Bighorn sheep once roamed the Western deserts and mountains in great numbers, but the range needs of livestock, the diseases of domestic sheep, and wanton killing have driven them to the few remaining areas of relative wilderness. The rugged canyon country of southeastern Utah still harbors some of the most prized game animals in North America. Quickened interest of sportsmen and conservationists has resulted in efforts to expand their numbers in the southeastern Utah area (see the June 1968 issue of Utah Science) and reintroduce them to their former habitat in the Wasatch Mountains. The efforts of Utah Fish and Game Personnel to stock the bighorns in the mountains near Brigham City, Utah are briefly described in this issue of Utah Science.
Bloat on dry alfalfa hay
and legume pasture

C. R. Acord, J. E. Butcher, and D. W. Thomas

Bloat, disorder of sheep, goats, and cattle, is characterized by an abnormal distention of the rumen by gas produced by rumen micro-organisms and impairment of the eructation (belching) mechanism.

Of all diseases effecting these farm animals, bloat is perhaps one of the most perplexing. It is a single manifestation of a condition usually caused by interactions between ruminant physiological peculiarities and certain feed components.

Frothy bloat, caused by feeding alfalfa, creates considerable financial loss to Utah livestockmen each year. It often occurs in the spring and fall on green alfalfa pasture. In certain areas of Utah, however, bloat even occurs when cattle are fed dry alfalfa hay.

WHAT CAUSES BLOAT

Legume plants, high in nitrogen, cause much more bloat than non-legume plants. Bartley & Bassett (1961) from their analyses of alfalfa bloat foams reported that the foaming constituent is primarily proteinaceous. McArthur & Miltimore (1964) have isolated from alfalfa leaves a protein with physical and chemical properties that make it an ideal bloat promoting agent. McClay & Thompson (1955) demonstrated that plants producing bloat have a higher content of saponins than plants with few or no bloat promoting properties. Studies of Bartley & Yadava (1961) found saliva, and more specifically mucin in the saliva, to be an effective antifoaming agent. Van Horn & Bartley (1961) added saliva to incubated frothing rumen contents and found that the additional saliva permitted greater quantities of gas to escape.

The purpose of this study was to determine if: (1) bloat can be controlled in ruminants by feeding poloxalene (an anti-bloat compound) in the block form when cattle are fed alfalfa hay, and (2) bloat can be controlled on pasture by feeding poloxalene in block form or as a top dressing on grain.

ALFALFA HAY STUDY

Four cooperators contributed a total of 346 calves, averaging about 364 pounds each. Each cooperator had experienced bloat problems with their stock. The calves were divided

Figure 1. This Hereford steer is suffering from a severe case of bloat.

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J. E. Butcher is Professor of Animal Nutrition in the Animal Science Department. D. W. Thomas is Extension Veterinarian.

March 1969
into a control and treated group on each cooperator's ranch. Control calves numbered 138 and 208 calves were treated. All calves were given, ad libitum, alfalfa hay and 1 pound of rolled barley per head per day.

The treated calves were offered a salt-molasses block containing 30 grams of poloxalene per 1 pound of block. The control calves received a salt-molasses block without poloxalene. The salt-molasses blocks were placed in the pens at the rate of one block per five head of calves. When the block was approximately 50 percent consumed, another block was added. Weekly consumption records were kept. Cattle were checked daily for severity and incidence of bloat, as well as death. The cattle were adjusted to the respective salt-molasses blocks for a week prior to the test. Severity of bloat was assigned scores according to Johnson et al. (1958).

RESULTS AND DISCUSSION

Average daily consumption of the respective salt-molasses block by treated and untreated groups is shown on each ranch in Table 1. The daily average daily consumption of the untreated groups was .22 pound and .344 pound for the treated group.

The incidence of bloat at each ranch is indicated in Table 2.

Ten calves in the untreated group bloated (7.2 percent), but only three calves in the treated group bloated (1.9 percent). The difference of bloat between the treated and untreated was 5.4 percent and was significant (P<.05). The test suggests that the poloxalene helped reduce the incidence of bloat in these trials.

### Table 1. Average consumption of salt-molasses block on dry alfalfa hay

<table>
<thead>
<tr>
<th>Rancher</th>
<th>Days on trial</th>
<th>Number cattle</th>
<th>Avg daily consumption block/head-lb</th>
<th>Number cattle</th>
<th>Avg daily consumption block/head-lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30</td>
<td>41</td>
<td>.30 .08 .20</td>
<td>62</td>
<td>.264 .132 .180</td>
</tr>
<tr>
<td>B</td>
<td>26</td>
<td>33</td>
<td>.508 .172 .254</td>
<td>55</td>
<td>.362 .154 .180</td>
</tr>
<tr>
<td>C</td>
<td>30</td>
<td>39</td>
<td>.244 .218 .226</td>
<td>21</td>
<td>.536 .236 .354</td>
</tr>
<tr>
<td>D</td>
<td>55</td>
<td>25</td>
<td>.136 .244 .16</td>
<td>70</td>
<td>.344 .2 .262</td>
</tr>
<tr>
<td>Total</td>
<td>138</td>
<td></td>
<td></td>
<td>208</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Summary of bloat on dry alfalfa hay

<table>
<thead>
<tr>
<th>Rancher</th>
<th>Number cattle</th>
<th>Bloat incidence</th>
<th>Number cattle</th>
<th>Bloat incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>41</td>
<td>0</td>
<td>62</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>33</td>
<td>3</td>
<td>55</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>39</td>
<td>1</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>25</td>
<td>6</td>
<td>70</td>
<td>1</td>
</tr>
</tbody>
</table>

Percent of calves bloating: 7.2% for untreated and 1.9% for treated.

### Summary

Three hundred forty-six calves, weighing approximately 364 pounds each, were fed alfalfa hay, ad libitum, and 1 pound of rolled barley per head per day. Two hundred eight were offered a salt-molasses block containing...
30 grams of poloxalene. Bloat incidence was 1.9 percent. The other 138 calves (controls) were given a salt-molasses block without poloxalene. Bloat incidence was 7.3 percent.

Sixty calves, weighing 475 pounds, were randomly divided into three lots and grazed for 125 days on an alfalfa-orchard grass pasture. Lot 1 received a salt-molasses block without poloxalene; lot 2, a salt-molasses block with 30 grams of poloxalene per 1 pound of block; and lot 3, a poloxalene premix top dressing of 1.5 grams per 100 pounds of body weight with .226 pound of rolled barley twice daily. Lots 1, 2, and 3 had a bloat incidence of 27, 3, and 0, respectively.

