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Biennial Report of the Director, 1934-35 and 1935-36
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Utah State Agricultural College, Logan, Utah
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1As of June 30, 1936.
2Part-time U. S. Department of Agriculture.
3On leave.
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Crops</td>
<td>1</td>
</tr>
<tr>
<td>Animal Diseases and Breeding</td>
<td>7</td>
</tr>
<tr>
<td>Livestock Feeding</td>
<td>11</td>
</tr>
<tr>
<td>Poultry</td>
<td>17</td>
</tr>
<tr>
<td>Insects</td>
<td>20</td>
</tr>
<tr>
<td>Plant Diseases</td>
<td>27</td>
</tr>
<tr>
<td>Weeds</td>
<td>33</td>
</tr>
<tr>
<td>Soils and Fertilizers</td>
<td>35</td>
</tr>
<tr>
<td>Dry-lands</td>
<td>46</td>
</tr>
<tr>
<td>Irrigation, Drainage, and Groundwater</td>
<td>49</td>
</tr>
<tr>
<td>Orchard and Garden Crops</td>
<td>55</td>
</tr>
<tr>
<td>Range Management and Intermountain Herbarium</td>
<td>63</td>
</tr>
<tr>
<td>Human Nutrition</td>
<td>69</td>
</tr>
<tr>
<td>Social Problems</td>
<td>72</td>
</tr>
<tr>
<td>Farm Income and Management</td>
<td>75</td>
</tr>
<tr>
<td>General Statement</td>
<td>79</td>
</tr>
</tbody>
</table>

*Seventh Biennial Report for biennium ended June 30, 1936, Agricultural Experiment Station, Utah State Agricultural College. Lowry Nelson, Director. Compiled by Blanche C. Pittman, Station Editor.*
Field Crops

BACTERIAL WILT extremely destructive to alfalfa in state .... Growing of corn for silage becoming more popular .... Markton oats recommended for Utah .... Baart least desirable for spring-wheat planting .... Erect, a new spring wheat, proves superior .... Spring cereals of value as livestock feed .... Need for smut-resistant wheats leads to development of interesting new varieties .... Velvon, a new barley bred at Utah Station .... Early planting of sugar-beets gives high yields .... Soybeans not tried sufficiently long to make recommendations .... Alfalfa-seed production decline due to several factors.

Alfalfa Yields Greatly Reduced by Bacterial Wilt

ALFALFA PRODUCTION in Utah is highly important, both for its value as a forage crop for livestock and its importance in the rotation system in supplying nitrogen to the soil. However, because of the presence of bacterial wilt in alfalfa fields in various parts of the state, both acreage and quality of alfalfa are being greatly reduced.

Designed to combine both quality and yield in certain wilt-resistant strains with quality and disease resistance in others, a large number of crosses have been made by R. J. Evans (Agronomy and Soils) during this two-year period. Thirty-eight alfalfa varieties and strains were planted on the Greenville Experiment Farm in the spring of 1935 to determine forage and seed yield as well as chemical composition. Inbreeding and selection within varieties show promising results.

Strains under test include ten Turkestan varieties, Russian Grimm, Cossack strains, Ontario variegated strains, and Hardigan. The Turkestan va-
Varieties are supposed to be generally resistant to wilt but are of low quality and are also relatively poor yielders. Russian Grimm selections show a high degree of variation. Experiments have not been conducted sufficiently long to draw any conclusions at this time.

Silage Corn Varieties Given Trial

Corn is well adapted to the irrigated sections of Utah. It fits well into the rotation and, compared with other forage or grain crops, ranks high in relative production. In areas of high summer rainfall, which include most of the southern half of Utah, corn is probably the best annual crop that can be grown where moisture is a limiting factor.

In most counties early-maturing varieties do not make sufficient growth for best silage yields. Late-maturing varieties, such as Improved Leaming, produce good silage yields although they may not mature good seed every year. It is, therefore, necessary to obtain seed from sections of the state where the frost-free period exceeds that of locations where silage corn is grown. In the opinion of R. J. Evans and R. W. Woodward* (Agronomy) extreme early- and late-maturing varieties should generally be avoided.

Over the major portion of the state the following varieties have done well: Minnesota 13, Improved Leaming, Sam Ford, Starley's, and other varieties with similar seasonal adaptations. Pride of Salina and selections from Reid Yellow Dent do well in Grand and Washington Counties, where the growing season is longer than in other sections of the state. Acre-yields of from 12 to 14 tons of quality silage may be expected on our irrigated farms, as evidenced by state uniform-variety-test yields of the past two years; in a few instances, acre-yields have exceeded 28 tons of silage.

The pit silo, which is becoming generally more popular, provides a cheap method of storage of good wholesome succulent feed. Its use has increased materially the growing of corn for silage in Utah.

Markton Oats Recommended for Planting in Utah

In a series of cooperative tests conducted by D. C. Tingey and R. W. Woodward (Agronomy) on the Greenville Experiment Farm since 1926 and throughout the state since 1931, Markton oats have proved superior. An average acre-yield of 9 bushels more has been obtained from Markton than from any other oat variety tested and 10 bushels more than for Swedish Select, a popular oat variety grown in the state; in 1934 it was outyielded by Markton by 15 bushels to the acre. Seed of Markton variety has been certified and distributed for commercial state production.

Baart Found Least Desirable of Spring Wheats for Utah

Although Baart wheat has been grown in Utah for a number of years on a limited scale for a spring wheat, it is inferior to Dicklow, Federation, and strains of hybrid origin, Q-80, Q-227, and 01-24. Even Dicklow and Federation, the two leading spring wheat varieties grown in the state, in a nine-year average are shown to be slightly lower in yield.

than the three strains of hybrid origin. D. C. Tingey and R. W. Woodward (Agronomy) report that Baart has yielded from 6 to 7 bushels (8 to 11%) to the acre less than any of the other varieties or strains. Climatic conditions and geographical distribution are limiting factors in yields of Federation and Dicklow and hybrid strains are superior to these varieties in straw strength, uniformity, and quality.

**Figure 1.** Oat nursery, Greenville Experiment Farm, Logan. It was here that Markton was first grown in Utah and was found to be superior to Swedish Select.

**Erect, a New Spring Wheat, Introduced This Year**

*E* SPECIALLY ADAPTED to irrigation is Erect, a new spring wheat, introduced this year to Utah farmers after several years' trial in various parts of the state. This wheat, developed at the Utah Station by D. C. Tingey and R. W. Woodward (Agronomy), is a selection out of a Dicklow x Hard Federation cross. It is a high-yielding, uniform, stiff-strawed, soft white wheat of good quality. Dicklow and Federation, Utah's present leading spring wheats, will in all probability be replaced by Erect, Dicklow because of its weak straw which makes harvesting difficult and Federation because of its off-colored flour. Considerable seed of Erect will be available for 1937 spring planting.

**Spring Cereals Prove Valuable as Livestock Feed**

R ESULTS of testing leading varieties of barley, wheat, oats, and corn grown on the same fields in fifteen Utah counties for four years by D. C. Tingey and R. W. Woodward (Agronomy) show that oats excel all other cereals in number of bushels per acre, with barley a close second. On the basis of pounds per acre, barley exceeded wheat, corn, and oats by 18, 27, and 31 per cent, respectively. So far as total digestible nutrients are concerned, barley exceeds these same feed grains by 17, 26, and 38 per cent, respectively. Based on relative feed value, the ultimate purpose of the test, barley exceeded them by 13, 23, and 38 per cent. While occasionally more wheat and corn were produced than barley, in no instance did oats exceed barley.
Smut-resistant Winter Wheats Bred

Conservative estimates place annual losses from covered smut in the intermountain area to be considerably over $1,000,000, Utah bearing 33 1/2 per cent of this loss. Because of the need for more effective means of controlling covered smut or bunt, Relief wheat was bred by D. C. Tingey (Agronomy). In addition to being resistant to various forms of covered smut, this wheat is also equal in yield, winter hardiness, and quality to the better varieties now being grown in this region. Relief descended from a Hussar x Turkey 26 cross.

Figure 2. Upper: A section of a field of Utah Kanred wheat. Low dwarf culms are infected with covered smut. The diseased plants are a result of soil infection. Lower: Same field two years later, showing Relief wheat, a new variety highly resistant to smut.

Two other selections from a Ridit x Utah Kanred cross appear to excel Relief. These selections have been sent to representative wheat-growing areas for trial before making any definite recommendations.

In addition to loose-smut resistance, in some wheat crosses, color of straw is influenced by disease, sunlight, and genetic factors.

Velvon, a New Superior Barley, Developed

Economic production of feed is a major problem with most farmers. Although generally recognized that barley produces more feed to the acre than do other cereal crops, it is not extensively grown in
the state at the present time. The Bureau of Census reports (1930) only 25 per cent of Utah farmers growing barley.

Trebi, which constitutes over 95 per cent of Utah's present total barley crop, has been a boon to farmers because of its high productive ability, yet its undesirable characters have caused farmers to substitute other crops or to reduce the acreage usually sown to barley. Its weak straw, rough awns, and susceptibility to covered smut have made it objectionable.

Realizing the need of a variety which would meet all requirements, in 1932 a cross of Trebi x Colorado Sel. 3063 was isolated by R. W. Woodward and D. C. Tingey (Agronomy). Yield tests for three years show this new strain, C. I. 6109 (designated as Velvon), to be the equal of Trebi, its parent, in this regard. In addition, its smooth awns and stiff straw should encourage a larger barley acreage because of ease in handling and increased value of straw for feed. Not only does Velvon possess these three desirable characters (high yield, smooth awns, and stiff straw), but it also possesses considerable resistance to covered smut (*Ustilago hordei* Pers. K. & S.), considerably more than either Trebi or Winter Club, another popular Utah barley.

**Early Planting of Sugar-beets Recommended**

ADVANTAGES OF EARLY PLANTING of sugar-beets were noticeably apparent in 1934-35, a year of unusual drought and an unusually warm spring. Beets planted on March 21 yielded 21.5 tons per acre, while beets planted on equally fertile soil with apparently equal irrigation but on April 7 yielded only 15.8 tons to the acre. This highly satisfactory yield in a

![Figure 3. A terraced field, Greenville Experiment Farm.](image-url)
year of unprecedented drought is attributed by D. W. Pittman (Agronomy and Soils) to early planting, to a warm April, and to unusual care in handling the limited amount of irrigation water available to eliminate waste.

**Soybeans Need Further Trial under Utah Conditions**

SOYBEAN YIELDS have been rather discouragingly small to date, but with more knowledge of the proper varieties and cultural methods, D. W. Pittman (Agronomy and Soils) feels that this condition may be improved. Under Utah conditions it seems necessary to inoculate this legume. Its particular species of nitrogen-fixing bacteria does not seem to be native to our soil, as is that which grows with alfalfa.

**Alfalfa-seed Production in Utah No Longer a Significant Source of Revenue**

SOON AFTER THE FIRST PLANTING OF ALFALFA had been made near the shores of Utah Lake in 1860, alfalfa-seed growing was attempted in many Utah settlements, such efforts being successful beyond expectations. As the crop gained in commercial importance, the industry became concentrated in a few counties of central and eastern Utah.

The peak of production for the state was reached in 1925, when approximately 441,600 bushels of alfalfa-seed were grown. Of this amount, 294,000 bushels were produced in Millard County and 147,000 bushels in the Uintah Basin. By 1925 previous high yields in Emery County had declined to the extent that this district was no longer regarded as an important alfalfa-seed growing center.

After 1935 Millard County and Uintah Basin yields also declined to the extent that in 1930 the average acre-yield for the state was 1.2 bushels as compared with 6 to 8 bushels in 1925. The total yield for the state reached the low level of 18,000 bushels in 1932, attributed in part to a diminished acreage of alfalfa harvested for seed in that year.

The cause of low yields has been the subject of research at the Uintah Basin Alfalfa-seed Experimental Farm* and in Millard County.** From conclusions drawn by J. W. Carlson and George Whornham (Agronomy) it would seem that success attendant on the production of alfalfa-seed is closely related with precipitation, since highest yields have been attained in years when precipitation has been normal or above. Unfavorable weather is believed to cause stripping of alfalfa, preventing the flowers from becoming properly pollinated and fertilized. Bud-blasting, another cause of poor seed-setting, results in part from injury by Lygus bugs. Other contributing factors to reduced seed production are poor harvesting methods, soil texture and moisture, water-table depth, and alkali concentration.

* The Uintah Basin Alfalfa-seed Experimental Farm, located at Fort Duchesne, was established on July 1, 1925 and continued until December 31, 1934. Mr. J. W. Carlson was in charge of this experimental substation.

** No regular substation was located in Millard County, although in the spring of 1929, Mr. George Whornham was assigned this territory for the alfalfa-seed study. Due to curtailment of funds this investigation was closed on December 31, 1933.
Animal Diseases and Breeding

HIGH MILK PRODUCTION dependent on proved sires . . . . Bang's disease studies continued . . . . Infected pastures not necessarily carriers of Bang's disease . . . . Effort made to determine effect of iritis on breeding hens . . . . Animal Disease Laboratory performs service for state . . . . Mosquitoes known to transmit equine encephalomyelitis . . . . Variation in wool shrinkage between clips apparent.

Proved Sires Best for Breeding Cows

REALIZING THE IMPORTANCE in most sections of the irrigated West for best means of obtaining highest milk level and butterfat production, the Federal Bureau of Dairying has furnished the Station four proved sires for the dairy experimental herd. These sires had proved their worth by a daughter-dam comparison at the Huntley (Montana) Federal Station. A daughter-dam comparison of two of these sires shows that the daughters of one of these sires produced 2231 pounds of milk and 68 pounds of butterfat more than did those dams whose production at maturity was 13,241 pounds of milk and 427 pounds of butterfat. The daughters of the second bull, according to G. Q. Bateman and G. B. Caine (Dairy Husbandry), exceeded their dams by 581 pounds of milk and 38 pounds of butterfat, these dams at maturity producing an average of 15,863 pounds of milk and 539 pounds of butterfat. One of the other two proved sires has five daughters in milk, but none of them is far enough along for a daughter-dam comparison. The fourth sire as yet has no offspring in the herd.

Immunity from Bang's Disease through Natural Exposure May Be Transitory

ELIMINATED because of sterility, mastitis, or general breakdown in productiveness, the last of the twenty original Bang's infected cows continue to show unchanged agglutination titres toward Bang's disease. Fourteen reactors were transferred from the College to the Station herd and twenty-two animals free from infection have been retained from one to five years without contracting the disease. Three of these negative animals, reports D. E. Madsen (Veterinary Science), which apparently possessed sufficient immunity to withstand infection by natural exposure finally developed high titre blood reactions and one of them aborted. One might thus infer that immunity conferred through natural exposure may be transitory.
Transmissibility of Bang’s Disease Among Dairy Cattle Not Probable from Infected Pastures

DANGER OF CLEAN HERDS contracting Bang’s infection through irrigation drainage from infected pastures is rather remote under conditions in the Hyde Park Area where observations have been made for several years by D. E. Madsen (Veterinary Science). Neither does the common practice of driving the cows to and from pasture in one large group, more or less, seem greatly to enhance the spread of this disease. Infection in nearly all newly infected herds can be traced either to the purchase of infected animals or to the practice of continuous contact by pasturing with infected stock of one’s neighbors, which is particularly true of dairy cows and heifers. Of the eighty-four cows aborting during the period of this investigation (eleven of which had been blood-tested for Bang’s disease), thirty-four gave negative tests.

Figure 4. The calf of this cow, affected with Bang’s disease, has been born dead.

Animal Disease Laboratory Serves State

ESTABLISHED IN 1929 for diagnostic service, this laboratory has proved of untold value both to stockmen and poultry-raisers of the state. During the past biennium alone nearly 8000 samples have been tested for Bang’s disease and 681 reactors (9.6%) definitely determined. These samples represent 852 consignments and have come from approximately 600 different herds. Cooperating with the Federal Bureau of Animal Industry, this laboratory, under the direction of D. E. Madsen (Veterinary Science), from September 1934 to the end of May, 1936, made 84,389 agglutination tests for Bang’s disease. Of the cattle tested, 7 per cent were diseased and later slaughtered. Infection was practically as prevalent in
range as in dairy cattle. Examinations were also made for foxes, cattle, hogs, sheep, and poultry. Of the poultry examinations (aside from the Station poultry flock with examinations for 344 chickens and 64 turkeys), 112 turkeys were examined, 358 baby chicks, and 69 chickens.

