treatment. The remaining 4 quarters proved free from infection. Two quarters with the type of infection not determined proved free from infection following treatment. The results to date suggest that silver oxide treatment is effective in eliminating infection from streptococci-infected udders.

Novoxil solution appeared to be more irritating to the udder tissue than the other solutions used. One quarter injected with Novoxil developed such a severe reaction that it appears that its production is permanently impaired as the result of the treatment.

A STUDY OF PARTURIENT HEMOGLOBINEMIA

This study continues to show the presence of aphosphorosis in herds experiencing this disease. Three cows were placed on phosphorus-deficient rations in an attempt to see if such rations resulted in the development of this disease. Two of the cows were eventually eliminated from the trial because of extraneous factors beyond the control of the experiment. The remaining cow showed the following blood changes soon after calving: Slightly lowered hemoglobin, red cell count, specific gravity, cell volume and inorganic blood phosphorus. It appears therefore that some of the changes noted in this cow are similar to those which commonly occur in field cases of parturient hemoglobinemia. No clinical symptoms of the disease were evident. This cow will calve again shortly and intensive studies of the blood changes will be made during the post parturient period.

Cows in herd where this disease recently occurred were found to be suffering with aphosphorosis even though the ration fed appeared to be well fortified with grain. This has suggested an investigation of the mineral content of the grains fed. Parturient hemoglobinemia is now much less prevalent in herds which formerly encountered much of this disease. Observation indicates this is the result of the more general feeding of bone meal.

THE ANIMAL DISEASE LABORATORY

Clinical examinations are made at the animal pathology laboratory of diseased animal specimens, and staff members consult with farmers having disease problems. The following tests have been made:

Bangs disease (July 1, 1940 to December 31, 1941). Bangs disease tests were made during this period on blood samples collected from 84,138 head of cattle. Of this number 3.7 percent was found to be reactors.

Turkey blood samples tested for pullorum disease (July 1, 1940 to April 1, 1942) 34,246 samples.
Turkey poults examined (less than 3 weeks of age) 11 consignments, 585 poults.
Turkeys examined (3 weeks of age and older) 48 consignments, 160 turkeys.
Baby chicks (less than 3 weeks of age) 56 consignments, 250 chicks.
Chickens (3 weeks of age and older) 47 consignments, 124 chickens.
Cattle, sheep, swine, and miscellaneous 41 consignments, 63 specimens.
Totals (exclusive of blood tests) 303 consignments, 1,182 specimens.

POULTRY

CHICKENS

Breeding for egg production. In selecting birds for the breeding program special emphasis has been placed upon good family records with regard to egg numbers, size, color and shape, shell texture, and hatchability and livability of the chicks. Stock has now been produced with hatchability of eggs between 80 and 100 percent and a high percentage livability of chicks. All birds now used in the breeding program show considerable improvement in these two important factors over those used three or four years ago, and at the same time these birds maintain a high average egg production and egg size.

Feeding for egg production—Coarse vs. fine grinding of mash ingredients for Leghorn hens. During the biennium the data accumulated on this study have checked quite closely with those obtained in previous years. The hens receiving the coarser mashes have consistently given a higher average annual egg production. The cost of grinding the grains so much finer and regrinding the bran, alfalfa meal, and other ingredients in the fine mashes would also tend to increase the advantages of the coarser mash by lowering the cost. There was little difference in grain or mash consumption per hen in these pens.

Various percentages of limestone (calcium carbonate) in the mash with limestone and granite for grit. The use of granite as a grit for Leghorn hens appears, from data accumulated during the biennium, to be of little value if not a definite handicap, unless limestone grit is also supplied or 6 to 8 percent of ground limestone added to the mash.

When granite was the only grit supplied average consumption of grit per bird was nearly three times as much as when only limestone grit was used. When both limestone and granite were given free choice, little granite was consumed.

When granite was supplied as the only grit with 2 percent of limestone in the mash the average egg production per bird for the two years was more than 2 dozen less than from any other pen of hens in this study.
Forced molting of Leghorn hens. Four pens of 50 S. C. White Leghorn pullets each were started in this study on October 1, 1939. The birds in three of the pens were forced to molt during the following summer. Pen A was molted in June, pen B in July, pen C in August and the birds in pen D were allowed to molt normally during the late summer and fall months.

The data obtained on this flock and on previous flocks used in this study show that forcing the molt has no effect on percentage mortality during the first or second year following the forced molt. There was only a slight increase in egg production during the second year in the forced molted pens and this increase was greatest during the period October to December in the pen forced to molt in August.

Turkeys

Turkey production studies. During the year 1940 data were obtained for the third year on the value of skim milk, wet mash, or soaked, chopped barley and alfalfa meal as supplements fed daily to a mixture of whole grain (equal parts of wheat and barley) and mash containing 19 percent (low) or 24 percent (high) protein. Both grain and mash were hopper fed and kept always available to the birds.

The data obtained during the third year of this study agree quite closely with those obtained during the two previous years. These studies indicate that there is no apparent advantage in using skim milk or the soaked barley and alfalfa or wet mash as supplements to the dry mash containing either a high or low percentage of protein after the turkeys are 7 weeks old until marketed at 29 weeks old.

The lowest feed cost per bird or per pound of gain for this year and for the three year average was obtained in the pen receiving the low protein mash without any supplement of milk or wet feeds.

During 1941 studies were started to determine the amount of alfalfa meal that can be used economically as a part of the growing mash for turkeys 7 weeks old until marketed at 29 weeks. Alfalfa meal of excellent quality is available in this state at a price about one-half that of most grains. All turkey growers are therefore interested in the maximum amount of this feed that can be used as a part of the mash and still produce well fleshed and well finished turkeys. A few years ago most turkey growing mashes contained only 5 to 10 percent of alfalfa meal. During the last two years some of the larger turkey growers have increased the alfalfa meal to 15 percent and are producing turkeys with as good or better finish than those produced a few years ago.

In this first year's study excellent turkeys were produced on mashes containing as much as 25 percent of alfalfa meal while birds that had free choice of well cured alfalfa leaves consumed as much as 9 pounds of leaves per bird or about 20 percent of the total mash consumption.
during this growing period. Additional data are necessary before it is advisable to recommend these high percentages as a general practice in commercial turkey production.

**Synovitis in turkeys.** Staphylococci nearly always are recovered from turkeys affected with synovitis. The disease can be reproduced by inoculating turkeys under the skin with cultures of the organism. It has not yet been reproduced by giving cultures by way of mouth. As yet no evidence has been obtained as to the method of transmission in the field.

The disease was not successfully treated with sulfanilamide or sulfathiazole. Neither were artificially infected birds protected by bacterins prepared from the causative organism. Turkeys and rabbits were susceptible to inoculation with the organism; chickens and guinea pigs were not susceptible. The cultural and biochemical characteristics of the organism are similar to those encountered in various pathogenic staphylococci strains recovered from domestic animals.

**REFERENCES FOR THE SECTION, ANIMAL INDUSTRY**


NUTRITION STUDIES
QUALITY APPRAISAL OF UTAH GROWN FRUITS AND VEGETABLES

Little work was done on this project in the summer of 1940 because the pea crop was a failure on the experimental plots. Two varieties of shelled peas held at room temperature were tested for ascorbic acid at intervals during one day. No significant loss was noted between 9 a.m. and 4 p.m. At the same intervals samples of the two varieties were blanched, frozen, and stored. Approximately one year later they were found to have retained 73 to 80 percent of their original ascorbic acid.

Nine of the twenty-one varieties and strains of peas frozen in 1939 showed almost complete loss of ascorbic acid after approximately two years' storage. It should be noted that place and conditions of storage changed at least twice during this period.

In the 1941 season ascorbic acid determinations were made on nineteen of the twenty-one varieties and strains of peas tested in 1939. Growing and cultural conditions were more nearly uniform, and with the exception of vining, all procedures connected with harvesting and handling of samples were under control, thus eliminating some of the delays which were unavoidable in 1939. Range in ascorbic acid was much narrower in the 1941 samples though maximum values were substantially the same.

