SERIOUS WATER SHORTAGE PREDICTED UNLESS THERE IS ABUNDANCE OF PRECIPITATION BEFORE MAY 1

Value of Snow Surveys in Estimating Water Supply Explained

By GEORGE D. CLYDE

This year the February 1 snow measurements on key courses throughout the state shows a serious potential water shortage. If the present rate of precipitation continues until May 1 the probable water supply for 1940 will not exceed 65 percent of normal. If, however, the precipitation between now and May 1 is normal the water supply will probably be as much as 75 percent of normal. Because of the present critical condition a supplemental snow survey will be made over all courses on March 1, but actual water-supply forecasts will not be made until after the April 1 surveys.

Utah is an agricultural state, and its agriculture is largely dependent upon the extent of its irrigation water supply. This supply is obtained from streams draining the main Wasatch Range, which traverses the state from north to south, and the Uinta Range, which begins at its intersection with the Wasatch Range and continues east across the state. Of the total water supply available in Utah during the period April 1 to October 1 of each year, approximately 80 percent is derived from the watersheds above 7,000 feet in elevation. This area constitutes approximately 20 percent of the total area of the state, and for the most part is uninhabited and practically inaccessible during the winter season. It is during this period that the precipitation, which falls in the form of snow, accumulates on the high watersheds and forms the water storage which later is utilized in the valleys for irrigation, power, and municipal purposes.

The major portion of the irrigated area in Utah is dependent upon a natural-flow water right. This dependence emphasizes the need for detailed information pertaining to the precipitation and runoff characteristics of watersheds in order that the users might adjust their cropping programs so as to make possible a maximum utilization of the water supply. Man cannot change the weather, the precipitation, or the temperature, and these are the factors which are basic to run-off. Therefore, he must modify his program to fit the natural conditions, and an advance knowledge of what the natural conditions are, is necessary for this modification.

In the past the irrigator has not been so much concerned with where the water came from, but has been interested only in knowing how much water was in the river at the diversion point. The considerable increase in water consumption and the decrease in water supply of the past few years have centered attention upon the source of the water supply. They have emphasized the need for a detailed study of watersheds and stream-flow forecasts.

Precipitation which falls in the form of snow is not easily measured. The isolation of our principal watersheds makes it difficult and impractical to secure continuous records of precipitation, yet such data are essential in the analysis of watershed conditions and the execution of a program of watershed management and water use.

Snow surveys were inaugurated (Continued on page 8)
FROZEN FRUIT AND VEGETABLE RESEARCH INITIATED BY STATION

Frozen Berries and Fruit Purees Especially Promising

By FRANCIS M. COE

A new research project initiated last season by the Experiment Station in cooperation with the U. S. Bureau of Agricultural Chemistry and Engineering and commercial concerns, which promises to be of great value to the producers and consumers of Utah, is the study of freezing preservation of Utah fruits and vegetables.

The purpose of the project is to determine the value of Utah grown fruits and vegetables for preservation by quick-freezing and to ascertain what varieties are best adapted to this process.

In addition to the Experiment Station and Bureau of Agricultural Chemistry and Engineering, the following commercial concerns are cooperating in the experimental work: Rocky Mountain Packing Corporation, Utah Ice and Storage Company, American Can Company, and Amalgamated Sugar Company.

Project leaders for the Bureau are Doctors E. M. Chace and D. G. Sorber of the U. S. Fruit and Vegetable Chemistry Laboratory at Los Angeles, while the Station staff members in charge of the various phases of the investigation are as follows: variety tests of Utah fruits for freezing, F. M. Coe, Horticulture Department; studies of vegetable varieties for freezing, L. H. Pollard, Vegetable Crops Department; nutritional value and quality testing, Mrs. A. P. Brown, Home Economics Department; studies of frozen fruits for ice cream and frozen desserts, A. J. Morris, Dairy Manufacturing Department.

Many Utah Fruits Tested

This first season’s work on the freezing project, although exploratory and preliminary in nature, is yielding tentative results of value to the infant freezing industry. In the fruit variety freezing tests, over four hundred different lots of frozen whole, halved, sliced, coarse, crushed or pureed fruits of over 200 varieties of tree fruits and berries were frozen for later judging or ice cream tests. Approximately 40 peach varieties, 10 nectarines, 20 plums and prunes, 60 raspberries, 20 cherries, 30 apricots and 20 varieties of other fruits were frozen. A number of experiments with various containers to compare tin cans, paper cartons and cups, cellophane lined packages, and kegs, with and without vacuum, were carried out.

The most promising types of fruit and fruit products for immediate commercial production are the berries and the fruit purees or pulps. Strawberries, red and black cap raspberries, and Boysenberries are now in demand commercially. Frozen strawberries and red raspberries have been marketed in large quantities from the northwest in recent years, mostly in barrels.

Barreled berries are used largely by preserve manufacturers, the ice cream trade, and to a lesser extent by bakers. Because of the slow freezing in barrels, a week being required in zero storage for complete freezing, certain oxidation changes take place that make the berries less attractive in color, shape and flavor than quick frozen berries in smaller containers such as packages, small cans, or 30 pound slip cover bins. Because of their superior flavor and appearance a large potential demand appears to await fancy whole or sliced berries, quick-frozen in smaller containers for making better grades of ice cream and for fresh-frozen strawberry and raspberry sundae toppings.