Alfalfa forage is of prime importance for livestock, and it often causes bloat in ruminants. If bloat can be controlled, as these tests indicate, then ranchers can realize increased animal units per acre, decreased hazard of livestock losses, increased net return, and can obtain full utilization of alfalfa for pasture.

### Table 3. Results of bloat on irrigated pasture

<table>
<thead>
<tr>
<th>Date</th>
<th>Untreated group</th>
<th>Treated group (block)</th>
<th>Treated group (top dressing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/16</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7/10</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7/14</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>7/28</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/6</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/11</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/19</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/27</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

* Significant (P < .05)

### Table 4. Summary of bloat incidence in 60 beef animals receiving different bloat prevention treatments while on irrigated pastures – 1967

<table>
<thead>
<tr>
<th>Number of calves</th>
<th>Incidence of bloating Number</th>
<th>%</th>
<th>Number of calves</th>
<th>Incidence of bloating Number</th>
<th>%</th>
<th>Number of calves</th>
<th>Incidence of bloating Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated*</td>
<td>20</td>
<td>27</td>
<td>135</td>
<td>20</td>
<td>3</td>
<td>15</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Treated (medicated block)**</td>
<td>20</td>
<td>20</td>
<td>3</td>
<td>15</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* Bloat in two calves was classified as severe. Others experienced moderate to slight cases of bloat.

** Bloat was classified as slight in three calves.

### LITERATURE CITED


Salty popcorn is great. Salty soil is trouble. And Utah has 11 million acres of so-called salt desert land. This amounts to about 21 percent of the state. Most of Utah’s salt desert is publicly (government) owned. Which means that all of us have a stake in what happens to it. An element of self-interest thus helped motivate scientists in USU’s Ecology Center to try to find out more about the nature of these lands.

One project, led by Dr. Neil West, has centered in Curlew Valley, an area about 20 miles southwest of Snowville, Utah. The saltiness of the soil there is caused primarily by the presence of large quantities (several thousand parts per million) of sodium, potassium and calcium chlorides, sulfates, carbonates, and bicarbonates. The main plants growing in the bottom of Curlew Valley are shadscale, greasewood, saltsage, gray molly, winterfat, and halogeton.

The ecologists and graduate students working in Curlew Valley have about decided that nature is playing one of her practical jokes on man with her salt desert plants. Those such as winterfat and gray molly, which are nutritious and well-liked by domestic and wild animals, are least able to compete. By contrast, the less desirable plants such as halogeton and greasewood, which are actually poisonous, seem to enjoy more than a fair share of nature’s favors.

For example, winterfat seeds must germinate within a year, or have a slim chance of ever germinating at all. Germination has to occur in the spring, immediately after the snow melt has removed much of the salt from the top few inches of soil. If the salt isn’t removed, the seedling will die because its salt tolerance is very low for 3 to 4 months.

On the other hand, halogeton may produce either or both of two kinds of seed at the rate of 75 seeds/inch of stem. One, black in color, appears late in the growing season. These seeds have the same time requirements (within 1 year) for germinating as do the winterfat seeds. But many halogeton plants insure their propagation by developing a second seed crop. These are brown and remain viable almost indefinitely (as least 10 years). They thus can germinate in whichever year provides favorable conditions.

The anatomy and physiology of the mature plants show the same pattern. Winterfat and gray molly are gradually being crowded out of the salt deserts because all of their growth is soft and palatable. Shadscale and greasewood, however, are spiny enough to prevent better than one-half of each year’s new growth from being grazed. In addition, halogeton as well as greasewood not only survive on unusually salty soil, they prosper most when the salt concentration is 5800 parts per million, or higher.

Halogeton has a further advantage because its seedlings can tolerate salt levels that would be fatal to most other young plants. Even when dead, halogeton contributes to continued success. The dead plants return large quantities of sodium to upper soil levels. The area’s low precipitation levels then allow most of this salt to accumulate year by year until seeds from other plants simply can’t germinate.

USU’s ecological studies of Utah’s salt deserts are giving new insights into the precarious balance that exists between such land and its plants. They are also calling attention to the major disruption of that balance that could follow any relatively minor changes in precipitation patterns, such as expected from weather modification activities.

Figure 1. Greasewood discourages grazing.

Figure 2. Halogeton sucks salt from the soil.

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LOIS M. COX

6
In addition to facing high costs and low profit margins in raising beef calves, farmers and ranchers in some areas of Utah are experiencing increased feed costs and decreased numbers of grazing units on public lands. Others are finding a decreased demand for cash crops, even to the extent of some cash crop factories being discontinued. Confronted with such situations, many are having to look to other alternatives for maintaining a living.

**ALTERNATIVES**

As alternatives they may: (1) sell out and seek other employment; (2) strive to improve their position through greater integration with feeders and retailers; or (3) undertake more efficient use and management of land resources at hand to produce more meat per unit of land and thus offset increased capital and current expenses. The latter alternative focuses attention on the possibility of more efficient use of irrigated pastures as a means of bolstering farm income.

The idea of grazing beef cattle on irrigated pastures is not new. In an Experiment Station Field Day Report given at Pleasant Grove, Utah, in August 1959, Lorin E. Harris et. al. indicated that from 1,249 to 1,705 pounds of beef gain per acre could be obtained on such pastures in a growing season. They had found that the amount of production depended largely on the treatment of the pasture and management of the cattle.

To produce large gains required pastures with a high legume content, however, which also presented serious bloat problems. For example, in 1966 eight head of cattle were lost in 2 days on a 6.2-acre test pasture in the Palmyra area of Utah County. The pasture had been seeded at 8 pounds orchard grass and 3 pounds alfalfa per acre. In 1967 a study was begun on this pasture to investigate the bloat problem and pasture production. How the bloat problem was corrected by treating with poloxalene is discussed in another circle, "Bloat on Dry Alfalfa Hays and Legume Pasture", in this issue of Utah Science. The present article aims to show the kinds of gains and returns one might expect from beef cattle grazing properly managed irrigated pastures.

**GAIN STUDY**

The 6.2-acre Palmyra pasture was designated as pasture A. It was treated with 66 pounds of available nitrogen in 1967 and irrigations were scheduled every 14 to 21 days depending on when water was available. On May 6, 60 steers and heifers, weighing an average of 475 pounds, were put on the pasture. It was divided into three sections with 20 head of cattle per section. Each section was then subdivided to provide intensive grazing. The cattle stayed on a subsection no longer than 5 or 6 days.