**Figure 5.** A common disease of turkeys is roup. One of its symptoms is noted in the swollen head of this bird.

**Two Native Mosquitoes Found Capable of Transmitting Equine Encephalomyelitis**

CAPABLE OF TRANSMITTING to guinea pigs the extremely virulent disease, equine encephalomyelitis, are two species of native mosquitoes, *Aedes nigromaculis* (Ludlow) and *A. dorsalis* (Maigen). Outbreaks of this disease in horses have been confined to and adjacent to poorly drained land where mosquitoes and other blood-sucking Diptera are usually abundant. In addition to the transmission studies made by G. F. Knowlton (Entomology) and D. E. Madsen (Veterinary Science), a preliminary survey was made of blood-sucking Diptera which might be suspected of transmitting this serious disease to horses. The epidemiology of the disease strongly
indicates that an active insect vector, or vectors, might be responsible for the rapid dissemination of the malady. Under laboratory conditions, *A. nigromaculis* proved to be the more effective vector of these two species of native mosquitoes.

**Iritis Not Transmitted to F$_2$ Progeny of Breeding Hens**

IN AN EFFORT to determine the effect of iritis of breeding hens on their progeny, out of thirty-three hens and four roosters, all of which were progeny of breeding hens affected with varying degrees of iritis, only two showed any evidence of so-called leucosis. One hen and two roosters did show definite pathology of the iris, while two other hens showed suspicious indications of iritis. During the second year when 102 F$_2$ progeny were observed by D. E. Madsen (Veterinary Science) and Byron Alder (Poultry Husbandry), no definite cases of iritis developed. Leucosis appeared somewhat less prevalent in the group of birds under special observation than in the regular Station flocks, where breeding hens were not necessarily selected for presence of eye lesions.

**Average Wool Shrinkage Lower than Generally Supposed**

A FACT not generally appreciated by wool growers is the amount of wool shrinkage by grades as well as the wide difference within individual grades, due to differences in locality and sheep management. This statement is made by A. C. Esplin (Animal Husbandry), who has been cooperating with the Utah Woolen Mills at Murray on grading and scouring investigations; he further states that the variation in shrinkage clips is as much as 12 per cent.
Livestock Feeding


Milk Yield Dependent on Ration

IN A FEEDING TEST with dairy cows during their lactation period, three rations were used: (1) Alfalfa hay and pasture, (2) alfalfa hay, pasture, and ground barley, and (3) alfalfa hay, corn silage, and pasture. Results obtained by G. Q. Bateman and G. B. Caine (Dairy Husbandry) show clearly that highest production is obtained from the ration composed of alfalfa hay, pasture, and ground barley. Ration 1, consisting of alfalfa hay and pasture, gave the lowest production and Ration 3, consisting of alfalfa hay, corn silage, and pasture, the lowest. On a percentage basis with Ration 2 as 100, Rations 1 and 3 rated 76 and 86 per cent, respectively.

Phosphorus Supplements Recommended for Sugar-beet By-product Rations

DURING THE PAST THIRTY YEARS an enormous amount of wet beet pulp and beet molasses, approximating many thousands of tons in Utah, have been fed to livestock with and without grain and with alfalfa hay. Although both wet pulp and beet molasses have proved to be excellent carbonaceous feeds, rations composed of them with alfalfa hay as a supplement have not proved efficient, even though well-balanced to a nutritive ratio.

Analyses of sugar-beet by-products and alfalfa hay indicate a definite phosphorus deficiency in the ration; wet beet pulp and beet molasses both contain less than 0.02 per cent phosphorus, while the phosphorus content of alfalfa usually ranges from 20 to 25 per cent. Further evidence of this mineral deficiency is indicated in beef and dairy cattle fed sugar-beet by-
product rations. A phosphorosis, a result of feeding phosphorus-deficient rations, is evidenced by bone-chewing (pica), a craving for salt, a lack of appetite for normal feeds, soreness and swelling of the joints, and the lower phosphorus content of the blood serum.

Sources of phosphorus capable of remedying the deficiency found in beet by-product rations, according to E. J. Maynard and H. H. Smith (Animal Husbandry) and J. E. Greaves (Chemistry), include cottonseed cake, millrun bran, steamed bonemeal, and barley. Of these, steamed bonemeal is the most efficient phosphorus supplement with beet by-product rations. Phosphorus supplements fed with beet by-product rations to fattening steers have definitely cured pica, improved appetite, increased gains, decreased feed costs, and increased net returns in fattening operations.

**Calcium-phosphorus Ration Affects Beef Cattle Gains**

While optimum amounts of phosphorus are needed in the cattle-fattening ration to produce maximum and most efficient gains, these amounts of organic phosphorus, as observed by E. J. Maynard (Animal Husbandry) and J. E. Greaves (Chemistry), are ordinarily supplied with customary amounts of grain and alfalfa or of grain, corn silage, and alfalfa. A surplus amount of phosphorus apparently produces negative results. For the cattle-fattening enterprise in other than beet-producing areas of the state, some cheap succulent carbonaceous feed (such as corn silage) is recommended to supplement grain and hay. More efficient rations may be secured by the additional use of sugar-beet molasses, which at present is a surplus commodity in beet-growing areas and which, because of its relatively low water content, can be shipped to advantage over the state. At present prices it should be used locally rather than exported to feed concerns out of the state. In several sections of the state the relatively high prices of grain and hay, because of their scarcity, make high replacement values for beet molasses.

**Phosphorus Deficiency Causes Low Gain in Summer Range Cattle**

Because of the general practice of stockmen turning their cattle on the range during the summer and further because of the characteristic low cattle gains secured on the summer range during the fall months, E. J. Maynard and H. H. Smith (Animal Husbandry), R. J. Becraft and L. A. Stoddart (Range Management), and J. E. Greaves (Chemistry) decided to ascertain the reason for this.

Two uniform groups of twenty-steers each were accordingly selected and grazed on summer pastures of 191 and 209 acres, respectively. Each month individual weighings were made and blood samples taken for phosphorus and calcium determination. Unfortunately, one group of steers was attacked by an outbreak of pinkeye, introducing an uncontrollable factor into the test. Low gain in the fall, however, was attributed to a phosphorus deficiency in both the summer range forage and in the blood plasma of the animals during the fall.
When sold on the Los Angeles market recently, these steers brought top prices. They had been fed for a period of 193 days a ration consisting of sugar-beet by-products supplemented with phosphorus.

**Figure 6.** When sold on the Los Angeles market recently, these steers brought top prices. They had been fed for a period of 193 days a ration consisting of sugar-beet by-products supplemented with phosphorus.

### Dairy By-products Recommended to Hog Feeders

The production and fattening of hogs in conjunction with dairy-farming has proved to be well adapted to the agricultural program in large dairy centers. By furnishing a ready market for dairy by-products (skimmilk, buttermilk, and whey), hogs help to strengthen the dairy industry, while home-grown grains and leguminous pastures complete adequate swine-growing and fattening ration for hogs raised on the farm. It is estimated that central creameries in the state are producing over 2000 tons of skimmilk powder and over 350 tons of buttermilk powder. The possibility of getting this concentrated protein supply back to the farms where the milk is originally produced appeals to creamery men, in face of a steadily increasing supply of the product.

**Figure 7.** These two pigs are the same age. The one on the left was fed a ration of ground wheat, tankage, alfalfa hay, and salt; the one on the right was fed ground wheat, water, and salt. Both were fed for 103 days.
In its concentrated form as powder or coagulated as semi-solid skim-milk protein, milk might easily be shipped back to the farmers in the cans used to transport the milk.

With this in mind, H. H. Smith and E. J. Maynard (Animal Husbandry) investigated the feeding value of skimmilk powder and of a semi-solid product, the result of coagulating skimmilk with rennin and pouring off the whey. A determination was made as to (1) the relative values of tankage, skimmilk powder, and semi-solid skimmilk protein when fed with ground barley or ground wheat in dry-lot and on alfalfa pasture, (2) the value of alfalfa pasture for fattening swine, and (3) the comparative value of barley and wheat on dry-lot and pasture rations.

Summarized results of their findings are:

1. Tankage is more economical for fattening hogs than skimmilk powder because of its lower cost.
2. On the pasture, however, tankage does not save enough feed at present prices to make it economical.
3. Grain alfalfa-pasture rations are improved by the use of supplements, skimmilk being the most efficient and the most economical.
4. Skimmilk yields better results when fed with grain on alfalfa pasture than does tankage.
5. Wheat is profitable for hog-feeding, provided its cost is not prohibitive.
6. Ground wheat is recommended on alfalfa pasture as being a little superior to barley.
7. Alfalfa hay materially improves a ration of grain in the dry-lot, which ranks with the pasture for effective gains, although on the latter the cost is a trifle less.
8. The 50-50 mixture of skimmilk powder and tankage in the dry-lot is worth less per ton than tankage alone, although higher daily gains are apparent.
9. At present prices, the use of the semi-solid skimmilk is economical.

No Apparent Difference Noted in Phosphorus Availability

Disodium Phosphate, monocalcium, commercial Digesta bone, steamed bonemeal, raw bonemeal, and superphosphate were compared by E. J. Maynard (Animal Husbandry) and J. E. Greaves (Chemistry) as to the availability of phosphorus when fed to rats at a low phosphorus level and constant calcium-phosphorus ratio. With each supplement was given a basal diet, low in phosphorus and calcium, which was fed to young rats for six-week periods. Conclusions reached by the investigators from analysis of bones and blood and from feeding records and growth data indicate that there is no apparent difference in the availability of phosphorus in any of the supplements, although it is felt that the arsenic content of superphosphate is probably sufficiently high to exclude it as a feeding supplement.

Sugar-beet Molasses Recommended for Lambs in Iron County

Sugar-beet molasses shipped into Iron County is an efficient carbohydrate supplement to use with grain and alfalfa produced in this section. Because of the scarcity of irrigated land here prices for grain and alfalfa are relatively high and molasses for livestock fattening purposes
can be shipped in at a profit. To further reduce feeding costs and to increase the efficiency of rations, limited amounts of corn silage are recommended for fattening lambs. According to E. J. Maynard and A. C. Esplin (Animal Husbandry), however, no more than 1 to 1 1/2 pounds of corn silage daily should be given lambs. Larger amounts tend to produce excessive growth rather than finish.

Farm-fed Sheep Produce More Wool and Less Shrinkage than Do Range-fed Sheep

WOOL GROWTH DIFFERENCES on farm-fed and range-fed sheep are clearly apparent in an eight-year study conducted by A. C. Esplin. At the beginning of this experiment sixty ewes were placed in each group, the summer range being comparable for the two lots. The winter feed given the farm-fed animals during the past three years of this experiment* included farm stubble pasture and choice alfalfa (3 pounds per head for the first year and 4 pounds per head for the second year); while still suckling lambs, they were given 1/2 pound of barley.

Farm-fed ewes proved distinctly superior to the range-fed animals, as is shown by the fact that they produced 3.78 pounds more grease and 1.43 pounds more scoured wool than the range-fed sheep; shrinkage was 0.22 per cent less. No significant difference, however, was apparent in length of staple.

Desert Sheep-feeding Study Conducted in Juab County

UTAH DESERT RANGES provide a valuable background for investigations in sheep-feeding in the opinion of E. J. Maynard and A. C. Esplin (Animal Husbandry). Such an investigation was conducted for two years on the winter range in Juab County with three bands of sheep, 100 in a band. One of these bands was given daily 1/4 pound of cottonseed cake, another band an equal portion of corn, and the third lot received no supplement and was used as a check.

To make more comparable the data with respect to the amount and chemical constituents of forage consumed by these sheep, identical parts of the plant which the sheep ate were collected by clipping or by removing by hand. These plant portions were then dried and shipped to the Station for identification, chemical analysis, and determination as to their nutritive value.

The principal desert forage plants sent in from Juab County and identified by R. J. Becraft and L. A. Stoddart (Range Management) are:

- Blue Sage (Artemisia tridentata)
- Brigham Tea (Ephedra nevadensis)
- Brown Sage (Kochia vestita)
- Bud Sage (Artemisia spinescens)
- Curly Grass (Hilaria jamesii)
- Curly Sage (Artemisia nova)
- Fourwing Saltbush (Atriplex canescens)

* Results of the first five years of this study are reported in the following publication: "Effect of Feed, Water, and Shelter upon Fleeces of Utah Ewes." By A. C. Esplin. Utah Agr. Exp. Sta. Bul. 240. 1932.
Results of the study for the past three years are complete and will be published in the near future.
Matchweed (*Gutierrezia sarothrae*)
Rabbit Brush (*Chrysothamnus nauseosus*)
Rice Grass (*Oryzopsis hymenoides*)
Russian Thistle (*Salsola pestifer*)
Salt Sage (*Atriplex nuttallii*)
Shadscale (*Atriplex confertifolia*)
White Cedar (*Juniperus utahensis*)
White Sage (*Europia lanata*)
Yellowbrush (*Chrysothamnus viscidiflorus*)

After identification, these plants were analyzed by J. E. Greaves (Chemistry) for total dry matter, protein, nitrogen-free extract, crude fiber, fat, phosphorus, calcium, sulphur, and magnesium. High percentages of crude protein and calcium were apparent, with a wide variation in percentages of the other elements.

The following rather interesting observations were made in regard to the three bands: (1) The non-supplement herd had better range and moved away from the ranch headquarters, (2) the corn-fed band herded out fairly well, and (3) the cottonseed-cake herd was prone to stay close to feeding headquarters.

It might be inferred from results obtained that the supplement which could be fed with impunity on Utah desert ranges with browse feeds would be for total nutrient and possibly for phosphorus rather than for protein. Where matured grass predominates on the range the protein supplement might be supplied.

Weight determinations of wool were made by A. C. Esplin (Animal Industry), with negative results. The herd with no supplement showed an average loss in weight of 1 pound per ewe, while the corn-fed and cottonseed-cake herds showed respective losses of 5 and 11 pounds. The non-supplement herd sheared 9 pounds of fleece per ewe, while the other two sheared 8.7 pounds each.
Poultry

S. C. WHITE LEGHORN hen lays 886 eggs in four years . . . . Increase in both size of egg and size of bird noted . . . . Grain and mash with grain litter gives high egg record . . . . Soft white wheat supplemented with barley considered better than hard red wheat . . . . Corn ration yields slightly higher results than barley ration . . . . Addition of animal protein supplements to mash shows 20% to be best . . . . No advantage found in forced summer molt . . . . Turkey mashes best when they contain from 14 to 20% protein.

High Record Held by S. C. White Leghorn Hen

THE AVERAGE HEN, according to Byron Alder (Poultry Husbandry), lays less than 100 eggs during her life, weighs less than four pounds, and usually does not live longer than two or three years. The Station poultry flock boasts of one S. C. White Leghorn hen which has sur-

Figure 8. Just completing her fourth year of production, this S. C. White Leghorn hen has a total record of 886 eggs.
passed both of these egg and weight records as well as having passed the three-year mark. During the four years of her life this four-pound hen has laid a total of 886 eggs! Her annual record is as follows: First year, 291; second year, 236; third year, 204; and fourth year, 155. The average weight of these 886 eggs is 26 ounces to the dozen, while their total weight is 121.59 pounds, which is 117.34 pounds of eggs over her own weight.

Size of Egg and Size of Bird Held to be Important

Some four or five years ago 22 ounces to the dozen was considered a good average for one dozen eggs. Since that time egg size has been increased until now it has reached 24.2 ounces to the dozen, observes Byron Alder (Poultry Husbandry). The same is true with regard to size of bird; whereas in 1932 and 1933 the average weight of laying pullets was 3.2 pounds, this average weight now has increased to 3.7 pounds.

Egg Production Dependent on Proper Feeding Rations

Not only is the feeding ration itself important for the poultry flock, but methods of feeding must also be considered. An all-mash ration fed to the Station poultry flock brought an annual average of 211 eggs to a bird; birds fed grain and mash with the grain litter produced an average of 212 eggs each; and where grain and mash were fed with the grain fed in the mash trough on top of the mash the average production was 200 eggs for each bird. No marked difference either in size of egg or in average weight of birds is apparent, according to Byron Alder (Poultry Husbandry).

Soft White Wheat is Superior to Hard Red Wheat

While no marked difference in average weight of birds or in size of eggs was apparent in a comparative feeding test of soft white wheat versus hard red wheat, yet Byron Alder (Poultry Husbandry) found that birds in pens fed soft white wheat supplemented with barley or yellow corn made an average annual production of 209 eggs as against 199 in pens where hard red wheat was given.