Fruit Pulps and Purees Promising

Fruit pulps and purees are made by crushing or pureeing fully ripe fruit with a seepose to remove skins of tree fruits and seeds of berries, adding sugar at the rate of 3 parts fruit pulp to 1 part of sugar. The puree is then filled into cans or cellophane lined packages, sealed and quick frozen at temperatures of minus 20 degrees to minus 30 degrees F. Quick freezing gives a frozen puree of fine texture resembling a sherbet or fruit ice, except for its rich fresh fruit flavor.

Fruit pulps and purees can be used directly as a frozen dessert or be made into ice creams, sherbets and frozen bars. Certain varieties, such as apricot puree, may also be useful for sundae toppings and fruit drinks. Ice creams made from frozen pulps and purees have the natural fresh fruit flavor so desired in high quality ice creams and sherbets, and offer the possibility of displacing part of the vanilla and chocolate ice creams now used, as well as the concentrated cooked fruit pre-

ANIMAL HUSBANDRY DEPARTMENT STRENGTHENED

Two New Men Added To Department Staff

The staff of the Animal Husbandry Department of the Station has been augmented by the addition of two new members, Dr. Ralph W. Phillips, new head of the Department, who replaced Dr. W. E. Carroll, who has become head of the Animal Husbandry Department of the University of Illinois, and Dr. R. A. Rasmussen, research assistant professor of animal nutrition.

Dr. Phillips received his undergraduate training at Berea College, Kentucky, and worked for his doctorate at the University of Missouri. While at Missouri he served as research assistant in animal husbandry, doing special work in the fields of breeding and nutrition. In 1933 he became instructor and assistant animal husbandman in the Experiment Station at Massachusetts State College.

For the past three and a half years, Dr. Phillips has been employed at the U. S. Animal Husbandry Experiment Station, Beltsville, Maryland, where he did research work in animal genetics and physiology.

Dr. Rasmussen is a native of Idaho, where he received his undergraduate training at the state university, majoring in agricultural chemistry. He worked for his master’s degree at the Pennsylvania State College and his PhD degree at Cornell University in nutrition. He comes here from the faculty of the University of Missouri.

The addition of these two men to the animal husbandry staff will materially enlarge the research program of the Station in this field and should do much to find ways of improving the livestock industry which is so important in the agriculture of Utah.

(Continued on page 4)
ADVISABILITY OF EXTENSIVE INTRODUCTION OF SOYBEANS INVESTIGATED

Income of 27 to 34 Dollars an Acre Possible

By D. W. PITTMAN

Yields of 22 to 27 bushels per acre of threshed soybeans have been obtained by the Experiment Station on good irrigated land in Utah under favorable conditions. At a normal price of about $1.25 per bushel this would give a total income of $27.50 to $33.75 per acre. It has been found that late varieties of soybeans will not mature in Utah. Early varieties mature easily but do not yield well. Mid-season varieties, such as Illini and Mukden give the largest yield in Utah but run considerable risk of injury by early fall frosts. These facts are the result of tests covering a five-year period conducted by the Agronomy and Soils Department in an investigation of the practicability and desirability of the development of the soybean industry in this state.

The soybean has become a crop of major importance in the United States. The crop is used for forage for livestock. It may be fed in the form of soybean meal to dairy and beef cattle, sheep, hogs and chickens, at least partially to replace such feeds as oatmeal and tankage. Soybeans are also used widely for industrial purposes such as in plastics, paint, paper coatings, paper sizing and for glue, and in many other ways. In the Orient they are a major item of human food. In this country an appreciable volume is used in dog foods and in edible foods, such as meat products and baked goods.

Produced Principally in Corn Belt

The principal soybean producing area is in the corn belt and adjacent states. Investigations at the Experiment Station have shown that if the soybean is to be grown in Utah it should be planted about May 1, and the seed should be inoculated when planted on land not previously in soybeans. Inoculant with instructions for its use, may be obtained from the seed companies.

On clean land, planting soybeans with a grain drill using two bushels of seed to the acre, is preferable to planting with a beet or bean drill with one bushel of seed per acre. But on weedy land planting in 20-inch rows and cultivating is preferable.

The amount and seasonal distribution of irrigation water needed by soybeans is about the same as for corn. The plant is not especially drought resistant and needs much of its water in late summer.

Soybeans should be harvested as soon as most of their leaves have fallen. They may be harvested with a combine or mower and thresher but they are rather difficult to thresh without a special bean thresher because of their tough stems and relatively large seed (compared to wheat.)

No Local Market

There is as yet no local market for threshed soybeans and probably will not be unless some relatively large local industry should be developed to handle them. A press to separate the oil from the cake will be the first requirement. Then some industry to utilize the oil in paint, margarine or plastics will be needed. The cake will find a ready local market as stock feed, as there are already 200 carloads of this feed shipped into the state each year, used mostly by the poultry industry. It may also supplant the cottonseed cake of which a considerable amount is also shipped into the state.

Although soybeans are grown extensively in the middle west for forage they will probably never become an important forage crop in Utah where alfalfa grows so well. It may be found desirable, however, to grow them where a one-year crop is wanted as alfalfa does not mature a crop the year it is planted. Soybeans may be grown along with corn in the same row and used for green feed or as silage.