**Table 1. Average gains of 60 beef cattle (steers and heifers) on 6.2-acre irrigated pasture at Palmyra, Utah County, during summer 1967**

<table>
<thead>
<tr>
<th>Item</th>
<th>5/6-6/17</th>
<th>6/18-7/14</th>
<th>7/15-8/14</th>
<th>8/15-9/9</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days in period</td>
<td>42</td>
<td>26</td>
<td>39</td>
<td>25</td>
<td>123</td>
</tr>
<tr>
<td>Avg wt/animal</td>
<td>555.2</td>
<td>587.8</td>
<td>612.8</td>
<td>640.0</td>
<td></td>
</tr>
<tr>
<td>(lbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg gain/animal</td>
<td>80.2</td>
<td>32.6</td>
<td>25.0</td>
<td>27.2</td>
<td>165.0</td>
</tr>
<tr>
<td>(lbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg Daily gain/</td>
<td>1.90</td>
<td>1.25</td>
<td>0.83</td>
<td>1.04</td>
<td>1.23</td>
</tr>
<tr>
<td>animals (lbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* (Avg initial weight – 475 pounds)
Each subsection was allowed to rest for 25 to 30 days before regrazing.

Gains were checked every month until the study was concluded on September 8. The results are shown in table 1. During the 123 days that the 60 steers and heifers were on the 6.2-acre pasture, they gained a total of 9,915 pounds or 1,599 pounds of beef per acre. If we estimate the value of beef produced at $25 cwt, each acre of pasture grossed a return of $399.75. Significantly, the 9.8 steers per acre were grazed for the 123-day period with no loss from bloat. The cattle treated with poloxalene did not bloat.

**IMPLANTATION GAINS**

In 1968 the pasture study, employing similar rotation and irrigation practices, was expanded to test the added advantage of diethylstilbestrol implants. The steers and heifers were also pastured separately. Thirty-four steers, averaging 380 pounds, grazed a 7-acre pasture in Heber Valley, Wasatch County. This 7-acre piece was designated pasture B. It contained a mixture of grasses seeded at 10 to 11 pounds per acre and alfalfa at 3 pounds. Sixty-nine heifers, averaging 520 pounds, grazed pasture A which had been expanded to 8.7 acres.

One third each of the steers and heifers on these improved pastures received different treatments: control, 15 mg, and 30 mg. The steers received the implants June 27 at the beginning of the study and the effects were checked at intervals during the 123-day grazing period. The heifers were implanted on July 17 and had the benefits of the implants for a 76-day period.

The over-all gains obtained may be seen in tables 2 and 3. The steers gained an average of 287.5 pounds or a total of 9,775 pounds in 123 days. That amounts to a production of 1,369 pounds of beef or $342.25 gross per acre (at $25 cwt). The heifers gained an average of 219 pounds of 15,111 pounds total in 151 days of grazing, making 1,736 pounds of beef or a gross return of $434 per acre for the season. It should be noted, however, that during the test period these heifers also were fed daily 2 pounds of rolled barley with poloxalene at 1.5 grams per 100 pounds of body weight to control bloat.

Data indicating advantages of the implants are shown in tables 4 and 5. Note that the 15 mg and 30 mg implants increased the daily gains of the steers over the controls by 10.6 and 21.8 percent respectively. This treat-

<table>
<thead>
<tr>
<th>Table 2: Average gains of 24 beef steers on 7-acre irrigated pasture at Palmyra, Utah County, during summer 1968*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing period</td>
</tr>
<tr>
<td>Days in period</td>
</tr>
<tr>
<td>Avg wt/steer (lbs)</td>
</tr>
<tr>
<td>Avg wt gain/steer (lbs)</td>
</tr>
<tr>
<td>Avg daily gain/steer (lbs)</td>
</tr>
</tbody>
</table>
*(Avg initial weight — 480 pounds)*

<table>
<thead>
<tr>
<th>Table 3: Average gains of 69 heifers on 8.7-acre irrigated pasture at Palmyra, Utah County, during summer 1968*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing period</td>
</tr>
<tr>
<td>Days in period</td>
</tr>
<tr>
<td>Avg weight/heifer (lbs)</td>
</tr>
<tr>
<td>Avg gain/heifer (lbs)</td>
</tr>
<tr>
<td>Avg daily gain/heifer (lbs)</td>
</tr>
</tbody>
</table>
*(Avg initial weight — 530 pounds)*

<table>
<thead>
<tr>
<th>Table 4: Average increases in gains and dollar value for 123-day period from use of stilbestrol implants on 34 steers grazing 7-acre irrigated pasture at Heber Valley, Wasatch County, Utah during summer 1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>Avg lbs gained/steer</td>
</tr>
<tr>
<td>Avg daily gain</td>
</tr>
<tr>
<td>Percent daily gain increase over control</td>
</tr>
<tr>
<td>Avg gain over control/steer (lbs)</td>
</tr>
<tr>
<td>Dollar value over control (at $25c/lb)</td>
</tr>
<tr>
<td>Effect of stilbestrol on avg daily gain (lbs)</td>
</tr>
</tbody>
</table>

Note: The author acknowledges and expresses thanks to Paul Daniels, County Agent; Marion Sorenson and Lloyd Lawton for their help in furnishing cattle, pastures and weighing of cattle; to Dr. D. W. Thomas for arranging for stilbestrol implants; and Hess & Clark, Ashland, Ohio, for furnishing the stilbestrol implants.
ment produced 37.3 and 63.3 more pounds of beef per animal respectively, or cash returns above the control group of $9.33 and $15.33 per animal (at 25 cents a pound), respectively.

Because of the shorter implant period, the treated heifers did not increase so much in dollar value as the steers. However, they did show a notable increase in gains and dollar value resulting from the implants.

**SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

Table 6 summarizes the beef production obtained during 1967 and 1968 on two different improved irrigated pastures under intensive rotation grazing. The emphasis was on the total pounds of beef produced per acre and the gross return per acre from the pastures. Although differences in areas, years, grazing periods and grazing intensities preclude meaningful comparisons between the pastures, we concluded that properly managed improved irrigated pastures can bring a gross return of $350 to $400 per acre in beef production. To obtain such returns, the pastures should be: (1) grazed in rotation; (2) grazed intensely for 4 or 5 days; (3) allowed to grow for 25 to 30 days before grazing again; and (4) irrigated according to plant needs—usually every 14 to 21 days.

To obtain high beef production from irrigated pastures containing high levels of alfalfa, stilbesterol implants are economically feasible and bloat prevention treatment is essential. In addition, we recommend: (1) winter the cattle to hold gains at not more than 1 pound per day before going on the pasture; (2) have them weigh approximately 450 to 550 pounds when they are turned onto the pasture in the spring; and (3) treat them for flies periodically during the grazing season. The increased efficiency gained from the recommended practices makes beef production on irrigated pastures a profitable, income-enhancing alternative for farmers and ranchers.