Determine Relative Merits of Barley and Corn

In a feeding test to determine the relative merits of barley and corn for Leghorn hens, both barley and yellow corn were supplemented with wheat and wheat products in both the mash and grain mixture. Wheat and wheat products, according to Byron Alder (Poultry Husbandry), represented approximately two-thirds and barley or corn one-third of the grain part of the ration. Birds on barley rations averaged 203.1 eggs per hen for each year, as against an average of 204.5 eggs for birds receiving corn. No significant difference was observed, however, either in egg size or in weight of hens in the two groups.
Study Made of Various Amounts of Animal Protein Supplement

AVERAGE EGG PRODUCTION per hen per year and percentage of annual mortality for 240 Leghorn hens placed in four pens and fed varying amounts of animal protein supplement in the mash are shown in the following summarized statement, prepared by Byron Alder (Poultry Husbandry):

<table>
<thead>
<tr>
<th>Pen No.</th>
<th>Animal Protein Supplement (%)</th>
<th>No. Eggs Produced</th>
<th>Annual Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
<td>214.2</td>
<td>20.0</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>209.7</td>
<td>16.0</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>190.1</td>
<td>19.5</td>
</tr>
<tr>
<td>D</td>
<td>25</td>
<td>212.5</td>
<td>13.0</td>
</tr>
</tbody>
</table>

One Year's Results Indicate No Measurable Advantage in a Forced Summer Molt

FORCED SUMMER MOLTING of Leghorn hens as a method of increasing fall and winter egg production showed no significant difference in egg production in any of the four pens in which hens were placed for this study. Further, states Byron Alder (Poultry Husbandry), practically all birds which were forced to molt went through a second molt during the winter months.

Turkey Feeding Based on Protein Costs as Well as upon Grain Fed

RESULTS of a turkey-feeding experiment conducted by Byron Alder (Poultry Husbandry) for one year only indicate that there is little difference in rate of growth of turkeys when fed rations with a protein level between 14 and 24 per cent of the mash mixture. Since protein supplements are usually the most expensive ingredients of a mash mixture and the real value of a ration is the cost of feed required to produce one pound of turkey, it is concluded that mashes containing from 14 to 20 per cent protein are better because they give a lower feed cost per pound of gain than mashes containing higher percentages of protein.

When the grain part of the ration is made up of wheat and barley, the rate of growth and pounds of feed per pound of turkey are practically the same as in those pens where barley is replaced by yellow corn in both the grain and mash mixture. The feed cost per pound of gain is lower in barley-fed pens because in Utah barley is less expensive than corn. The addition of skimmilk or dried milk to the growing ration after the first six weeks apparently has little effect either on rate of growth of the birds or on amount of feed required to produce one pound of gain. The extreme variation in the feed cost of producing one pound of turkey was 3.2 cents; in the high protein ration with yellow corn the cost was 9.1 cents per pound of gain, while the low protein ration with barley cost 5.9 cents.
Insects

LARGE QUANTITIES OF FORAGE on Utah range lands consumed by insects . . . . Pale western cutworm infests spring- and fall-planted wheat fields . . . . Mormon crickets invade parts of state . . . . Canning-pea industry suffers extensive damage from pea aphid . . . . Kerosene sprays recommended for control of boxelder bug. Say’s plant bug causes 50 per cent loss to grain and alfalfa fields . . . . Spray dates for codling moth determined . . . . Prevention of over-grazing and proper handling of range land aid in beet leafhopper control . . . . Poisoned bait found effective in grasshopper control . . . . Shriveled alfalfa-seed traced to presence of tarnished plant bug . . . . Strawberry and dewberry crops damaged by insects . . . . Potato insects under investigation . . . . Utah tomato growers and canners suffer $250,000 annual loss from tomato fruitworm . . . . Green soldier bug and peach twig borer difficult to control . . . . Seasonal development of curly-top on tomatoes being investigated. Lygus bug, alfalfa weevil, chalcis-fly, and leafblister mite damage crops.

Range Lands Affected by Amount of Forage Consumed by Insects

COMPETING WITH LIVESTOCK and often materially lessening the carrying capacity of the range are insects which consume large quantities of forage upon Utah range lands. Serious outbreaks of grasshoppers, Mormon crickets, and cutworms often interfere with the seeding of native grasses, in some cases causing range deterioration. Preliminary studies conducted by G. F. Knowlton (Entomology) show many species of insects to be engaged in the eating of forage plants, while others reduce plant vitality by sucking out plant juices. Many crop pests breed on range waste land, later moving on to cultivated crops and causing varying amounts of injury.
Control of Pale Western Cutworm a Serious Problem

Growers of wheat in Cedar Valley (Utah County) in the spring of 1934 awoke to the realization that approximately 10,000 acres of their spring- and fall-planted wheat was infested with the pale western cutworm. The infestation, together with effects of drought in this region, resulted in almost a total loss of the wheat crop in this district. Damage was even greater in 1935, when it occurred in greater numbers and covered a wider range than ever before in the state. Cedar Valley suffered great loss again in 1936, when by April 15th over 7500 acres of wheat had either been completely destroyed or so seriously injured that it was not worth harvesting. By June 1st, 500 acres of wheat on the Levan Ridge (Juab County) had been destroyed. Infestations occurred also in the Scipio District (Millard County) and in the dry-farm area north of Lehi (Utah County), extending eastward almost to Alpine.

Because of the increasing magnitude of this problem, a specific program of investigation was organized by C. J. Sorenson (Entomology), investigations beginning on June 1st (1936), conducted mainly in the dry-farm area west of Lehi and in Cedar Valley. It is too early to cite any conclusions as to the effect of this control campaign, but indications are that the numbers of this destructive pest were considerably reduced.

Bands of Mormon Crickets Invade Utah

Migrating toward the cultivated fields of Oak City (Millard County), bands of Mormon crickets threatened serious crop damage in June 1935. In addition to the Oak Creek Range Area, outbreaks of Mormon crickets occurred in Tooele County. These outbreaks have greatly increased in the state in 1936 over 1935, both in numbers and as to areas of infestation. Due to the gravity of the situation created by cricket infestations seriously damaging the range and threatening farm crops near Oak City and Tooele, in April 1936 the U. S. Department of Interior, through its Division of Grazing, the U. S. Forest Service, and the State Department of Agriculture cooperated with C. J. Sorenson (Entomology) in formulating a control program. A "spike" camp consisting of twenty-five men was set up at Oak City, these men being equipped with dust guns and a dust mixture of crude arsenite and slaked lime with which to destroy the young crickets while they were clumped in early morning, late afternoon, and early evening. Crickets upon which dust was applied were killed within twenty-four to forty-eight hours after application, the principal difficulty being to get the dust on the crickets before they had secured protection under vegetation, rocks, debris, and cracks in the ground.

Pea Aphid Causes Extensive Damage to Canning Peas

Occurring in outbreak proportions in Salt Lake, Tooele, and Weber Counties in 1934, the pea aphid appeared again in April and May of 1935 in the Moab districts and again in June of 1936 in Davis and Tooele Counties. Control efforts, according to C. J. Sorenson (Entomology), consisted of a combination plank platform and chain drag,
although even more effective as control agents were coccinellid larvae and adults.

Pea aphid damage is also reported by G. F. Knowlton (Entomology) in Boxelder, Cache, and Davis Counties and to a lesser degree in Morgan County. In some instances farmers cut their peas to avoid serious injury. Some of the earlier infestations in these districts were almost entirely controlled by predator larvae of syrphid flies, adult and larval ladybird beetles of several species, damsel bugs, and big-eyed bugs. Some concern was experienced by farmers when large numbers of pea aphids left the peas and settled on tomatoes; such aphids soon died, however, and no noticeable injury was observed.

Boxelder Bug Continues to Be a Serious Household Pest

EXCELLENT OPPORTUNITY is afforded in the control of this annoying pest at the time the adult bugs come from hibernation on warm spring and fall days, when they sun themselves on the south and west sides of buildings and tree trunks. Sprays recommended by G. F. Knowlton (Entomology) are:

1. Kerosene alone
2. Kerosene to which has been added a 5-10% cheap heavy lubricating oil
3. Kerosene (19 gals.), pyrethrum concentrate (1 gal.), and cheap heavy lubricating oil (1½ gals.)

Grain and Alfalfa Fields Seriously Damaged by Say's Plant Bug

A HEAVY INVASION of Say's plant bug in the grain fields at Grafton and Virgin (Washington County) occurred early in June 1935, and resulted in serious damage. Millard County grain fields suffered severe damage by the latter part of June and during July of the same year, the estimated loss to grain yields being 50 per cent. After the grain had entered the dough stage the bugs attacked developing alfalfa-seed. According to C. J. Sorenson (Entomology), Sevier and Utah Counties also suffered severe damage; near Goshen (Utah County) alfalfa-seed on second-growth alfalfa was completely destroyed by these bugs.

Cover-spray Applications for Codling Moth Effected

TIMING OF COVER SPRAY-APPLICATION for codling moth control was effected early in the spring of 1935 by C. J. Sorenson (Entomology). Through the cooperation of county agricultural agents and agricultural inspectors in the apple- and pear-growing districts of the state, bait-trap records were obtained and spray dates determined for local application of codling moth cover sprays. With the appointment of an Extension Horticulturist in the spring of 1936, the program for future determination of spray dates will no longer be a Station responsibility.
Possibility of Control of Beet Leafhopper Foreseen

In the desert breeding grounds many species of birds feed upon the beet leafhopper to an appreciable extent, especially during the fall migration. Stomachs of birds taken at random over the state and not in areas where this pest is abundant have occasionally contained beet leafhoppers. Pipunculus parasitism of adult and nymphal beet leafhoppers was usually high during 1935. Beet leafhopper injury during 1934 and 1935, as reported by G. F. Knowlton (Entomology), was rather extensive to sugar-beets, cantaloupes, cucumbers, squash, beans, and certain other crop plants. Cucurbits were most severely damaged in the Green River and Moab districts. Tremendous numbers of beet leafhopper nymphs as well as adults were found upon seriously injured potato plants at Moab. Plantings from the resistant varieties of sugar-beets stood up fairly well in most Utah localities, in many instances producing a paying crop in spite of beet leafhopper abundance.

The very existence of the tomato industry was threatened by the serious outbreaks of curly-top, the repeated losses being disheartening to growers and canners alike.

Breeding-area control of the beet leafhopper, through prevention of over-grazing and proper handling of the range land, seems to be an important possibility. Should grasses and other native vegetation replace the important introduced host plants of the leafhopper over large areas of range breeding grounds, much relief might result to cultivated crops now affected by this insect and the curly-top disease which it transmits. Direct control of this insect, as reported by G. F. Knowlton (Entomology), might be feasible during certain seasons of abundant over-winter survival and the early

Figure 9. Fortunately and wisely, Utah has protected the seagull because of the beneficial work to the farmers in helping to keep grasshoppers in check. The work of the seagulls needs to be supplemented by the use of insecticides and poisoned bait in years of serious outbreak. From all appearances, western states are facing another outbreak of Mormon cricket, in the control of which the gull and other predacious birds and animals are important.
development of a large spring generation upon important small local breeding areas.

Grasshopper Control by Means of Poisoned Bait Effective

SEVERAL HUNDRED TONS OF BAiT were spread in Utah in 1934 and again in 1935 in an intensive campaign against grasshoppers and their allies, with special reference to the species which menace farm crops and range forage. The spreading of this bait, according to W. W. Henderson (Entomology), resulted in reducing the number of these insects to a minimum. On 317 farms surveyed, nineteen species of grasshoppers were collected.

Tarnished Plant Bug Causes Reduction in Alfalfa-seed Production

WHILE TARNISHED PLANT BUGS do not constitute the only factor causing shriveled alfalfa-seed, still apparently it is an important one as it has been found that the feeding of these bugs upon seed-bearing alfalfa have a direct relation to the amount of shriveled seed. Not only are shriveled seeds due to this cause, but the total number of seeds is also reduced as a result of their feeding. Therefore, the conclusion reached by C. J. Sorenson (Entomology) is that heavy infestations of tarnished plant bugs in alfalfa-seed fields contribute to lower seed yields and to poorer quality of seed.

Berry Crop Insects Cause Damage

SO GREAT had become the insect damage to strawberry and dewberry plants that a study was begun to determine not only the extent of this damage but also what insect or insects might be causing the trouble and to suggest possible means of control to the growers. Three insects are held responsible by G. F. Knowlton (Entomology) for causing most of the damage—the strawberry leafroller, strawberry root weevils, and the dew-
berry fruitworm. Life-history studies have been made of the strawberry leafroller under field conditions; several parasites, collected in northern Utah localities, have been reared. Repeated spring rains interfered with control experiments and no recommendations for their control can be offered at this time. Poisoned baits show promise in the control of two strawberry root weevils, *Brachyrinus ovatus* and *B. rugostriatus*. A small lepidopterous larva, somewhat resembling the strawberry leafroller, which has been infesting dewberry fruits in the Granite-Butlerville Area of Salt Lake County, has been determined as the dewberry fruitworm. The larvae of the dewberry fruitworm reach part of their growth in the berries, some of them moving on to the leaves and acting as leafrollers.

**Control Methods Necessary to Potato Insects**

In an attempt to determine what potato insects have been causing most appreciable damage to potatoes in Utah, an inspection was made of some of the potato fields in Washington and Iron Counties infested by the potato tuber moth. The application of effective control measures was urged by G. F. Knowlton (Entomology). Only preliminary studies of the potato flea beetle were possible. A study of the biological control of *Paratrixia cockerelli* (Sulc) has shown it to be attacked by ladybird beetles, chrysopid larvae, the big-eyed bug, damsel bugs, and by syrphid larvae.

**Attempt Made to Time Control Operations for Tomato Fruitworms**

The seasonal occurrence and extent of injury from tomato fruitworms in various tomato-growing districts of the state was investigated by G. F. Knowlton (Entomology), hoping that it might be possible to aid in timing control operations as soon as fruitworm injury is first discovered. An estimated loss of more than $250,000 from this insect was sustained by Utah tomato-growers and canners during 1934 and again during 1935. The Utah Canners Association and the U. S. Bureau of Entomology and Plant Quarantine are cooperating in attempts to control this pest.
Stone-fruit Insect Control Investigated

STONE-FRUIT GROWERS in various parts of the state have sustained considerable loss from infestations of the green soldier bug, the peach twig borer, and Lygus bugs. Investigational work was begun on June 1, 1935, by C. J. Sorenson (Entomology) on the Davis County Experimental Farm to determine the time of occurrence of injuries resulting to various stone fruits from the feeding activities of these insects, together with type, nature, and extent of damage. Valuable data have been secured relative to the first two—the green soldier bug and the peach twig borer.

Is the Beet Leafhopper Correlated to Curly-top?

IN TOMATO DISTRICTS of Northern Utah curly-top on tomatoes and other garden crops had developed to considerable extent during 1934 and 1935 and, while not so severe during 1935-36, a study of the seasonal development of curly-top on tomatoes under experimental conditions was begun only this last spring. This study is in cooperation with the U. S. Bureau of Entomology and Plant Quarantine. Tomato plot tests have been set up and inoculations with curly-top virus by means of the beet leafhopper made at weekly intervals by G. F. Knowlton (Entomology). An investigation as to the length of adult life of this insect upon the tomato is also being conducted in the Hooper district and in a small area around Vineyard where curly-top counts are apparently the highest.

Additional Insect Infestations Reported

FURTHER INSECT DAMAGE is reported by C. J. Sorenson (Entomology) from Lygus bugs which have caused heavy loss in alfalfa fields of the state by bud-blasting and increased blossom drop and shriveled seed. Millard County alfalfa growers have sustained considerable loss from the alfalfa weevil, although early cutting and dusting with calcium have proved effective. Reported damage to alfalfa-seed by the chal-
Plant Diseases


Investigate Possibilities of Chlorosis Control

SEASONAL FLUCTUATIONS in total nitrogen, phosphorus, soluble-iron content, and pH of several soils supporting normal and chlorotic plants were believed to influence to a marked degree the extent of chlorosis in Utah. Only slight differences in soils from green and from chlorotic areas, however, were observed by F. B. Wann (Plant Physiology). Soils with chlorotic plants apparently had as much or more total nitrogen at all depths as soils with normal plants. Some of the chlorotic soils appeared to be deficient in soluble phosphorus. Differences in pH were negligible, the normal areas tending to be slightly more acid than chlorotic areas and no consistent differences in soluble iron were observed.

In an attempt to determine the status of soluble and total iron in normal and chlorotic plants, it appears that chlorotic plants contain as much soluble iron as normal green plants; moreover, the pH of the tissue fluids of grape is low enough to keep iron in solution. These facts appear to contradict the belief as to the fundamental cause of chlorosis—lack of soluble iron in the plant.

Several thousand grape cuttings and grafts as well as sixteen varieties of raspberries and several thousand Marshall strawberry plants are being isolated and propagated by A. L. Wilson (Horticulture and Vegetable Crops). While there is evidence of resistance to chlorosis in all of these small fruits, no outstanding individuals have as yet been isolated. The grafting of Concord grape scions on vinifera roots appears to be promising,
although grafting technique must be improved before it can be considered commercially successful.

**Appearance of Peach Mosaic in State Significant**

**S**ince the appearance of peach mosaic in Grand County, a new significance attaches to the study of chlorosis. In many respects, according to F. B. Wann (Plant Physiology), some of the early symptoms of mosaic are suggestive of chlorosis; in fact, they too consist in the production of yellow blotched areas on young leaves. They are so similar in certain stages that it is difficult to differentiate between them.