The question of the introduction of soybeans into Utah should be decided on economic considerations. Soybeans would displace some other crop on good irrigated land. If they bring in more returns or support more people than the crop displaced then the introduction would be economic, otherwise not. Prices and local conditions must determine.

Soybeans growing on the Agronomy Farm. Right are cultivated rows: Left rows planted with a grain drill.
Farm and Home Science
Published Quarterly by the Utah Agricultural Experiment Station
Logan, Utah
R. H. WALKER, Director
GLADYS L. HARRISON, Editor
Address correspondence regarding material appearing in these columns either to the editor or to the author.
More detailed information on the subjects discussed here can often be found in Station bulletins and circulars or may be had through correspondence.

FARM AND HOME SCIENCE

"FARM and Home Science" is published to acquaint farm and home people with the progress of the various experiments being conducted at the Utah Agricultural Experiment Station and to make available to them in non-technical terms the results of this research. Although this publication is intended primarily for the rural people of Utah, anyone interested in the work of the Station may receive it.

The results of experiments conducted at the Station are published in bulletins, circulars and leaflets, and also in scientific journals. Many of these publications are of necessity lengthy and of a highly technical nature. This is quite essential for a complete report of the research but it has been difficult for most people to glean from the reports the essential and useful information for their particular purpose. Furthermore the publications in scientific journals are accessible to only the professional workers, and the material published therein gets back to the farm people very slowly and only by indirect means.

It is also significant that many of the experiments conducted by the Station are of a long-time character and it is necessary to extend them over a five- or sometimes even a ten-year period or longer. In these cases usually there is no publication made of the results until the completion of the experiment. In the meantime the farm people of the state have no way of knowing of the work in progress at the Station nor of the results secured from year to year.

In order to overcome these objections and inherent difficulties in the present publication policy this new publication is being instituted. It is hoped that Farm and Home Science will make clear to the rural people of the state just what the Experiment Station is and what it is doing to help solve their problems.

ORGANIZATION AND PURPOSE OF THE AGRICULTURAL EXPERIMENT STATION

The Utah Agricultural Experiment Station was established in connection with the Agricultural College by the passage of the Federal Hatch Act of 1887 and the Territorial Legislative Act of 1888. Through these acts funds were made available and the Station was authorized "to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiments respecting the principles and applications of agricultural science."

The responsibility of the Station was more clearly defined, and additional funds were provided, by the Adams Act of 1906, the Purnell Act of 1925 and the Bankhead-Jones Act of 1935. Federal funds for the support of the Station are made available under these acts each year. State funds are also made available by the State Legislature through the appropriation to the Utah State Agricultural College for each biennial period.

In general it is the purpose and responsibility of the Experiment Station to conduct experiments that will lead toward a more prosperous, permanent and efficient agriculture, and for the development and improvement of the rural home and rural home life. These objectives are to be attained through the avenues of scientific research.

It is not the purpose of the Station to conduct mere demonstrations of good agricultural practice nor to operate a model farm. Neither can it perform personal services on individual farms. Scientific investigation of unsolved problems confronting the farm and home people of the state is the objective of all work undertaken.

There are approximately 60 persons on the staff of the Experiment Station. Many of these staff members devote a portion of their time to college teaching or extension work, but a few are full time Experiment Station workers. Federal workers located in Logan and Ogden and other places throughout the state cooperate with the Station in the investigation of various problems. The Station work is in progress during the entire year and is conducted in a great many localities throughout the state as well as on the campus and the Experiment Station farm at Logan.

FROZEN FRUIT AND VEGETABLE RESEARCH

(Continued from page 2)

Serves and syrups now used in making fruit ice creams.

Fruit purees and coarse crushed frozen fruits which appear especially promising for ice cream and sherbet uses are Chinese apricot, Carrmen South Haven and Rosebud peach, Montmorency and Morello cherry, Cuthbert and Taylor red raspberry, Marshall strawberry, Santa Rosa plum and Boysenberry. The Cuthbert raspberry, Marshall strawberry, Santa Rosa plum, Boysenberry and Chinese apricot pulps are now sold commercially for ice cream manufacture.

Halved and Sliced Fruits Less Promising

Quick frozen halves and slices of peaches, plums and prunes and apricots do not appear as promised as the berries and fruit purees, because of the rapid oxidation of these fruits after defrosting, and the lack of exchange of acids, flavor, and sugars between the fruits and the syrups, although the fresh flavor and appearance is better preserved than by the canning process.
VALUE OF SUGAR-BEET MOLASSES IN FEEDING OF YOUNG HOGS QUESTIONED

While Older Hogs Fed Molasses Thrived, Younger Animals Did Not Grow As Well As Those Receiving Other Feed

By HARRY SMITH

Recent feeding experiments with hogs point to the conclusion that molasses should not be included in the feeding ration until the hogs weigh at least 100 pounds. While experiments conducted in 1936-37 showed that hogs weighing over 100 pounds fed sugar-beet molasses made slightly higher gains at lower cost than did hogs receiving no molasses, later experiments on younger hogs have produced opposite results.

In the earlier experiments two lots of hogs averaging 122 pounds each were fed different rations. Lot 1 received a ration of barley, tankage and alfalfa hay, while lot 2 received, in addition to these feeds, 25 percent as much molasses as barley. The results showed that the hogs receiving the molasses made slightly higher gains, and made 100 pounds of gain at $1.38 less than did the hogs which received no molasses.