**Table 5. Average increase in gains and dollar value for 76-day period from use of Stilbesterol implants on 69 heifers grazing on 8.7-acre irrigated pasture at Palmyra, Utah County, during summer 1968.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>15 mg</th>
<th>30 mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg initial weight (lbs)</td>
<td>640</td>
<td>630</td>
<td>625</td>
</tr>
<tr>
<td>Avg gain/heifer (lbs)</td>
<td>105</td>
<td>119</td>
<td>113</td>
</tr>
<tr>
<td>Avg daily gain/heifer (lbs)</td>
<td>1.38</td>
<td>1.57</td>
<td>1.49</td>
</tr>
<tr>
<td>Percent daily gain increase over control</td>
<td>13.7</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>Avg gain over control/heifer (lbs)</td>
<td>14</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Dollar value over control/heifer ($/25¢/lb/heifer)</td>
<td>$3.50</td>
<td>$2.00</td>
<td></td>
</tr>
<tr>
<td>Effect of stilbesterol on avg daily gain (lbs)</td>
<td>0.18</td>
<td>0.105</td>
<td></td>
</tr>
</tbody>
</table>

**Table 6. Summary of pasture production study.**

<table>
<thead>
<tr>
<th>Pasture</th>
<th>A 1967</th>
<th>A 1968</th>
<th>B 1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number cattle</td>
<td>60</td>
<td>69</td>
<td>34</td>
</tr>
<tr>
<td>Total acreage</td>
<td>6.2</td>
<td>8.7</td>
<td>7</td>
</tr>
<tr>
<td>Total grazing days</td>
<td>123</td>
<td>151</td>
<td>123</td>
</tr>
<tr>
<td>Avg initial wt</td>
<td>475</td>
<td>530</td>
<td>380</td>
</tr>
<tr>
<td>Avg final wt</td>
<td>640</td>
<td>749</td>
<td>667.5</td>
</tr>
<tr>
<td>Avg total gain/animal</td>
<td>165</td>
<td>219</td>
<td>287.5</td>
</tr>
<tr>
<td>Avg daily gain/animal</td>
<td>1.23</td>
<td>1.50</td>
<td>2.35</td>
</tr>
<tr>
<td>Total lbs beef</td>
<td>9,915</td>
<td>15,111</td>
<td>9,775</td>
</tr>
<tr>
<td>Total lbs beef/acre</td>
<td>1,599</td>
<td>1,736</td>
<td>1,369</td>
</tr>
<tr>
<td>Gross return/acre @25¢ lb</td>
<td>$399.75</td>
<td>$434.00</td>
<td>$342.25</td>
</tr>
</tbody>
</table>

**Wash Your Hands After Mixing or Spraying PESTicides**

U. S. Department of Agriculture

MARCH 1969
SOIL CEMENT LININGS FOR CANALS

C. W. LAURITZEN

Soil-cement has possibilities in some sandy-soil areas for lining canals and reservoirs. To determine the adaptability of soil-cement for canal lining, a series of laboratory and field tests were undertaken. The Eden Project in the vicinity of Farson, Wyoming was selected for the field tests, because the soils in that area are generally sandy and canals there have heavy seepage losses. This seepage has contributed to high groundwater tables and salinity conditions. Furthermore, the absence of good concrete aggregate and the marginal character of the agriculture in the area limited the expenditure justified to control seepage. The lack of suitable aggregate also influenced the type of lining economically feasible.

FIELD STUDIES

The ditch selected for the field installations paralleled the west side lateral and served as the supply ditch on one of the development farms. The field tests were designed primarily for the evaluation of standard soil-cement linings, but plans included some plastic soil-cement; and, as the work progressed, some sand concrete linings were placed.

The standard tests required for the design of soil-cement were not made, but the short-cut method indicated that satisfactory soil-cement could be obtained by using 7 percent cement

1 These tests were conducted in cooperation with the Portland Cement Association and Region 4 of the U.S. Bureau of Reclamation. Mr. M. L. Burgener and Mr. L. Norling were present and assisted with the field installations.


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by volume. Exposed installations generally require additional cement; so the minimum figure was arbitrarily increased to 9 percent. Because of the high sulphate content of the Eden soils, Type 5 cement was used.

The soil was bladed into a windrow on the berm of the ditch with a grader patrol. The size of the windrow was properly adjusted with a windrow proportioner (figure 1) which provided the quantity of soil required per foot of ditch lining. Then bags of cement were spotted at the calculated spacing on the windrow to provide the amount of cement specified in the mix design (figure 2). The bags were then opened, and the cement was spread uniformly on the windrow. The soil and cement were mixed with a modified Wood Roadmixer (figure 3).

Just before the lining was placed, the ditch subgrade was dampened by sprinkling with water. The soil and cement were picked up from the windrow by the mixer as it moved forward. Water was added as a spray to the mix in the pugmill to raise the moisture content of the mix to that required for optimum compaction as determined by the Proctor Method,\(^3\) and the mix was placed as a lining in the ditch in one continuous operation (figures 4 and 5). Shortly after the mix was in place, it was compacted with a Jackson plate vibrator, (figure

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\(^3\) ASTM D558

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Figure 3. Wood Roadmixer assembly and spreader box mixing and placing soil-cement.

Figure 4. Perspective view of mixing equipment used in soil-cement ditch lining tests.

MARCH 1969

11
Three passes with this vibrator were made on each section of ditch. After compaction, the soil-cement lining was sprayed with a white pigmented concrete curing compound.

Cores were taken after the lining had cured to determine the quality of the lining structure. These cores were 2 inches in diameter and taken with a core bit powered with an electric drill. One core was taken in the bottom and one on each side in the middle of the slope of each ponded ditch reach. Sampling was limited to reaches that appeared to represent the best quality soil-cement for each given treatment. In addition to bulk density measurement, the cores were analyzed for the actual cement percentage according to ASTM method D806.

RESULTS AND DISCUSSION

Difficulty was experienced in coordinating the multiple operation of mixing, placing, and compacting the soil-cement linings. In most cases, the percentage of cement was less than the plan design. This is especially true of 9 and 12-percent cement mixes where the actual cement content for the two 9-percent sections was 5.3 and 5.8 and the 12-percent was 6.5 percent.

The actual cement content as determined from the analyses of core samples and the bulk density are given in table 1. Although the number of samples taken were not sufficient to fully determine the average compaction, the results indicate that the field density approached the laboratory density of 125 pounds per cubic foot.

