DURING the past 20 years prices received by Utah producers for eggs have fluctuated more widely than has the cost of producing eggs (fig. 1). In both 1932 and 1933 the average price received by producers was only $.16 while in 1947 it was $.513 per dozen. The average of the 20 yearly prices is $.29.

The difference between the net cost of production and the selling price represents profit or the reward to the producer for the risk he assumes and for superior management. The average profit for the past 20 years amounted to only $.027 per dozen. In 6 of the 20 years there were losses. This means that the total costs exceeded the selling price. The largest loss, $.025, was in 1940 while the largest gain was $.106 in 1943. The profit for each year as well as the selling price and the cost of production can be read from figure 1. The vertical distance between the selling price and the net cost lines directly above each year represents the profits. The crosshatched portion where the cost exceeds the selling price represents losses.

Cost of Production

The net cost of producing a dozen eggs ranged from a low of $.176 in 1933 to a high of $.462 in 1948. The 1947 cost of $.448 was next highest (fig. 1). The average for the 20 years was $.263 per dozen. It is important to remember that these costs include the operator’s labor and the feed that he grows and all other farm and family contributions as well as cash costs.

Changes in the general price level have remained about the same. Other changes include a change in the composition of the scratch feeds. There has been a decrease in the amount of corn fed from 10 pounds per hen in 1929 to only 4.2 pounds in 1946. The decrease in corn was replaced by an increase in wheat and barley. Between two-thirds and three-fourths of the scratch grain was wheat.

The increase in the amount of feed fed to hens has been accompanied by an increase in the number of eggs produced per hen. While this has fluctuated from year to year, the production during the last 5 years averaged about 14 eggs more than during the first 5 years. No doubt this is a result in part at least of the increased amount of feed fed.

One of the most important changes during the past 20 years is an increase of approximately 10 pounds in the feed fed per hen. It is possible that this increase has not actually taken place so uniformly during the years as is shown in the table, but the evidence is fairly conclusive that it has taken place. Essentially all of this increase has been in laying mash while the scratch feeds

Fig. 1. Selling price, net cost, and profit per dozen eggs—commercial flocks, Utah, 1929-1948

The hours of man-labor required to care for a flock of a given size have remained essentially constant over the past 20 years. For flocks of average size 1.5 man-hours per hen are required. Flocks of less than average numbers usually require more, and flocks larger than average less than this. This does not include the labor required in caring for baby chicks or cockerels or pullets up to the time they are placed in the laying pens.

Death loss of layers is another important cost. It varies widely from flock to flock, but much less widely from year to year for all flocks. The average is about 20 percent and the data since 1929 show no significant trends.

(Continued on page 19)
Expansion of the Research Program

DURING the past biennium there has been a general expansion in the research program of the Agricultural Experiment Station to meet the requests of agricultural groups for solutions of pressing problems. This expansion was made possible through increased state legislative appropriation and through federal funds made available by the Agricultural Research and Marketing Act which passed Congress in August 1946, although funds were not available until August 1947. Grants-in-aid by state and private agencies have also made other research possible.

More Cooperative Research Initiated

Much of the new research is cooperative with agencies of the federal government or with other agricultural experiment stations in the western states. Cooperative research has many advantages in that it increases the facilities and trained personnel and the problem can be approached from a number of angles at the same time, shortening the time needed for a solution.

Some of these new cooperative projects and other new research studies are noted briefly in the following paragraphs.

Study of Virus Diseases of Stone Fruits Expanded

The Bureaus of Plant Industry, Soils, and Agricultural Engineering and Entomology and Plant Quarantine are cooperating with the Utah Station in an expanded program of study of the problem of virus diseases of stone fruits. Each of these bureaus has appointed a full-time scientist and a plant pathologist has been employed by the Station to work on this problem. Two field plots, one fifteen acres just south of Kaysville, and the other at Holladay are being used for this work.

A large laboratory on the campus has been equipped for virus studies. This equipment includes an electron microscope, the first instrument of its kind in the Intermountain region. This microscope makes it possible to see and study materials, including viruses, never before seen. It makes possible magnifications as much as fifty times greater than can be obtained with the most powerful light microscope. Specimens may be magnified as much as 100,000 times.

Some of these new cooperative projects and other new research studies are noted briefly in the following paragraphs.

Marketing Research Gains in Importance

The greatest expansion in the program has been in marketing research which received added stimulus with the enactment of the Agricultural Research and Marketing Act. Practically all of this work is on a regional basis and is cooperative with other western states.

Studies now under way have to do with the marketing of turkeys, peaches, feeder and slaughter cattle, sheep and lambs. Studies are also being made on the major factors that affect prices received by farmers and on increased demands for agricultural products from Utah on California markets.

Toxicity of DDT Studied

The introduction of a number of powerful new insecticides has brought up the question of their toxicity to man, either directly or through the use of products sprayed with them, or fed to animals that are later consumed by man. The Utah Station, during the past biennium, has undertaken intensive study of the toxicity of DDT to farm animals and poultry and its accumulation in products consumed by man. This project is sponsored in part with a research grant-in-aid from the National Institute of Health.

Cooperative Research in Range Livestock Production Problems Started

Cattle breeding research, anticipated for many years, but because of the great expense involved, not started earlier, was outlined and begun during the biennium. This work was made possible by appropriation of funds under the Agricultural Research and Marketing Act and through cooperation with the Bureau of Animal Industry and experiment stations of the other western states. Some of the animals used in this work were gifts to the Station, others were purchased with money given by the Sears Roebuck Foundation for this purpose. The objectives of this work are to test and develop lines of Hereford and Shorthorn cattle that will show improvement in such characteristics as rate and economy of gain, fertility, nursing ability, longevity, and carcass quality when maintained under Utah conditions.

Other new work in animal husbandry in addition to breeding and marketing studies is concerned with disease control. Studies are being made on trichomoniasis and on mineral deficiency diseases of range cattle.

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High Milk Production Dependent upon Adequate Feed Supply

High Yielding Pasture, Well Cured Alfalfa Hay, Corn Silage, and Barley Basis of Good Dairy Ration

By GEORGE Q. BATEMAN

EVEN though dairying is one of the major agricultural enterprises in Utah, the present production of dairy products is inadequate to supply the needs for milk in the state. The prospects for a continued demand for dairy products are indicated by the high income of consumers, the increase in population, and the more favorable understanding by the public of the superior value of dairy products in the diet.

Milk production in Utah must be increased if this demand is to be met. The most important factor in increasing production is to grow a more abundant feed supply for the dairy herd. Forage production for winter feeding can be increased by increasing the acreage of corn for silage, and by better care and management of hay fields and the planting of winter-hardy, wilt-resistant alfalfa varieties such as Ranger. The summer feed supply can be increased by better care and management of pastures.

There are four main dairy feed crops that when grown on irrigated land and fed properly will give high milk and butterfat production at a reasonably low cost. These crops are pasture, alfalfa for hay, corn for silage, and barley to form the basis for the grain ration and straw for bedding. Barley as a rule produces more feed nutrients per acre than other grains when grown on irrigated land.

A study has been under way at the dairy experimental farm for a number of years on these four crops to find out the relative amount of nutrients produced per acre when grown on similar land. Production data have been kept on fertilized and unfertilized pasture, alfalfa, corn, and barley. The yield per acre of the different crops, the total digestible nutrients produced per acre, and the milk and butterfat production per acre that can be expected when these crops are fed to cows producing an average of 350 pounds of butterfat per year are shown in table 1.

Unfertilized pastures produced 183 standard cow days of grazing per acre per year. These same pastures when fertilized with manure and phosphate gave 257 standard cow days of grazing. The average yield of alfalfa hay was 4.57 tons per acre, corn for silage 17.5 tons, and barley 85 bushels per acre and 3,400 pounds of straw.