Weights and rations of hogs in feeding experiment, July 11-November 17, 1939

Table based on one average pig

<table>
<thead>
<tr>
<th>Lots</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
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<td>10</td>
<td>10</td>
<td>12</td>
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<tr>
<td>Rations</td>
<td>Barley Tankage (Self fed) Alfalfa Molasses</td>
<td>Barley Tankage (Self fed) Alfalfa Molasses</td>
<td>Barley Tankage (Self fed) Alfalfa Molasses</td>
<td>Barley Tankage (Self fed) Alfalfa Molasses</td>
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</tr>
<tr>
<td>Average weight</td>
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<td>pounds</td>
<td>pounds</td>
<td>pounds</td>
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<tr>
<td>Initial weight</td>
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<td>52.5</td>
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<tr>
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<td>213.1</td>
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<tr>
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<td>149.4</td>
<td>149.0</td>
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<td>171.2</td>
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<td>Average daily gains</td>
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<td>1.25</td>
<td>1.18</td>
<td>1.10</td>
<td>1.35</td>
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<td>Average daily rations</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Barley</td>
<td>5.22</td>
<td>4.57</td>
<td>3.71</td>
<td>3.06</td>
<td>5.60</td>
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<tr>
<td>Molasses</td>
<td>.58</td>
<td>.62</td>
<td>.60</td>
<td>.56</td>
<td>.74</td>
</tr>
<tr>
<td>Tankage</td>
<td>.18</td>
<td>.20</td>
<td>.16</td>
<td>.18</td>
<td>.14</td>
</tr>
<tr>
<td>Feed consumed for 100 pounds of gain</td>
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<td>Barley</td>
<td>384.4</td>
<td>364.5</td>
<td>315.0</td>
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<td>49.3</td>
<td>50.7</td>
<td>51.0</td>
<td>45.8</td>
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<tr>
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<td>16.2</td>
<td>13.2</td>
<td>16.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Feed cost per 100 lbs. gain</td>
<td>4.03</td>
<td>4.50</td>
<td>4.39</td>
<td>4.44</td>
<td>4.62</td>
</tr>
</tbody>
</table>

Feed costs—barley $15 per ton; molasses $10 per ton; tankage $50 per ton; alfalfa hay $9 per ton.

Block salt was kept in all lots but only a negligible amount was eaten.

more, the gains in the molasses fed animals were more costly.

The initial weight of the hogs varied from 40 to 68 pounds. In each group where molasses was fed there were from two to four hogs which did not do well; in lot 3 there was one hog which weighed only 102 pounds and another only 139 pounds, but one weighed 277 pounds at the end of the experiment. In other words, in the groups fed molasses, the hogs finished unevenly, while in group 1 which received no molasses there was not much variation between the heaviest and the lightest. In general, the hogs which failed to do well in the groups fed molasses were the ones which were the smallest at the start, and the ones which did the best were the largest at the start.

Death Loss High

The death loss was also high in the groups fed molasses. Four hogs were lost, one each from groups 2 and 3 and two from group 4. These hogs first began to stagger as though they were drunk, and some, in four or five days, would reach a stage where they could scarcely walk. About one-fourth of all hogs fed molasses became affected in this way, but all but four recovered in a couple of weeks. During this period little or no gain was made. Post mortem examinations were made on the pigs that died by Dr. D. E. Madsen of the Veterinary Department and the cause of their death was described as gastroenteritis, or inflammation of the linings of the stomach and intestines.

Group 5, composed of the pigs left after the other four groups had been selected, were fed the same basal ration as the first group, and in addition molasses was self fed by keeping it in a trough at all times. There were no death losses in this group. The pigs seemed to be in good health at all times, except that there was a tendency for some of them to show rough coats. They consumed about 48 percent as much molasses as they did ground barley which was offered to them in a self feeder. They ate an average of 9 percent as much tankage as molasses and barley.

(Continued on page 11)

Thrifty feeder hogs make the most economic gains
QUALITY OF FROZEN PACK PEAS AND VITAMIN-C CONTENT OF TOMATOES INVESTIGATED IN HOME ECONOMICS LABORATORY

Best Variety and Cooking Time of Peas Decided

By MRS. ALMEDA P. BROWN

FROZEN pack peas cooked eight minutes (actual boiling time) were judged the best by faculty members, laboratory workers, growers and canners and others in an investigation made in the Home Economics Laboratory on the quality of frozen pack peas. Peas cooked in a salt solution with a concentration of one-half of one percent met with the greatest approval, and Morse's Market, dark podded Thomas Laxton, Gradus, and Hundred-fold were the varieties, of the twenty-one tried, liked best by the judges.

At the time these twenty-one varieties were harvested in July 1939, samples were tested in the laboratory for vitamin-C content. Vitamin-C content of raw peas ranged from 8 to 33 milligrams per 100 grams (about 4 ounces) which places some of these varieties in the class with tomatoes as a good source of vitamin C. The effect of freezing on vitamin content and the best way to cook them to preserve vitamin-C content are yet to be investigated.

This study is part of a large project having for its objective the finding of those varieties of fruits and vegetables, suited to Utah soils and cultural procedures, which will retain their esthetic and food values when preserved by the frozen pack method.