It was intended to investigate plastic soil-cement. This differs from the standard soil-cement in that the mix has a higher moisture content giving it the consistency of morter. This plan was abandoned because of the difficulty encountered with the mix sticking to the conveyor belt. To determine if aggregate with a lower percentage of fines would present less of a problem, three concrete mixes using a sandy aggregate with 4.5, 5.5, and 7.0 bags of portland cement per cubic yard respectively were substituted. It was intended to place the mixture at about a 2-inch slump, but the nozzle capacities in the pugmill were not regulated to supply enough water, and the resulting mix had a slump of about 1 inch. DAREX, an air-entraining agent, was added to the mixing water to increase the workability of the concrete and its resistance to frost action. After the mix was placed, the reach was sprayed with asphalt emulsion as a curing compound.

Like plastic soil-cement, concrete did not lend itself to placement with the equipment assembled. The concrete mixes were too dry, and the resulting lining had an open porous structure with a bulk density of about 125 pounds per cubic foot, compared to 150 pounds per cubic foot for good concrete. Seepage through the concrete-lined reaches, table 2, was about as much as from the unlined reaches. The porous nature of the linings could have been corrected if some method of compaction had been used following placement. Although too dry for slipformed concrete, the mixes were too wet for compaction with the vibrator used on the standard soil-cement linings.

The condition of the standard soil-cement linings on September 24, 1967—11 years after installation—is indicated in figure 7 and figure 8.
Table 1. Cement content and bulk density of concrete and soil-cement linings

<table>
<thead>
<tr>
<th>Station sampled</th>
<th>Position</th>
<th>Type</th>
<th>Designed cement %</th>
<th>Actual cement by wt %</th>
<th>Cement by vol %</th>
<th>Bulk density lbs/cu ft 1958</th>
<th>Notes at time lining sampled for bulk density measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 85</td>
<td>bottom side</td>
<td>concrete</td>
<td>17</td>
<td>11.2</td>
<td>13.8</td>
<td>121</td>
<td>Good, hard, no crumbling</td>
</tr>
<tr>
<td>1 + 50</td>
<td>bottom side</td>
<td>concrete</td>
<td>20</td>
<td>10.0</td>
<td>11.5</td>
<td>128</td>
<td>Good, hard, slight crumbling</td>
</tr>
<tr>
<td>2 + 00</td>
<td>bottom side</td>
<td>concrete</td>
<td>26</td>
<td>17.1</td>
<td>17.5</td>
<td>124</td>
<td>Good, not too hard, no crumbling</td>
</tr>
<tr>
<td>2 + 50</td>
<td>bottom side</td>
<td>s/c</td>
<td>16</td>
<td>17.1</td>
<td>17.0</td>
<td>125</td>
<td>Good, not too hard, no crumbling</td>
</tr>
<tr>
<td>2 + 85</td>
<td>bottom side</td>
<td>s/c</td>
<td>16</td>
<td>28.7</td>
<td>25.0</td>
<td>123</td>
<td>Good, hard, no crumbling</td>
</tr>
<tr>
<td>3 + 40</td>
<td>bottom side</td>
<td>s/c</td>
<td>9</td>
<td>29.0</td>
<td>28.2</td>
<td>124</td>
<td>Good, hard, texture like cinder block</td>
</tr>
<tr>
<td>4 + 50</td>
<td>bottom side</td>
<td>s/c</td>
<td>9</td>
<td>5.4</td>
<td>6.5</td>
<td>118</td>
<td>Good, fairly hard, crumbles</td>
</tr>
<tr>
<td>5 + 50</td>
<td>bottom side</td>
<td>s/c</td>
<td>12</td>
<td>5.1</td>
<td>6.4</td>
<td>118</td>
<td>Good, fairly hard, slight crumbling</td>
</tr>
<tr>
<td>6 + 50</td>
<td>bottom side</td>
<td>s/c</td>
<td>12</td>
<td>6.8</td>
<td>7.1</td>
<td>127</td>
<td>Fair, not too hard, very easily crumbled</td>
</tr>
<tr>
<td>7 + 50</td>
<td>bottom side</td>
<td>s/c</td>
<td>15</td>
<td>10.3</td>
<td>12.2</td>
<td>120</td>
<td>Good, hard, no crumbling</td>
</tr>
<tr>
<td>8 + 50</td>
<td>bottom side</td>
<td>s/c</td>
<td>9</td>
<td>6.1</td>
<td>8.0</td>
<td>120</td>
<td>Good, hard, no crumbling</td>
</tr>
</tbody>
</table>

Previously noted, the cement content determined by analysis deviated widely in some instances from the designed quantity. Also, in many instances, construction difficulties involving moisture control and compaction were encountered. Where the actual cement content equaled or bettered the designed value, and satisfactory compaction and curing were achieved, the resultant lining remained in reasonably good condition after 11 years of service. An example is one section in which one-half had a cement content of 9 percent and the other half about 14 percent. Notes at the time the lining was constructed indicate that the operation was well controlled and that good quality soil-cement should result.

It would appear, therefore, that construction of quality standard soil-cement linings with the equipment used is possible. It is doubtful, however, that the method is practical, in view of the control required and the

Table 2. Seepage rates for soil-cement and concrete linings.

<table>
<thead>
<tr>
<th>Pond no.</th>
<th>Lining type</th>
<th>Ponded reach</th>
<th>Seepage ft³/ft²/24 hr 1957</th>
<th>1958</th>
<th>Cement content by wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>l/c</td>
<td>0 + 69 - 1 + 09</td>
<td>1.19</td>
<td>2.02</td>
<td>10.6</td>
</tr>
<tr>
<td>3</td>
<td>l/c</td>
<td>1 + 09 - 1 + 61</td>
<td>1.09</td>
<td>3.90</td>
<td>17.1</td>
</tr>
<tr>
<td>4</td>
<td>l/c</td>
<td>1 + 61 - 2 + 23</td>
<td>5.92</td>
<td>1.91</td>
<td>28.8</td>
</tr>
<tr>
<td>5</td>
<td>s/c‡</td>
<td>2 + 68 - 3 + 13</td>
<td>0.98</td>
<td>0.57</td>
<td>20.9</td>
</tr>
<tr>
<td>6</td>
<td>s/c</td>
<td>3 + 30 - 4 + 10</td>
<td>0.60</td>
<td>0.76</td>
<td>5.2</td>
</tr>
<tr>
<td>7</td>
<td>s/c</td>
<td>4 + 30 - 4 + 98</td>
<td>0.38</td>
<td>0.75</td>
<td>5.8</td>
</tr>
<tr>
<td>8</td>
<td>s/c</td>
<td>5 + 53 - 6 + 22</td>
<td>0.58</td>
<td>1.41</td>
<td>6.4</td>
</tr>
<tr>
<td>9</td>
<td>s/c</td>
<td>7 + 05 - 7 + 64</td>
<td>0.25</td>
<td>0.44</td>
<td>9.4</td>
</tr>
</tbody>
</table>

‡ s/c Standard soil cement
§ l/c Low slump concrete
number of operations that must be coordinated, unless long reaches of canal are to be lined.