**Verticillium Wilt More Responsible for Tomato-crop Failures than Fusarium Wilt**

**W**hile it has been generally supposed that Fusarium wilt has been responsible for much of the tomato-crop loss in the state, survey studies conducted by H. L. Blood (Plant Pathology) for the past two years indicate that Verticillium wilt is much more prevalent and is much more frequently responsible.

**Bacterial Soft Rot of Dahlia New to Science**

**N**ew to science is bacterial soft rot of the dahlia. The organism has been isolated and determined by B. L. Richards (Plant Pathology) as a strain of the species *Bacillus carotovorpus* and is probably identical with *B. phytothorpus*, which causes blackleg of the potato. Three types of dahlia rot have been found and recognized, all of which are phases of the same disease—soft rot, dry rot, and hollow heart. Provision of proper storage will prevent loss from soft rot.

**Fermentation Method of Seed Extraction Recommended for Tomato Bacterial Canker Control**

**B**acterial canker as a factor in tomato production in the state has been practically eliminated by the fermentation method of seed extraction. It is highly important, says H. L. Blood (Plant Pathology), that the seed grown be canker-free and the plantbeds free from infection. Four years of experimentation have proved that seed extraction by fermentation in the whole fruit juice for 96 hours is more effective than copper sulphate, mercury bichloride, or any other inorganic chemical or hot water treatment used in the control of bacterial canker. Certain organic acid seed-soaks appear promising as a control measure. Fermentation should proceed at a temperature not to exceed 70°F. for a 96-hour period; otherwise, the viability of the seed is affected. To prevent contamination, the fermentation process should be followed by chemical treatment in which the seed is soaked from 6 to 20 hours in a copper sulphate solution (1 pound of chemical dissolved in 8 gallons of water).

Possible control for bacterial canker may also be found in *L. pimpinelli-folium* and in some strains of wild *L. esculentum*, there being a possibility that a strain of tomato might be developed which would have natural resistance to the canker disease.
Bacterial Wilt of Alfalfa Increases Rapidly Since Its Discovery in 1925

DISCOVERED first in Utah in 1925 by B. L. Richards (Plant Pathology), and then in but three fields in Salt Lake County and one in Boxelder County, bacterial wilt has since become fairly well distributed throughout the state. The drought of 1934 checked its appearance in its most active stage in most of the infected areas, although reestablishment of effective moisture supply causes its reappearance. Where but little drought occurred this past year, bacterial wilt of alfalfa was disastrously destructive in Minersville (Beaver County), Annabella (Sevier County), and Logan and Smithfield (Cache County).

Curly-top Highly Destructive to Beans and Tomatoes

CURLY-TOP DISEASE on the tomato developed in epidemic proportions in 1930, 1931, 1934, and 1935, resulting in an annual loss of over $1,000,000 to the state. In 1936 destruction was confined to a few localized areas where the infection was so heavy as to result in a complete crop loss.

Cooperative resistance tests with Federal Bureau of Plant Industry, being conducted at the Hurricane trial grounds, indicate that some resistance to the disease is possessed by certain strains of wild tomato. An intensification of this expression of resistance, states H. L. Blood (Plant Pathology), will be attempted by an exhaustive program of hybridization and selection. A number of bean fields in the Syracuse, Westpoint, and Hooper districts were completely destroyed this past year and considerable loss experienced in the Bear River City district because of curly-top. Reports received indicate that in 1935-36 the occurrence of curly-top among
the bean fields of southern Idaho was one of the worst in the history of the bean industry. From plantings made at the Hurricane (Utah) trial grounds, Red Mexican, although not immune, had the least percentage (12.7) of damage. Plantings were also made at Logan from which single-plant selections will be made and later propagated, selected for type, and tested for resistance.

Field plot data indicate that the most susceptible varieties of bean exhibit about the same relative degree of resistance as the most resistant

Figure 14. Harvest of curly-top resistant tomato stocks, Hurricane trial ground tests, 1936. Large bags contain cuttings from surviving and recovering individuals to be rooted and planted on trial grounds in 1937. Small bags contain fruit from surviving and recovering individuals from which seed was extracted for planting on trial grounds in 1937. This harvest represents selections of best resistant material from six years of trial ground selections.

Figure 15. The greatest degree of resistance to curly-top is found among the wild sorts of tomatoes which are small (right) compared with the standard tomato (left). The wild sorts will be developed into the acceptable commercial tomato by an exhaustive hybridizing and selecting program.
strains of the tomato. There appears to be no biochemical basis for comparison of beans and tomatoes in regard to resistance of curly-top. Because the two plant types showed significant differences among varieties for entirely different characteristics (except for pH), it might be suggested that these mass chemical and physical-chemical determinations do not reveal the factors really concerned with resistance. Further work toward more refined micro-chemical analyses is necessary before conclusions can be reached.

Significant Differences Shown in Healthy Curly-top and Bean-tomato Tissues

 Diseased leaves and stems of the bean are higher in dry matter, solids, sugar, and freezing point depression than healthy tissues. This is the conclusion reached by F. B. Wann (Plant Physiology) in a comparative study of healthy curly-top and bean-tomato tissues. Diseased tissues were lower in pH but not significantly different in titrable acidity, and diseased leaves were lower in total, soluble, and coagulable nitrogen, while healthy leaves were higher in these constituents. All forms of nitrogen apparently move out of the leaves into the stem, as a result of the disease, which is confirmed by a higher amount of amino-nitrogen in both leaves and stems of diseased plants. Evidence indicates an accumulation of nitrate nitrogen in diseased stems and to a lesser degree in the leaves, as well as a marked increase in amino-nitrogen in diseased tissue. It is quite apparent that the normal nitrogen metabolism is considerably altered by curly-top, which is highly significant.

Tomatoes Grown in Shade Less Susceptible to Curly-top

Tomato plants have been grown during this period under four types of cloth shading and in the open. Samples from diseased plants grown under similar conditions were taken for comparison with the healthy plants. It is evident, according to F. B. Wann (Plant Physiology), that shading reduces the dry-matter, solids, freezing-point depression, total sugar, and titrable acidity values in the healthy tissues. Total nitrogen, bound water, and pH values are increased. Since tomatoes under shade appear to be less susceptible to curly-top, it is conceivable that one or a combination of several of these changes is associated with this increase in resistance.

Strawberry Root Rot Has Become a Definite Limiting Factor

Strawberry root rot, which is relatively new to Utah, was particularly severe in Utah, Salt Lake, and Boxelder Counties where it has become a definite limiting factor in crop production. Just why there should be this uneven distribution of this disease has not been determined although, according to B. L. Richards (Plant Pathology), there is some indication that soil fertility, the particular pathogen present, and the type of soil are all contributing factors.

The more common type of root rot, that which affects the root at any point along its entire length and results in complete killing and subsequent
blocking of the affected tissue, appears to be generally distributed through­
out the state and is possibly the most important type of injury.

During the months of April and May a second and distinct type of root
injury, clearly different from the other, makes its appearance. This type of
root rot is confined apparently in general to the cortex of the various pri­
mary and secondary roots, resulting in a distinct browning at any point
along the root; it may also produce a distinct tip root at a point where meris­
tematic or thin-walled cortical cells are involved.

**Nematode also Factor in Diseased Strawberry Roots**

ALTHOUGH THE SPECIES was not determined in survey studies made
by B. L. Richards (Plant Pathology), several Weber County fields
showed serious nematode injury. Hence, nematodes must be consid­
ered a factor in the etiology of strawberry roots in certain districts of that
county.
Weeds

IRRIGATION WATER one of most effective agencies for spread of weed seeds . . . . Manure often a source of weed infestation . . . . Viability of weed seeds retained for long periods of time . . . . Tillage most economical as well as most effective method of weed control.

Farmers of Utah Contributing to Huge Monetary Loss from Weeds

IN A REPORT advocating the needs for weed research, the U. S. Chamber of Commerce through its Agricultural Service Department makes the statement that the loss from weeds in the United States amounts to twelve times the loss from animal diseases, one and two-thirds times the loss from plant diseases, and three times the loss from insect pests. In monetary terms, this represents an estimated annual loss of $3,000,000,000.

Farmers of Utah, observes D. C. Tingey (Agronomy), are unwittingly contributing their share to this tremendous loss. In fact, the irrigation farmer is undoubtedly contributing more than his portion toward this loss, since irrigation water is one of the most effective agencies in the spread and growth of many weed species.

Show Danger of Using Weed-infested Manure

MANY WEED SEEDS are carried in hay, straw, and feeds, eventually finding their way into manure and later being hauled to the land. Especially is this true of chicken manure where grain containing weed seeds is fed in the litter as scratch feed. The rapid increase in poultry-raising in the state has resulted in large quantities of such manure, with its accompanying benefits and hazards. In the opinion of D. C. Tingey and R. J. Evans (Agronomy), farmers ordinarily would not hesitate to use manure if weed dangers were eliminated, while under present conditions many refuse to do so.

Weed Seeds Retain Viability for Long Time

SEEDS of morning glory (Convolvulus arvensis L.), whitetop (Lepidium draba L.), and Russian knapweed (Centaurea piciis Poll) were put in wire containers in chicken manure, stored in different ways for various periods of time, and then germinated in soil and on blotter paper. At different intervals from ten days to four months the seeds were removed from the various piles and germinated. In no case did D. C. Tingey and R. J. Evans (Agronomy) find the viability of morning glory seed destroyed. In fact, they report that morning glory seed has been
known to retain its viability in soil for as long as forty years. The viability of whitetop and Russian knapweed seeds was destroyed in the experiment conducted after being in moist, loose manure for twenty days or after being in the moist compacted manure for one month. In the unmoistened piles the viability of these two weed seeds at the end of four months was not completely destroyed.

**Tillage Found to Be Cheapest and Most Effective Method of Weed Control**

In an effort to discover ways and means of more effectively combating this ever-increasing menace, extensive weed-control experiments are being conducted by D. C. Tingey and R. J. Evans (Agronomy). In their experimental investigations it has been found that the most difficult weeds to eradicate are those which produce underground stems or stolons, the perennial tissues of which live over from year to year. Experiments conducted on the comparative effectiveness of different tillage and chemical treatments on the rate of exhausting the food reserves in these underground stems reveal interesting facts regarding comparative effectiveness and economy of different methods of weed eradication.

Tillage is more effective and costs from one-fourth to one-eighth that of any chemical method tried, provided it is begun early in the spring. Some chemicals are highly expensive and yet are worthless as effective weed exterminators. Shallow cultivation, if begun early in the spring and repeated every two weeks, is the most economical known method of control. While plowing is as effective as shallow cultivation, its cost is over twice as much.

Chemical analyses of underground stems show that different treatments have little effect on root composition. They do, however, markedly affect the reduction in quantity of roots.

Fine-textured Soils of Delta Area Make Diversified Farming Difficult

COOPERATING with the Federal Bureau of Soils (since, designated as the Bureau of Chemistry and Soils), the Utah Station in 1919 made a soil survey of the Delta Area. In 1928 a supplemental cooperative investigation was begun, being completed in 1935. Some of the findings of this investigation are briefly summarized by D. S. Jennings (Agronomy and Soils) as follows:

1. The Delta Area contains a high percentage of fine-textured or heavy draft soils. Cultivation of these fine-textured soils and the establishment of a favorable tilth is difficult. Alfalfa and alfalfa-seed require a minimum of cultivation. Largely as a result of these two factors, the general practice of single-crop farming has developed.

2. All plant-food elements, except nitrogen, are sufficiently abundant to produce high crop yields in the soils of the area. The universal presence of soluble bicarbonate in the soil solution indicates that the available forms of phosphorus may be low.
3. The soils of the Delta Area are relatively young. There is no indication that hydrolysis of the silicate minerals has taken place to any extent. Compact horizons were found in three of the series, although most of the horizons of the other important soil series of the area are generally only slightly compact or open to loose.

4. Although much of the Delta Area was served by drains from 1919 to 1932, there is no indication of any reduction of alkali concentration in a large portion of this drained area. In 1932 there were still many localities which contained concentrations higher than those given as the toxic limits for farm crops. This slow response to drainage is probably due to (1) the high percentage of fine-textured soils, (2) the high ratio of sodium to calcium in the soil alkali and irrigation water, resulting in a lower permeability to soil moisture, and (3) upward moving waters which increase the alkali content of the upper soil layers. The alkali of this area is composed mainly of sodium chloride, sodium sulphate, and small amounts of bicarbonates.

5. Class rating for this area is based upon profile, surface texture, surface relief, internal drainage, and alkali.

6. The attempts of 1919 and succeeding years towards diversification of crops, including sugar-beets and small grains along with alfalfa, had by 1932 largely given way to a single-crop system of farming. It is highly probable that the high percentage of extremely fine-textured soils, with the resulting difficulty or practical impossibility in some areas of working the soils into a good tilth in the time required, has been an important factor in the failure to grow sugar-beets in the Delta Area.

What is Responsible for Loss of Nitrogen and Organic Matter in Dry-land Soils?

Nitrogen is being lost from the dry-land soils by crop removal more rapidly than can be accounted for. An analysis of the factors responsible for the loss of both nitrogen and organic matter from these dry-land soils reveals that temperature in cultivated soil, especially in bare fallow, is considerably higher than in adjacent virgin soil. It may be assumed, say J. E. Greaves (Chemistry) and A. F. Bracken (Agronomy and Soils), that the higher temperatures and the direct action of ultraviolet rays may decompose the protein as well as the organic matter, with the liberation of carbon and nitrogen. To test this assumption, a constant temperature incubator has been constructed so that soils may be kept at varying constant temperatures with and without irradiation. Apparently irradiation has no effect on the loss of carbon or nitrogen from the soil, although losses are materially increased due to rise in temperature.

Soil Surveys of State Are Resumed

After a lapse of ten or twelve years, soil-survey studies have been resumed under the direction of D. S. Jennings (Agronomy and Soils). Approximately 65,000 acres in Carbon and Emery Counties have been surveyed and a soil-type and land-classification map prepared as well as a crop-productivity-index table for soil types completed. Field work on the Virgin River Area has been completed; this represents an area of slightly less than 200,000 acres. All valley lands in Salt Lake County, comprising slightly less than 250,000 acres, have been surveyed and data assembled for publication. An alkali and land-classification map, covering 120,000 acres, of the Delta Area in Millard County has been prepared and filed in the county commissioner’s office at Fillmore to aid in avoiding the sale of
poorer classes of land. A soil survey of Utah County has recently been begun, and measurements of physical and chemical properties of soil types in Salt Lake and Washington Counties are being computed.

**Study Made of Soil Productivity in Regard to Land and Water Use**

A SURVEY of approximately 150,000 acres in the Washington County Area during the past biennium includes 110 soil types, type phases, and different classes of mapped miscellaneous material. The soils of Pine Valley and the central area have not yet been surveyed; neither have two dry-farming sections, known locally as the Great Plain and the Troughs (near the southeastern part of the county), nor have the irrigated lands at Enterprise and New Harmony been fully investigated. A land-classification map of the area surveyed has been completed by D. S. Jennings (Agronomy and Soils), this map indicating the relative productivity and relative desirability of the land for farming purposes. Copies of this map have been sent to the Utah Emergency Relief Administration and to the State Planning Board.

Supervision has been given to the study being conducted in the Uintah Basin, and an area of approximately 80 square miles near Roosevelt has already been completed.

**Determine Friability of Soils**

TREATING THE SOIL with sodium lowers the index of friability, thus producing a soil inferior in physical condition to calcium-treated soils. The difference between the index of friability of a sodium-treated soil and a calcium-treated soil is greater for the wet than for the dry soil. Such are the conclusions reached by D. S. Jennings *et al.* (Agronomy and Soils) in a study of the physical properties of soils. Further conclusions of this same study reveal that the index of friability of soils corresponds more closely to the chemical treatment than to the replaceable bases present after treatment.

**Strawberry Clover Shows Promise for Western Alkali Lands**

IN A PASTURE-IMPROVEMENT STUDY, strawberry clover was seeded on damp, alkali lands in Cache, Sanpete, Sevier, Utah, and Weber Counties. Electric bridge tests were made of the soils in many fields in these areas to determine the proper range of alkali content. One season’s results, observe R. J. Evans and D. W. Pittman (Agronomy and Soils), indicate that strawberry clover possesses high alkali tolerance and is extremely palatable, promising to become an important factor in the utilization of western alkali lands.

**What Is the Proper Treatment of Alkali Land?**

THE FIRST QUESTION to decide in considering the proper utilization of alkali land is whether it should be used as it is, abandoned, or reclaimed. Much of the wet alkali land has considerable value as cow pasture as it is, and this possibility should be considered in planning
Figure 16. Wet alkali soil, part black alkali and part white alkali. Strawberry clover is crowding in from the left. This crop is quite palatable and seems to offer some promise as a pasture plant on wet alkali land.