Stone Tomatoes High in Vitamin C

Vitamin-C investigations on Stone tomatoes place this variety on the list of good vitamin-C foods which rates it about one-half as good, weight for weight, as the best oranges available on the local market. This study shows a vitamin-C value for this variety of 28 milligrams per 100 grams (about 4 ounces) of tomato. Hence, the home vegetable garden can be made to produce this essential food constituent in abundance, obviating the necessity of purchasing higher priced foods to supply the vitamin C essential in the diet.

The results of this study are soon to be published in a bulletin of the Experiment Station; watch for the announcement in this publication.

PRODUCTION EFFICIENCY

(Continued from page 1)

On the other hand, farmers with crop yields 50 percent above average for the state received labor earnings in Sanpete and Sevier Area of 955 dollars and in Utah County, 1,188 dollars. In the Utah County study it was shown that farmers with twice the yield received labor earnings twelve times greater than the group of low yielding farms. Labor earnings are the returns to the farm operator for his year's labor and management plus the value at the farm of farm products used in the household and the rental value of the farm house.

Size of farm business for each group was about the same.

Labor earnings increased in proportion as crop yields increased for all types of farming studied in these areas. The relationship of productivity to income held for general irrigated farms, part-time farms, dairy farms, poultry farms and for beef cattle and sheep ranches.

Relation of crop yield index to labor earnings Sanpete, Sevier and Utah Counties

<table>
<thead>
<tr>
<th>Crop Index</th>
<th>Labor Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sanpete-Sevier</td>
</tr>
<tr>
<td>Less than 57 percent of state average yield</td>
<td>$105</td>
</tr>
<tr>
<td>75 to 99 percent of state average yield</td>
<td>414</td>
</tr>
<tr>
<td>100 to 124 percent of state average yield</td>
<td>699</td>
</tr>
<tr>
<td>125 to 150 percent of state average yield</td>
<td>750</td>
</tr>
<tr>
<td>Over 150 percent of state average yield</td>
<td>955</td>
</tr>
</tbody>
</table>

* Crop index based on average yields for the state for the period 1926-1931 = 100. A crop yield index for an individual farm or group of farms is the percentage these yields are of state average yields.

A study of poultry farms in Utah with less than 125 eggs per hen showed a loss of 68 cents per hen, while farms with egg production of more than 176 eggs per hen had a net profit of 45 cents per hen.

On sheep ranches in the Uinta Basin with the percentage lamb crop below 70 percent, the operator had a labor income of minus $507, while the ranches with lamb crop of more than 70 percent had a labor income for the operator of $753.

Other Measurements of Farm Efficiency

Other measurements of farm efficiency were also related to crop yields. These relationships showed that the farmers who had high crop yields were also more efficient in the care of their livestock and other farm practices. The farms with high crop yields showed also higher butterfat per cow, higher percentage lamb crop, and more wool per head of sheep. There was also a decidedly lower death loss of sheep and beef cattle on farms with higher crop yields.

According to the results of these economic studies, the farmer should have crop yields equal or above average for the state if he expects to have a paying business, or receive reasonable returns for his labor. In most cases the farmers who received the highest labor earnings had also crop yields about 50 percent above those of their neighbors or the average for the state.

In areas where crop yields are low or below average, it is necessary to increase the size of the farm and reduce the cost of production to secure farm income equivalent to those of farmers with high yields on the average sized farm.

The economic study of farms in Utah County may be obtained in bulletin form by writing to the Experiment Station. Ask for Bulletin 289. Other studies mentioned in this article are either out of print or not yet published. Watch for the announcement of publication of the Sanpete-Sevier study.

During January 1940, 1,892 bulletins were sent out by the Publication Office on the written request of 404 persons. Three hundred and seventy-five requests were from people in the United States, 92 being from Utah. Twenty-nine requests were received from foreign countries. These requests are in addition to the bulletins sent out on the regular mailing list and those requested by individuals calling at the Bulletin Office.
TOO EARLY GRAZING INJURES RANGE VEGETATION

Studies Made Show That the Ability of the Plant to Increase In Size, Especially in Root Spread, To Store Food, and To Produce Seed—All Diminished By Too Early Or Too Heavy Grazing.

By L. A. STODDART

Stockmen face a critical period of range management in the spring of the year, usually between March 15th and June 15th. During this period the animals on dry feed are anxious to get onto fresh green feed, and those on the winter and spring ranges are becoming short of feed.

This spring period which is so critical to the livestock is also critical to the range. At this time of year the snow melts and the soil becomes saturated. Wet soil is damaged by trampling of livestock and, also, the young plants are easily uprooted as the animals attempt to eat them.

Most important of all, however, is the effect of early grazing upon the body functions of the range plant. Plants behave very like animals in that they breathe, drink, eat, store food reserves, and grow. Plants hibernate or become dormant during the winter just as many animals do and during this period they live on stored food. Plants store food in their roots, mostly in the form of starch. The leaves of a plant are its source of food. It makes sugar in the leaves out of the carbon of the air, sunlight, and water. Much of this food is, in turn, stored in the roots as a reserve from which next year's leaves are made.

The food is manufactured in proportion to the amount of leaves the plant supports, so, if animals eat part of the leaves, the food storage is diminished. Fortunately plants are well adapted to rapid regrowth, and usually they are easily able to overcome the effects of leaf removal by grazing animals. In the early spring, however, there is a low root storage reserve since most of the food has been used to produce leaves and, if the leaves are grazed then, there is little regrowth possible. For this reason, if range plants are to make a good growth they must be allowed a few weeks immediately after their first spring growth in which to replenish their root storehouse before grazing animals are allowed to remove the leaf food factories. Thereafter, if they are not grazed too frequently as a result of excess stock, they can make satisfactory growth.