Twelve varieties and strains of lima beans which had been blanched and frozen without delays showed ascorbic acid values ranging from 16 to 29 milligrams per 100 grams. Green lima beans had higher ascorbic acid values than white. Small beans were higher in ascorbic acid per unit weight than large ones of the same variety.

VITAMIN C (ASCORBIC ACID) VALUE OF TOMATOES

Investigation of the vitamin C content of different varieties of tomatoes was begun in 1940 (1). A late spring caused delayed plantings, unseasonable summer heat came early, as did the fall rains which resulted in a poor crop of tomatoes. However, duplicate vitamin-C determinations were made on eighteen varieties and strains from one to three times during the season, the number of determinations depending upon availability of samples. Values ranged from 18 to 25 milligrams per 100 grams.

The following season the tomato experimental plot was destroyed by heat and lack of moisture before fruits began to ripen. Notwithstanding this situation it was found possible, by means of samples from the North Logan farm, to make vitamin-C determinations on ten of the varieties investigated the previous season. In nine of the ten varieties
higher values were found. The range in values this second season was from 17 to 28 milligrams per 100 grams.

Varieties with a vitamin C content of 20 to 25 milligrams per 100 grams in both seasons were Baltimore, Earliana, and Clark's Early Special; varieties with vitamin C content 20 to 25 milligrams the first season and 25 to 28 the second, were Valiant, Marglobe, Early Bison, Scarlet Dawn, and Stokesdales. The Cardinals showed values in this latter range in both seasons.

**The Capillary Resistance Test as an Indicator of Vitamin C Deficiency**

Collection of data for this project was completed prior to 1940. However, capillary resistance tests by the Dalldorf technique were made on more than one hundred women students during 1941 for correlation with blood plasma ascorbic acid levels.

Few cases of drastic ascorbic acid deficiency as measured by the capillary resistance test have been encountered. There was no correlation found between results of the test made by the two different techniques, and no correlation between blood plasma ascorbic acid levels and results of capillary resistance tests by either the Dalldorf or the Rumpel-Leede technique.

When drastic deficiency is suspected because of low ascorbic acid intake the capillary resistance test by either technique might be useful in identifying such deficiency. Both are simple and easily applied in cases where there are no facilities for determining blood plasma levels.

**Ascorbic Acid Nutrition of College Students**

That blood samples taken within one-half hour after an ascorbic-acid-free breakfast can be used for determining index of ascorbic acid nutritional status was indicated by a correlation coefficient of 0.98 between ascorbic acid values of such samples and of fasting samples taken on the same morning.

One-half (51 percent) of a group of 111 women students was found to be in a state of good to excellent ascorbic acid nutrition through analysis of blood samples by 2, 6 dichlorophenolindophenol titration. About one-tenth were in a poor state of ascorbic acid nutrition.

The average blood plasma ascorbic acid level of young women living at home was slightly higher than similar averages for those boarding, keeping house for themselves, or living in dormitory or in sorority houses.

No significant correlations were found between blood plasma ascorbic acid levels and the following factors: Basal metabolic rate, blood pressure, capillary fragility, and body build.
Ten of the 19 young men included in the investigation were in a poor state of nutrition.

**Nutritional Status Indices for Rural and Urban Utah School Children**

In this study, country girls were found to have the highest mean indices with slightly less variation than was true for the other groups. Mean indices of city girls were second highest, country boys third, while city boys had the lowest mean indices. Variation as measured by standard deviation was mainly in the same order. Correlation between indices ranged from 0.38 to 0.73. Highest correlations were found between indices for weight and those for musculature.

The outstanding conclusion reached through this study is that the indices do not furnish an explanation of the larger size of city children over country children in Utah schools (2).

**References for the Section, Nutrition Studies**


RURAL SOCIOLOGY
COMMUNITY PLANNING

Need for more attention to community planning in Utah towns is shown as the result of a study of community assets and institutions being made in the towns of Tremonton, Lewiston and Plain City. During the past biennium, housing, including additions or changes, and home conveniences were checked in each of these communities along with information on the culinary water systems and the street improvements. Historical growth of the community institutions has also been studied.

A STUDY OF RURAL YOUTH IN UTAH

Schedules and instructions were prepared and 70,000 sent out to superintendents and principals of all schools in Utah. When returned, these schedules were checked and forwarded to Berkeley for tabulation. However, because of the war emergency and the pressure of other work, no further progress has been made on this study. No doubt the economic changes brought about by the war will materially change the conclusions resulting from this investigation.

CRIME AND DELINQUENCY IN URBAN AND RURAL AREAS OF SIX UTAH COUNTIES

During the biennium school truancy cases, city court records, and sheriffs’ office files in Ogden and in Garfield, Grand, Piute, Sevier and Box Elder Counties have been checked and crime records copied. As far as possible all cases have been interviewed. All data will be tabulated and conclusions drawn during the next biennium.
INTERMOUNTAIN HERBARIUM

The Intermountain Herbarium serves as an effective research instrument to general and economic studies of the flora of the State of Utah, and to special graduate revisionary studies in plant taxonomy. The plant collection has now attained approximately 70,000 specimens. The special library treating the taxonomy of flowering plants has reached several hundred volumes and is steadily acquiring essential literature necessary to the researches of the herbarium. One of the more important aspects of the activities of the herbarium is its general service in the identification of plants for various departments of the institution, county agents, agricultural workers, government agencies and private individuals.

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<td>Herbarium sheets mounted</td>
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PUBLICATIONS


CRICKET AND GRASSHOPPER STUDIES

Field studies have been made of cricket and grasshopper species in Washington, Kane, Duchesne, Uintah, Carbon, Emery, Grand, and San Juan Counties and numerous specimens added to the insect collections. Insects have been classified into family, genus, and species and taxonomic relations determined.

PUBLICATIONS

COOPERATIVE CONTROL PROGRAM
Grasshoppers have been destructively abundant in many parts of Utah during recent years. The federal-state-county-cooperative grasshopper control program conducted in the affected counties has been under the supervision of one of the Experiment Station entomologists. During 1940, 2,084 farmers used the mixed bait prepared from materials supplied by the U. S. Department of Agriculture, resulting in an estimated crop savings of $439,087. In the 1941 control program, 3,100 farmers and home owners procured and scattered the bait on grasshopper infested cropland, resulting in an estimated crop saving of $789,089. Field observations during this biennium gave little, if any evidence that grasshopper baiting was of importance in causing losses of honeybees.
Federal-state-county cooperation also destroyed populations of Mormon crickets in over 85 percent of the infested areas of Tooele, Juab and Utah Counties. Successful control was obtained by dusting the nymphal crickets with a powder consisting of one part sodium arsenite to each four parts of hydrated lime, applied directly to the crickets by either power dusting equipment or by hand-operated dust guns. A poisoned bait consisting of three pounds of sodium fluosilicate, 100 pounds of bran and one gallon of oil, used during the hotter part of the summer during 1940 and 1941 also gave excellent kills.
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COOPERATIVE AGREEMENTS

The research of the Utah Agricultural Experiment Station is supplemented by investigations conducted by specialists of the U.S. Department of Agriculture working cooperatively with the station. During the biennium 14 scientists paid by the federal government were located on the college campus investigating problems of vital concern to Utah. A list of these investigations is given below:

COOPERATIVE AGREEMENTS BETWEEN THE UTAH STATION AND VARIOUS FEDERAL AGENCIES

Western Regional Laboratory for research on utilization of farm products at Albany, California

Cooperation: Bureau of Agricultural Chemistry and Engineering and 11 states in western farm producing area

Objectives: To find new means of utilizing surplus supplies of apples, alfalfa, fruits, potatoes, poultry products and by-products, vegetables and wheat. Leader: R. H. Walker