Figure 17. Attempts are being made to measure the relative resistance of different soils to erosion.
for its most effective utilization. Similarly, some borderline white alkali may be adapted to alfalfa-seed or some rather tolerant crop.

It may be most economical to abandon alkali land, leaving it as slightly used range land. However, in this event, warns D. W. Pittman (Agronomy and Soils), precaution must be taken that the area does not become a breeding place for noxious weeds, insects, or plant diseases and that it does not silt up streams and reservoirs below by erosion.

Trials at Sanpete County Farm* Indicate Best Practices for Peat Soils

MUCK OR PEAT SOILS weigh less than mineral soils. In 1929 the average weight of dry muck soil on the Sanpete Farm was 17 pounds to the cubic foot; by 1931 it had increased to 22 pounds. When dry, a cubic foot of mineral soil weighs from 70 to 100 pounds. It is thus evident that muck soils require somewhat different management from other soils. For one thing, muck soil has a high water-holding capacity, as shown by the abundant crops grown each year in this region without irrigation during the growing season (not applicable, however, to certain vegetable crops) and by actual soil-moisture measurements.

* While the Sanpete County Farm was closed officially immediately preceding the beginning of the present biennium, experimental results were not brought together until February 1936. Mr. LeMoyne Wilson of the Agronomy and Soils Department was in charge of investigational experiments conducted on this farm.
Experimental work conducted for a six-year period on this farm clearly shows that muck soil, under proper management, will produce satisfactory yields for certain crops like celery and cabbage and, possibly, asparagus. Fertilizer treatments indicate that in addition to some rotation to maintain crop yields on a high level, farm manure or superphosphate is necessary. Sod-breaking is best accomplished with a special sod plow. It is generally advisable to delay cropping until the second or third year after breaking, disking only often enough to keep the land free from weeds. A heavy cement roller used immediately after seeding causes increased yields of barley, oats, and corn.

**Carbon County Soils Subject to Erosion**

The soils of Carbon County, developed under desert conditions, are usually treeless, except on the mesas which are covered intermittently with juniper and pinion pine. The soil, which is a fine sandy loam, is usually free from gravel, except for limited quantities on the surface in places where it has been washed down from surrounding higher slopes and mesas.

All of this makes these soils peculiarly subject to erosion. The extremely fine sandy loams absorb water slowly, making runoff materially higher than on a coarse soil. Here most erosion occurs in the form of gullies, locally known as arroyos. While some sheet erosion is present it is not as important a factor in this section as is gully erosion. In some irrigated sections gullies have been started by allowing waste water to run in the same place for a long period of time. After a gully has been formed it continues to enlarge with each succeeding rain or influx of waste water. The gully usually makes its first appearance at the lower end of a depression because of the larger volume of water at that point. As the eroding action of the water increases, the steepness of the slope becomes greater and greater and the gully becomes larger and larger.

In the immediate neighborhood, where the Carbon County Farm* was located, is a gully which during the past several years has cut back several hundred feet. There are several other gullies in this region, many of which are from 100 to 200 feet wide and from 10 to 70 feet deep. In flood periods the water has undercut the banks and caving is not uncommon. Occasionally, irrigation water has broken from the ditch and has run into a nearby gully. When a gully cuts down to the underlying shale, an undermining process begins, causing huge blocks of soil to cave into the trenches, which melt rapidly with subsequent floods; farming and grazing lands are thus endangered.

Leveling, adding organic matter, planting tolerant crops, and using care in cultivation (only when the soil is at the right moisture content) are usually the best means of handling mild alkali. More severe cases may be drained and washed (where feasible), used as they are for swamp pasture, or left as range land.

*The Carbon County Farm, established in 1927, was officially closed just before the present biennium, experimental results not being assembled until February 1936. Mr. I. D. Zobell of the Agronomy and Soils Department was in charge of experimental investigations.
Summarize Results of Cropping and Manuring Systems on Soil Productivity

That manure and rotation are highly beneficial in maintaining permanent soil productivity is clearly demonstrated in a long-time study conducted by D. W. Pittman (Agronomy and Soils), with and without manure and with long and short rotations. The same crops were grown continuously with various quantities of manure, and in 1935, when all plats were plowed up and planted to sugar-beets, the following significant conclusions were reached:

1. Manure is essential to the maintenance of soil productivity, especially for such crops as sugar-beets, alfalfa, corn, and potatoes. (It may lodge small grains.)
Figure 20. Soiled grass may be a source of considerable loss in a cow pasture. In the rather extreme example shown, 9 per cent of the area of the pasture was not grazed because it was soiled by manure. Harrowing to break up and distribute the manure when dry and keeping the cows off the grass when not actually grazing are suggested.

2. Rotation is more important than manure for the small grains.
3. Alfalfa, a perennial legume, if left for several years is of considerable value in maintaining productivity. Annual legumes apparently are of little value in this respect.
4. Soil analyses show that manuring, with the use of alfalfa in rotation, will build up the organic matter and total nitrogen content of the soil.
5. Manure may greatly increase the available phosphorus content of the soil.
6. The nitrogen and organic matter in the soil may be maintained by use of rotations including alfalfa and the careful return to the soil of the manure produced by feeding the alfalfa.

Commercial Fertilizers Prove Highly Beneficial in Irrigated Pasture Studies

The question of increasing the capacity of irrigated pastures by fertilization has long been of paramount importance. In experiments conducted by George Q. Bateman (Dairy Husbandry) and R. J. Evans and D. W. Pittman (Agronomy and Soils), by measuring the effect by the clipped yield and composition of the pasturage, the following results are apparent:

1. Phosphate fertilizer alone increased the yield of the pasturage, the phosphorus and protein content of the pasturage, and the percentage of clover as compared to grass. The phosphate was slow in taking effect, but this effect continued for at least two years.
2. Nitrogen fertilizer took effect immediately and for a short time increased the yield and nitrogen content of the pasturage and the percentage of grass as compared to clover; this effect was short-lived.
3. A combination of nitrogen and phosphate fertilizer gave best results.

![Figure 21. Phosphorus Fertilizer: Plats to left of right-hand stake produced more clover, as is shown by the blossoms, than the check plat to the left.](image)

**Benefits of Commercial Fertilizers to Soil Fertility Summarized**

BEGUN IN 1928 by J. E. Greaves (Chemistry) and D. S. Jennings and D. W. Pittman (Agronomy and Soils), as a long-time study of the effects of various commercial fertilizers on the maintenance of soil fertility and on the properties of the soils and crops produced by irrigation on a highly calcareous soil, sugar-beets, potatoes, barley, wheat, and alfalfa are grown in rotation on permanent plats and fertilized with various combinations of nitrogen, phosphorus, potash, and manure. These crops have also been analyzed for nitrogen, calcium, phosphorus, magnesium, and sulphur.

The fertilizers had no effect upon the calcium and magnesium content of potatoes, beets, barley, and wheat, and only a slight influence on the calcium and magnesium content of alfalfa, probably because the soil of the Greenville Farm (where this experiment has been conducted) is exceedingly rich in both calcium and magnesium. The sulphur-carrying fertilizers increased the sulphur content of beets, potatoes, and alfalfa, although the effect on grains was imperceptible. Additional significant conclusions established by this nine-year study are:

1. Manure with phosphate gives the highest yield of any crop.
2. Manure gives a higher yield of any crop than phosphate.
3. Nitrogen and phosphate is the most effective commercial combination for any crop.
Figure 22. Showing results of phosphorus fertilizer two years after application. Right: Phos­phated plat (83.7 lbs.). Left: Unfertilized plat (32.7 lbs.).

4. Phosphate is the most effective single material for beets and alfalfa.
5. Nitrogen is the most effective single material for grain.
6. Manure is the only effective fertilizer for potatoes.
7. Potash alone or with nitrogen has no effect; potash with phosphate gives a slight increase in beets and alfalfa over phosphate alone.
8. Raw rock phosphate and sulphur are of no value on this particular soil.
9. Both nitrogen fertilizer and manure increase the nitrate content of the soil.
10. Both phosphate and manure increase the available phosphorus in the soil.
11. Manure increases the organic content of the soil by approximately 0.25 per cent.

Statewide Commercial Fertilizer Tests Show Interesting Results

WHILE CLIMATIC AND SOIL CONDITIONS in Utah are widely different, it is of interest to note (1) that many of Utah’s soils respond to nitrogen and to phosphate fertilizer and few to potash and (2) that while sugar-beets and alfalfa, and to some extent lawn grass and pasture, are responsive to phosphorus, grain and fruit respond most noticeably to nitrogen. The phosphorus content of alfalfa is usually increased by the addition of phosphate. It has been observed by D. W. Pittman (Agronomy and Soils) that the beneficial effects of an especially heavy application may persist for several years. To be most effective for row crops, the fertilizer should be applied below or beside the seed. The effects of inorganic nitrogen fertilizers are short-lived. Poultry manure is used extensively throughout the state by many farmers.

Orchard Soils Analyzed for Arsenic Content

IN A STUDY ON FACTORS influencing the bacterial activities of the soil an analysis was made by J. E. Greaves and K. R. Stevens (Chemistry) of fifty-one orchard soils varying widely in chemical, physical, and biological properties for total arsenic, water-soluble arsenic, and various
soluble salts. Large quantities of arsenic may accumulate in the soil, varying from 7.2 to 367 pounds. Believing that the toxicity of arsenic to plants and to soil microorganisms is governed by the solubility of the soil arsenic, a determination was made of the correlation between various soluble salts and soluble arsenic. Because of the limited number of soil samples analyzed and further because of the high probable error, conclusions are only tentative.

Alfalfa Changes Nitrogen-fixing Properties of Soil

SOIL SAMPLES taken from wheat and alfalfa fields and adjacent representative virgin soils in foot-sections to a depth of 3 feet were taken from the dry-lands of Cache and Juab Valleys. These soils were inoculated by J. E. Greaves and K. R. Stevens (Chemistry) into a special synthetic medium and after three weeks' incubation the total nitrogen was determined. Results indicate that the alfalfa changes the nitrogen-fixing properties of the soil. The difference, however, between virgin and fallow soil is negligible.

Greenville Farm Soil Has Abundance of Nitrogen

IN A PERMANENT FERTILITY study conducted at the Greenville Farm by J. E. Greaves and C. T. Hirst (Chemistry), an analysis was made of fourteen crops of alfalfa, crimson clover, cowpeas, Canada field peas, soybeans, garden beans, lupine, and wheat. Total nitrogen analyses were made after the stems, leaves, and roots had been separated. The following treatments were given the plants: (1) Not inoculated, crop removed; (2) inoculated, crop removed; (3) not inoculated, crop returned to soil; and (4) inoculated, crop returned to the soil.

Inoculation increased the yields of alfalfa, cowpeas, and Canada field peas. Inoculated alfalfa, cowpeas, soybeans, garden beans, lupine, and Canada field peas contained higher percentages of nitrogen than the uninoculated. Returning the crop to the soil increased the yield but not the nitrogen content of the plant.

Results indicate the relative abundance and availability of nitrogen in the Greenville Farm soil.
Dry-lands

Dry-farming practiced for three-quarters of a century in Utah. Turkey 26 used as parent plant for smut resistance. Twenty-year average shows no difference between spring and fall plowing. Increased amounts of manure increase yield and quality of winter wheat. No appreciable benefit apparent from burned stubble. Alternate cropping best for dry-lands of Juab County. Crested and western wheat grass well adapted to Utah dry-lands. Baart wheat shows highest and Sevier lowest nutritive value. Variety main factor in determining copper content of Utah-grown wheats.

Dry-land Crops Important in Utah

During the 75 years that dry-farming has been practiced in Utah, many changes in tillage practices, cropping systems, crops, and crop varieties have taken place, in keeping with earlier experience and later as experimental evidence, together with experience, has directed. This progressive improvement has resulted in a nearly complete standardization of crops and cropping methods. Wheat is the dominant crop on Utah dry-lands, and more than 95 per cent of the dry-land wheat produced is of the Turkey and Kanred varieties. Cropping and tillage methods consist of alternate crop and fallow, fall or early spring plowing, rigid weed control, and seeding of 5 to 6 pecks of clean treated seed to the acre on clay loams and somewhat less on sandy soils.

Turkey 26 and Turkey 926 Strains Favored for Dry-land Winter Wheat

Growers of dry-land wheat in Juab district for planting purposes prefer two strains—Turkey 26 and Turkey 926. According to A. F. Bracken (Agronomy), the former is being used as a parent plant at the Nephi Dry-land Substation for smut resistance on some of the crosses made at Logan. Other selected strains are now being used in yield tests to determine their adaptability to dry-land conditions before any recommendations are made. Kofod winter wheat, beardless and with a white kernel, has not yielded as well to selection as has Turkey. Several crosses have been made between the highest yield strains of Kofod and Turkey. These are now ready for plat tests.
Figure 23. A weedy fallow not only reduces the subsequent wheat yield but increases preparation-of-seedbed costs.

What Type of Plowing Is Best for the Dry-lands?

While both 1934-35 and 1935-36 results favored spring plowing, the 20-year average showed no difference whatsoever in experiments conducted by A. F. Bracken (Agronomy) at the Nephi Dry-land Substation. Spring plowing with rough fallow or no tillage, except for weed hoeing or weed pulling, proved to be as effective as when the land was given normal or frequent tillage. In ordinary seasons the period of spring plowing should not exceed twenty-four days. If done in the fall, plowing should be no deeper than 7 inches.

No advantage is apparent in the use of the moldboard over the new large disk. This new type of plow has the very distinct dual advantage of cutting the operating cost by approximately 50 per cent and of greatly reducing the time of operation.

Fertility Practices Recommended for Dry-land Wheat

Significant increased yields in winter wheat result from the application of manure, especially when higher amounts (10 tons or more) are used. As determined by nitrogen content, the quality of the wheat shows increased percentages for increased amounts of manure. This conclusion, reached by A. F. Bracken (Agronomy), is based on averages for a 21-year period.

While peas plowed under as a green-manure crop at various stages of growth increase the protein percentage of the grain, no increase in yield is apparent. Wheat used as a green manure has no effect on the quality of the succeeding crop, although significant reduced yields have resulted, particularly for the more advanced stages of plowing under.

47
Only Occasional Burning of Stubble Recommended

The beneficial effect of yield of winter wheat by various ways of disposing of the stubble over a 20-year period is not appreciable, according to observations of A. F. Bracken (Agronomy), although if there is any apparent difference it is in favor of burning the stubble, indicating that this practice may be resorted to occasionally without any apparent damage.

Recommends Best Cropping and Rotation Systems for Utah's Dry-lands

Alternate cropping is safest and best for the dry-lands of Juab Valley. Ordinarily, wheat after fallow yields only 2 bushels, more or less, than wheat following an intertilled crop, such as peas, potatoes, and corn. The advisability, therefore, of using one of these intertilled crops, alternating with wheat in place of fallow, depends upon whether or not the returns justify such practice. It has been found by A. F. Bracken (Agronomy), however, that wheat following peas, potatoes, or corn yields only from one-half to two-thirds as much as wheat after fallow.

Crested and Western Wheat Grass Adapted to Dry-lands

From experiments conducted at the Nephi Dry-land Substation by A. F. Bracken (Agronomy), indications are that crested wheat and western wheat grass or slender wheat grass are well adapted to the dry-lands of Utah. A number of introduced forages are also being tried to determine their adaptability to Utah's dry-lands.

Nutritive Value of Dry-land Wheats Differs with Varieties

The nutritive value of high versus low calcium- and phosphorus-carrying wheats, as measured in terms of quantity necessary to produce 1 gram increase in weight and the composition of bones and blood of albino rats, varies widely with different varieties of dry-land wheat. With the wheats used in this experiment by J. E. Greaves (Chemistry), this value is greatest in Baart and lowest in Sevier. Attempts are being made to increase the nutritive value of wheat having a low nutritive value by the addition of certain constituents, made partly possible by the addition of calcium to the low calcium-carrying wheats; apparently, however, the nutritive value of wheat is greater with the addition of phosphorus.

Variety Is Limiting Factor in Determining Mineral Content of Utah-grown Wheats

Thirty varieties of wheat grown on the Nephi Dry-land Sub-station for a 10-year period have been analyzed for calcium, magnesium, iron, sulphur, and phosphorus, the quantity of each mineral varying with the variety and season. Wheat has been analyzed for copper; from meager data obtained to date by J. E. Greaves (Chemistry) and A. F. Bracken (Agronomy) it appears probable, under Utah conditions, that not only is variety the main factor in determining the copper content of Utah-grown wheats but that copper is a limiting factor in both plant and animal nutrition.
Irrigation and Drainage and Groundwater

DELTA AREA TYPICAL of many drainage enterprises in the United States. Anticipated water-supply accurately forecast by snow cover. Deep cultivation immediately before irrigation increases initial penetration of water. Basic field maps of state prepared and principal sources of water-supply located. Method of irrigation a major factor in influencing water-application efficiency. From 20 to 30 inches of irrigation water annually produce highest corn yields. Drainage of water-logged and alkali lands more effective when fundamental principles of hydromechanics are observed.