In order to get a more accurate measure of the feeding value of these four crops the total digestible nutrients produced per acre were determined. For pastures, these were determined by grazing the pastures with the dairy herd. The total digestible nutrients in the other three crops were calculated. It will be noted that the corn for silage gave the highest yield with 5,614 pounds of T.D.N. to the acre, alfalfa was next with 4,614 pounds, fertilized pasture third with 4,111 pounds, barley fourth with 3,244 pounds, and the unfertilized pasture last with a production of only 2,922 pounds of T.D.N. to the acre. The data indicate that alfalfa produced on the average of 12 percent more nutrients per acre than fertilized pasture, and that fertilized pasture produced a 40 percent increase...
in feed nutrients over pasture that had received no fertility. The nutrients produced in corn silage exceeded the fertilized pasture by 36 percent and alfalfa by approximately 21 percent. Even though barley had an average yield of 85 bushels per acre it was exceeded in feed production by corn silage, alfalfa, and fertilized pasture. This fact emphasizes the high nutrient producing ability of good pasture, alfalfa, and corn silage. An increase in the acreage and an improvement in the management of these three crops are

sound ways to increase the dairy feed supply. Even though barley does not produce as large amounts of nutrients as the other three crops it is important in the ration. Dairy cows, in order to produce at a high level of efficiency, need proper amounts of grain.

Where possible all four of these crops should be grown to feed the dairy herd. When these four feeds were fed to the dairy experimental herd it was found that the average feed consumption per cow per year was 3 tons of alfalfa hay, 3.5 tons of corn silage, 150 standard cow days of pasture, and 2,670 pounds of grain, with an average production per cow of 11,353 pounds of milk containing 400 pounds of butter-fat.

At the crop yield given per acre for the four crops it would require approximately .66 of an acre to grow the alfalfa for 1 cow, .20 of an acre for the silage, .58 of an acre would produce the pasture, and .66 of an acre the amount of grain consumed, making a total of approximately 2.1 acres of high producing irrigated land to produce the feed for 1 cow for one year.

These data indicate that it is possible to increase the dairy feed supply by increasing the acreage of corn for silage, and managing hay fields and pastures so that they produce large amounts of nutrients to be used for the production of milk.

**RESEARCH PROGRAM**

(Continued from page 2)

started during the biennium include studies of the influence of cultural and harvesting methods and varieties on the yield and quality of vegetables, studies on the improvement of lima beans, control of celery insects and diseases, and studies on onion improvement through the development of inbred strains and hybrids.

**Nutrition and Health Projects Outlined**

The health of the rural population, especially as it is affected by nutrition, is a field of increasing public interest. During the biennium a regional project has been initiated to study the nutritional status of population groups in the western states. For this study a mobile laboratory has been equipped and staffed with a doctor, a dentist, and a nurse. This unit will travel through the various states to determine the nutritional status of the rural people, and the factors that condition this status. Another study has also been initiated on the inter-relationship between the composition of the soil and plants and the nutrition of animals and man.

**Ways of Increasing the Acreage of Cultivated Land Studied**

Expanded demands for agricultural products has stimulated interest in expanding the acreage of cultivated land. One method of doing this is to salvage much of the low-lying valley lands that have been taken out of cultivation because of water-logging through the excessive use of irrigation water on the higher lands. New research projects are planned to develop new and improved methods of design, operation, and maintenance of drainage systems, both gravity and pumping systems, and to work out irrigation and soil management practices that will eliminate many of the drainage problems. Other studies are concerned with salinity and its relation to crop production and drainage.

While thousands of acres of land in Utah can be reclaimed by drainage, only about one-sixth of the arable land

(Continued on page 19)
WEEDS, THE MOST COSTLY CROP PEST

Research has Found Economical Methods of Weed Control

By D. C. TINGEY

IN AGRICULTURAL waste, losses from weeds are second only to losses of soil from erosion. Few people realize the enormous and varied waste caused by weeds.

Weeds compete with crops for light, moisture, and plant food, and consequently cause reduced crop yields. It has been estimated that the average annual reduction in forage in pastures, as a result of weeds, amounts to 20 to 25 percent. In spring grain, the reduction in yield, caused by weeds, is estimated at between 12 and 15 percent. In winter wheat, potatoes, hay and corn, the reduction in yield from weeds is estimated between 7 and 10 percent. These estimates on reduced crop yields are conservative as indicated by some studies made in Canada. In the Saskatchewan Department of Agriculture it was found that where weeds were kept out of wheat in 1931, the yield was 30 percent greater than where weeds were allowed to grow. In 1932, the yield was 23 percent higher; and in 1933, 33 percent higher. The degree of weed infestation on these areas was not extreme. Studies made at Hayes, Kansas, on morning-glory-infested land showed the following reduction in grain yields from morning-glory: barley, 32 percent; oats, 26 percent; rye, 20 percent; wheat, 42 percent; corn, 67 percent; kafrir, 85 percent; and milo, 89 percent.

At Logan, Utah, it was found that morning-glory-infested wheat yielded 20 percent less than non-infested.

Weeds increase the costs of labor and equipment in crop production. The average cost of tillage on cultivated land has been estimated at 16 percent of the value of the crop, and about one-half of the tillage is necessary because of the presence of weeds. In addition to these costs, there are those for weed control along ditches, roadways, railroad right-of-ways (estimated at $10 per mile), in lawns, golf courses, and waste places.

Weeds reduce the quality of farm products. Weeds in hay, and weed seeds in farm seeds reduce the quality and price received by farmers. Some seeds such as mustards, ragweed, corn cockle, sweet clover, wild onion bulbs, or wild garlic in wheat make the grain unfit for human consumption.

Certain weeds such as wild garlic, bitterweed, and ragweed impart an objectionable flavor to milk from cows that graze upon them. Fruits of some weeds become entangled in the wool of sheep and reduce its value. Many animals die from eating poison weeds.

Weeds harbor insects and diseases that attack crops. Many insects destructive to farm crops pass part of their life on weeds, which serve either as food or as a place of refuge in winter. One of the common insects in this area is the sugar beet leafhopper, which lives part of the year on Russian-thistle, salt bushes, mustards, and others. Corn borers can survive for years in large stemmed weeds, such as jamison-weed or smart weed. Corn root aphid can live on asters, plantains, and many other weeds. Pink boll weevil is found on weeds related to the cotton plant. Nematodes, so destructive to sugar beets, live and multiply on weeds.

Some diseases destructive to farm, orchard, and forest crops develop one stage of their life cycle or live during one period of the year on one or another of our weeds. Typical examples are some of the rust fungi. Numerous virus diseases, such as occur on potatoes, tomatoes, melons, and cucumbers, are traceable to weed plants as the source of the infective material. These examples are just a few of the many to show the relation of weeds to the perpetuation and spread of some insects and diseases.

Weeds cause depreciation of land value and reduce farm loans. Farms infested with creeping perennials, such as morning-glory, whitetop, Russian knapweed, and Canadian thistle, are reduced in value because of these weeds. Likewise, the loan value is considerably reduced.

Fields of morning-glory and whitetop staked off for experimental purposes. From such experiments come improved methods of weed control. It has been found that it is possible, with little extra expense, to grow good crops on such weed infested land and at the same time eradicate the weeds.

D. C. TINGEY, professor of agronomy, has charge of the weed research work at the Utah station.

(Continued on page 18)
RESULTS of a fourth year in the range sheep production investigations in the Cedar City area continue to show that yearling ewes produced by range ewes bred to Columbia rams produce more grease wool with longer staple than similar yearlings sired by Rambouillet rams. The original range ewes have increased in pounds of lamb produced per ewe each year from 1945 to 1948. More data are needed before the differences in lamb production per ewe can be definitely determined for the three crossbred types of sheep. The original range ewes have produced an average lamb weighing 83.4 pounds at weaning when bred to Columbia rams and 80 pounds at weaning when bred to Rambouillet rams. On an average, 27 percent of the Columbia and 11.6 percent of the Rambouillet sired lambs were graded fat by a commercial buyer from 1945 to 1948. Targhee lambs produced from Columbia first cross ewes appear to be fatter at weaning than Rambouillet sired lambs. More data are needed before conclusions are drawn as to the differences between Columbia and Targhee sired lambs.

The Utah Agricultural Experiment Station in cooperation with the Branch Agricultural College has maintained a herd of approximately 1,000 breeding ewes in the Cedar City area since 1945. These sheep are used to study problems of range sheep management and to determine what breed and type of sheep is most productive of wool and lambs under southern Utah range conditions.