Preservation and utilization of fruits and vegetables grown under Great Basin conditions by freezing

Cooperation: Bureau of Agricultural Chemistry and Engineering

Objectives: To aid the fruit and vegetable industries of Utah and the intermountain region as well as consumers generally by studying cooperatively the preservation and utilization of fruits and vegetables. Leaders: F. M. Coe, L. H. Pollard, Mrs. A. P. Brown, A. J. Morris

Agricultural land use planning and research relating thereto

Cooperation: Bureau of Agricultural Economics, Utah State Agricultural College Extension Service

Objectives: To develop an agricultural land-use program, in which will be correlated the suggestions and work of farmers, and the cooperating agencies, and in which all of these agencies can make the greatest and most effective contribution to agricultural adjustment, conservation, crop insurance, farm forestry, flood control, land retirement, rehabilitation, and water utilization. Consideration is given to the land-use implications of community facilities, credit, marketing, public finance, land taxation, tenancy and transportation. Leaders: All staff members

A study of rural youth in Utah: education, employment, and migration

Cooperation: Bureau of Agricultural Economics

Objectives: To get information on the following and other closely allied questions: (1) What areas in Utah are losing youthful population in relatively great proportions? (2) What farm groups in Utah are losing youthful population in relatively great proportions? (1) What are the characteristics (age, sex, marital status, education) of those departing and of those remaining? (4) What relationships are to be found between the amount of education, family occupational background, family religion, and size of family, and the tendency to migrate or to remain in Utah? (5) What intrastate population movements are to be found among young people, and what relationships are to be found between such movements and the factors listed in question 4? (6) What are the present occupatons of the young people who have remained and those who have migrated? (7) What relationships are there between amounts of education and present occupations of young people both migrant and nonmigrant? (8) To what extent are young people being retained on the farms and in rural areas in Utah without adequate work opportunities? Leader: J. A. Geddes
Land utilization, type of farming, and agricultural adjustments in Utah

Cooperation: Bureau of Agricultural Economics

Objectives: (1) To obtain a picture of how lands of various types are utilized in the farm and livestock ranching industry, and the trends that are taking place in their utilization. (2) To determine factors and influences responsible for the present pattern of land utilization in livestock ranching areas and related or contiguous irrigated areas and the trends therein. (3) To determine by farm type the factors that affect ranch incomes, organization and operations, including the influence of land tenure and public land policies and the inter-relationship between range and irrigated land. (4) To evaluate the effect of feasible changes and adjustments in farm and ranch organization and operation, public land policies, leasing terms, and other factors that may contribute to better land utilization and increased profits in livestock ranching and general farming. Leaders: W. P. Thomas, G. T. Blanch, Dee Broadbent, H. C. Cutler.

Causes of country bank difficulties in Utah and effect of such difficulties upon supply of credit for farmers

Cooperation: Bureau of Agricultural Economics

Objective: To determine and appraise the importance of the causes of country bank failures and the restrictions of country bank loans in Utah during the depression. This will require careful consideration of agricultural credit problems and analysis of the operating practices and resulting financial condition of country banks in Utah. Leaders: W. P. Thomas, H. H. Cutler

Cooperative research for the improvement of sheep for western ranges through the application of breeding methods (Laboratory at Dubois, Idaho)

Cooperation: Bureau of Animal Industry and Stations in the western range region

Objective: The improvement of sheep for the production of wool and lamb meat under the conditions of the western ranges through the application of breeding methods. Leaders: F. F. McKenzie, A. C. Esplin

Cooperative work to conduct (a) general dairy cattle breeding investigations and (b) investigations of dairy cattle feeding and management problems peculiar to the region

Cooperation: Bureau of Dairy Industry

Objectives: (1) The breeding of registered Holstein-Friesian cattle that will be pure in their inheritance for the hereditary factors determining a high level of production, this to be accomplished by the continued use for generation after generation of sires that have shown by the producing ability of their offspring that they are homozygous for the factors determining a high level of production, and (2) investigations of pasture grasses and pasture problems, and in the curing and preservation of roughages in their most desirable feeding form. Leader: G. Q. Bateman

Cooperative effort to protect crops from grasshoppers during the crop season

Cooperation: Bureau of Entomology and Plant Quarantine, Utah State Agricultural College, Extension Service

Objective: To provide for cooperative effort in the control of grasshoppers so as to protect crops from damage. Leader: G. F. Knowlton

To investigate the extent and cause of heavy losses of honeybees

Cooperation: Bureau of Entomology and Plant Quarantine

Objective: To investigate the extent and causes of heavy losses of adult bees in various sections of Utah, supposedly owing to such causes as insecticidal spraying or dusting operations, grasshopper control methods, or to the effects of smelter fumes. Leader: G. F. Knowlton

Investigation of the beet leafhopper as a pest of beets, tomatoes, and other susceptible vegetable crops, and the tomato fruitworm

Cooperation: Bureau of Entomology and Plant Quarantine

Objective: To study all phases of the sugar beet leafhopper problem with the purpose of developing effective measures for control. Leaders: Walter Peay, G. F. Knowlton
Rehabilitation and restoration to range of abandoned cultivated lands through reseeding, management, and conservation of soil and water

Cooperation: Forest Service, Bureau of Plant Industry, Soil Conservation Service

Objectives: (1) To determine the most effective and economical methods of restoring abandoned farm lands to range through reseeding and through soil and water conservation. (2) To determine the best management methods and practices for such lands, both during and after rehabilitation and restoration. Leaders: Wesley Keller, A. F. Bracken, L. A. Stoddart, F. F. McKenzie, George Stewart

Investigations in range land economics

Cooperation: Forest Service

Objectives: To conduct area studies to determine the effect of different administrative policies in the allocation of grazing privileges to the farms and ranches, and in the management and use of the national forest and other public land range resources, upon the economy of the farm and upon the economic and social welfare of rural communities. Leader: W. P. Thomas

Factors affecting the size of lamb crops in range sheep and other factors affecting the production of wool and mutton

Cooperation: Intermountain Forest and Range Experiment Station

Objective: To provide information on factors affecting lamb crops and other factors affecting production that will enable producers to obtain a larger and more economical production per animal unit maintained. Leader: F. F. McKenzie

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

Cooperation: Forest Service and Weather Bureau

Objective: (1) To make annual surveys between March 25 and April 2, over prescribed snow courses on the principle watersheds of Utah; to make monthly snow surveys over prescribed key snow courses; to make general mid-winter snow surveys when necessary; and to collect such additional climatic, meteorological, and physical data on the watersheds of Utah as will be necessary to form the basis of stream-flow forecasts. (2) To determine the relationship between the precipitation on, and the run-off from, the various watersheds of the state, and to disseminate the information gathered each year in the form of monthly reports of snow cover conditions on the watersheds and in detailed forecasts of stream-flow at the beginning and during the run-off season. Leader: G. D. Clyde

Breeding and improvement of range and pasture grasses and reseeding investigations at Logan, Utah

Cooperation: Bureau of Plant Industry, Forest Service

Objective: To obtain through basic research, facts and materials applicable in pasture and range improvement. Leaders: Wesley Keller, Dean McAllister

Improving the effectiveness of vegetation in controlling soil erosion

Cooperation: Bureau of Plant Industry, Soil Conservation Service

Objective: To conserve more effectively soil and moisture through the use of superior plants and improved methods of vegetative control. Leader: A. F. Bracken

Soil Survey

Cooperation: Bureau of Plant Industry

Objective: To prepare accurate soil maps, accompanied by adequate descriptions of the soil types and phases as to their suitability for the growth of crops, grasses, and trees under alternative systems of management. Leaders: D. S. Jennings, Lemoyne Wilson, O. F. Bartholomew
Cooperative research on the relationships of salinity of irrigation water and of soil conditions to plant growth and related factors involved in a permanently successful irrigated agriculture (Laboratory at Riverside, California)