The condition of the sand-concrete linings is shown in figures 8 to 10. These, it will be noted, show less sign of degradation and are in better condition than the standard soil-cement linings.

Only a very short reach of the canal, as mentioned, was lined with plastic soil-cement, and it was finished in part by hand troweling. In appearance it was similar to slipformed concrete. The structure was hard and showed little degradation due to weathering, indicating that plastic soil-cement, batched and mixed similar to concrete and placed with the conventional concrete slipform, should be considered in sites such as the Eden area. The shortness of lined section did not permit a seepage-loss measurement, however.

Seepage measurement of the soil-cement linings were taken in 1957 and again in 1958. Ponds were constructed by installing plastic dams at the ends of each reach in which seepage was to be measured; then, the ditch between the dams was filled with water pumped from the canal. The seepage rate was calculated by the drop in the water-surface. The seepage rate of the linings is given in table 2.

It will be noted in table 2 that the seepage was greater in 1958 than in 1957 in all but two reaches. In this interval, transverse cracks had developed on 4- to 5-foot centers in the linings which probably accounts—in part at least—for the larger seepage rate in 1958.

The rate of seepage through the standard soil-cement was less than through the low-slump concrete linings but higher than considered allowable for lined ditches—1 to 1/4 cubic feet per day per square foot. The losses from reaches in which the soil-cement was rated better were not always lower than for reaches that were in a more advanced state of deterioration when inspected in 1967.

In field ditches in this area, ditch stability is the chief function and justification for a lining. Seepage losses, associated with intermittent use, seldom justify lining field ditches on the basis of the value of the water saved in this or other areas. Ditch stability may be all that should be sought. If this is assumed, soil-cement—even that of poor quality—has been reasonably effective for a period of over 10 years.

Figure 7. Condition of standard soil-cement lining with cement content of 5.2 percent on September 24, 1967—11 years after installation.

Figure 8. Condition of standard soil-cement lining with cement content of 14 percent on September 24, 1967—11 years after installation.
About 130 years ago, mountain sheep were abundant all along the Wasatch. In his "Journal of a Trapper", Osborne Russell often refers to seeing "thousands of mountain sheep". On one occasion, while hunting south of the Salt Lake, he killed 4 of a band of 100 rams. Another time he describes "sheep rock" (Soda Point, Idaho) as being frequented by mountain sheep all year.

The situation changed quickly, however, as white settlers followed the trail-blazing trappers such as Russell. The mountain sheep, along with much of the other wildlife, were killed or they moved to less accessible areas. Some of the sheep persisted in Utah in the Uinta Mountains, but they disappeared along the Wasatch.

The "never-satisfied" nature of man, though, made it inevitable that someday, someone would want to reintroduce mountain sheep to their former home grounds. Wildlife managers and researchers, whether on a university campus or with state or federal agencies, are especially susceptible to that kind of day dreaming.

In 1960, with personnel of the Utah Division of Fish and Game taking the lead, the hope finally began to move toward reality. Letters were written and contacts made with likely sources of bighorn sheep. By 1965, possible areas around Wellsville and Brigham City were being evaluated for paddock construction in anticipation of taking delivery on bighorns from Wyoming and Canada.

The first 80-acre holding pen was built on Wasatch Mountain just above the Intermountain Indian School at Brigham City. This was one of the locations where Osborne had seen numerous sheep between 1834 and 1843. The Wyoming bighorns (5 rams, 9 ewes) were being shipped to Utah from around Dubois, Wyoming and arrived on March 8, 1966. The Canadian shipment (6 rams, 14 ewes) from Waterton Lakes National Park was delivered during April. The first bighorn lamb known to be born along the Wasatch since pioneer days, arrived in May 1966.

Before the end of 1968, the mountain sheep had provided Utah's Fish and Game personnel with several interesting (and frustrating) adventures. Winter weather had taken annual tolls of fences — and rebuilding fence in mid-winter is quite a chore. Many of the bighorns that escaped the paddocks were never captured. Several lambs had been born to ewes remaining inside the fences, and a few had been glimpsed outside the fenced areas.

Overall, it looks as if the Wasatch Mountains are "home" once again for the Rocky Mountain Bighorn.
Louse-like keds cause sheepskin defects

The wingless parasitic fly known as the sheep tick, or ked, is a more costly pest than has been realized.

Sheep raisers have known that the louse-like fly (*Melophagus ovinus*) irritates animals and causes biting and scratching that damages fleeces. Recently, two Agricultural Research Service scientists found that ked bites also make the raised, pimple-like blemishes in sheepskin called cockle.

Cockle costs the leather and allied industries millions of dollars a year. The defects are of varying size and elevation and impair both the grain and flesh sides of the skin. They cannot be completely flattened out or covered with dyes and stains.

Now that the cause-effect relationship of keds and cockle is known, treating sheep to eradicate the flies becomes even more important.

Dipping in vats containing toxaphene, lindane, or rotenone, or dusting with dieldrin are among the most satisfactory of the many approved treatments for ked control. One treatment a year usually provides good control and is most effectively and economically administered shortly after shearing the ewes. If the ewes are shorn after lambing in the spring, special attention should be given to treating the lambs as well as the ewes. In preparing and using insecticides for this purpose, the directions furnished by the manufacturer should be closely followed.

The relationship between keds and cockle was established by two cooperating Agricultural Research Service scientists working nearly 2,000 miles apart: Microscopist A. L. Everett of the Eastern Utilization Research Laboratory in Philadelphia, Pennsylvania, and I. H. Roberts, veterinarian in charge of the Agricultural Research Service Animal Parasite Station in Albuquerque, New Mexico. Everett, who observed keds in many of the woolskins he examined for cockle, and Roberts, who was thoroughly familiar with this sheep parasite, inferred that the insect might be causing the skin blemishes.

The two men planned an experiment to test their theory, employing Roberts’ facilities for work with live sheep. Roberts worked with a flock of about 150 sheep that had been protected since birth from external parasites. He deliberately infested half of them with keds, keeping the rest in isolation. At regular intervals he selected animals for slaughter and shipped the skins to Everett for analysis.

Extensive cockle in all skins of the infested sheep and virtual absence of the defect in the skins of the animals protected from keds proved conclusively that the insect is responsible.

In later phases of the test, Roberts showed that sheep can spontaneously recover from ked bites. When animals were protected from further bites, either by shearing or by immersing in an insecticide bath, the lesions receded. (Reprinted from Agricultural Research, USDA, February 1969)

WILDLIFE NOTES

Trumpeter swans are the largest American birds in terms of weight, males sometimes reaching 30 pounds.