Purebred Rambouillet and Columbia rams are being mated to range ewes predominately of Rambouillet breeding, and production of the offspring is being recorded. Lambs resulting from the mating of Rambouillet rams on the original ewes are called first cross Rambouillets or R 1's, while the lambs from the Columbia mating are known as first cross Colombias or C 1's. Each new generation is being mated to purebred Rams of its respective breed to produce R2 and C2 lambs or second cross Rambouillet and Colombias, respectively. Since 1946 half of the C1 ewes have been mated to Targhee rams. The offspring of this mating are designated as T1 lambs. Ewe lambs of this cross will be mated to Targhee rams to produce T 2's. This scheme of breeding with selection will be continued until the herd is made up of grade Rambouillets, Targhees, and Colombias. These graded-up Rambouillets, Targhees, and Colombias will be selected to shear a heavy fleece of fine wool, ½ blood, and ¾ blood, respectively, as far as possible and to produce a large grass-fat market lamb.

Average wool and lamb production data for the various types of sheep and the original range ewes are recorded in tables 1, 2, 3 and 4.

**Table 1. Grease wool production and staple lengths of first cross yearling ewes produced by crossing Columbia and Rambouillet rams on range ewes**

<table>
<thead>
<tr>
<th>Year</th>
<th>Columbia-sired yearlings</th>
<th>Rambouillet-sired yearlings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grease wool</td>
<td>Staple</td>
</tr>
<tr>
<td></td>
<td>pounds</td>
<td>inches</td>
</tr>
<tr>
<td>1946</td>
<td>9.3</td>
<td>2.40</td>
</tr>
<tr>
<td>1947</td>
<td>8.8</td>
<td>2.74</td>
</tr>
<tr>
<td>1948</td>
<td>8.7</td>
<td>2.83</td>
</tr>
<tr>
<td>Average</td>
<td>8.9</td>
<td>2.66</td>
</tr>
</tbody>
</table>

**Table 2. Grease wool production and staple length of first cross two and three year old ewes and second cross yearling ewes produced by crossing Columbia and Rambouillet rams on range ewes**

<table>
<thead>
<tr>
<th>Cross</th>
<th>Age</th>
<th>Year</th>
<th>Columbia-sired group</th>
<th>Rambouillet-sired group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grease wool</td>
<td>Staple</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>pounds</td>
<td>inches</td>
</tr>
<tr>
<td>First</td>
<td>2</td>
<td>1947</td>
<td>10.4</td>
<td>2.74</td>
</tr>
<tr>
<td>First</td>
<td>2</td>
<td>1948</td>
<td>9.4</td>
<td>2.69</td>
</tr>
<tr>
<td>First</td>
<td>3</td>
<td>1948</td>
<td>9.3</td>
<td>2.58</td>
</tr>
<tr>
<td>Second</td>
<td>1</td>
<td>1948</td>
<td>8.9</td>
<td>3.16</td>
</tr>
</tbody>
</table>

DR. LOUIS L. MADSEN is head of the Animal Husbandry Department. DR. T. DONALD BELL is professor of animal husbandry with headquarters at the Branch Agricultural College at Cedar City. MILFON A. MADSEN is assistant professor of animal husbandry and a specialist in sheep and wool production. JAMES A. BENNETT is assistant professor of animal husbandry whose specialty is animal breeding.
length of fleeces shorn from first cross yearling ewes produced in three years from range ewes mated to Columbia and Rambouillet rams are given in table 1. The Columbia sired yearlings sheared 8.9 pounds of grease wool with a staple length of 2.66 inches as compared to 7.8 pounds of wool with a staple length of 2.23 inches for the Rambouillet sired group. Similar data for the first cross 2 year and 3 year old ewes and second cross or C2 and R2 yearlings are given in table 2.

Lamb production in terms of pounds of lamb produced per ewe for the original range ewes and first cross ewes is given in table 3. It appears from these data that the original range ewes are producing more lambs as they grow older and that the C1 and R1 ewes may be producing more lambs per ewe than corresponding age groups in the original range ewes. This conclusion is only preliminary, however, since the condition of the summer range in the various years has been variable.

Weaning weights of lambs and percent of grass-fat lambs from range and first cross ewes are given in table 4. The original range ewes in four lamb crops have produced lambs at weaning averaging 83.4 pounds live weight when bred to Columbia rams and 80.0 pounds live weight when bred to Rambouillet rams. A commercial buyer has graded 27 percent and 11.6 percent of the C1 and R1 lambs, respectively, grass-fat at weaning time. Average weaning weight and percent of grass-fat lambs produced by C1, R1, and T1 two and three year old ewes are also included in table 4.

Table 3. Pounds of lamb per ewe produced by range and first cross ewes bred to Columbia and Rambouillet rams and first cross Columbia ewes bred to Targhee rams

<table>
<thead>
<tr>
<th>Breed of ram used</th>
<th>Columbia</th>
<th>Targhee</th>
<th>Rambouillet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kind</td>
<td>Age</td>
<td>Year</td>
<td>Number* per ewe</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Range</td>
<td>2</td>
<td>1945</td>
<td>439</td>
</tr>
<tr>
<td>Range</td>
<td>3</td>
<td>1946</td>
<td>395</td>
</tr>
<tr>
<td>Range</td>
<td>4</td>
<td>1947</td>
<td>332</td>
</tr>
<tr>
<td>Range</td>
<td>5</td>
<td>1948</td>
<td>257</td>
</tr>
<tr>
<td>First cross</td>
<td>2</td>
<td>1947</td>
<td>53</td>
</tr>
<tr>
<td>First cross</td>
<td>2</td>
<td>1948</td>
<td>70</td>
</tr>
<tr>
<td>First cross</td>
<td>3</td>
<td>1948</td>
<td>53</td>
</tr>
</tbody>
</table>

*Number based on ewes bred and alive at lambing time

Table 4. Weaning weight and percent of grass-fat lambs* produced by range and first cross ewes mated to Columbia and Rambouillet rams and first cross Columbia ewes mated to Targhee rams

<table>
<thead>
<tr>
<th>Breed of ram used</th>
<th>Columbia</th>
<th>Targhee</th>
<th>Rambouillet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Kind</td>
<td>Age</td>
<td>Number of lambs</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>----------------</td>
</tr>
<tr>
<td>1945</td>
<td>Range</td>
<td>2</td>
<td>267</td>
</tr>
<tr>
<td>1946</td>
<td>Range</td>
<td>3</td>
<td>327</td>
</tr>
<tr>
<td>1947</td>
<td>Range</td>
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</tr>
<tr>
<td>1948</td>
<td>Range</td>
<td>5</td>
<td>368</td>
</tr>
<tr>
<td>Average</td>
<td>Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1947</td>
<td>First cross</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>1948</td>
<td>First cross</td>
<td>2</td>
<td>54</td>
</tr>
<tr>
<td>1948</td>
<td>First cross</td>
<td>3</td>
<td>62</td>
</tr>
</tbody>
</table>

*Based on estimate of a commercial buyer

Fig. 2. Representative Targhee, Columbia, and Rambouillet rams used in studies to determine what type of sheep will be most productive under southern Utah range conditions.
Planting Grass on Utah's Ranges

By L. A. STODDART

SEED of most grasses is at the highest price in history. This, combined with the high price of labor, makes it more important than ever before that ranchers use proper methods in seeding range land. To justify present seeding costs of 4 to 10 dollars per acre, failures must be held to absolute minimum and grazing of new seedings must be done carefully so they are not injured.

Seeding is not a sure method for increasing range forage. The high hopes of many a rancher have ended with bare ground rather than waving fields of grass. This is an expensive lesson because it can easily double the price of land, and plowed land upon which seeded grass has failed may not yield as much livestock feed as it did before the expensive plowing. But by proper methods and holding costs to a minimum range seeding is a potentially great source of wealth to ranchers. These planted grasses not only give high forage yields but the forage come at a season when natural ranges need protection from grazing. Therefore seeded areas enable proper grazing of other ranges and so their yield may also be materially greater.

DR. LAURENCE A. STODDART is head of the Department of Range Management.

Utah is a highly variable area. Her mountains, her foothills, her deserts—all offer different problems in seeding. There are good soils but there are shallow, infertile, and salty soils. Many areas are too dry to give any hope whatever of successful grass-growing. High snowfall in mountain ranges makes their seeding an entirely different problem from certain low lands which may be seeded in midwinter. Therefore, no single set of rules will apply on every ranch. Each offers a separate problem. This is further complicated by variable weather. We have been fortunate in recent years to have had unusually good growing years because of above average precipitation. These make people more optimistic than average conditions might justify. Past records suggest that a dry period may be ahead. This will necessitate even greater care in grass planting if success is to mark our efforts.