Among the important plant body processes which are affected by excessive and too early grazing is seed formation. Misuse results in small, weakened, plants which have only a fraction of the normal seed crop. They may form seed heads which appear normal but examination will show practically no seeds formed within the head.

**Comparison of Grass on Heavily and Late Grazed Range**

Studies have recently been made by the Utah Agricultural Experiment Station in which the grass produced on two ranges was compared. The two areas were comparable in all respects except that one had been heavily grazed throughout the growing season and the other had not been grazed at all during the spring. Measurements of the density of wheatgrass on the two areas showed 2,343 square feet of grass per acre on the late grazed and only 248 square feet on the early grazed area. The late grazed grass averaged 26 inches in height compared to 20 inches for the early grazed. The late grazed range had about 17 times as many seed stalks and 52 times as many viable seeds per acre. This means that there was 52 times as much opportunity for a new plant to become established.

Further studies were made upon the roots of plants from the two ranges. It was found that the roots of the late grazed plants averaged 26 inches in depth compared to 17 inches for the early grazed. This difference of 9 inches in root depth would be very important to the plant in resisting dry periods since it could reach farther into the moist soil. The later grazed plants not only had deeper roots but their root systems were calculated to weigh more than six times as much.

Chemical analyses of the roots of grasses showed very significant differences between the heavier and earlier growth of the birds, and if not identical with, the piosis that affects chicks and young pouls is a common ailment of flocks in the intermountain area. The disease is characterized by a bony enlargement of the hock joint with a twisting or bending at that joint so that the leg is thrown off alignment. Most birds so affected finally succumb as the result of cannibalism or the inability to obtain food.

An analysis of the blood serum in five flocks where this disease occurred has shown that the serum calcium of affected turkeys is less than that of normal turkeys, whereas the serum phosphorus of affected turkeys is increased over that of normal turkeys. Forty-two affected birds and 274 normal birds were used in this study. Females were found to be seldom affected.

Although this study has shown a disturbance of normal calcium-phosphate relationships of the blood, it has not progressed sufficiently to explain the manner in which this difference functions. Recently completed tests at the Utah Agricultural Experiment Station have shown that the addition of 6 percent bone meal to a ration generally considered to be adequate in calcium and phosphorus has a tendency to produce this bone deformity. It seems likely that the disease results from some disturbance in mineral balance, but the minerals involved and those which are in excess or deficient are not yet well understood.

Keeping stock on farm pastures in the spring helps the range

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SERIOUS WATER SHORTAGE

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for the purpose of securing necessary basic data for use in the analysis of precipitation-runoff relationships. The object of the snow surveys is to secure measurements of accumulated water in snow storage which, together with other supplementary meteorological and physical data, will furnish the basis for forecasting runoff from Utah watersheds in advance of the planting season, in order that the farmer may so plan his operations as to utilize to a maximum the available water supply.

A study of the precipitation-runoff relationships was begun by the Utah Agricultural Experiment Station in 1923, and the first measurements of snow cover were made during the winter of 1923-24 on the Logan River watershed. These measurements have been continued to date. The early studies on the Logan River watershed indicated that each drainage area was so distinctively different that the snow-cover-runoff relationships needed to be worked out for each watershed. This necessitated the establishment of snow surveys on individual watersheds.

The Utah Cooperative Snow Surveys, established in 1930, were first conducted under an informal agreement between the Utah Agricultural Experiment Station, the U. S. Forest Service and the U. S. Weather Bureau. Later the state engineer became actively interested and through an act of the State Legislature procured funds to aid in the conduct of the surveys and streamflow forecasts. Water commissioners under the direction of the state engineer, park rangers from the Park Service and municipalities later joined in the work. In 1935 the U. S. Bureau of Agricultural Engineering became interested and procured a federal appropriation which enabled them to cooperate with the states by furnishing equipment, and payroll budget necessary in the conduct of snow surveys. This bureau became the coordinating agency between states and made possible streamflow forecasts on interstate streams. There are now 83 snow courses being measured annually in Utah and approximately 700 in the 11 western states.

The first tangible benefits resulting from snow surveying were evident in 1931. During that year the snow-cover conditions on the watersheds in northern Utah indicated such a pronounced water shortage that the Amalgamated Sugar Company and the Franklin Sugar Company withheld their contracts for sugar beets until the water-supply forecast was available. This forecast indicated a water shortage and as a result the contracts were limited. The inadequate water supply during the summer of 1931 justified the restricted planting.

By 1934 there were 10 years of snow-cover records available on the Logan River watershed and 4 years on the other principal watersheds of the state. Either of these records was much too short to form an adequate basis for a water-supply forecast; yet in the spring of 1934 it was evident from the limited data available that Utah faced a water shortage, greater than it had ever before experienced. The forecast issued on April 1, 1934, indicated a water supply which would not exceed 35 percent of normal and on many watersheds considerably less. With this information available, immediate steps were taken by the state administration, under the direction of Governor Blood, to develop a water conservation program under which water users were contacted and urged to consolidate their irrigation streams, and to limit planting so that those crops which were planted might be matured with the limited water supply. At the same time a program for the development of supplementary water supplies for irrigation and municipal use was inaugurated through the facilities of the FERA. Having advance information with respect to the water shortage, it was possible to develop this program in time to furnish supplementary water before the crops burned up. Under this program about 400,000 acre-feet of supplementary water were developed in time for use.