Cooperation: Bureau of Plant Industry and the states in the western range region and Hawaii

Objective: To provide for correlation of research on the relationships of the salinity of irrigation, and of soil conditions to plant growth and related factors in a permanently successful irrigated agriculture to be done at the regional laboratory and at the various state agricultural experiment stations in the western region. Leader: O. W. Israelsen

Cooperative investigations on cereal improvement

Cooperation: Bureau of Plant Industry

Objective: To improve the status of cereal production through (1) developing better cultural practices, (2) producing varieties superior in yield and quality, and more resistant to disease and other factors adversely influencing production, (3) studying the diseases of cereals and determining methods for their control, (4) developing and applying methods for utilizing and maintaining quality seed stocks, and (5) determining the underlying principles concerned in the biology of cereal plants, including research in genetics, cytology, and physiology. Leaders: D. C. Tingey, R. W. Woodward

Investigations on western yellow blight and other diseases of tomatoes

Cooperation: Bureau of Plant Industry

Objective: To develop practicable methods of control of curly top and other diseases of tomatoes; determine the nature of those diseases, and inter-relations of disease, host and environment; and the factors governing severity of the disease and their control. Leaders: H. L. Blood, Michael Shapovalov

Alfalfa investigations (breeding and improvement)

Cooperation: Bureau of Plant Industry

Objective: These investigations relate primarily to (1) the increase of superior strains of alfalfa for further testing in various parts of the United States; (2) studies of factors influencing seed production of alfalfa; (3) testing of alfalfa strains assembled from different parts of the United States, and (4) studies related to the general alfalfa improvement program which has been formulated in cooperation with different states through the Alfalfa Improvement Conference. Leaders: R. J. Evans, J. W. Carlson

Relative to investigations on the adaptation of strawberry clover to saline soils, and with other clovers adapted to the intermountain region

Cooperation: Bureau of Plant Industry

Objective: To study the introduction, development and adaptation of the strawberry clover to saline soils of the Intermountain region. Additional studies on the adaptation of other species of Trifolium and Melilotus. Leader: R. J. Evans

Investigations on potato breeding and culture

Cooperation: Bureau of Plant Industry

Objective: To conduct potato breeding and cultural experiments including pathological investigations, with special reference to breeding for disease resistance. Leader: R. J. Evans

Investigations on virus diseases of stone fruits in Utah

Cooperation: Bureau of Plant Industry

Objective: To determine the nature of suspected virus diseases of stone fruits (particularly the disease suspected of being identical with "x-disease" in the Eastern States), to determine the species and varieties of plants affected by the disease, to determine the symptoms in the various varieties and species, and to conduct related studies relative to the dissemination and control of the disease. Leader: B. L. Richards
Investigations on onion culture, breeding, and diseases
  Cooperation: Bureau of Plant Industry
  Objective: To conduct onion breeding and cultural experiments with special reference to the breeding of insect and disease resistant onions. Leader: L. H. Pollard

Tillage method demonstrations in dry-land grain producing areas of the state of Utah
  Cooperation: Utah State Agricultural College Extension Service, Soil Conservation Service
  Objective: To demonstrate the use of sub-surface tillage implements on a field basis and determine the effectiveness of a straw mulch maintained on and near the soil surface on soil erosion, and its effect as a continued practice on grain yields and on the amount of available nitrate in the soil. Leader: A. F. Bracken

Irrigation investigations and research
  Cooperation: Soil Conservation Service
  Objective: (1) To prepare for publication the results of the survey of irrigation practices, and methods. (2) To make intensive studies of water-application efficiencies and their relation to irrigation methods and water use. Leader: O. W. Israelsen

Research in soil erosion and its control
  Cooperation: Soil Conservation Service
  Objective: To study in a thoroughly coordinated manner the main factors and forces involved in the incidence of soil erosion under general farming conditions, methods of prevention or control and the most economic method of restoring lands already injured to varying degrees by the uncontrolled action of wind or water. Leaders: Willard Gardner, C. W. Lauritzen

Soil Conservation surveys
  Cooperation: Soil Conservation Service
  Objective: To conduct soil surveys in areas for which it is contemplated to cooperate in the formulation and execution of land-use programs. Leaders: D. S. Jennings, LeMoyne Wilson, Ray Walker.

Laboratory and field investigation of basic factors governing soil erosion by irrigation water
  Cooperation: Soil Conservation Service
  Objective: To study the basic physical relations of soil properties, slope of land, and size of stream to soil erosion and conservation in order to find practical methods of reducing erosion and soil depletion caused by irrigation. Leaders: O. W. Israelsen, C. W. Lauritzen

COOPERATIVE NUTRITION STUDIES

The state agricultural experiment stations are cooperating with the U. S. Department of Agriculture in a study of the conservation of the nutritive values of foods. In the western region, comprising Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Utah, Washington, and Wyoming, the research is concentrated on the following products or commodities: apples, dried apricots, green lima beans, dry Pinto beans, string beans, beef, carrots, citrus fruits, lamb, dried peaches, fresh peas, potatoes, and tomatoes.

The Utah Station has charge of the research on tomatoes and lamb, and is assisting with the investigations on green lima beans and fresh peas.
The work is concerned with the conservation of nutritive values through the processes of marketing, storage and cookery or other home preparation. The conservation of the vitamin values in the foods is receiving the major attention.

COOPERATION WITH NON-FEDERAL AGENCIES

In addition to the cooperative agreements with the federal government, the station cooperates with various state and private agencies in the investigation of fundamental problems. These cooperative agencies and the type of investigation undertaken are presented below:

Growing seed of improved alfalfa strains

Cooperation: Wisconsin Agricultural Experiment Station, New Jersey Field Crop Improvement Association

Objective: To grow under isolated and partly controlled conditions of pollination, foundation seed of alfalfas which are improved for resistance to bacterial wilt, leafhopper yellowing, cold, etc. as per the program of the Alfalfa Improvement Conference. The seed obtained is intended for the establishment of foundation seed fields as a basis for a commercial alfalfa seed industry based on the satisfactory performance of new and improved strains of alfalfa. Leader: J. W. Carlson

Irrigation and soil erosion studies on the Utah State Prison farm

Cooperation: Utah State Board of Correction

Objective: To (1) measure the amount of water stored in the soil of particular irrigation plots at each irrigation and to compare these amounts to the amounts applied to the experimental plots. (2) To find the effect of size of stream and slope on the erosion of soils irrigated by furrow methods. (3) To correlate soil and water conservation practices with the methods of irrigation and the efficient use of irrigation water and with erosion accompanying irrigation. (4) To acquaint inmates with problems of soil and water conservation thereby developing an interest and understanding of a problem which will help them become better citizens. Leaders: O. W. Israelsen, D. S. Jennings

Production of foundation seed stocks

Cooperation: Utah Crop Improvement Association

Objective: (1) To produce and maintain a supply of pedigreed foundation seed stocks of all crop seeds commonly certified in this state and of commercial importance. (2) To produce seed stocks true to variety, free from disease, of uniform quality and purity. (3) To release under contract supervision new varieties of crop seeds for thorough testing and provide as a source of seed for new varieties. (4) To provide a source of pedigreed foundation seed which can be used by plant breeders and certified seed growers in the production of high quality pure seeds. Leaders: R. J. Evans, D. C. Tingey

Tuber index work on seed potatoes grown or offered for sale in Utah

Cooperation: Utah Crop Improvement Association

Objective: (1) To determine the disease content of seed potatoes grown in Utah or of seed offered for sale within the state. (2) To ascertain the general quality of seed for foundation stock. (3) To characterize further the various virus diseases responsible for seed degeneration. (4) To aid in perfecting such diagnostic techniques as will aid in decreasing degeneration diseases in potato seed stock in the state. Leader: B. L. Richards

Testing of electrical equipment

Cooperation: Utah Power and Light Company

Objective: To determine the suitability of various types of electrical equipment for use under ordinary farm conditions. Leaders: G. Q. Bateman, Byron Alder, F. M. Coe, F. F. McKenzie
Peach mosaic survey