Experimental Work

Because of the problems involved in range planting, the Utah Station in cooperation with the U. S. Department of Agriculture has, over the past ten years, conducted experimental work on species and planting methods to determine the surest ways to establish good grass stands with a minimum of expense. Anyone can plow carefully chosen and expensive land, fallow it, drill in expensive seed, and come out with an impressive and showy stand of grass. The practical rancher, however, is interested in dollars and he cannot afford to plant grass unless it pays for itself. He needs inexpensive methods.

The Station experiments have been conducted largely on sagebrush lands located at Logan in northern Utah, Benmore in central Utah, and at Cedar City in southern Utah.

Preliminary results of the tests at Logan are given in this report. The area is typical sagebrush bench-land with fairly deep and fertile soil. Native cover before seeding consisted of sagebrush and some junegrass and native bluegrass. It was estimated that six acres were necessary to supply a cow month of forage (fig. 1).

Experiments were designed to test (a) various methods of eliminating sagebrush, (b) the success of some 20 species of grasses, legumes and shrubs, and (c) various methods and seasons of planting.

Elimination of Sagebrush

Sagebrush is among the easiest of all plants to destroy. It never sprouts from the roots, it is brittle enough to be broken by any heavy machine or even a grubbing hoe, and it is highly inflammable and easily killed by fire. Even a light burn will kill all brush it contacts.

Five methods of brush elimination were compared. Hand grubbing was effective but prohibitively expensive. In addition, it does not disturb the soil to make a favorable seedbed. Ninety-five percent eradication was obtained by use of a 20-inch-disk Wheatland (fig. 2) with the disks set at about a 30 degree angle to give deep plowing action. When the disks were set almost straight only a 35 percent brush kill was obtained. This has an advantage, however, where there is a good stand of native grass because only about 45 percent of the grass is killed, whereas, deep plowing will kill almost all. Dragging brush with a 20-foot triple railroad rail, with following single rails gave as good a brush kill as did shallow disking and generally is less expensive. It damages existing grass but little. Burning was found to be the most effective brush killing method (fig. 3).

Sagebrush can be burned any time from
July 1 to October 1 if the weather is dry and wind is brisk. Brush with plenty of junegrass underneath is easily burned. Otherwise, the brush must be rather dense to carry the fire from one bush to another. Burning in early morning is difficult even in midsummer. Midafternoon, when humidity is low and temperature high, is the easiest time to burn.

Burning may be the cheapest way to eliminate brush depending upon the size of the area and the amount of fire lane necessary for safety. But it is not without its cost. Dependable fire lanes must be made around the area to be burned and state laws make the burner responsible if the fire escapes and damages adjacent property (fig. 4). All burning must be under permit from the county sheriff or county fire chief by state law. Be sure you are ready to burn before you light the match. Fire is not easily stopped and, uncontrolled, it is a ruthless enemy of man. Without further treatment, burned land is usually a good seedbed into which grass may be drilled (fig. 5).

**Species to Plant**

Several native shrubs were planted without satisfactory results. Seeds must be hand collected with great difficulty and the poor results from their planting at present certainly do not justify the cost.

Four native and introduced legumes also were found unsatisfactory because of poor stands. Sweet clover germinated well but did not maintain itself.

Common rye and Michels rye produced good stands but were sparse after two years and virtually were eliminated after four years. Except as temporary feed, perennial grasses are preferable to rye for range seeding.

Three wheatgrasses, crested wheatgrass (*Agropyron cristatum*), hairy wheatgrass (*Agropyron trichophorum*), and tall wheatgrass (*Agropyron elongatum*) gave excellent and permanent stands, with the latter two generally outyielding crested wheatgrass (fig. 5). Bulbous bluegrass (*Poa bulbosa*), slender wheatgrass (*Agropyron trachycaulum*), smooth brome (*Bromus inermis*), ricegrass (*Oryzopsis hymenoides*), tall oat (*Arrenatherum elatius*), and native bluegrass (*Poa secunda*) all gave excellent stands under certain planting methods. However, all except the two bluegrasses failed to maintain satisfactory stands after drought periods. These two were considered unsatisfactory because of their extremely low yields and short season of usefulness.

**When and How to Plant**

Fall rye and Michels rye grow best when drilled or when broadcast on deep-disked land. Broadcasting seed ahead of the disk was found to be much better than broadcasting behind the disk. These plants are ready to graze shortly after planting and their great volume of growth makes them ideal to support livestock on a small part of their normal range while the other part is being planted to perennial grasses, all of which take a long time to become established.

In general, the wheatgrasses all grew well when broadcast onto heavily disked land. Broadcasting seed behind the disk was almost always best. If the soil was allowed to settle before the seed was broadcast, however, chance of success was much reduced. Crested wheatgrass should never be broadcast ahead of deep-disking.

Drilling gave no better stands than did broadcasting behind deep disk (fig. 2) but drilling generally was preferable to broadcasting on land that was shallow disked or railed. Drilling was always superior to broadcasting on burned land (fig. 5). Broadcasting before burning gave unsatisfactory stands and broadcasting after burning generally gave unsatisfactory stands. Best results from broadcasting on a burn, however, were obtained with bulbous bluegrass and crested wheatgrass, and when burned immediately preceding the broadcasting. Broadcasting on burned sagebrush land is not recommended. Drilling as soon as possible after fall burning appeared best.

Unplowed burned sagebrush land was excellent seedbed, although on some soils there is danger of wind erosion. If land is plowed, deep disk ing appeared to give sufficiently better grass stands than shallow disk ing or raling to justify the additional cost. Some of this cost can be offset by broadcasting rather than drilling seed on the deep-disked land. Fall-drawn grass did best on burned land, second on land deep-disked the previous spring, third

(Continued on page 18)
LITTLE CHERRY, A VIRUS DISEASE OF SWEET AND SOUR CHERRIES IN UTAH

By B. L. RICHARDS, B. N. WADLEY, G. W. COCHRAN

STUDIES at the Utah Station have shown that western x of peach and chokecherry, wilt and decline of cherry, and little cherry disease are all caused by one virus. These diseases threaten the fruit industry of Utah. Losses are now great and will continue to increase in magnitude unless they can be controlled. Scientists at the Utah Station are now making an intensive study of the virus disease problem in stone fruits in an attempt to find how the virus is transmitted and methods for its control.

Fruit production is a major agricultural industry in Utah. In the past, the orchards here have been considered relatively free from plant diseases; particularly those diseases caused by bacteria and fungi which are so destructive in more humid areas. However, cherry, peach, apricot, and prune orchards now frequently prove unprofitable. Research has shown that much of this decline in productivity is caused by plant viruses which get into the living substance of the trees and induce serious and permanent injury. The result of this damage is usually decreased production of marketable fruits. Frequently the trees are permanently injured or killed. Little cherry disease is one of the virus diseases that is threatening the fruit industry in Utah.

History of the Little Cherry Disease

Little cherry disease was first observed in sweet cherries in the Kootenay district of British Columbia in 1933. No control measures were employed in this area, and as a result, the disease spread rapidly throughout the district. Within five years many orchards were taken out of commercial production. In the relatively short period of 15 years' time commercial cherry growing in the Kootenay area had become impracticable.

The little cherry disease was found in Washington, Oregon, and Idaho in 1946. Workers there believe that this disease had been in these states about five years. Surveys made in 1947 and 1948 in Washington and Idaho show one to two percent of the cherry trees affected. A similar disease in Oregon called albino cherry is rapidly killing the sweet and sour cherries in the Medford and Ashland districts. In these areas it is considered useless to replant where trees have been removed for this disease.

In Utah, symptoms resembling those of little cherry in the Northwest were first observed in 1946 in orchards in Box Elder, Weber, and Davis Counties. A survey in 1948 showed diseased trees also in Salt Lake and Utah Counties. While the total number of trees affected with this disease in these counties is probably not large, the spread of this disease to adjacent healthy cherry trees seems to be rapid.

There appears to be several viruses or virus strains responsible for little cherry symptoms in the different areas of the Northwest. Research at the Utah Agricultural Experiment Station has shown that the little cherry disease in Utah is caused by the western x virus. The disease has been found in Utah only on sweet and sour cherries.