On the Bear River system alone the program of water conservation and the development of supplementary water supplies were responsible for the saving of crops to the extent of $2,000,000 and over the state as a whole the saving, exclusive of livestock, was estimated to be $5,000,000. The benefits of advance information in the form of water-supply forecasts are thus evident.

Information obtained from snow surveys is fundamental and necessary to a program of maximum land and water use. It is necessary to the state engineer for the proper and efficient administration of the state’s water resources. It is necessary to the farmers in their crop planning, and through the farmers such information vitally affects industry, banking, commerce and social welfare.

New experimental greenhouses in use at the Experiment Station during the past winter for the first time. Each house is 25 feet wide and 75 feet long. In the far end, but not shown in the picture, is a rather substantial head house used by the Departments of Agronomy, Horticulture and Vegetable Crops, for planting, plant propagation, soil work, and also for other types of experimental and class work closely related to the greenhouse experiments. The greenhouse is used extensively for plant breeding work with grasses and cereals, soil fertility trials, experiments with vegetable crops production and fruit breeding.
MANY of the Concord vineyards throughout the state are severely affected by the nutritional disease called chlorosis. This disease occurs usually in localized areas where soil conditions prevent the proper absorption or utilization of iron by the plants, and is characterized by the resulting yellow color of the leaves. Chlorotic vines are weak in vigor and eventually die unless iron is supplied to the canes or leaves. Several methods have been used successfully to accomplish this, among which may be mentioned spraying the leaves with dilute iron sulfate solution, injection of dry iron citrate into the cane, and placing large quantities of iron sulfate in the irrigation furrow. These and other similar control measures, however, are merely temporary in their effect and a more permanent method of control is therefore desirable.

In an effort to obtain such a method three possibilities have been investigated at the Utah Agricultural Experiment Station by the author and the late Dr. A. L. Wilson, as follows: (1) selection for chlorosis resistant strains of Concord; (2) testing varieties for resistance to chlorosis; (3) use of chlorosis resistant roots for Concord scions.

The selection studies were based on certain principles of general vineyard practice as well as on numerous observations in chlorotic plantings. In obtaining cuttings for new vineyard plantings it is usually recommended by experienced growers as well as by specialists in this field that only healthy, vigorous, heavy-bearing vines in clean vineyards be selected as mother plants. It is assumed that such a selection will insure the production of high yielding, vigorous progeny and a clean, healthy new vineyard. While in general the practical experience of vineyardists may show that this assumption is well grounded, actual experimental tests indicate that there is a limit to the number of characteristics we may expect the progeny cuttings to inherit from the mother plant. It appears that general vigor and productiveness are not necessarily passed on to the progeny but that these are largely the result of proper rooting of the cuttings and cultural care of the plants.

Survival of Healthy Plants on Chlorotic Soils

With respect to chlorosis it has been observed in many Concord vineyards that occasional rows or groups of vines may be severely chlorotic whereas adjacent rows or vines are healthy and green. When the chlorotic plants die out it might be assumed on the basis of the general practice noted above that the missing vines could be replaced by laying down a vigorous cane from the adjacent green plants or by planting cuttings from vigorous vines from other portions of the vineyard. Experiments were therefore conducted to determine whether or not the green plants in chlorotic areas possess a characteristic or quality of resistance to chlorosis which can be transmitted to progeny vines by cuttings. In this test over 4,000 cuttings were selected from vines throughout the state and propagated in the campus vineyard. Many of the mother plants which supplied the cuttings were vigorous green plants located in vineyards having chlorotic areas; other cuttings were from vines showing varying degrees of chlorosis. All cuttings received the same cultural treatment in nursery and vineyard. In their second year the cuttings were set in rows in the vineyard which occupies a plot of chlorotic soil on the college campus. Cuttings from all the selections involved in the test became chlorotic in this vineyard. At the end of four years only 148 of the plants were still alive and most of these were severely chlorotic. The results indicate that chlorosis is definitely caused by soil conditions and that the appearance of chlorosis in cuttings is a response to these soil conditions rather than to the original character of the mother vine. Attempts to fill in missing vines in chlorotic vineyards with cuttings from green plants would thus seem to be fruitless.

Variety Tests

The variety tests were also conducted in the campus vineyard at Logan and included 6 labrusca varieties, 12 labrusca hybrids and 3 vinifera varieties. All of the labrusca varieties and hybrids were more or less chlorotic, Worden and Fredonia being the only promising ones. The vinifera varieties, however, were green and vigorous in this location. This result is in harmony with many general observations throughout the state which indicate that most of the vinifera varieties grown here are resistant to chlorosis.

The general resistance of vinifera varieties to chlorosis suggested the possibility of using these varieties as rootstocks for Concord scions in chlorotic areas. Trials conducted at the Experiment Station demonstrated that Concord scions would remain green and make vigorous growth on vinifera roots whereas Concord cuttings on their own roots soon died. The explanation is associated no doubt with some physiological difference in root activity in the two types of varieties, though this remains to be demonstrated.