Cooperation: State Department of Agriculture

Objective: To survey peach-growing areas of Utah for peach mosaic so that diseased trees can be eradicated in an effort to stamp out the disease. Leaders: B. L. Richards, F. B. Wann, F. M. Coe

State agricultural correlation committee

Cooperation: Utah State Agricultural College, Utah State Agricultural College Extension Service, State Department of Agriculture, State Farm Bureau Federation

Objective: To correlate the study of agricultural problems throughout the state. Leaders: R. H. Walker, R. J. Evans

Snow surveys

Cooperation: State Engineer

Objective: To make annual snow surveys of precipitation on and runoff from the various watersheds in Utah and report the information gathered to aid in an estimation of the anticipated runoff during the irrigation season. Leader: George D. Clyde

Weed eradication program

Cooperation: State Department of Agriculture, State Works Progress Administration

Objective: To provide a working basis for a statewide weed eradication program. Leaders: R. J. Evans, D. C. Tingey

Canning crops improvement studies


Objective: To study the effects of fertilizer application and legume seed inoculation on the yield and quality of canning crops. Leaders: L. H. Pollard, D. W. Thorne

Marketing studies of Utah fruits and vegetables

Cooperation: Agricultural Trade Relations, Inc.

Objective: To determine the economic position of Utah fruits and vegetables on various markets, and the efficiency of marketing agencies handling these products in order to develop a program for the state that will assist growers to place the production and marketing of these products on a basis to meet competition and give to the grower a larger return. Leader: W. P. Thomas

Study of factors influencing lamb production

Cooperation: Sears Roebuck Company

Objective: To study the causes of the low lamb crop in Utah and to discover management methods that will increase production. Leader: F. F. McKenzie
ORGANIZATION OF THE EXPERIMENT STATION

The Utah Agricultural Experiment Station consists of the director's office, 17 technical research departments at Logan and two substations, the horticultural farm in Davis County and the Dry Land Substation at Nephi.

DEPARTMENTS OF THE AGRICULTURAL EXPERIMENT STATION AT LOGAN

- Agricultural Economics
- Agronomy and Soils
- Animal Husbandry
- Bacteriology and Biochemistry
- Botany and Plant Pathology
- Chemistry
- Dairy Husbandry
- Entomology
- Home Economics
- Horticulture
- Irrigation and Drainage
- Physics
- Poultry Husbandry
- Range Management
- Rural Sociology
- Vegetable Crops
- Veterinary Science

The Experiment Station staff is comprised of 76 persons. Of this number only 10 members including clerical and administrative workers devote their full services to Agricultural research; the others spend some time in teaching or extension work or are engaged in cooperative employment with the federal government.

While much of the research work is conducted in the laboratories on the college campus and on the experimental farms near Logan, there are also many projects that take experiment station workers into every part of the state. A glance at the various project reports will give some idea of the broadness of the scope of the work not only in subject matter, but in the extent of the state covered by these studies.

INFORMATIONAL SERVICE

Aside from conducting technical research on specific problems to which they have been assigned, members of the Station staff are called on for a great deal of service by farmers and others writing for information. These requests range from the identification of insects, plant specimens, the diagnosis of diseases, soil tests, questions on the raising of various crops and livestock to outlining the entire set-up on a farm. The staff members not only spend much time answering letters, they visit farms, attend farm meetings, give radio talks and hold demonstrations in the various parts of the state.
Field days are also held in which farmers visit the experimental plots and the many phases of the work are explained to them, and they see at first hand the results of different practices.

Staff members also give technical advice to state and local committees; they cooperate with various agencies in formulating action programs, and they take part in short courses and conventions.

In addition the Station has been represented on many committees having to do with the war emergency problems and similar organized efforts.

The public is informed of the results of research investigations through a number of channels. Extension Service specialists carry the information into the rural areas. It is broadcast over the radio, and sent out to the local newspapers throughout the state. Where investigations are of local or sectional interest, the men who have supervised them go to the communities and discuss the findings with the people most interested.

The results of experimental work are also published by the station. During the biennium 10 bulletins containing a total of 365 pages, 4 circulars containing 75 pages, and 47 articles in scientific and technical journals totaling 315 pages, making a total of 755 pages, have been published.

Forty-seven mimeograph sheets on subjects of immediate importance were issued for state distribution. Each month a partial list of publications received by the Station was also issued in mimeographed form.

The publication of the station quarterly, Farm and Home Science was continued. This publication contains timely articles by staff members and progress reports on research projects. It is published in order to acquaint the farm people of the state with the results of station work more quickly than is possible through means of bulletins.

In Farm and Home Science as well as in the Utah Farmer and the daily papers, the Station has attempted since the war emergency to publish useful information including accumulations from previous work as well as sifting out new results from current research. As a result much information having direct value and application to the war effort has been issued.

Over the two year period there has been an average monthly distribution of 1,500 publications in answer to requests. This is in addition to publications sent out on the regular mailing list and those given out to people calling at the office.

Publications are sent to libraries, publishers and experiment stations throughout the United States. Besides this they are sent in exchange to scientific institutions and libraries in foreign countries. The foreign mailing list has been curtailed considerably, however, by the war. The complete mailing list at the present time contains about 3,500 names.
### Publications Issued During the Biennium

#### Bulletins

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<td>Alma C. Esplin, Milton A. Madsen, and Ralph W. Phillips</td>
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<td>R. W. Woodward and D. C. Tingey</td>
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<td>Comparison of two methods of determining wool density.</td>
<td>Milton A. Madsen, Ralph W. Phillips, John V. Christensen, and Roy L. Henrie</td>
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<td>Uton, a new high-yielding white oat resistant to loose and covered smuts.</td>
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<td>F. B. Wann</td>
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<td>A study of farm organization by type of farm in Sanpete and Sevier Counties.</td>
<td>W. Preston Thomas, George T. Blanch and Edith Hayball</td>
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#### Circulars

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<td>Dynamometer tests of draft horses.</td>
<td>Ralph W. Phillips, Milton A. Madsen, and Harry H. Smith</td>
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<td>Fertilizers for Utah soils.</td>
<td>D. W. Pittman and D. W. Thorne</td>
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<td>Lawn weeds and their control.</td>
<td>D. C. Tingey and Bassett Maguire</td>
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### Articles Published in Scientific and Technical Journals

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<td>Four new Hercostomus from Utah (Dolichopodidae: Diptera)</td>
<td>F. C. Harmston and G. F. Knowlton</td>
<td>Ent. Soc. Wash. Proc.</td>
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<td>R447</td>
<td>Tachytrechus studies (Dolichopodidae: Diptera)</td>
<td>F. C. Harmston and G. F. Knowlton</td>
<td>Canad. Ent.</td>
<td>111-115</td>
</tr>
</tbody>
</table>


R450—Effect of various soil treatments on nitrates, soil moisture, and yield of winter wheat, by A. F. Bracken. Soil Sci. 50: 175-188. 1940.


R462—Vitamin C content of tomatoes, by Almeda Perry Brown and Faye Moser. Food Res. 6: 45-55. 1941.