Fig. 1. Comparison of little cherry and healthy Lambert fruits from the same tree (natural size). Healthy fruits (bottom), little cherry fruits (top). Note dull light color of fruits

Fig. 2. Little cherry diseased fruits of chokecherry, No. 2, 3, 4 and 5 from left. No. 1 healthy. These little cherry fruits in chokecherry were produced by inoculation with the virus in diseased buds from Lambert trees, fruits of which are shown in fig. 1

Dr. B. L. Richards is head of the Department of Botany and Plant Pathology and in charge of the virus disease studies. Dr. Bryce N. Wadley, a native Utahn, was employed a year ago by the U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, to work on virus diseases of stone fruits at Logan. Dr. George W. Cochran, associate professor of plant pathology was employed by the college over a year ago to work on this same problem. He came to Utah from the Rockefeller Institute for Medical Research at Princeton, New Jersey.

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cherries growing on mazzard rootstock. Our research shows conclusively that this same virus which causes the little cherry disease also causes wilt and decline disease in sweet and sour cherries on mahaleb rootstock, western x disease of peach, and the red-leaf disease of chokecherry. The host range of this virus may be greatly extended with further research.

**Distribution and Economic Importance**

Little cherry disease is found in many of the older Utah cherry orchards that have been propagated on mazzard rootstock. In one orchard in Weber County, 83 percent of the Lambert trees had little cherry disease in 1947. This orchard is in an unproductive condition, but none of the trees has died. In an adjacent orchard, growing on mahaleb rootstock, 65 percent of the trees have died with the wilt and decline disease (fig. 3). Areas have been found in Davis, Box Elder, and Utah Counties where similar conditions of high incidence of wilt and decline occur adjacent to little cherry-diseased trees.

The high proportion of unmarketable fruits and decreased fruit production are the immediate losses from little cherry disease. Breakdown of the trees may occur so that they are not as vigorous as healthy trees. The trees are not killed as with the wilt and decline disease but live for a number of years serving as reservoirs of infective material which may be spread to other trees. The most serious danger from little cherry disease appears to result from the transfer of the virus to trees growing on mahaleb rootstock producing wilt and decline disease.

**Cause of the Little Cherry Disease**

The cause of little cherry disease in Utah is a transmissible virus generally referred to as the western x virus. Experiments conducted at the Utah Agricultural Experiment Station plot at Farmington on virus transmission have shown that when buds and spurs from little cherry diseased trees are grafted into sweet and sour cherries growing on mahaleb rootstock, the virus is transmitted to these trees causing a definite wilt and decline the year following inoculation (fig. 5). Diseased buds from little cherry-affected trees, grafted into peach trees, have induced western x disease of peach. The virus has been transmitted to chokecherry and caused western x red-leaf and little cherry disease of chokecherry (fig. 2). Little cherry disease is most abundant in areas of high incidence of western x disease of peach and chokecherry. Western x disease is widespread in peach orchards and native chokecherry in the northern part of the state. In many of the older peach orchards in Davis, Weber, and Box Elder Counties more than 50 percent of the trees are affected with western x disease.

Cherry trees in Utah orchards have been wilting and dying for at least twenty-five years. This was in the past attributed to rootstock failure. However, our results show that western x virus induces wilt in a high percentage of cases whenever cherries grown on mahaleb rootstock are inoculated with this virus.

**Symptoms of Little Cherry Disease**

The symptoms of the little cherry...
disease are found essentially in the fruits (fig. 1 and 2). Affected fruits are seldom more than half the normal size, are inclined to be more pointed than normal, and retain the reddish color of an immature cherry far beyond the picking date. Diseased fruits often acquire a dull rather than the normal glossy appearance, particularly at the time of maturity and later. Depending on the variety, fruits vary from almost white to nearly normal color. They lack flavor and sweetness in varying degrees, often having a bitter taste. Little cherry fruits remain attached to the trees long after the crop is harvested. The percentage of small fruits on a tree will vary with the variety, severity of the disease, and the fertility level of the orchard. Entire trees may be affected or only a few branches may show symptoms. The size of the fruits on affected trees will vary somewhat and is influenced by the severity of the disease, amount of fruit set on the trees, and the cultural care and general growing conditions prior to maturity, but the nature of the symptoms in the early stages makes positive diagnosis difficult before the normal full maturity or later. Seldom do all of the fruits, even on severely affected trees, show little fruit symptoms.

Symptoms other than affected fruits may be found associated with little cherry disease in Utah. Under certain conditions stipules become elongated and persist much longer than on healthy trees. Bud scales remain attached for several weeks after the buds open in the spring. The internodes on new growth may become shortened resulting in a rosetted appearance which is striking in severe cases. The leaf margins may become undulated and give a wavy appearance to the leaves. The color of leaves after harvest is frequently light green rather than the usual dark green. Late in the autumn a variable, percentage of the terminal buds breaks dormancy which results in secondary growth. Dieback and "winter killing" have been observed on severely affected trees.

All commercial varieties of sweet cherries have been observed with little cherry disease. Some varieties may be more severely affected than others. This disease has also been found on semi-sweet, sour, and on seedling mazzard trees. Infected trees of all ages have been found and even the young trees in our nursery plots have been infected with buds from diseased trees.

Control

Keeping little cherry diseased trees in the orchard is a dangerous practice since such trees provide reservoirs of infective material which may soon spread to adjacent trees. From observations it seems that the spread of the virus from the little cherry diseased trees is much more rapid than from western x of peach or from red-leaf diseased chokecherry trees to cherry trees. So far as we know little spread occurs from trees showing wilt and decline disease.

Nothing is known as to how little cherry virus is spread. It is assumed that some insect is responsible and the vector is being sought. Entomologists with the U. S. Bureau of Entomology and Plant Quarantine, cooperating with the Utah Agricultural Experiment Station, are attempting to find the insect so that a means for controlling the natural spread of this disease might be developed.

Since little cherry disease is found in Utah only on mazzard rootstock, it is evidently dangerous to grow trees on this rootstock. It appears to be a safer practice to plant mahaleb seedlings and topwork these to desired varieties. The western x virus does not go into the mahaleb wood, so if virus infection takes place in one branch of the tree only this arm is affected. The affected limbs can be removed, or if left, they may recover, and after two or three years produce normal healthy fruits. To insure success of this procedure, the little cherry diseased trees should be removed from the vicinity of the new planting. New plantings of cherry trees should be as far as possible from old diseased cherry and peach orchards and from native chokecherry. Some varieties and species of prune and plum are known to carry viruses without showing symptoms. While much research remains to be done on the host range of the western x virus, it will be safer to keep cherry plantings away from prune and plum orchards.

It is essential if any control program is to be effective, that nurserymen provide disease-free trees for planting. This can be accomplished only if the budwood source is virus-free. Budwood should be selected only from bearing trees of known fruit and vegetative characters, production performance, and freedom from virus disease.

Building and Equipment Added

The availability of surplus war material has made it possible to add much-needed buildings and equipment during the past biennium. A laboratory building has been erected and equipped at the Farmington Sub-station and one at the Horticultural Farm at North Ogden. Other steel buildings have been converted into garages providing coverage for the station trucks for the first time. A machine shop has been built, a seed laboratory, a laboratory for bee investigations, a small animal laboratory, feeding pens are provided for conducting nutritional studies and research on animal diseases where individual animals can be fed separately, and space is available for studies with chickens and turkeys.
In Utah, irrigation is a basic necessity for the production of agricultural crops. This was realized when the pioneers came, over a hundred years ago. Today, nearly four-fifths of Utah's farm income is from irrigated farms; one-fifth is from dry farms and range lands combined. Through the years past irrigation and drainage research has contributed substantially to Utah's progress. It is believed, therefore, that everyone concerned with the advancement of Utah and the West will be interested in a review of Utah's irrigation and drainage research of yesterday, today, and tomorrow.

**Yesterday's Irrigation and Drainage Research**

During the early period various irrigation and drainage research problems have been carefully studied by state and federal scientists. More than 100 irrigation and drainage publications have been issued reporting the progress of this research.

During the decade just past, numerous requests have come to the Utah Agricultural Experiment Station for information concerning the pioneer irrigation and drainage research. Among these requests have come inquiries from foreign countries, including China, Palestine, and South America. These inquiries, together with the wide recognition given the value of this research by American leaders, is evidence of the value of Utah's contribution to the irrigation and drainage research of yesterday.

**Today's Irrigation and Drainage Research**

Active irrigation and drainage research projects in Utah today include studies of five major problems:

1. The sources of irrigation water supplies, including factors affecting watershed yields and streamflow forecasts.

2. Conveyance of irrigation water from rivers, lakes, or reservoirs to farm lands.

3. Consumptive use of water by irrigated crops and by native vegetation, and the relation of crops produced to water consumed.