Success of Vinifera Rootstocks

The vinifera varieties which have been successfully used in this connection are, among others, Tokay, Muscat, Malaga, Black Prince and Rose of Peru. The last mentioned root has produced the most vigorous vines, whereas Black Prince seems to be least desirable from the standpoint of vigor. Tokay, Muscat and Malaga roots have all produced vines of good vigor and color.

The use of grafted plants would appear to be a particularly promising method of renewing the vineyard. Where weak and missing vines occur in Concord plantings as a result of chlorosis these spaces cannot be filled in successfully by replacing with other Concord cuttings. However, a Concord scion on a vinifera root has a fine chance of surviving and producing a vigorous vine in such locations. Thus eventually the various "chlorotic spots" of the

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FARM LOSSES FROM WEEDS GREATER THAN FROM ALL OTHER PESTS

Weed Control Program Outlined

By R. J. EVANS

The report of the Agricultural Committee of the United States Chamber of Commerce shows an annual loss from weeds of three billion dollars and a total from all other agricultural pests, including animal and plant diseases and insect pests on crops and livestock of two and one-half billion dollars. There is no information available on the estimated losses from weeds in Utah but it is quite generally agreed that the loss is proportionately higher in states where irrigation is practiced than in the country as a whole. The greatest problem in Utah comes from the group of weeds which have been declared noxious by the State Board of Agriculture, the principal ones being whitetop, wild morning glory, Canada thistle, Russian knapweed and perennial sow thistle.

In 1937 the State Legislature appropriated 110,000 dollars for noxious weed eradication. A comprehensive program, approved as a W. P. A. project, was adopted with the State Agricultural Correlation Committee as sponsors. The project organization consisted of a state committee with a supervisor in charge of field operations, and a county committee in each participating county consisting of one or more county commissioners, the president of the county Farm Bureau, the county agricultural agent, the district agricultural inspector and the W. P. A. engineer. The salaries of county weed supervisors, appointed for each county in the state, is paid from the legislative appropriation. Labor and material to carry on the work on public lands, irrigation canals, highways, water courses is furnished by the W. P. A. The state pays half the cost of chemicals in addition to furnishing the supervisory force. Part of the money appropriated was allotted to the State Land Board to participate in the program of cleaning up state-owned lands, and part to the Crop Improvement Association to aid in the prevention of the distributing and planting of weeds with farm seeds.

About 13½ percent of the money was allocated for experimental work to determine the most efficient ways and means of weed eradication and control, which is being done under the direction of the Agricultural Experiment Station. Seven experimental farms located in Box Elder, Utah, Sanpete, Sevier, Wasatch and Uintah Counties were established in 1937 and 1938 to determine the best methods of weed control. Work on the control of whitetop, morning glory, Canada thistle and perennial sow thistle is being carried on at these stations.

The Agricultural Experiment Station also has the responsibility of checking on the fields worked under the general eradication program, and advising as to when they should be turned back to cropping. In 1939 a total of 1,130 acres were checked, of which 917 acres were recommended to be turned back to cropping and 212.5 acres were recommended to be continued in the program.

The program for 1940 is now well underway. A one-week's training school for county supervisors was held at the College February 19th to 24th. At this school all details of the work were discussed and a course in weed plant and seed identification and control was conducted. Thirty-two supervisors participated in the school.

The proposed methods of weed eradication as recommended by the Utah Agricultural Experiment Station and discussed at this school are as follows:

Recommendations for 1940 Weed Program

1. That sodium chlorate or atlatcide be used on ditch banks, non-movable fence lines, or clay or gravelly lands which cannot be cultivated, and on roadways. That it be applied as a powder in preference to spray, and that the rate of application be applied as follows: For white top and knapweed 4 pounds per square rod any time from early spring till early fall. This dose may have to be repeated in the fall where first application was applied in the spring or the next spring where the first application was applied in the late summer or fall.

2. That carbon bisulfide be used only on small patches which occur on the better farm lands. Poor results may be expected on heavy clay, gravelly or coarse sandy soils and on soils too wet or too dry. Avoid early spring or late fall application. Labor and equipment should be furnished by W. P. A. to do the work.

3. That clean cultivation be the rule on all cultivatable land accessible to such methods. Generally the work is most effectively done by power machinery. Deep fall plowing is preferable to prepare the land for early spring cultivation. If plowing is done in the spring, it should be done early, and cultivation started as soon as plant growth occurs. Fields should not be cultivated when the soil is too wet. Soil should be kept moist and in good condition to stimulate rapid plant growth. Late spring plowing is to be discouraged. Cultivators should be strongly built especially when pulled by tractors. Cultivations should be at 10 to 14 day intervals except when the plants become weakened; then the intervals between cultivations may be lengthened. Short regrowth between cultivations is not serious. Young seedlings should be cultivated as they emerge.

Cultivation should be 3 to 5 inches deep and should not leave ridges. Cultivators should be kept in first class condition at all times. The blades should be sharp and reserve sets supplied to change as needed. Poor results may be expected when any of these rules are violated.

4. Three year contracts should be signed with the land owners who come into the program. This contract should provide that the land may be returned to cropping at the end of any year when the local committee is convinced that the weeds are sufficiently destroyed to warrant this return, but the first year's crop grown should be approved by the committee and the weed supervisor should check these fields as he does those still under clean cultivation.

Wild morning glory growing in a sugar beet field