A single egg mass from a female Gypsy moth contains from 100 to 1,000 eggs.

Like eagles, ospreys use the same nests year after year, rebuilding them to the extent that some weigh up to 1,000 pounds.

The flight musculature of the tiny hummingbird is the strongest of any bird—one-third its weight.

When the jack rabbit shifts into high gear, it can travel at speeds up to 45 mph, and make 20-foot jumps.

The only hoofed animal having its origin in North America is the pronghorn antelope.

A worker bee can lift 24 times its weight, a horse only half its weight.

A ground mole will die in approximately 1 day if deprived of its food.

Antelope fawns are capable of running up to 25 miles an hour for short distances when only 1 or 2 days old.

FOUR KEYS TO PESTICIDE SAFETY

READ THE LABEL ON EACH PESTICIDE CONTAINER BEFORE EACH USE. Follow instructions; heed all cautions and warnings. Why read the label each time? Because the chemical nature of pesticides and their uses vary greatly. You should refresh your mind each time on the material’s specific uses.

APPLY PESTICIDES ONLY AS DIRECTED. Apply them only to the crops specified, in amounts specified and at times specified in label instructions, or by your agricultural authorities.

DISPOSE OF EMPTY CONTAINERS SAFELY. It is almost impossible to remove all material from a container. “Empty” containers contain small amounts of pesticides which could harm children or animals who might get into them. It is best to dispose of empty containers by burying them at least 18 inches deep in an isolated area provided for this purpose away from water supplies.
Agathangelides, Demetrios
Apple production in northern Utah 29(4):103-107, 124

Allred, Keith R.
Use alfalfa-intermediate wheatgrass where water is limited-upgrading irrigated pastures 27(2):47-51
What about birdsfoot trefoil—upgrading irrigated pastures 27(3):110-112, 116

Anderson, J. LaMar
Training fruit trees is important 27(1):32-35 (joint author)
Peach varieties for Utah's Dixie 27(1):39-41 (joint author)
Pruning bearing trees and rejuvenating old trees 27(2):55-58 (joint author)
Destructive animals in Utah fruit orchards 27(3):93-97 (joint author)
effects of girdling and giberellic acid treatments on Thompson Seedless grapes 28(4):116-118 (joint author)
X-disease of sweet cherries 29(4):108-110 (joint author)
New chemical may aid mechanical harvesting of sweet cherries 29(4):111-113 (joint author)

Anderson, Melvin J.
Feed efficiency in dairy cattle 28(1):28-29 (joint author)
Influence of sire and ration on differences in gross feed efficiency in dairy cattle 28(2):50-52 (joint author)
Meeting the protein needs of dairy animals 28(3):84-87 (joint author)

Anderson, Roice H.
Man—Nature's recalcitrant anomaly—bioclimatology—a practical science 29(2):49-54 (joint author)

New rules for an old game—bioclimatology— a practical science 29(3):69-74

Bagley, Jay M.
Estimation of Utah's water yield—from physiographic data 27(1):11-17
The Great Salt Lake—hub of Utah's water development 28(1):14-20 (joint author)

Ballard, J. Clark
Resource development on the Bolivian Altiplano 27(2):72-77 (joint author)

Balls, Lew Dell
Combating rangeland cripplers 29(1):20-25 (joint author)

Barfuss, Brent W
Utah weather reporting—its origin and destiny 28(1):22-25 (joint author)

Beale, Donald M
Seasonal forage use of pronghorn antelope in western Utah 29(1):3-6,16 (joint author)

Bennett, James A.
Meat for an expanding population 27(4):144-146

Binnns, Wayne
Combating rangeland cripplers 29(1):20-25 (joint author)

Bishop, A. Alvin
How to develop and use water—Utah's lifeblood 27(4):124-126

Bishop, Cly S.
Utah Christmas tree sales—1965 27(1):36-38 (joint author)

Black, Theral R.
Utah's population—past and future 28(4):127-128

Blake, Joseph T.
Sex hormones and the growth of nursing calves on high mountain ranges in Utah 28(3):97-99 (joint author)

Bohl, Wayne H.
The art and science of relocating birds—ecology in action 29(3):84-87 (joint author)
Exotic game birds in Utah's future 29(4):117-123 (joint author)

Bolin, H. R.
Production and quality of cherry raisins and pickles 29(4):99-102 (joint author)

Brown, Perry J.
Consumer sentiment and Utah's out-of-state visitor 28(4):119-120 (joint author)

Bylund, H. Bruce
Early trials of new food products—powerful consumers 28(4):114-115 (joint author)

Call, Anson B. Jr.
Peach varieties for Utah's Dixie 27(1):39-41 (joint author)
Training fruit trees is important 27(1):32-35 (joint author)
Pruning bearing trees and rejuvenating old trees 27(2):55-58 (joint author)
Destructive animals in Utah fruit orchards 27(3):93-97 (joint author)
Sex hormones and the growth of nursing calves on high mountain ranges in Utah 28(3):97-99 (joint author)

Chachin, Kazuo
Maintaining quality in fresh produce 27(2):62-65 (joint author)

Chadwick, Duane G.
Development of a low-cost hydrologic sensing telemetering system—at the Utah Water Research Laboratory 28(1):11-13

Christensen, Rondo A.
Who pays the tax bill? 27(1):6-8, 17
Assessing farm land according to its value for agricultural use 29(2):37-41
The Green Belt Amendment and its probable impact on assessed values, taxes and mill levies in Salt Lake County 29(3):64-68, 83 (joint author)

Cook, C. Wayne
Herbicide control of rabbit brush and sagebrush in mixed stands 27(1):9-10,23
Increase capacity through better distribution on mountain ranges 28(2):38-42

Cox, Lois M.
Food is a science at USU 27(4):120-123
Bioclimatology—a practical science 28(2):35-38 (joint author)

Dirty air—a peripatetic peril 28(2):53-57
The original go power—bioclimatology—a practical science 28(3):88-93 (joint author)
Nature's unsung middlemen—bioclimatology—a practical science 28(4):124-129 (joint author)
The fugue expands—bioclimatology—a practical science 29(1):7-13 (joint author)
Help for the desert bighorn 29(2):34-36 (joint author)
The reluctant jumpers 29(2):41-42 (joint author)

Man—Nature's recalcitrant anomaly—bioclimatology—a practical science 29(2):49-54 (joint author)

The art and science of relocating birds—ecology in action 29(3):84-87 (joint author)

Exotic game birds in Utah's future—ecology in action 29(4):117-123 (joint author)
Hunt, John D.
McDaniels mites and the resistance problem in Utah 28(1):26-27