4. Drainage of waterlogged lands—agencies, methods, progress, and needs.

5. The management, operation, and maintenance of irrigation and drainage facilities.

**Research Locations**

The research on the problems above is being conducted in five of Utah's counties: Box Elder, Cache, Millard, Salt Lake, and Uintah. Field studies are being made near Fielding, Logan, Lewiston, Richmond, Delta, Draper, and Vernal.

**Research Contributors**

Utah's irrigation and drainage research of today is supported financially by public and private agencies. The Utah Agricultural Experiment Station is fortunate in having generous cooperation in both finance and personnel of the Soil Conservation Service and the Bureau of Plant Industry, Soils, and Agricultural Engineering. The Bureau of Reclamation is cooperating in studies of water conveyance and canal lining.

Draper Irrigation Company is a generous cooperator. Nine of Utah's drainage districts—four in the Delta Area and five in the Lewiston Area—are contributing to cooperative irrigation and drainage research. The Utah Power and Light Company, after a careful study of basic needs in Utah agriculture, made a liberal grant for new research on the drainage of irrigated lands.

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DR. O. W. ISRAELSEN, professor of irrigation and drainage, has charge of the research program in irrigation and drainage at the Utah Station. DR. C. W. LAURITZEN and J. HOWARD MAUGHAN are collaborators in this work employed by the Soil Conservation Service and stationed at Logan.

For December, 1948
Progress in irrigation and drainage in Utah and the West is dependent on education much more than is generally realized. It is essential not only for a few men to be well informed, but for many men to understand the basic elements of efficient, dependable, and scientific irrigation and drainage. Realizing this fact, Utah Agricultural Experiment Station leaders have established a number of research fellowships in irrigation and drainage. Recent college graduates having special interest in the advancement of these basic aspects of Utah's agriculture today have responsibility for assisting with cooperative research in the mountains, on the canals and the irrigated farms, and in the low-lying waterlogged areas.

The fellowships serve two purposes. They provide additional training in the science of irrigation and drainage for specially qualified students and the research which they make possible extends our knowledge of factors of basic value to the future of irrigated agriculture. The reward for the knowledge gained and the contribution made to science is the advanced degree. This motivates the fellow's activity and stimulates endeavor for advancement of knowledge.

Some Results of Today's Research

Only brief mention can here be made of the wealth of practical and scientific information developed in Utah's irrigation and drainage research of today. Much of it has been summarized in recent Station publications and in bulletins now in press.

Snow surveys and stream flow forecasts, but little known when the Utah Station began its winter-mountain-climbing research, are now so widely recognized as being of value to farmers and irrigation companies they are regularly used in all of the western irrigation states.

The magnitude and significance of seepage losses from canals and reservoirs has become better known and understood. The benefits of lining to reduce seepage losses have been demonstrated. Linings of many types are effective in reducing seepage losses. The objective is to develop better linings at lower costs. Among linings having the lowest initial cost are those of clay and soil bentonite mixtures. Long-time testing in operating canals supplemented by model testing under controlled conditions will determine the relative annual costs of various types of linings and the limitations of each type. Experience thus far supports the conclusion that earth linings will last for many years without excessive maintenance costs provided suitable material is used and properly protected with erosion-resistant covering such as a layer of gravel.

Carefully conducted consumptive-use-of-water studies promise to develop a sound basis for estimating annual water needs on entire river systems, and for predicting stream flow depletion in the extension of irrigated areas on the lands of interstate stream-watershed areas. Information thus accumulated will be of substantial value in the development of Colorado River basin lands.

Utah has more than 200,000 acres within its drainage district boundaries. Adequate drainage has thus far been provided for less than one-half of this area. Moreover, there are many farms outside the drainage districts that urgently need drainage to make the soils fully productive by lowering the water table and leaching out the excess soluble salts. The greatest single hope for progress in drainage is the improvement of methods with accompanying reduction of annual drainage costs. Whether the necessary drainage is provided by construction of open drains, covered tile drains, pumping of ground water, or elimination of the source of ground water by lining irrigation canals and using water on the farms more effectively or by combinations of methods, makes little difference provided sufficient drainage is assured at reasonable annual costs. Utah's cooperative drainage research, in its physical aspects, and also its institutional or management and operation phases, is attempting to develop the best ways to reach desired drainage goals.

Tomorrows Irrigation and Drainage Research

Achievement in all phases of scientific endeavor depends on vision, determination, driving force, and continued painstaking effort. Utah irrigation companies have over 200 surface reservoirs having storage capacity for more than two million acre-feet of water, enough to provide some stored water for irrigation of 650,000 acres. Somewhat striking, however, is the fact that Utah also has large capacities in natural underground reservoirs as yet but little used. Protection of surface soils from excess salinity, production of farm crops on greatly increased areas, provision of more irrigation water during periods of urgent need—all these can be accomplished by intelligent use of Utah's underground reservoirs if based on careful research. California and Arizona pump annually for irrigation millions of acre-feet from ground water. This irrigation pumping has solved perplexing drainage problems by lowering the water table.

Profitable pumping depends in part on finding saturated gravel formations of high permeability that will yield a sufficient volume of water with reasonably static water lift, low drawdown, and low power requirements. Pumping from clay is impossible and from sands expensive. Striking to the irrigation farmer is the fact that favorable ground water gravels yield with a given drawdown several hundred times as much water as fine sands, and that coarse sands under a given power requirement may yield 50 times as much as a fine sand. The permeability of ground water formations greatly influences the water yield. Knowledge of the permeability of formations is essential to efficient design of irrigation and drainage wells, and thus to adequate use of Utah's ground water reservoirs.

Utah irrigation companies convey annually about 5 million acre-feet of water from sources of supply to the irrigated farms, and lose approximately one-fifth, or more, of this volume, or more than a million acre-feet. Not only is the water lost, but large areas of productive soils are injured because of rise of the ground water and the development of soil salinity and drainage problems in the lowlying areas.

It is estimated that under the best irrigation practices of today Utah's irrigation efficiency does not exceed 35 percent and in many areas it is as low as 10 percent. Doubling—or even tripling the irrigation efficiency of some of Utah's lands is not only desirable but also possible. The first and basic step toward such achievement is continued and greatly expanded irrigation and drainage research. The second and final step is the intelligent use and application of the results of research by Utah's irrigation companies, drainage enterprises, and irrigation farmers.
POLLENATING THE ALFALFA SEED CROP

By M. W. PEDERSEN and FRANK E. TODD

A flower shows that the sexual parts, the stamens and pistil, are tightly enclosed within the keel, a hood-like structure, which protects them from contact with outside objects. These flower parts must be released from the keel to expose them when the flower is fertilized by its own pollen. It is when pollen from another plant reaches the stigma that good seed is produced. This process is called cross pollination. In work done by H. M. Tysdal it was found that plants grown from seed produced by self-fertilization yielded only 68 percent as much hay as did their parent plant. On the other hand, plants grown from cross pollinated seed yielded more hay than did their parent plants. The seed production of these self and cross fertilized plants showed similar performance. It is evident that self-fertilized seed is not desirable seed. Fortunately, because of the nature of alfalfa, little self-fertilized seed can be produced. Most of the seed produced has come from flowers that have been tripped and cross fertilized.

Bees Essential to Seed Production

How is alfalfa tripped and pollinated? Many studies have been made of the mechanism of alfalfa pollinating, all leading to the same conclusion; that the only agents capable of tripping and cross-pollinating alfalfa flowers on a field basis are bees. In its search for pollen or nectar the bee inserts its head into the throat of the alfalfa flower and trips the blossom. In this process pollen is deposited on the bee’s head. This pollen is carried on the bee to another flower where cross pollination may take place.

It has been observed that some flowers may be self-tripped, tripped by rains, or by other objects, but such...
tripping produces little seed and the seed produced by these methods is not desirable because it is not cross pollinated. Efforts have been made to trip fields of alfalfa flowers by dragging chains over the field. These efforts have resulted in failure to increase seed production, in part at least, because such methods do not effect cross pollination. So the fact remains that bees are essential to the production of alfalfa seed.