STAFF

ADMINISTRATIVE

Elmer George Peterson, B.S. (U.S.A.C. 1904), A.M. (Cornell 1909), Ph.D. (1911)
   Asst. prof. Zool. & Ent., 1906-08; Prof. Bact., 1911-12; Dir. Ext. Ser. 1912-16;
   Pres. 1916-

   Dir. Exp. Sta. 1938-

William Peterson, B.S. (U.S.A.C., 1899)
   Inst. Hort. & Math., 1899-1901; Asst. prof. Geol. & Miner., 1904-06; Prof. Geol. &
   Physics, 1906-08; Prof. Geol., 1910; Dir. Exp. Sta., 1921-28; Dir. Ext. Ser.,
   1924-

Russell Elwood Berntson
   Sec.-Treas., 1927-

David Alvin Burgoyne, B.S. (U.S.A.C. 1919), M.S. (Illinois, 1937)
   Sec. to Dir., 1922-36; Exec. Sec., 1937-

Gladys Loynd Harrison, A.B. (B.Y.U., 1922), Cert. Lib. (Calif., 1936)
   Bul. ed. & Lib., 1936-1938; Bul. ed., 1938-

Frances Rawlins Hayes, B.S. (U.S.A.C., 1942)
   Stenographer, 1942-

Bonnie Bee Thompson Allen
   Stenographer, 1943-

Judith B. Richardson, B.S. (U. of U., 1941)
   Stenographer, 1943-

RESEARCH STAFF

Byron Alder, B.S. (U.S.A.C., 1912)
   Asst. prof. Poul. Husb. & Head dept., 1913-25; Assoc. prof., 1925-27; Prof., 1927-

George Quaile Bateman, B.S. (U.S.A.C., 1922)
   Asst. prof. Dairy Husb. & Supt. Dairy Exp. Farm, 1925-

*Wayne Binns, D.V.M. (Iowa State, 1938)
   Asst. prof. Vet. Sci., 1940-

George Thomas Blanch, B.S. (U.S.A.C., 1930), M.S. (1931), Ph.D. (Cornell, 1940)
   Assoc. prof. Agr. Econ., 1934-

Aaron Francis Bracken, B.S. (U.S.A.C., 1914), M.S. (1924)
   Asst. prof. Agron., 1915-17; Asst. prof. and Supt. Nephi Dry Farm, 1920-33; Assoc.
   prof., 1933-

Dee Albert Broadbent, B.S. (U.S.A.C., 1936), M.S. (Illinois, 1938)
   Inst. Agr. Econ., 1938-40; Asst. prof., 1940-

Almeda Perry Brown, B.S. (U.S.A.C., 1901), M.A. (Columbia, 1915)
   Asst. prof. Home Econ., 1926-37; Assoc. prof., 1937-

George Ballif Caine, B.S. (U.S.A.C., 1912), A.M. (Missouri, 1914)
   Asst. prof. An. Hus., 1914-16; Asst. prof. Dairy Hus., 1916-17; Assoc. prof., 1917-
   20; Prof. & Head dept., 1920-

John Victor Christensen, B.S. (U.S.A.C., 1938), M.S. (1941)
   Res. asst. An. Hus., 1940-

*On leave.
Roy Merrill Christiansen, B.S. (U.S.A.C., 1928)  
Res. asst. Pl. Path., 1937-

Christine Bockholt Clayton, B.S. (U.S.A.C., 1915), M.S. (Minnesota, 1927)  
Nut. spec. Ext. Ser., 1923-24; Asst. prof. Foods, 1924-28; Prof., 1928- Dean Home Ec., 1932-

George Dewey Clyde, B.S. (U.S.A.C., 1921), M.S. (Calif., 1923)  
Asst. prof. Irr. & Drain., 1923-28; Assoc. prof., 1928-32; Prof., 1932- Dean Engineering, Ind. & Trades, 1936-

Francis Morse Coe, B.S. (Oregon State, 1923), M.S. (Iowa State, 1924)  
Asst. prof. Hort., 1927-35; Assoc. prof., 1935- Head dept., 1938-

Bliss Hansen Crandall, B.S. (U.S.A.C., 1937), M.S. (Iowa State, 1942)  
Asst. prof. Agron., 1942-

Harold Harris Cutler, B.S. (U.S.A.C., 1933), M.S. (1934)  
Asst. prof. Agr. Econ., 1934-42; Assoc. prof., 1942-

Asst. prof. An. Hus., 1942-

Alma Cox Esplin, B.S. (U.S.A.C., 1916), M.S. (1941)  
Asst. prof. An. Hus., 1925-29; Assoc. prof., 1929-42; Prof., 1942-

Robert James Evans, B.S. (U.S.A.C., 1909), Ph.D. (Cornell, 1912)  
Ext. agron., 1913-20; Ext. dir., 1920-24; Prof. Agron. & Head dept., 1931-

Assoc. prof. Physics, 1918-24; Prof., 1924-

Joseph Arch Geddes, A.B. (B.Y.C., 1907), A.M. (Columbia, 1913), Ph.D. (1924)  
Assoc. prof. Soc., 1926-28; Prof., 1928- Dir. Grad. Div. Soc. Work, 1939-

Joseph Eames Greaves, B.S. (U.S.A.C., 1904), M.S. (Illinois, 1907), Ph.D. (Calif., 1911)  

Prof. Zool. & Ent. & Head dept., 1917-20, 1926-

*Reuben Lorenzo Hill, B.S. (U.S.A.C., 1912), Ph.D. (Cornell, 1915)  
Prof. Chem., and Head dept., 1919-

Charles Tarry Hirst, B.S. (U.S.A.C., 1910), M.S. (1914)  
Inst. Chem., 1910-15; Asst. prof., 1915-24; Assoc. prof., 1924-

Orson Winso Israelsen, B.S. (U.S.A.C., 1912), M.S. (Calif., 1914), Ph.D. (1925)  
Asst. prof. Irr. & Drain., 1916-17; Assoc. prof., 1917-19; Prof., 1919-

David Stout Jennings, B.S. (U.S.A.C., 1912), Ph.D. (Cornell, 1917)  
Prof. Soils, 1918-

Louis William Jones, B.S. (U.S.A.C., 1936), M.S. (1937)  
Res. asst. Bact. & Biochem., 1937-42; Asst. prof., 1942-

George Franklin Knowlton, B.S. (U.S.A.C., 1923), M.A. (1925), Ph.D. (Ohio State, 1932)  
Asst. prof. Ent., 1926-30; Assoc. prof., 1930-

Frederick Francis McKenzie, B.S.A. (Brit. Col., 1921), A.M. (Missouri, 1923), Ph.D. (1925), D. Agr. (Chile, 1942)  
Prof. An. Hus., Head dept., 1941-