Analysis Made of Drainage and Irrigation Conditions in Delta Area, Millard County

ALTHOUGH THE DELTA AREA drainage movement was begun in 1909, actual construction was done largely between 1916 and 1920, a period of war prices. The failure of a substantial percentage of the farms within the several drainage districts to pay the drainage taxes levied against them during the years of drainage construction and immediately following resulted in considerable speculation as to the causes. After having received many requests from parties interested, the Utah Station in 1928 initiated an endeavor to study the irrigation, drainage, and related problems in the hope of finding to what extent the financial difficulties were caused by each of the influencing factors.

The Delta Area was not alone in facing a serious situation. In recent years many drainage enterprises in the United States have been confronted with serious financial difficulties. The 1930 report of the U. S. Census Bureau shows that 1064 enterprises, with approximately 17 per cent of the invested capital and covering about 12 per cent of the land in organized districts, were reported in arrears in payment of principal interest on bonds or other obligations. There are many causes of financial difficulties of American drainage districts, two of the most important being: (1) Construction at times of peak costs and prices and (2) reduction in farm incomes. Irrigation projects themselves have been at fault, largely because of engineering mistakes, exploitations, colonization difficulties, and
changes in the financial and economic situation. The Delta Area is only typical of hundreds of such enterprises.

That the experiences of Millard County in drainage matters may be of value to farm communities in Utah and in other western states and to investment bankers in several respects, O. W. Israelsen (Irrigation and Drainage) offers the following suggestions:

1. Irrigated soils which naturally contain appreciable amounts of alkali require artificial drainage unless the water-table can be kept well below the land surface by careful irrigation, by the prevention of excessive seepage losses from canals, and by making the best possible use of natural drainage.

2. It is highly important that thorough consideration be given to available water-supplies for the land to be drained.

3. The need is apparent, in advance of construction of the drainage systems, for a liberal margin between estimated annual costs and revenues in order to meet unforeseen and unavoidable cost increases and revenue decreases.

**Importance of Snow Surveys Emphasized**

The presence or absence of a low snow cover largely determines the extent and distribution of the spring flood-flow on Utah streams. Valuable data have been gathered regarding the factors of snow cover affecting runoff and soil-moisture measurements indicating the extent of absorption or expected water losses from a given snow cover.

The use and value of snow surveys in forecasting flood-flow has been demonstrated in this spring's runoff. The unusual amount of low snow, together with abnormally high spring temperatures, brought out exceptionally high water on the Logan, Ogden, and Weber Rivers. The April 1st
snow survey showed an extremely high density of snow cover. The low snow, therefore, melted quickly, with a rise in temperature; the high snow, however, increased in density to more than 50 per cent before the water started to run. Flood flows were predicted by George D. Clyde (Irrigation and Drainage) and in many cases precautions were taken which prevented later damage.

The extreme drought of 1934 brought out many important facts with respect to effect of low snow cover, spring rains, and early spring temperatures on runoff. The absence of a low snow cover eliminates spring high water and is conducive to excessive watershed losses.

Experience in making snow surveys has emphasized the point that the snow course must be thoroughly marked and described. Accordingly, work is now under way to completely resurvey, mark, and describe all snow courses in the Utah network.

Much of the obsolete snow surveying equipment has been replaced with new aluminum equipment developed at the Utah Station. As fast as funds permit all steel tubes and dial scales will be replaced with aluminum tubes and tubular scales. Cooperating with the snow survey investigation is the State Engineer's Office, which has received a legislative annual appropriation of $1000 for snow surveys, thus permitting the extension of the Utah network of snow surveys and a refinement of the runoff forecasts. This appropriation also makes possible further research of factors affecting runoff by making funds available for securing both additional data from the high watersheds of the state and snow-surveying equipment.

Informal cooperation for the purpose of obtaining measurements of snow cover is being conducted with Salt Lake City, the Water Commissioners on Weber and Beaver Rivers, and the Strawberry Valley Water Users Association. The Utah State Highway Commission has agreed to maintain snow courses at each of its mountain pass maintenance stations. Automatic temperature records are being obtained in the Brighton Basin watershed, through arrangement with the Salt Lake City corporation. These temperature records, together with the measurements of snow depth and density during the melting season, will furnish valuable information with respect to effect of spring temperature on yield.

Penetration of Water Increased by Deep Cultivation

OPENING UP OLD IRRIGATION FURROWS in a beet field by deep cultivation just before irrigation greatly increased the initial penetration of the water. After the water reached the lower end of the furrow, however, it was observed by D. W. Pittman (Agronomy and Soils) that the rate of penetration was the same as in the unopened furrow.

Basic Field Maps of State Prepared

PROBABLY one of the most far-reaching studies being made at the Utah Station is the one that has to do with its agricultural resources and their utilization, initiated in the spring of 1936. Basic field maps have been prepared under the direction of George D. Clyde (Irrigation and Drainage), which will form the basis for future studies. The principal sources of Utah's water-supply have also been located.
Irrigation Efficiency Dependent on Water Application

 CONTRIBUTING to the solution of the Utah Lake and Jordan River irrigation and water-supply problem, a study has been made of all lands in Salt Lake County to which Utah Lake and Jordan River water is applied, with the exception of those lands on the west side of the river and which are above the canal of the Utah and Salt Lake Canal Company. Included in this study are the thirty-eight irrigation companies, or groups, developed from 1850 to 1903, the period when the present irrigation laws were made a basis of Utah irrigation code and when the Office of State Engineer was created. From this survey it is noted by O. W. Israel­sen and George D. Clyde (Irrigation and Drainage) that of the 87,336 acres surveyed, approximately 55 per cent is actually under irrigation.

The method of irrigation is a major factor in influencing the water­application efficiency. In the Jordan River Valley, for example, nearly all of the lands are irrigated by two general methods: (1) The flooding method and (2) the furrow method. Excluding lands which are naturally wet, there is only a negligible area irrigated by the sub-irrigation method. Of the 43,415 acres of irrigated lands included (excluding fallow lands), the method of irrigation for 41,163 acres (95%) has been determined.

The flooding method includes: (1) Flooding from field ditches, (2) border-strip flooding, (3) flooding from portable slip-joint pipe, (4) check flooding, and (5) basin flooding. Of these five flooding methods, the first two are most extensively practiced on the lands surveyed.

The furrow method includes: (1) Deep furrows and shallow furrows or corrugations. The first is used for such crops as potatoes, celery, corn, and in some cases orchards, while the second is used for such crops as sugar-beets, grain, and alfalfa.
Water-application efficiency is influenced not only by the method of irrigation but also by soil permeabilities as well as by the time-rate of water application, which depends in part on the length of the irrigation run.

In the flooding methods of irrigation, on the east side of the Jordan River lengths of run from 201 to 400 feet are most used; those from 410 to 600 feet are next in order of use; lengths under 200 feet are third; lengths from 601 to 800 feet are fourth; from 801 to 1000 feet are fifth; and lengths over 1000 feet are seldom used. Lengths of run from 201 to 6000 feet are used for 70.1 per cent of the land irrigated by flooding.

On the west side of the Jordan River where the flooding system of irrigation is used, 3.64 per cent of the flooded lands has lengths of run from 201 to 400 feet, with 27.5 per cent having lengths of run from 401 to 600 feet.

![Image of irrigation conveyor](image-url)

**Figure 26.** Two types of irrigation conveyors cross each other, Salt Lake County. The ditch is being measured for its width.

There is striking similarity in percentages of flooded lands having “runs” of given lengths and furrow-irrigated lands with given lengths of furrows, as is shown in lengths of run up to 200 feet (14.5 and 14.9 per cent, respectively), with respective percentages of 36.4 and 36.4 for lengths of run from 201 to 400 feet.

Exchange agreements between Salt Lake City and twenty irrigation companies, or groups, in Salt Lake County provide that the city shall supply Utah Lake and Jordan River water (or other water suitable for irrigation purposes) to the companies to be used for irrigation and that in exchange for irrigation water thus provided the city may take for culinary use water which flows from the Wasatch Mountains (early appropriated for irrigation purposes). The provisions, the obligations which they involve, their operation with respect to sources of irrigation water, and their contractual water demands show liberal provision of water for the land actually irrigated and constitute an important part of this investigation.
Proper Amount of Irrigation Water Increases Corn Yields

Farmers do not always know just how much irrigation water they should apply to obtain the maximum yields of corn under their particular conditions. Experiments conducted on the Greenville Farm by D. W. Pittman (Agronomy and Soils) show that highest yields of corn are obtained when from 20 to 30 inches of irrigation water annually, neither more nor less, are applied. The annual average precipitation received at the Greenville Farm is 16.5 inches, which is representative of extensive areas in Northern Utah and other parts of the state.

Fundamental Principles of Hydromechanics Important

Advantage has been taken of the fundamental principles of hydromechanics in a study of the control of groundwater. This study requires the use of tedious mathematics, but the results obtained are of far-reaching practical importance and point the way to more efficient and more effective methods for the drainage of water-logged and alkali lands.

According to Willard Gardner (Physics), this study has furnished a new outlook on a problem of great importance to irrigation and drainage engineers. Heretofore, this branch of engineering has lacked a quantitative method of approach and, although the problems confronted are problems of serious difficulty, these studies are regarded as a major forward step toward a satisfactory and successful solution.

In the application of these principles, two sources of difficulty have been encountered: (1) Mathematical methods have been required in research and (2) consequently, it has been difficult to present the findings for popular understanding.

The work of this department is recognized as a substantial contribution in this field of agricultural research. It is work of this kind which is coming more and more to be recognized as fundamental to scientific and industrial progress.
Orchard and Garden Crops

NO APPARENT DIFFERENCE in size or vigor of Large Early Montgamet apricot on peach and apricot rootstocks . . . . Leading apricot varieties identified . . . . Sweet and sour cherry varieties recommended for Utah planting. Promising peach and plum varieties being tested. Curing of onions facilitated by proper storage. Strain of White Sweet Spanish onion developed. Wide spacing induces doubling of onions . . . . Non-bolting strain of Sweet Spanish onion being perfected . . . . Electricity cheaper than hot water or manure for heating hotbeds.

Investigate Orchard Rootstocks

CONFIRMATORY EVIDENCE that the trees on morello have bloomed and fruited much more heavily for their size than those on mahaleb has been secured by F. M. Coe (Horticulture). This shows that this stock has a dwarfing effect and causes early fruiting under Utah conditions, as is claimed for it in California. There is no apparent difference either in size or in vigor of Large Early Montgamet (Chinese) apricot on peach and apricot rootstocks. Studies on sweet cherry embryo abortion indicate that Lambert, Geant d’Hedelfingen, Giant, Bing, Napoleon, and Yellow Spanish have a fairly high proportion of viable embryos, while Windsor, Schmidt, Tartarian, Lyons, and Seneca have a high proportion of abortive seeds. Both sterilized and unsterilized peat moss was used in preliminary after-ripening tests on cherry, plum, peach, and apple seeds.

Large Early Montgamet Same as “Chinese” and Other Misnamed Apricot Varieties

THE LEADING APRICOTS IN UTAH, locally called “Chinese” and “Jones,” have been determined to be identical with each other and with varieties tested under the names of Colorado, Wilson, and “Montgamet.” The correct name of this variety apparently is Large Early Montgamet. Most of the younger trees in Utah are of this variety, while “Moorpark” is important in the older plantings. The “Moorpark” grown in Utah is apparently not the Moorpark described by earlier authorities and appears identical with Routier Peach and Wenatchee Moorpark, although this identification is not positive.
Riland appears to be a promising new early variety, having high color and good quality. A number of sweet-kernelled seedlings of the Large Early Montgamet grown at the Davis Experimental Farm, which appear promising because of large size, high color, and good quality, have been propagated for further testing.

Figure 27. "Moorpark": An important variety in the older apricot orchards of Utah. But little planted in recent years, this variety is now preferred by Utah shippers. Because of its large size, high quality, productivity, and regular bearing, "Moorpark" should be given an important place in new Utah plantings.

Sweet and Sour Cherry Varieties Recommended for Utah Planting

Unfortunately, all varieties of cherries now grown in Utah have faults or fail to reach the ideal in one or more important characters. They may lack size, productivity, hardiness, or quality. They may lack vigor or be susceptible to diseases and insects. They may ripen at an undesirable time, have the wrong color of skin or flesh,
or be soft and bruise easily in handling. They may be intersterile, as is the case with the leading commercial varieties of cherries, and require special pollinizers. Some of these faults, observes F. M. Coe (Horticulture), can be remedied by cultural methods, such as pruning, fertilization spraying, etc., but many of them cannot be changed and many of those varieties which have remedial faults are objectionable because of increased costs of production.

Because of its greater hardness of tree and the large size, attractive color, firmness, and quality of its fruits, Lambert appears to be the best variety for commercial shipping, although Bing is also desirable for the same purpose on the warmer lands and Napoleon in similar locations for canning. Of the minor varieties, Windsor appears to be the most generally valuable for pollination, although Black Tartarian is also useful where early cherries are desired. Schmidt (Black Orb) and Yellow Spanish also appear to have value as pollinizers. Seneca is the best of the extra early varieties, ripening two weeks before Tartarian. Major Francis appears worthy of testing because of being hardier than Tartarian. Deacon and Elkhorn are new main crop varieties also worthy of trial as pollinizers.

Figure 28. Royal Duke (May Duke): Grown in Utah as "May Duke," this cherry variety has been identified as Royal Duke. An early variety of superior size, appearance, and high quality, it is particularly useful for home orchard and limited local market planting. Duke cherries are hybrids between sweet and sour cherries.
Figure 29. Candoka: A promising new peach variety from Washington. It is of the same type and season as J. H. Hale and is said to be hardier, better-colored, and is practically fuzzless. It is suggested for limited trial in Utah as a main-crop shipping and local-market variety.
Figure 30. President: The most promising new plum in the Station test orchard. It is a late-season variety, large, firm, and an exceptionally good shipper and keeper. It has excellent quality and brings highest prices in eastern markets. The tree is hardy and highly productive.

Of the sour cherries, Montmorency appears to be best for commercial cannery and local market, with Royal Duke (“May Duke”) useful for early local market home use. Wragg, which appears to be identical with English Morello, is the best of the late, red-juiced morello type sour cherries tested and is especially useful for home orchard and dooryard planting be-
cause of its dwarf drooping habit, ornamental flowers, heavy and early production of attractive fruit, unsurpassed for pies, jelly, and juice purposes. Late Duke is also useful for home orchard purposes because of large size, attractive color, and long-ripening season.

**New Peach and Plum Varieties Are Worth a Trial**

PARTICULARLY PROMISING peach varieties worthy of further testing on a limited scale by Utah growers are Sunbeam, Goldfinch, Golden Jubilee, July Elberta, Hale Haven, South Haven, Valiant, Halberta Giant, Candoka, Rio Oso Gem, Gaume Cling, and Phillips Cling.

Promising new domestica plum and prune varieties recommended by F. M. Coe (Horticulture), as a result of his variety studies, are Sugar, Pacific, Standard, Stanley Hall, and President. Japanese plums of the blood-fleshed type which are promising are Flaming Delicious, Duarte, and Elephant Heart, while Santa Rosa, Formosa, and Gaviota are promising yellow-fleshed type plums.

**Storage Methods Important in Keeping Qualities of Onions**

CARELESS HANDLING in the field and in the warehouse constitutes the greatest loss from decay in the successful production of onions, according to A. L. Wilson (Horticulture and Vegetable Crops). Apparently there is no difference in the keeping quality of onions whether the crop is pulled, topped, and crated the same day or whether it is allowed to cure for a week (either topped or untouched), provided the crates are stored to facilitate curing. He also observes that late irrigation and over-maturity reduce the keeping quality of onions.

Figure 31. The keeping qualities of onions are assured, provided they are properly bagged and crated and then placed in a well-ventilated storage room under controlled temperature conditions.
Superior Sweet Spanish Onion Strain is Developed

Stock seed from the strain of Sweet Spanish onion developed on the Davis Experimental Farm has proved to be the most outstanding strain of Sweet Spanish onions in the United States. Stock seed is in constant demand by many growers both in and out of the state as well as by research workers in various state agricultural experiment stations. A strain of White Sweet Spanish has also been developed by A. L. Wilson (Horticulture and Vegetable Crops) which promises to be much superior to existing strains. This strain will be released in the near future under the name of "Utah White Spanish."

Figure 32. Doubles and scallions increase as the distance of thinning is increased. Twenty-five bulbs were pulled in consecutive order from a representative area in each thinning treatment. Upper: No thinning, which shows no doubles or scallions. Lower: Four-inch spacing, which shows considerable doubling of onion bulbs. As the rate of spacing is increased to 6, 8, and 10 inches, multiple bulbs increase in proportion.
CONSISTENT RESULTS have been obtained for the past four years which indicate conclusively that wide spacing induces doubling. That more multiple bulbs result when onions are spaced 4 inches or more apart than with closer spacing is the observation made by A. L. Wilson (Horticulture and Vegetable Crops).