Wild Bees Are Valuable

Numerous studies have shown that certain wild bees are the most efficient trippers and cross pollinators of alfalfa. These wild bees are: (1) the leaf-cutter bee, Megachile, (2) the alkali bee, Nomia, (3) the bumble bee, (4) certain other species. In most fields, however, an examination will show that wild bees are not abundant. Since a 500 pound seed yield is estimated to require the tripping of 38,000,000 flowers, it is evident that wild bees are too few in numbers to be depended upon to pollinate any extensive acreage. Wild bees are valuable to seed production and every effort to conserve their numbers should be made. How to increase the wild bee population in seed producing areas is one of the problems now under investigation.

Honeybees Do Most of the Tripping

The value of the honeybee as an alfalfa pollinator has long been questioned. It has been shown, however, that the seed yield of Utah tends to fluctuate with the number of honeybee colonies located in the alfalfa-seed producing areas. In Utah the honeybee is the chief pollinator of the alfalfa seed crop.

Some members of the honeybee colony collect only nectar, but others collect only pollen. The nectar collectors can obtain their loads without tripping the flower. Many times not more than two percent of the flowers they visit may be tripped, at other times more may be tripped. This difference in the activity of nectar and pollen collectors has confused many investigators as to the value of honeybees. When honeybee nectar gatherers are abundant, they do trip many flowers, but it requires more nectar bees a longer time to pollinate a crop than it does pollen collectors.

On the other hand, honeybees cannot get their pollen loads without tripping and pollinating the flowers. Honeybee pollen collectors are as effective pollinators of alfalfa as are wild bees. Pollen collection from alfalfa does vary with the locality. For example, pollen collecting honeybees are common in Delta Area alfalfa fields but much less so in Cache Valley. Another problem under investigation is how to increase the number of pollen collectors on alfalfa.

Why Lugus Bugs Must Be Controlled

Much attention has been devoted to the effect of lygus bugs on alfalfa. With the advent of DDT the protection of seed fields from lygus bugs has become a reality. The most noticeable feature following DDT dusting is an increase of flowering on the treated fields. It is evident that with more flowers in the field, the chances of a good seed crop are greatly enhanced, provided the flowers are tripped and cross-pollinated.

Investigators have found that an application of 20 pounds of 10 percent DDT dust during the prebloom period will give practical protection against lygus damage for about three weeks without damage to the pollinating bees. The faster a crop can be "set up" the faster it will mature and the shorter will be the time that the crop is subject to damage by harmful insects. It has also been found that dusting alfalfa while in flower may damage the bee pollinators.

Practical Suggestions

Although much is yet to be learned about the production of alfalfa seed, certain measures are suggested. The grower can increase his chances of producing a seed crop by controlling lygus bugs at the proper time. Lygus bug control will increase the number of flowers on his fields. He must remember that to produce a good seed crop the flowers have to be tripped and cross pollinated by bees. If wild bees are not abundant he can encourage bee-keepers to move honeybee colonies to his field. The number required may vary with the locality, however, no less than one colony per acre of seed is suggested. Locating honeybee colonies within the alfalfa field may give more effective tripping than when they are located at a distance. The grower should exercise care when applying insecticides to avoid the damage they may cause to pollinating insects.

New Greenhouse

A new greenhouse to be used in studies dealing with virus diseases of stone fruits has been constructed recently at the Agricultural Experiment Station.

The new greenhouse will greatly facilitate the work of this project. Transmission studies can be undertaken with large numbers of fruit stocks under controlled conditions. Small isolation rooms will make it possible to study the role of various insects in the transmission of the virus from diseased to healthy plants.

The effects of temperature and light variations on the transmission and development of the disease can be studied. Furthermore, the new greenhouse will make it possible to follow up studies made in the field during the summer with experiments conducted inside during the winter months.

Farm and Home Science
LADYBIRD BEETLES AID IN PEA APHID CONTROL
By GEORGE F. KNOWLTON

Ladybird beetles of several kinds occur commonly in Utah pea and alfalfa fields whenever the pea aphid, Macrosiphum pisi (Kalt.), occurs in outbreak abundance. These are among the most beneficial of the insect-eating beetles present in Utah, and usually they are the most abundant beetle predators present in fields wherever injurious aphid outbreaks exist. Ladybird beetles are particularly helpful when aphid outbreaks develop during warm weather. Because of their importance in reducing populations of pea aphids, they are an asset to the growers of canning and market peas, alfalfa, and sweet clovers. They also are of help to the home gardener, growing a few rows of garden peas or blossoming sweet peas in the flower garden. Because of ladybird beetles and other beneficial predators and parasites which commonly attack the legume infesting pea aphid, it has often been possible for growers to raise aphid-susceptible crops for a number of years in succession without need for chemical control effort and expense.

Several species of ladybird beetles are of special importance in pea aphid control. One of the most common, numerous, and beneficial is the convergent ladybird beetle, Hippodamia convergens Guerin. This and other species were abundant in pea aphid injured pea and alfalfa fields during 1936, conspicuously reducing population during late May and June, but the help came a little late for greatest crop savings. In the spring following this unusually destructive aphid outbreak, which severely damaged hundreds of acres of peas and alfalfa in Utah, many growers were fearful of again planting canning peas. Because of the high regard in which so many farmers hold the ladybird beetles in aphid control on peas, two canning companies and the Utah-Idaho Canning Crops Association purchased approximately ten million adult convergent ladybird beetles. The purchase of these beetles, collected from their high mountain hibernation quarters in California and later released in northern Utah and southern Idaho pea growing areas during late May and early June, had a marked psychological effect. Growers took renewed courage from the ladybird beetle introductions and again raised canning peas in 1937, with only moderate pea aphid injury or local need for insecticidal control. Many growers credited the introduced ladybirds with much of the success in pea aphid control. The ten million beetles introduced were only a token addition to the several billions of aphid-eating ladybird beetles present each season in northern Utah agricultural areas.

Each female H. convergens may deposit from 200 to more than 1500 eggs. Eggs of the convergent ladybird beetle hatch in 3 to 5 days. The larvae produced from these eggs feed on aphids almost exclusively for approximately 13 to 17 days, then pupation occurs. Development from egg to adult of this species requires approximately one month.

Convergent ladybird beetles often have been watched by fieldmen, farmers, and viner operators, as they ate pea aphids on infested pea and alfalfa shoots in the fields, when both predators and aphids were numerous around the viners. One female beetle was collected when found feeding on an aphid in a pea field. A larvae from eggs laid by this female, when reared in the laboratory, ate an average of six fourth-instar pea aphids per day during the entire period of larval development. One adult female, reared in the laboratory, ate or otherwise killed a total of 776 pea aphids in 57 days. This was at the rate of approximately 13.6 aphids eaten or otherwise destroyed per day, throughout its adult life. Another female convergent ladybird ate 563 fourth instar pea aphids in 19 days, during which time she also laid 519 eggs. The average daily consumption of aphids by this individual was 33.2.

The five spotted ladybird beetle, Hippodamia quinquesignata Kirby, is common in aphid infested pea and alfalfa fields, feeding voraciously on these soft bodied plant parasites. One adult, caged with adult and nearly mature pea aphids, ate 438 during a period of 29 days. This ladybird passes through the winter as an adult beetle, hibernating under rocks high on our mountains.

DR. GEORGE F. KNOWLTON, professor of entomology, needs no introduction to the farmers of Utah. He is extension entomologist as well as being on the research staff.
A common red ladybird beetle female, Coccinella transversogutta Fald., consumed a total of 1,170 fourth instar pea aphids in 29 days, or an average of 42 per day. During this time, this same female deposited 1,175 eggs. A second female ate 293 pea aphids.

A Leconte ladybird, Hippodamia lecontei Muls., ate 376 pea aphids and laid 260 eggs during twelve days in a cage. A H. parenthesis (Say) female ate 181 aphids and laid 233 eggs in fourteen days. A Coccinella novemnotata Hbst., ate 502 aphids and laid 389 eggs for production of a new generation of aphid predators, in eighteen days.

Agriculture in Utah and throughout the country benefits from the large numbers of beneficial ladybird beetles which commonly occur in the region.

**NEW PUBLICATION**


This bulletin reports the costs and returns of producing peaches on 103 farms in Utah, Box Elder, Weber, and Washington Counties. This study showed that the average peach orchard consisted of 5.4 acres with a yield of 177 bushels per acre. The average cost of production was $1.66, 43 percent of which was for labor, 29 percent for overhead, 17 percent material, and 11 percent power. Receipts averaged $1.74 per bushel.