*On leave.
David Edward Madsen, D.V.M. (Colorado State, 1928), M.S. (Cornell, 1941)
   Prof. Vet. Sci., 1929-
*Milton Andrew Madsen, B.S. (U.S.A.C., 1934), M.S. (1939)
   Res. asst. prof. An. Hus., 1936-
*Bassett Maguire, B.S. (Georgia, 1926), Ph.D. (Cornell, 1938)
   Asst. prof. Bot., 1931-38; Assoc. prof., 1938-
Arthur John Morris, B.S. (U.S.A.C., 1921), M.S. (1930)
   Asst. prof., 1931-34; Assoc. prof., 1934-
James Elmo Packer, B.S. (U.S.A.C., 1941)
   Res. Asst. Dairy Hus., 1941-
   Inst. Agron., 1940-
   Inst. Agron., 1916-20; Asst. prof., 1920-24; Assoc. prof., 1924-
Leonard Heber Pollard, B.S. (U.S.A.C., 1932), M.S. (1934), Ph.D. (Calif., 1939)
   Asst. prof. Veg. Crops & Head dept., 1939-40; Assoc. prof. & Head dept., 1940-
Bert Lorin Richards, B.S. (U.S.A.C., 1913), M.S. (1917), Ph.D. (Wisconsin, 1919)
   & Head dept., 1924-
   Res. asst. Vet. Sci., 1943-
*Irving Gerard Sampson, B.S. (U.S.A.C., 1941)
   Res. asst. Veg. Crops, 1941-
David L. Sargent, B.S. (U.S.A.C., 1915), M.S. (1927)
   Asst. prof. Agron., 1920-
*Arthur Dwight Smith, B.S. (U.S.A.C., 1936), M.S. (Calif., 1937)
   Inst., 1937-39; Asst. prof. Range Mang., 1939-
Charles James Sorenson, B.S. (U.S.A.C., 1914), M.A. (1927)
   Asst. prof. Zool. & Ent., 1914-20; 1926-29; Assoc. prof., 1930-
Arvil Lane Stark, B.S. (U.S.A.C., 1929), M.S. (Iowa State, 1931), Ph.D. (1934)
   Asst. Hort., 1934-35; Ext. Hort., 1936- Assoc. prof., 1940-
Kenneth Richards Stevens, B.S. (B.Y.U., 1927), M.S. (Rutgers, 1929), Ph.D. (1932)
   Inst. Bact., 1931-33; Asst. prof., 1933-41; Assoc. prof., 1941-
Laurence Alexander Stoddart, B.S. (Colorado State, 1931), M.S. (1932), Ph.D. (Nebraska,
   1934)
   Prof. Range Mang., 1935- Acting Dean of For., 1942-
Joseph Nathaniel Symons, B.S. (U.S.A.C., 1927), M.S. (1932)
   Inst., 1936-40; Asst. prof. Soc., 1940-
William Preston Thomas, B.S. (U.S.A.C., 1914), M.S. (Cornell, 1926), Ph.D. (1939)
   Asst. prof. Ext. Ser., 1915-25; Asst. prof. Agr. Econ., 1926-28; Prof. & Head dept.,
   1928-
David Wynne Thorne, B.S. (U.S.A.C., 1933), M.S. (Iowa State, 1934), Ph.D. (1936)
   Assoc. prof. Soils, 1939-
*Delmar Clive Tingey, B.S. (U.S.A.C., 1922), M.S. (1924)
   Asst. in Agron., 1922-25; Inst., 1925-28; Asst. prof., 1927-35; Assoc. prof., 1935-
Leroy Van Horn, B.S. (Wyoming, 1939), M.S. (1941)
   Asst. prof. An. Hus., 1942-
Frank Burkett Wann, A.B. (Wabash, 1914), Ph.D. (Cornell, 1920)
   Assoc. prof. Bot., 1926-
LeMoyne Wilson, B.S. (U.S.A.C., 1927), M.S. (1932)
   Asst. prof. Soils, 1929-34, 1937-
*On leave.
### Federal Collaborators

Reed Warner Bailey, B.S. (Chicago, 1924), M.S. (1927)
- Intermountain Forest and Range Experiment Station, U. S. Forest Service, Ogden

Oscar Fitzallen Bartholomew, B.S. (Oregon State, 1928), M.S. (1930)
- U. S. Bureau of Plant Industry

George Quasyle Bateman, B.S. (U.S.A.C., 1922)
- U. S. Bureau of Dairy Industry

Heber Loran Blood, B.S. (U.S.A.C., 1926), M.S. (1928), Ph.D. (Wisconsin, 1930)
- U. S. Bureau of Plant Industry

John Wilford Carlson, B.S. (U.S.A.C., 1922), M.S. (1927), Ph.D. (Wisconsin, 1939)
- U. S. Bureau of Plant Industry

Roy Merrill Christiansen, B.S. (U.S.A.C., 1928)
- U. S. Bureau of Plant Industry

Wesley Keller, B.S. (U.S.A.C., 1929), M.S. (1932), Ph.D. (Wisconsin, 1939)
- U. S. Bureau of Plant Industry

Cyril Walker Lauritzen, B.S. (U.S.A.C., 1930), M.S. (Michigan State, 1932), Ph.D. (1934)
- U. S. Soil Conservation Service

Dean Ferdinand McAlister, B.S. (U.S.A.C., 1931), M.S. (1932), Ph.D. (Wisconsin, 1936)
- U. S. Bureau of Plant Industry

Joseph Howard Maughan, B.S. (U.S.A.C., 1916), M.S. (1924)
- U. S. Bureau of Agricultural Economics

Harold Marriner Nielson, B.S. (U.S.A.C., 1933), M.S. (1936)
- U. S. Bureau of Animal Industry

Walter Peay, B.S. (Univ. Utah, 1933), M.S. (U.S.A.C., 1939)
- U. S. Bureau of Entomology and Plant Quarantine

Michael Shapovalov, B.A., M.S. (Maine, 1913)
- U. S. Bureau of Plant Industry

George Stewart, M.S. (U.S.A.C., 1913), M.S. (Cornell, 1918), Ph.D. (Minnesota, 1926)
- Intermountain Forest and Range Experiment Station, U. S. Forest Service, Ogden

Rollo William Woodward, B.S. (U.S.A.C., 1925), M.S. (1930)
- U. S. Bureau of Plant Industry

### Appointments to the Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Wayne Binns</td>
<td>Research assistant professor of veterinary science</td>
<td>August 1940</td>
</tr>
<tr>
<td>R. Scott Jackson</td>
<td>Collaborator in veterinary science</td>
<td>August 1940</td>
</tr>
<tr>
<td>Howard B. Peterson</td>
<td>Research assistant in agronomy</td>
<td>October 1940</td>
</tr>
<tr>
<td>Laura Johnson</td>
<td>Stenographer</td>
<td>October 1940</td>
</tr>
<tr>
<td>G. Alvin Carpenter</td>
<td>Research assistant professor of agricultural economics</td>
<td>November 1940</td>
</tr>
<tr>
<td>Paul Heufner</td>
<td>Research assistant in agricultural economics</td>
<td>December 1940</td>
</tr>
<tr>
<td>Gerard Sampson</td>
<td>Research assistant in vegetable crops</td>
<td>July 1941</td>
</tr>
<tr>
<td>J. Elmo Packer</td>
<td>Research assistant in dairy husbandry</td>
<td>July 1941</td>
</tr>
<tr>
<td>Walter Peay</td>
<td>Collaborator in entomology</td>
<td>April 1941</td>
</tr>
</tbody>
</table>
Fred F. McKenzie . . . . . Research professor and head of the Department of Animal Husbandry . . . . . . . . . . September 1941
Herbert G. Folken . . . . . Collaborator in agricultural economics . . . . . . . . . . September 1941
Vernon L. Israelsen . . . . . Research assistant professor of agricultural economics . . . . . October 1941
G. Max Beal . . . . . Research assistant professor of agricultural marketing . . . . . . . . . . October 1941
Jerome E. Coffman . . . . . Collaborator in veterinary science . . . . . . . . . . November 1941
Barbara B. Howells . . . . . Stenographer . . . . . . . . . . December 1941
Boyd A. Ivory . . . . . Research assistant in poultry husbandry . . . . . . . . . May 1942
Frances R. Hayes . . . . . Stenographer . . . . . . . . . . June 1942
Grace B. Farnsworth . . . . Stenographer . . . . . . . . . . June 1942
Leroy Van Horn . . . . . Research assistant professor of animal husbandry . . . . . . . . . . September 1942
Irvin F. Edwards . . . . . Research assistant professor of animal husbandry . . . . . . . . . . September 1942
Bliss H. Crandall . . . . . Research assistant professor of agronomy . . . . . . . . . . October 1942
Marian L. Crockett . . . . Stenographer . . . . . . . . . . October 1942
Bonnie Bee T. Allen . . . . Stenographer . . . . . . . . . . January 1943
Charles Willard Riggs . . . Research assistant in veterinary science . . . . . . . . . . January 1943
Judith B. Richardson . . . Stenographer . . . . . . . . . . January 1943