Attempt Made to Develop Non-bolting Strain of Sweet Spanish Onions

AN ATTEMPT is being made to develop a non-bolting strain of Sweet Spanish. Plants are first grown in Washington County and later transplanted to the Davis County Farm. Selections of non-bolting bulbs are then used to produce seeds. Seeds from the first selection, according to A. L. Wilson (Horticulture and Vegetable Crops), will be planted in the fall of 1936.

Hotbeds Cheaper to Heat with Electricity than with Hot Water or Manure

TRIALS HAVE BEEN MADE by A. L. Wilson (Horticulture and Vegetable Crops) to determine the most economical method of heating hotbeds. At first it appeared that the cost of electrical energy was too great to warrant the use of electrical hotbeds. Hotbeds in 1935 were increased in size from nine to twenty-four sashes, making available a new electric schedule. Cost of electric heat, under the new schedule, exclusive of depreciation and interest charges, is approximately 75 cents a sash as compared to a total cost of $1.15 for manure-heated hotbeds. Due to greater overhead costs, however, total operating expenses are slightly greater with electricity than with manure.
Range Management and Intermountain Herbarium

RANGE PLANTS in summer range east of Logan collected, identified, mounted, and analyzed. Sod plantings of western wheat grass especially successful . . . . Quick-production plantings made for erosion control on ranges . . . . Heavy grazing causes formation of gullies . . . . Water and wind also cause erosion . . . . Intermountain Herbarium performs service to state.

Important Range Plant Species Collected

IN THE MOUNTAINOUS SUMMER RANGE east of Logan the more important range plant species consumed by range animals have been collected monthly and identified by R. J. Becraft* and L. A. Stoddart (Range Management). These specimens are mounted and are on file in the departmental herbarium. A chemical analysis as to the nutritive value of fifty-four species has been made by J. E. Greaves (Chemistry), these analyses being made only for that portion of the plant actually consumed by range animals.

The most important forage plants collected on this range include slender wheat grass (Agropyron pauciflorum), mountain bromegrass (Bromus carinatus), wild pea or pea vine (Lathyrus leucanthus), wild geranium (Geranium fremontii), chokecherry (Prunus melanocarpa), and bitter brush (Purshia tridentata).

Wheat Grasses Adapted to Range Planting

PLANTINGS of western, slender, and crested wheat grass and of yellow sweet clover, made on a dry-farm at the mouth of Green Canyon and some two or three miles north and east of the college campus, made satisfactory growth in spite of the severe drought in 1934. Sod plantings of western wheat grass were especially successful in the opinion of R. J. Becraft and L. A. Stoddart (Range Management). Cliff rose continues to show promise for reseeding on pinion-juniper range lands.

Dry-land experiments have been continued on the Greenville Farm and seed has been collected for future plantings.

* R. J. Becraft resigned in September 1935; he was succeeded by L. A. Stoddart.
Plantings Made for Quick Production in Erosion Control

As a means of quick production for erosion control, forty native species were tested as to feasibility of cuttings made in the fall, winter, and spring. While a few of the plantings show promise, most of the results are negative. Other erosion control plantings made by L. A. Stoddart (Range Management) included 900 rooted transplants from New Mexico, nine of these species having proved of especial value in the Southwest. Further erosion-control plantings have included twenty important European grasses and forbs.

Initial tests of the more valuable range species are being made in the Forest Nursery, adjoining the campus, where an overhead spray system was installed in 1934 on a 120-by-100-foot nursery space.

Heavy Grazing Is a Menace to Ranges of Utah

Much of the erosion on our western ranges, observes L. A. Stoddart (Range Management), is a direct result of heavy grazing. Eventually trails are made by the trampling; in this way the tender vegetation is crushed and many range plants are killed. Not only are the plants killed, but the soil is loosened and the water is enabled to move rapidly down the steep hillsides. Heavy grazing not only removes valuable forage plants but leaves unpalatable annual weeds which do not have heavy root systems, so essential for binding and holding the soil against the forces of wind and water.

As the soil is trampled and the vegetation killed out, the soil begins to be carried down the mountain slopes by each successive rainstorm. As a result, minute gullies begin to form, causing an immense loss of fertile soil. This permits the exposure of subsoil clays and rocks, both incapable of producing forage plants.
As vegetation becomes weakened by heavy grazing, the soil may actually move over the top of the vegetation, flowing like melted sugar and burying all vegetation that lies in its path. This illustration shows valuable desert forage shrubs being buried by clay. In time, all vegetation will be killed out.

Ranges also Damaged by Water and Wind Erosion

Rain, if allowed to go unchecked on the hillsides, causes the formation of small, meandering gullies in the fertile valley bottoms. As this runoff water increases, the soil at the heads of these gullies is undermined, leaving natural bridges of soil (Fig. 35) ready to be dislodged and washed away. These small gullies later come together and cut immense channels through the deep valley-bottom soils, their waters finally reaching large river channels. Disastrous floods are the result, with immense unnecessary loss of water and soil. In Utah where water is the limiting factor in crop production this, in the opinion of L. A. Stoddart (Range Management), presents a serious situation. Drought conditions on adjacent lands, he further observes, are also greatly increased and serious forage loss experienced.

Wind often causes as much damage to range land as does water. Overgrazed range areas are not protected against forces of wind. The soil may be blown out from around clumps of vegetation (Fig. 37), leaving a rough hummocked surface. The flying sand particles may act as a sand blast and actually cut the vegetation off at the surface of the ground, leaving nothing but the stumps of dead vegetation.
As the runoff waters continue to flow from hillsides, small meandering gullies are formed in the fertile valley bottom soils. As these runoff waters increase, the soil at the heads of these gullies may be undermined, leaving natural soil bridges ready to be dislodged and washed forever from the area (Figure 36).
Figure 36. This gully, the result of the washing away of the natural soil bridge (Figure 35), provides subdrainage for hundreds of acres of once productive bottomland soil, leaving it dry and useless.
Figure 37. An excellent example of wind erosion. The flying sand particles may act as a sandblast and actually cut the vegetation off at the surface of the ground, leaving stumps of dead vegetation.

**Intermountain Herbarium Proves Valuable Asset**

Some 20,000 mounted plant specimens and an equal number of unmounted plant specimens have been acquired by the Intermountain Herbarium since its establishment four years ago. Seventy-five per cent of these specimens, states Bassett Maguire (Herbarium), are native to Utah and the Great Basin and have been obtained largely as a result of field activity. The remaining 25 per cent comprise plants from the rest of Continental North America; a considerable number of these have also been acquired through field activity, the balance being sent in exchange from major herbaria throughout the country.

The Intermountain Herbarium is rapidly becoming an important factor in the general service offered by this institution not only to Utah but to the Great Basin as a whole. During the past year alone 625 plants have been identified for various government agencies, the College Extension Service, various College and Station departments, and private individuals. Information concerning the control and remedy for weeds and poisonous plants has also been provided by the Herbarium personnel.
LIMITED AMOUNTS of raw fruits and vegetables as well as of whole-grain products in winter diet of many Utah rural school children. Physical well-being of children dependent on diet, health, and environment. Weight-height-age relationships show significant differences in heights and weights of rural and urban school children. Vitamin C deficiency responsible for dental caries. Bromthymol-blue and chloride tests show relationship of soft-curd milk to subclinical mastitis.

Absence of Necessary Vitamins Apparent in Rural School Child's Winter Diet

FOOD-CONSUMPTION RECORDS for a four-year period from 891 children in six rural Utah schools give information on the qualitative nature of the diet as well as on the frequency with which various foods are eaten. The size of portion usually eaten was ascertained from weighted three-day food records obtained from fifty of the 891 children, evenly distributed throughout the six communities.

The limited amounts of raw fruits and vegetables as well as of whole-grain products in the diet suggest the probability of its being deficient in vitamins, particularly Vitamins B and D. Accordingly, experiments were planned by Almeda P. Brown (Home Economics) for testing the vitamin content of the diet by observing its effects on laboratory animals when fed alone and with various vitamin additions. Dietary records were examined for different varieties of fruits, vegetables, meats, etc., included in the various food groups and a synthetic diet made up according to the pattern based on types of food and proportionate amounts of each food constituting the winter diet of the average school child in six rural communities in Utah.

A diet similar to the average diet reported by the 891 rural school children produced severe scurvy in guinea pigs in three to four weeks' time. Guinea pigs on this diet were protected from scurvy by daily additions to the diet of 3 cc. of fresh orange juice or a like amount of commercially canned tomato juice. Rats fed this diet alone maintained steady though slow growth. Increased growth was secured by adding sources of Vitamins A and D, Vitamins A, D, and B, and Vitamins A, B, D, and G, best growth being secured by the last combination.
Diet, Health, and Environment Important in Physical Well-being of Children

WHY CHILDREN PLAYING TOGETHER, working together, under conditions which apparently vary but little, should exhibit such wide variation in health conditions is a question of vital importance to all concerned with the care of children. It was with the hope of finding some of the causes behind these variations that this study was begun by Almeda P. Brown (Home Economics). On the basis of a physical examination, fifty-two rural school children were divided into two equal groups, one the “less healthy” group and the other the “more healthy” group. No dramatic differences in health history or nutrition between the two groups were found by the methods of this study. There were, however, some small but consistent differences brought out, no one of great significance by itself but which in the aggregate may influence physical well-being.

Comparison Made of Rural and Urban School Children as Determined by Weight-Height-Age Relationship

DATA WERE COLLECTED from rural children in twenty-one of Utah’s twenty-nine counties and from children in Salt Lake City, Provo, and Logan schools. Comparison of these data, made by Almeda P. Brown (Home Economics), show statistically significant differences both in heights and in weights of rural and urban children at most ages from 7 to 14 years, the urban children being the larger. These differences, small at first, increase with increasing age. Comparison of heights and weights of these children with Baldwin-Wood standards for children of the same ages and sex shows Utah rural school children to be below medium size at most ages from 7 to 14. Urban children are medium-tall but below weight for height and age.

Relationship Shown between Capillary Resistance and Dental Caries

AN APPLICATION of a capillary resistance test to determine Vitamin C deficiency and the relationship of such deficiency to incidence of dental caries was applied to children in two small rural schools by Almeda P. Brown (Home Economics). To eliminate conditions other than Vitamin C deficiency known to affect fragility of blood vessels, all children were examined by a physician as to condition of mucous membranes, tonsils, thyroid gland, and heart. Systolic and diastolic blood pressures were determined. Ninety-two children were tested in the fall by the Göthlin technique and eighty-one in the spring. Of those tested in the spring, 42 per cent showed increased capillary fragility, 20.6 a decrease, and 28.4 no change. Of the forty-three children tested in the fall by the Dalldorf technique, thirty-nine were retested in the spring, this test also indicating increased fragility of blood vessels.

In cooperation with the College Home Economics Department 182 college students were tested, thus permitting comparison of results with the Göthlin standard. Ten students (5.5%) were listed as deficient in Vitamin C and an equal number as borderline cases. Eighty-two college students were
tested by the Dalldorf technique, the averages indicating a greater degree of capillary fragility than reported by Dalldorf.

**Attempt to Determine Relationship of Soft-curd Milk to Subclinical Mastitis**

PUREBRED HERDS of Ayrshire, Guernsey, Holstein, and Jersey breeds, totaling 804 individual tests, were made for both the curd test and for mastitis in Cache, Sanpete, Utah, and Weber Counties. Each udder was tested separately, using the bromthymol-blue and chloride tests. Most of the quarters which reacted as "positive" to subclinical mastitis had a curd test too high to be classed as giving soft-curd milk, although the quarters reacting to the mastitis test had milk which on the average was softer than on non-reacting quarters. Some cows which reacted as "positive" last year to the subclinical test gave a negative reaction this year, indicating either that they had overcome the infection or that there was a seasonal variation in the chloride content, in which case they were not necessarily infected.

Further studies are being conducted by R. L. Hill (Human Nutrition) to determine if factors other than subclinical mastitis might give an abnormally high chloride test.
Social Problems

Utah Villages Organized on Religious Pattern

Influence of competition being felt. Type "A" Village defined. Survey indicates edge-of-town families make most use of local community agencies and institutions. Village-farm groups have high average for all types of agencies. Relative advancement of socially organized agencies and institutions in Delta Area dependent on collective or group effort within area.

Utah Village Has Interesting Historical Background

The American tendency for farm families to live on the farm has been greatly modified in Utah where a large part of the farmers of the state live in villages. The Utah development arose in part out of the Mormon conception of social organization, in part out of the influence of irrigation, and in some measure out of the Indian menace. In early days practically all farm families lived in the villages. Gradually as a sense of security developed and as population grew, many moved out on the farms. Whether this development was due to population pressure, by which numbers were forced out on less desirable lands and into less desirable social forms of organization, or whether the farms lying about the villages offered better homesites and more favorable opportunities than the villages offered has remained undetermined.

Utah villages differ from many others in that the great majority of them were settled by the Mormon pioneers who organized their communities on a religious pattern. All such villages and towns are strongly organized in the field of religious living. Some of them have become sufficiently strong to organize adequately in other major fields. Many have been able to go much beyond religion and education. In these communities it is necessary for the people to go to other larger towns for services which the home town cannot supply or for the school and the church to expand their services to include other fields such as health, recreation, vocation, etc.

Little conflict has arisen in Utah between villages and farmers living in the surrounding open area, due in part to the fact that the majority of village folk in this state are also farmers with like interests. Their position in the village, however, provides them with somewhat different problems, interests, and opportunities.

Three quarters of a century have passed since the early villages were settled. Today not only have towns grown into cities and drawn about themselves semi-urbanized farm families, but changes have occurred to the vil-
lages themselves. Some have grown in population and potency, some have declined in population but have grown in beauty and adequacy; still others, remaining stationary in numbers, have diminished, held their own, or have increased in effectiveness. Many farm families who would have built homes in the villages in the earlier periods have chosen to build homes on the farm. Here they can have the increasingly useful services of the cities in the form of the daily newspaper, magazine, and radio. These, with the aid of the automobile and good roads, can be supplemented with village services.

Study Undertaken of Village and Open-country Farm Groups

WITH A KNOWLEDGE of the foregoing, a study was initiated by J. A. Geddes (Rural Sociology) which deals primarily with the village and open-country farm groups. It takes them, where they are now after a considerable period of development, and attempts through various appraisements to determine how they have fared under the influence of a competition of which they have scarcely been aware, but which has been, and is now, slowly working its way.

Is Farm Living Less Desirable than Village Living?

UNDER PREVAILING UTAH CONDITIONS for farm people, is farm living less desirable than village living? This question prompted a rural sociological investigation in 1927 which has not yet been completely solved. The present study, conducted by J. A. Geddes (Rural Sociology), concerns itself with what is designated as a Type "A" Village, with a population of less than 1000, which is defined as a farm village in which farm leadership is dominant, while business and professional life is curtailed by the competitive influences of a nearby urban center.

The conditioning factors in this study, briefly, included (1) historical events indicating social movements, (2) people themselves, (3) the land base, (4) the climate, (5) the water supply for irrigation, (6) culinary water, (7) the means of communication, and (8) the community traditional and social heritage. Under housing conditions comparison is made between the following village groups: (1) Farm dwellers, (2) village farmers, (3) edge-of-town farm families, and (4) non-farm families. Interesting observations were made in the previous biennium for these factors by J. A. Geddes (Rural Sociology).

Edge-of-town Farm Families Use Village Agencies

EDGE-OF-TOWN FARM FAMILIES use the village agencies more than any other group. Village-farm people stand second, non-farm folk third, and the farm dwellers use them least. The margin of difference between farm dwellers and edge-of-town families is measured by an 87.7 per cent increase of the latter over the former. Village-farm families exceed farm dwellers by 52.7 per cent and non-farm families exceed them by a 33.1 per cent margin. In housing facilities, it was found that non-farm people were least well-housed. In use of local community agencies they move up past the farm-dweller group.
Village-farm Groups Have High Average

If the two farm groups which live in the village, that is, the edge-of-town-farm families and the village-farm families, are merged for local, semi-local, outside, and non-community agencies (school attendance included), the village-farm groups have a higher average for all four types of agencies combined than has the farm dweller.

The comparatively large average built up by the farm dwellers in the non-community field consists mainly of long trips to national parks, mountain resorts, camps, etc., during the autumn months. Important and desirable as such trips are, it is obvious, observes J. A. Geddes, that they belong to a somewhat different category from the local, semi-local, and outside community offerings.