This publication may be obtained free from the Utah Agricultural Experiment Station.

**WEEDS**

(Continued from page 5)

lower, and often loans are refused on infested lands.

Weeds are injurious to the health of people. Deaths occasionally occur from eating poison seeds, berries, or tubers. Poison oak, poison ivy, and poison sumac cause suffering and distress to those who come in contact with these plants. Many people suffer from hay fever, and much of this is caused by the pollen of certain weeds.

These examples illustrate some of the ways that weeds affect the welfare of man.

There are three other classes of agricultural pests in addition to weeds. They are: (1) animal diseases, (2) plant diseases, and (3) insects. The Agricultural Service Committee of the U. S. Chamber of Commerce has made a study of the losses from these four pests. They concluded that weeds cause 12 times the losses from animal diseases; 12½ times the losses from plant diseases, and 3 times the losses from insects. Weeds thus cause greater losses than plant and animal diseases and insects combined.

Why, in view of this great agricultural waste resulting from weeds, has the public failed to support weed research to the extent that the problem justifies? Opportunities for developing more effective weed control through research are as great as those for insect and disease control, and the returns for money invested in weed research have possibilities of being even greater because of the relative magnitude of the problem. How research can help in improving weed control methods is illustrated by experiments conducted at the Utah Agricultural Experiment Station.

Experiments on frequency of cultivation as related to the control of creeping perennials showed that it was possible even to improve an old established method of control, namely that of cultivation. It was found that cultivating only half as often as earlier recommended was just as effective in weed control. This comparatively simple principle resulted in reducing the cost of eradicating creeping perennials by about one-half. Using this improved method of cultivation to control creeping perennials, thousands of acres of infested land in Utah have been cleared of weeds and we are now producing good crops.

Later experiments revealed that it was possible further to reduce costs of weed control, and at the same time grow a crop on the land. This improved method consisted of growing certain crops in combination with improved cultivation methods.

It was found that morning-glory, one of the most troublesome and persistent weeds in Utah, could be easily and inexpensively eradicated by growing winter wheat in combination with cultivation.

Likewise, whitetop, another pernicious weed in Utah can be controlled easily and inexpensively by a combination of spring barley and cultivation. The cultivation is done after the crop is harvested.

These weed control methods involving cropping and cultivation provide a means of eradicating creeping perennials at little extra expense beyond the usual cost of growing the crop.

More recent research on weed control has dealt with the use of 2,4-D. These experiments have pointed the way to more efficient use of this material. They have resulted in large savings to farmers in the state. Costs of 2,4-D for weed control in 1949 were from a fourth to a half as much as they were in 1946 and 1947. These savings, by more efficient use of 2,4-D, are considerable when it has been estimated that a million dollars worth of 2,4-D was sold in Utah in 1947.

From these examples of results of research, it is obvious that it is possible to do something to reduce the cost of weed control. More efficient weed control will help farmers in two ways; first, it will reduce the cost of keeping weeds out of crops; and second, it will result in increased yields of higher quality crops. This means more grains and feeds available for production of milk and beef and other livestock products. The production of these animal products is limited only by the supply of feeds available.
COSTS AND RETURNS FROM EGG PRODUCTION
(Continued from page 1)

As evidence of the importance of changes in the level of prices on costs, the price of 100 pounds of the average poultry ration and the cost per hour of man labor are shown. Feed price varied from $1.25 per hundred pounds in 1932 to an estimated $4.16 for 1948. In 1947 it was $4.10. This is nearly a 3 ½ fold increase. Labor estimated for 1948 at 80 cents per hour is just 4 times the 1933 rate of 20 cents.

The items listed above do not include all the costs of producing eggs but they are the most important ones. During the past 20 years feed costs have averaged 53 percent and labor 17 percent of the total (fig. 2). The maintenance of the laying flock accounts for another 16 percent. This includes not only the cost of the layers that die but also the decrease in value of the birds from the time they are put in the laying pen as pullets to the time they are removed as culled and sold for meat. Obviously, the relation of meat prices to the prices of pullets for laying will influence the net cost. Over the years the laying flocks have been made up on the average of about 60 percent pullets and 40 percent hens. This means that for each 100 layers started each year, about 20 die, 40 are culled out and sold or eaten, and 40 are carried over as layers.

Table 1. Changes in the major factors that influence the cost of producing eggs, Utah 1929-48

| Year | Feed per hen | Mash fed per hen | Eggs produced per hen | Hours of labor per hen | Death loss of hens | Cost per hour of labor | Cost of 100 lbs. of poultry rations*
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*During the period covered the ration averaged 53 percent mash, 33 percent wheat, 7 percent barley, 6 percent corn, and 1 percent oats
†Preliminary—Estimated on basis of first 9 months of year

Overhead costs which include taxes, insurance, interest on the investment, and depreciation and repairs on buildings and equipment make up 9 percent of the total cost. The other 6 percent includes all other costs such as litter, lights, veterinary assistance, disinfectants, medicines, auto and truck costs, telephone, and sundry supplies.

The data and the discussion above pertain to commercial egg production, but not to the production of eggs by farm flocks. The differences between the two are primarily in practices followed, but usually commercial flocks are also much larger than farm flocks. These data generally apply to flocks of 300 or more laying hens with the average during the period covered varying from about 1,000 hens to 1,500 hens.

All the data presented were not obtained from poultry producers. The basic data were derived from a comprehensive study of a fairly large sample of poultry farms in 1929, 30, and 31 and another similar, though less comprehensive in scope, study in 1946. Data for the other years have been obtained from many sources, particularly the Bureau of Agricultural Economics, and business organizations that market chickens and eggs and sell poultry feeds. Data from such sources have been assembled and used within the framework of the results of the detailed and original studies.

RESEARCH PROGRAM
(Continued from page 4)

A new field of research for the Utah Station is that of housing. During the biennium studies have been initiated to determine the functional requirements of rural housing in Utah as a basis for the design of houses that meet these needs. Another project is concerned with a study of the open shed compared to the closed stanchion barn for housing dairy cattle.

Panguitch Farm Developed Into Livestock Feed Research Center

During the biennium the Panguitch Farm was organized for research on the production of feed for livestock. This farm had not been used for research purposes since the depression because of lack of funds and the distance from Logan. The new research started in this area includes pasture research, work with cereals, and with fertilizers and soil management practices. It is hoped that this farm will be a center for the solution of livestock feed production problems in the southern Utah area.

for December, 1948
STUDIES have begun this year on 1900 head of cattle on the Seven-Mile and U. M. ranges of Wayne County to determine the cause of a disease that has been prevalent in the area for many years and which has caused losses of from 2 to 4 percent of the cattle grazing the range each year.

The disease was brought to the attention of the Experiment Station by the county agent with a request that the causes and prevention of the disease be studied. After looking over the cattle and the area, collecting for-age and blood samples, and interviewing cattlemen, members of the animal husbandry and veterinary science departments have outlined a project to study the cause and prevention of the death losses.

Losses among cattle grazing on the Seven-Mile and U. M. ranges have occurred more or less regularly for at least 35 years. Heavier losses seem to occur during years of abundant rainfall. Some cattlemen believe that feeding bone meal and salt has materially reduced the number of affected animals, but losses still prevail in spite of this practice.

Affected animals are first noticed each year from about August 13 to September 1. The disease has been seen in cattle of all ages, and breeds including range bulls. Affected cattle are usually noticed standing away from the rest of the herd. They have a rough hair coat, usually a greatly distended abdomen caused by an accumulation of fluid (ascites) and frequently have a profuse diarrhea.

Yearlings' and older cattle frequently have a swollen brisket. The swelling or edema may extend up the neck and also be prominent in the throat region. Calves do not swell in the brisket region as much as older cattle but they may have some swelling in the throat region. Affected calves usually breath hard and fast, have a severe diarrhea, may drool saliva, lose weight rapidly, and have a rough hair coat. Forced driving of affected animals often proves fatal. On several occasions affected animals have apparently recovered when taken to the home ranch in Loa valley, but when taken to the range the following year they never survive.

Preliminary findings indicate that affected animals show variable degrees of anemia (low hemoglobin in blood). Several mineral supplements are now being supplied to the cattle in an attempt to determine if the disease is of nutritional origin.

A typically affected yearling Hereford heifer from the U.M. range. Not enough hair coat, marked depression, enlarged abdomen, and poor condition. This animal is anemic and has some swelling (edema) between the lower jaws.