Resignations from the Staff

<table>
<thead>
<tr>
<th>Name</th>
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<th>Date</th>
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<tr>
<td>Wade H. Westmoreland</td>
<td>Collaborator in veterinary science</td>
<td>July 1940</td>
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<tr>
<td>Edith Hayball</td>
<td>Research assistant in agricultural economics</td>
<td>November 1940</td>
</tr>
<tr>
<td>G. Alvin Carpenter</td>
<td>Research assistant professor of agricultural economics</td>
<td>January 1941</td>
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<tr>
<td>Ralph W. Phillips</td>
<td>Research professor and head of the department of animal husbandry</td>
<td>July 1941</td>
</tr>
<tr>
<td>Dilworth Walker</td>
<td>Collaborator in agricultural economics</td>
<td>September 1941</td>
</tr>
<tr>
<td>Laura Johnson</td>
<td>Stenographer</td>
<td>November 1941</td>
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<tr>
<td>Jerome E. Coffman</td>
<td>Collaborator in veterinary science</td>
<td>January 1942</td>
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<tr>
<td>G. Max Beal</td>
<td>Research assistant professor of marketing</td>
<td>February 1942</td>
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<tr>
<td>Vernon L. Israelsen</td>
<td>Research assistant professor of agricultural economics</td>
<td>March 1942</td>
</tr>
<tr>
<td>Rex Daly</td>
<td>Research assistant professor of agricultural economics</td>
<td>April 1942</td>
</tr>
<tr>
<td>Barbara B. Howells</td>
<td>Stenographer</td>
<td>May 1942</td>
</tr>
<tr>
<td>Paul Heufner</td>
<td>Research assistant in agricultural economics</td>
<td>June 1942</td>
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<tr>
<td>LaRue H. Hardy</td>
<td>Stenographer</td>
<td>June 1942</td>
</tr>
<tr>
<td>Grace B. Farnsworth</td>
<td>Stenographer</td>
<td>October 1942</td>
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<tr>
<td>Russel A. Rasmussen</td>
<td>Research associate professor of animal husbandry</td>
<td>November 1942</td>
</tr>
<tr>
<td>Boyd A. Ivory</td>
<td>Research assistant in poultry husbandry</td>
<td>January 1943</td>
</tr>
<tr>
<td>Marian L. Crockett</td>
<td>Stenographer</td>
<td>January 1943</td>
</tr>
</tbody>
</table>
Leaves of Absence

Dr. George T. Blanch, research associate professor of agricultural economics and marketing spent the year 1940-41 in study at Cornell University where he completed work for the doctorate degree.

Dr. D. E. Madsen, research professor of veterinary medicine also spent the year 1940-41 in study at Cornell University. He was granted the degree of master of science in the spring of 1941.

Professor D. W. Pittman, research associate professor of soils, has spent the past two years in Iran working for the Department of Agriculture there.

Dr. R. L. Hill, head of the Chemistry Department; Dr. Wayne Binns, research assistant of veterinary science; Milton A. Madsen, research assistant professor of animal husbandry; H. E. Dorst, federal collaborator in entomology; Clyde Stewart, federal collaborator in agricultural economics; R. Scott Jackson, federal collaborator in veterinary science, and Arthur D. Smith, cooperator in range management have been called into the armed services of the United States.

Milton A. Madsen, research assistant professor of animal husbandry spent the summer of 1941 in study at the University of Wisconsin.

Harold H. Cutler, research assistant professor of agricultural economics, who was on leave of absence during the year 1941-42, did work toward his Ph. D. degree at Iowa State College.

D. C. Tingey, research associate professor of agronomy, has been granted a leave of absence for the duration of the war, to work on rubber investigations in California for the U. S. Bureau of Plant Industry.
FINANCIAL STATEMENT OF THE UTAH AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR 1940-41, INCLUDING THE AMOUNT AND SOURCE OF FUNDS AND THE CLASSIFICATION OF EXPENDITURES

<table>
<thead>
<tr>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
<th>Bankhead</th>
<th>*State</th>
<th>Bankhead Offset</th>
<th>Total</th>
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<tr>
<td>dollars</td>
<td>dollars</td>
<td>dollars</td>
<td>dollars</td>
<td>dollars</td>
<td>dollars</td>
<td>dollars</td>
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<tr>
<td>Appropriations</td>
<td>15,000.00</td>
<td>15,000.00</td>
<td>60,000.00</td>
<td>10,503.68</td>
<td>58,756.93</td>
<td>10,756.45</td>
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<td>Expenditures</td>
<td>9,939.05</td>
<td>9,905.60</td>
<td>37,823.19</td>
<td>5,790.12</td>
<td>16,050.77</td>
<td>5,099.81</td>
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<td>Salaries</td>
<td>1,741.18</td>
<td>2,766.70</td>
<td>11,199.68</td>
<td>3,491.35</td>
<td>13,111.44</td>
<td>2,977.70</td>
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<td>Labor</td>
<td>146.14</td>
<td>81.42</td>
<td>434.82</td>
<td>187.08</td>
<td>1,403.76</td>
<td>232.11</td>
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<tr>
<td>Stationery &amp; office supplies</td>
<td>270.56</td>
<td>583.09</td>
<td>2,119.16</td>
<td>182.22</td>
<td>868.86</td>
<td>95.95</td>
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<tr>
<td>Scientific supplies</td>
<td>1,630.41</td>
<td>63.60</td>
<td>697.76</td>
<td>899.02</td>
<td>3,290.79</td>
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<td>Feeding stuffs</td>
<td>207.60</td>
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<td>658.09</td>
<td>13.44</td>
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<td>Sundry supplies</td>
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<td>Fertilizers</td>
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<td>45.65</td>
<td>940.23</td>
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<td>Communication service</td>
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<td>747.65</td>
<td>144.59</td>
<td>989.17</td>
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<td>Travel expense</td>
<td>25.30</td>
<td>65.78</td>
<td>40.47</td>
<td>317.84</td>
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<td>467.53</td>
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<tr>
<td>Transportation of things</td>
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<td>788.57</td>
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<td>742.80</td>
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<td>3,164.42</td>
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<td>Heat, lights, water &amp; power</td>
<td>35.26</td>
<td>61.67</td>
<td>747.65</td>
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<td>Scientific equipment</td>
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<td>1,405.93</td>
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<td>Livestock</td>
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<td>290.62</td>
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<tr>
<td>Tools, machinery &amp; implements</td>
<td>59.21</td>
<td>22.57</td>
<td>472.35</td>
<td>82.25</td>
<td>3,209.29</td>
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<td>Building and land</td>
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<td>965.08</td>
<td>7,807.68</td>
<td>133.81</td>
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<td>15,000.00</td>
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<td>10,503.68</td>
<td>54,392.65</td>
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*Includes
Allotment from College State appropriations | 39,638.00 |
Sales and miscellaneous | 16,251.48 |
Balance from previous year | 9,043.90 |
Contributions | 4,580.00 |

Total | 69,513.38 |
## Financial Statement of the Utah Agricultural Experiment Station for the Fiscal Year 1941-42, Including the Amount and Source of Funds and the Classification of Expenditures

<table>
<thead>
<tr>
<th></th>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
<th>Bankhead Jones</th>
<th>*State</th>
<th>Gifts &amp; Contributions</th>
<th>Bankhead Jones Offset</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td><strong>Appropriation</strong></td>
<td>$15,000.00</td>
<td>$15,000.00</td>
<td>$60,000.00</td>
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<td>$4,478.61</td>
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<td>$162,740.38</td>
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<td><strong>Expenditures</strong></td>
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<tr>
<td>Salaries</td>
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<td>$10,462.56</td>
<td>$40,354.13</td>
<td>$6,024.96</td>
<td>$15,587.09</td>
<td>$315.00</td>
<td>$4,926.66</td>
<td>$89,110.48</td>
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<td>$2,704.61</td>
<td>$12,799.71</td>
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<td>$5,036.11</td>
<td>$925.05</td>
<td>$4,108.77</td>
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<td>$87.92</td>
<td>$392.49</td>
<td>$237.92</td>
<td>$975.63</td>
<td>$30.85</td>
<td>$27.30</td>
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<td>$909.30</td>
<td>$725.03</td>
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<td>$683.90</td>
<td>$43.53</td>
<td>$105.88</td>
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*Includes Allotment from College State appropriation $34,000.00
Special from State Engineer $750.00
Special State for Tomato disease work $2,250.00
Sales and miscellaneous $17,293.81
Balance from previous year $3,464.28

**Total** $57,758.09