Social Advancement Dependent on Social Qualities

The relative advancement of socially organized agencies and institutions in the Delta Area (Millard County), where this eight-year study has been conducted by J. A. Geddes (Rural Sociology), is dependent on collective or group effort within the area. Social advancement as concerned in this approach is dependent not only on developments in the fields of irrigation, soils, and economic advancement but upon quality of human stock, quality of leadership, and the existing state of the social heritage.
Farm Income and Management

PRESENT USE and future possibilities of agricultural resources of state under investigation. Average farm income in Delta Area insufficient to pay farm-operation costs, high taxes assessed for special improvements, and support farm family. Four representative counties selected for farm-mortgage-foreclosure study. The diversified-irrigated farm presents variety of enterprise combinations. Tax delinquency in state greater on rural than on urban property. Effect of bank difficulties on farmer's credit forms basis of study. Agricultural adjustment program suggested.

Economic Study Made of Agricultural Resources in Utah and Their Utilization

CORRELATION OF THE USE OF LAND AND WATER and other resources by areas and the analysis of basic factors in terms of present use and future possibilities in order to apply such factors to the various farming communities of the state is the ultimate purpose of this recently-initiated study. Investigations are being made (1) in the Washington County Area, where field work has already been completed, (2) in the Uintah Basin, and (3) in Utah County.

Funds for conducting the Washington County study were supplied in part by the Utah Emergency Relief Administration in cooperation with the Utah State Planning Board. Agricultural resources of this county and their present utilization have been determined by W. P. Thomas, W. U. Fuhriman, and G. T. Blanch (Agricultural Economics). Suggestions will be offered for better utilization and for the development of new agricultural resources with the idea of improving the standard of living of the farm population in this area.

Information collected on the Uintah Basin Area includes history of land settlement in this region, its use, its present land use, crop production and disposal, numbers and kinds of livestock, farm indebtedness and available credit, the tax situation, farm and ranch organization, agricultural exports and imports, and population trends. From over 400 farm management records collected data will be compiled and analyzed to determine the potential use of the resources of the Uintah Basin.
In cooperation with the Farm Credit Administration approximately 400 farm-management survey records of the 1935 year's business have been secured from Utah County farmers. Two thousand crop-yield records for individual units of land under the Strawberry Reclamation Project for the 11-year period from 1925 to 1935, inclusive, are being analyzed to determine changes in crops grown and yields obtained and to show yield differences. Plans are under way for collecting 400 crop-yield records from farmers in the northern part of Utah County to determine yields over a number of years. A study of the relation of range utilization to crop farming and of farming to other industries is contemplated.

Secure Data on Economic Position of Delta Area Farmers

For the past fifteen or sixteen years the economic position of the farmers in the Delta Area (Millard County) has been highly unfavorable. In addition to the problem of low farm prices during this period, this area has experienced extreme water shortage, low crop yields (especially with its principal crop, alfalfa-seed), and excessive irrigation and drainage costs. These factors, according to W. P. Thomas and G. T. Blanch (Agricultural Economics), have made it impossible for many farmers to pay their farm expenses, support their families, and make payments on their indebtedness. Consequently, a considerable portion of land in this area has changed from individual ownership to that of corporation, county, and state ownership, due principally to farm mortgage foreclosures. Many farms have been entirely abandoned.

In 1928 the Utah Station began an investigation of the problems confronting the farmers here; it was not until 1929, however, that the economic phase was undertaken. Results of the farm analysis made show acre-yields and farm income to be low, resulting in low net farm income. The average farm income is not sufficient to pay farm-operation costs, the high taxes assessed for special improvements, and at the same time support the farm family.

Analyze Farm Organization and Farm Management Records

Seventy-six individual farmers and the College Extension Service assisted W. P. Thomas (Agricultural Economics) in making a survey of farm organization and farm management on Utah farms. On the basis of labor income, these seventy-six farmers were grouped into (1) the most profitable one-third, (2) the least profitable one-third, and (3) the average one-third. Those farmers who were classed as "most profitable" had the highest labor income.

Analyze Farm Mortgage Foreclosures and Trends in Tax Delinquency on Agricultural Lands

Four Utah counties were selected as being representative for conducting a survey of the farm-mortgage foreclosures and trends in tax delinquency on agricultural lands of this state. These counties were Iron, Sevier, Summit, and Weber.
Types of Farming Best Adapted for Utah

THE PHYSIOGRAPHY, climate, and soils of Utah present frequent, sharp, and marked contrasts within small areas as well as between the major geographic divisions of the state. These natural differences, together with social and economic factors, have resulted in much diversity in agriculture. The most significant distinction is between irrigated lands (2.5% of land area of state) and the mountain and desert range lands which cover most of the state. Likewise, the greatest differences in farm organization are between the diversified irrigated farms located on the irrigated land and the range livestock ranches which, while usually having some irrigated land, obtain most of their income from cattle and sheep which graze the ranges throughout a large part or all of the year. Sales of livestock and of livestock products is an important source of income on many other farms.

W. P. Thomas, W. U. Fuhriman, and G. T. Blanch (Agricultural Economics) have found that the average size of ranches is larger than the average size of diversified-irrigated farm, with great variation in size of these ranches. Although some ranches run both cattle and sheep there is a marked tendency to specialize in one or the other. Nearly all Utah sheep are on ranches, but many operators of diversified-irrigated farms have a range-cattle enterprise. Except in size, cattle and sheep ranches present greater uniformity in organization and practice than other types of farms, with the possible exception of the specialized dry-land wheat farms.

The diversified-irrigated farms present a great variety of enterprise combinations. In many, one enterprise is sufficiently stressed so that it may be dairy, poultry, crop-specialty, fruit, or truck farm, and if no single enterprise is dominant it is classed as a general farm. Natural conditioning factors are climate, soil, and water-supply, while economic forces also play an important part. Conditioning factors are more influential on truck and fruit farms than on crop-specialty, dairy, and general farms where the human factor wields a greater power of selection.

Although in a general way the agricultural use of land in Utah is adapted to the present conditions, many serious maladjustments exist. In some localities dry-farming has been extended into areas having insufficient precipitation or too poor soil for successful dry-farming; in others, maladjustments in use of water-supply exist. Serious deterioration of forage resources on some ranges has resulted from improper grazing practice. The most profitable crop and livestock enterprises are not always followed. Farms are frequently too small and usually consist of small non-contiguous tracts.

Utah Tax Study Reveals Interesting Facts

IT HAS BEEN GENERALLY RECOGNIZED that the tax-delinquency situation in Utah constitutes a serious problem, the nature and extent of which has been known only in a general way. With this in mind, a study on tax delinquency and farm mortgages was initiated early in 1934 to determine more specifically the nature and extent of tax delinquency in various counties of the state, hoping that such factual material would shed
light on the advisability of making necessary adjustments in the taxation structure of Utah.

Accumulated data, state W. P. Thomas and W. U. Fuhriman (Agricultural Economics), show that net taxes levied on rural property in Utah from 1928 to 1933, inclusive, amounted to approximately 20 per cent of the total state property taxes, while about 50 per cent of all property taxes are levied on urban property, with 30 per cent on mines and utilities. Net property taxes reached their peak in 1930, when they totaled nearly $21,000,000. Tax delinquency is greater on rural than on urban property. In 1932 delinquent taxes on rural property averaged 38.6 per cent, on urban property 24.5 per cent, and on mines and utilities but 4.8 per cent. In all counties, delinquency on both rural and urban property increased greatly from 1928 to 1932.

Probably the most significant fact brought out to date from this investigation is the wide variation in delinquency shown among counties and among minor civil divisions of counties and of the close relationship of tax delinquency to farm income. Tax delinquency on rural property ranged from 11.8 to 53.5 per cent, which would indicate that the problem of rural tax delinquency requires more than blanket remedies.

Attempt Made to Determine Effect of Bank Difficulties upon the Utah Farmer's Credit

CAUSES OF BANK DIFFICULTIES in Utah and their effect on the supply of the farmer's credit has formed the basis of a study begun during the past biennium. The primary object of this study has been to determine and to appraise the importance of the causes of country bank failures and the restriction of country bank loans during the depression and the effect of this restriction of credit upon agriculture. Accordingly, the books of most of the banks closed during the depression and a like number of solvent banks have been examined as well as careful analysis made of the agricultural credit problems and practices and the resulting financial condition of the country banks in Utah. Credit facilities and need for agricultural credit by areas are now being studied and analyzed. The results of this study, observe W. P. Thomas and H. H. Cutler (Agricultural Economics), should show (1) the quality of services rendered to agriculture by country banks in the state and (2) how the banking policy of an individual bank may affect farmers and agricultural production within a given area.

Many Factors Enter into Any Agricultural Adjustment Program

ADJUSTMENTS in use of land, water, and other resources as well as in crop and livestock systems within the state are necessary to insure permanency to Utah's agriculture and to secure the best possible returns from available resources. According to W. P. Thomas et al. (Agricultural Economics), type of adjustments recommended are those of a concrete nature, which might be put into effect through local and state agencies, cooperating with the Agricultural Adjustment Administration, and represent desirable adjustments for the next two- to five-year period.
These recommendations are based largely on the present outlet for Utah farm products and represent nine type-of-farming areas in the state. So long as the irrigated farms in Utah remain at their present small acreage and a surplus of farm labor exists, the type of farming should be more intensive. There is opportunity to further intensify Utah's agriculture in certain irrigated sections of the state, provided a market can be found for such crops. (The problem of marketing more of these intensive crops, however, has not been fully investigated.) Reduction in freight rates and change in production and marketing demands, together with other variable factors, may influence the intensification of farming in these areas. Any long-time agricultural program in Utah should provide for the possibility of greatly extending the intensive production of crops and livestock products.

General Statement

Personnel

During this period P. V. Cardon, Station Director from 1928 to 1935, resigned to become Principal Agronomist, in Charge of the Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture. Dr. Lowry Nelson, former Extension Service Director at the Brigham Young University, was named as his successor. Professor R. J. Becraft, associated with the Experiment Station in the Range Management Department since 1918, resigned in September 1935 to become a member of the School of Forestry, University of Idaho. Dr. L. A. Stoddart of the Soil Conservation Service at Pullman, Washington, succeeded him. Mrs. Blanche C. Pittman, Station Librarian and Editor for many years, resigned effective July 1, 1936.

A sabbatic leave of absence was granted in 1935-36 to Dr. F. B. Wann, Associate Plant Physiologist; part of Dr. Wann's time was spent in travel in Europe and the remainder in study at Cornell University and at the Boyce Thompson Institute. Professor F. M. Coe, Associate Station Horticulturist, returned to the Station on September 1, 1935, after a year spent in advanced study at Cornell University. Effective January 1, 1936, Professor D. C. Tingey, Associate Agronomist, was granted a nine-months' leave to work with the Soil Conservation Service at Pullman, Washington. John W. Carlson, Assistant Agronomist and former Superintendent of the Uintah Basin Alfalfa-seed Experiment Farm, spent the fiscal year 1935-36 in advanced study at Wisconsin University.

Professors W. Preston Thomas and A. F. Bracken, Agricultural Economist and Associate Agronomist, respectively, resumed their Station duties at the beginning of the past fiscal year. They had been associated with the Agricultural Adjustment Administration.

Professors George T. Blanch and H. H. Cutler received appointments as Associate and Assistant Agricultural Economists, respectively.

Cooperative Relationships

For several years the Utah Station has enjoyed splendid cooperative relationships with various agencies, particularly with the different bureaus of the U. S. Department of Agriculture as well as the State Department of Agriculture, the State Engineer's Office, and other agencies. These coopera-
tive relationships are extremely valuable in advancing research which would
otherwise probably be impossible. Many of the larger problems which affect
Utah agriculture are regional in character and of such magnitude as to re­
quire more money and equipment than is available through the Experiment
Station. It is only through such cooperation that facilities can be provided
for making effective attack on these problems.

Briefly, cooperative relationships during the past biennium include the
following:

U. S. Department of Agriculture
Bureau of Agricultural Economics
Bureau of Agricultural Engineering
Bureau of Chemistry and Soils
Bureau of Dairy Industry
Bureau of Entomology and Plant Quarantine
Bureau of Plant Industry
Forest Service
Soil Conservation Service
Weather Service

Other Federal Agencies
Agricultural Adjustment Administration
Civil Works Administration
Department of Interior
Federal Emergency Relief Administration
Public Works Administration
Resettlement Administration

General
Pacific Bone, Coal, and Fertilizer Company
State Department of Agriculture
State Engineer’s Office
State Planning Board
Utah Canners Association
Utah Woolen Mills

Projects

All investigational research at the Utah Station is conducted under de­
initely approved and authorized projects. Funds supporting Station projects
include (1) those received from the state and (2) those received from the
federal government. There are four sources for the latter: Hatch (1887),
Adams (1906), Purnell (1925), and Bankhead-Jones (1935). All projects
are carried by specific numbers. Some years ago, the Nephi Dry-land Sub­
station, established in 1903, was designated as Station Project No. 1; project
leaders have since been assigned 180 additional project numbers.

Active Projects.—At the close of the present period, the following active
projects, by fund, were conducted:

<table>
<thead>
<tr>
<th>Fund</th>
<th>Number</th>
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<tbody>
<tr>
<td>Adams</td>
<td>7</td>
</tr>
<tr>
<td>Bankhead-Jones</td>
<td>3</td>
</tr>
<tr>
<td>Hatch</td>
<td>8</td>
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<tr>
<td>Miscellaneous</td>
<td>1</td>
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<tr>
<td>Purnell</td>
<td>34</td>
</tr>
<tr>
<td>State</td>
<td>25</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>78</strong></td>
</tr>
</tbody>
</table>

Some projects are carried individually, some in cooperation with other
Station staff personnel, and some cooperatively with various federal bureaus.

Discontinued Projects.—During the past biennium, projects which have
been discontinued or closed number thirty-three. In most cases, results have
been summarized and published either as Station publications or as technical articles in various scientific journals. In several instances, projects have been reoutlined to meet changing needs.

**New Projects.**—Since July 1, 1934, twenty new projects have been initiated. In some instances these new projects merely replace old projects which have completed the phase of investigation under consideration. Most of them, however, represent new phases of research made necessary by changing agricultural adjustments and needs.

**Research Library**

During the past few years the Station Research Library has increased from several hundred bound volumes to 7085, with an additional 322 departmental accessions, making a total of 7407 bound volumes at the end of this biennium. Almost complete files are found of publications of the various agricultural experiment stations in the United States, the various branches of the United States Department of Agriculture, the United States Geological Survey, various state departments of agriculture, and to a lesser extent the Smithsonian Institution. Many technical and scientific journals are found on the shelves as well as many agricultural publications from foreign countries. A complete record has been maintained for checking and recording publications as they are received, and all bound volumes are accessioned as received. Departmental book acquisitions are also accessioned in the Station Library files.

**Publication of Agricultural Research**

During the past biennium the Utah Agricultural Experiment Station has published twenty-two bulletins, three circulars, twenty-two leaflets, two so-called miscellaneous publications, and seventy-seven reprints of technical articles. In the near future will appear six station bulletins (Nos. 272-277, inclusive) and thirty-two reprints of technical articles, as well as the Annual Summary of Publications (Circular 108) all of which have also been edited and prepared for publication during this biennium.

**BULLETINS**

250—Summary Report of Progress: July 1, 1932 to June 30, 1934. P. V. Cardon et al.
251—Apricot Varieties. F. M. Coe
253—Cherries of Utah. F. M. Coe
254—Summer and Winter Rations for Fattening Hogs. H. H. Smith and E. J. Maynard
255—Drainage and Irrigation, Soil, Economic, and Social Conditions, Delta Area, Utah: Division 1—Drainage and Irrigation Conditions. O. W. Israelsen
256—Drainage and Irrigation, Soil, Economic, and Social Conditions, Delta Area, Utah: Division 2—Soil Conditions. D. S. Jennings and J. Darrel Peterson
257—Factors Promoting Positive Health in School Children. Almeda Perry Brown
258—Alfalfa-seed Investigations in Utah. John W. Carlson
260—Oat Varietal Tests in Utah. R. W. Woodward and D. C. Tinge
261—Barley Varietal Tests in Utah. R. W. Woodward and D. C. Tinge
262—Comparative Yields of Spring Wheat Varieties in Utah. D. C. Tinge and R. W. Woodward
263—Relative Production of Feed Grain from Spring-grown Cereals in Utah. R. W. Woodward and D. C. Tinge
266—Comparative Size of Rural and Urban Utah School Children as Determined by the Weight-Height-Age Relationship. Almeda Perry Brown
267—Work-soil Management and Crop-production Studies (Sanpete County Farm, 1927-33, incl.). LeMoyne Wilson

* In addition to the 126 publications listed, thirty-nine additional manuscripts have been prepared for early publication by the Station Editor. Six of these are to be Station Bulletins, one a Station Circular, and the remaining thirty-two technical articles have been submitted to and accepted for publication by various technical journals and will appear as Station Reprints.

(College Series No. 536.)