Degiorgio, Fred
The Green Belt Amendment and its probable impact on assessed values, taxes and mill levies in Salt Lake County 29(3):64-68, 83 (joint author)

England, Barry G.
Llama reproduction—a South American problem 29(4):43-45 (joint author)

Evans, W. Duane
Meat consumption in Cache and Box Elder counties, 1965-66 29(1):14-15 (joint author)

Farnsworth, Larry
Help for the desert bighorn 29(2):34-36 (joint author)

Flake, Gerry
Consumer response to use of turkey 28(4):121-123, 129 (joint author)

Foote, Warren C.
Llama reproduction—a South American problem 29(2):43-45 (joint author)

Gardner, B. Delworth
Water for Utah—by plan or by accident 27(2):78-81

Gifford, Gerald
Range resources and water shed management—a need for research 29(3):90-91

Glenn, McNeil
Utah Livestock auction prices 27(1):29-31 (joint author)

Griffin, Richard E
Community water development in Ashley Valley 27(1):18-23 (joint author)

Grimsaw, Paul R
Precondition feeder calves for greater returns 28(3):100-102, 107 (joint author)

Higgins, Donna
The Great Salt Lake—hub of Utah's water development 28(1):14-20 (joint author)

Hill, K. W.
What is the Agricultural Experiment Station—editorial 27(3):88-89
The Station serves us all—editorial 27(4):119
Research—the solid base of agriculture and industry 29(2):80-83

Hooper, Jack
Grazing vs. wheat production on marginal Utah cropland 29(2):32-33,60 (joint author)

Huber, Don
Peach varieties for Utah's Dixie 27(1):39-41 (joint author)
Effects of girdling and gibberellic acid treatments on Thompson Seedless grapes 28(4):116-118 (joint author)

Hunt, John D.
Utah Christmas tree sales 27(1):36-38 (joint author)
Consumer sentiment and Utah's out-of-state visitor 28(4):119-120 (joint author)

James, Lynn F.
Combating rangeland crippers 29(1):20-25 (joint author)

Johnson, A. Earl
Combating rangeland crippers 29(1):20-25 (joint author)

Johnson, Walter H.
Utah's little known forest industries 28(2):70-74

Jones, Norman B.
From sewage to clean water 28(1):7-10, 31 (joint author)

Keeler, Richard F.
Combating rangeland crippers 29(1):20-25 (joint author)

Keith, Russell R.
Farm flocks pay off 27(2):82-83

Keller, Jack
The effect of water application on soil tilth 28(3):93-96

Kim, Yun
Utah's population—past and future 27(4):127-128 (joint author)

Lamb, Robert C.
Reproductive performance of dairy cows on an all-forage ration 27(2):66-68 (joint author)
Feed efficiency in dairy cattle 28(1):28-29 (joint author)
Influence of sire and ration on differences in gross feed efficiency in dairy cattle 28(2):30-52 (joint author)
Meeting the protein needs of dairy animals 28(3):84-87 (joint author)
Growth rates for dairy herd replacements 29(3):75-79 (joint author)

Lamborn, Ellis W.
Utah livestock auction prices 27(1):29-31 (joint author)
Meat consumption in Cache and Box Elder counties, 1965-66 29(1):14-15 (joint author)

Lauritzen, C. W.
Farm ponds and plastic liners 27(3):90-92
Rain traps of steel 28(3):79-81

LeBaron, Allen
Minning water in Iran 29(3):88-89, 92 (joint author)

Lee, C. Y.
Maintaining quality in processed fruits 27(3):104-107 (joint author)

Lindsay, Ben W.
Community water development in Ashley Valley 27(1):18-23 (joint author)

Ludlow, John M.
Breeding bees to the crop 29(2):46-48, 60 (joint author)

Mackensen, Otto
Breeding bees to the crop 29(2):46-48, 60 (joint author)

McAllister, Devere R
Resource development on the Bolivian Altiplano 27(2):72-77 (joint author)

Mathews, Darrell H
Resource development on the Bolivian Altiplano 27(2):72-77 (joint author)

Matthews, Doyle J
Precondition feeder calves for greater returns 28(3):100-102, 107 (joint author)

Matthews, Verl B.
Tall Bluebell—an important forage plant on aspen range—in Utah 29(1):17-19, 23

Mickelsen, C. H.
Reproductive performance of dairy cows on an all-forage ration 27(2):66-68 (joint author)

Mohr, Malek
Mining water in Iran 29(3):88-89, 92 (joint author)

Neuhold, John M.
From sewage to clean water 28(1):7-10, 31

Nielson, Darwin B.
Research on public land pricing policies at USU 29(4):95-98 (joint author)

Nelson, Rex F.
Fertilizing winter wheat in Utah 27(2):68-71 (joint author)
Good pastures are possible—even high and dry 28(2):43-46

Nury, F. S.
Maintaining quality in processed fruits 27(3):104-107 (joint author)

Nye, William P.
Breeding bees to the crop 29(2):46-48, 60 (joint author)

Olson, L. E.
Maintaining quality in fresh produce 27(2):62-65 (joint author)

Perkes, L. S.
Reproductive performance of dairy cows on an all-forage ration 27(2):66-68 (joint author)

Peterson, Howard B.
The Utah Center for Water Resources and Research 28(1):3-4

Post, Frederick J.
From sewage to clean water 28(1):7-10, 31 (joint author)

Reynolds, George W.
Climate—the pulse of life 27(4):129-131 (joint author)

Richardson, E. Arlo
Climate—the pulse of life 27(4):129-131 (joint author)
Utah weather reporting—its origin and destiny 28(1):22-25 (joint author)
Bioclimatology—a practical science 28(2):35-38 (joint author)
The original go power—bioclimatology—a practical science 28(3):88-93 (joint author)
Nature's unsung middlemen—bioclimatology—a practical science 28(4):124-129 (joint author)

From sewage to clean water 28(1):7-10, 31 (joint author)

The fugue expands—bioclimatology—a practical science 35-38 (joint author)

The fuge expands—bioclimatology—a practical science 29(1):7-13 (joint author)
Man—Nature's recalcitrant anomaly—bioclimatology—a practical science 29(2):49-54 (joint author)
New rules for an old game—bioclimatology—a practical science 29(3):69-74 (joint author)

UTAH SCIENCE
Robert, N. Keith
Resource development on the Bolivian Altiplano 27(2):72-77 (joint author)
Research on public land pricing policies at USU 29(4):95-98 (joint author)

Salisbury, Frank B.
Plant science and space exploration 27(4):138-143

Salunkhe, D. K.
Maintaining quality in fresh produce 27(2):62-65 (joint author)
Best fruit varieties—for processing 27(3):107-109
Maintaining quality in processed fruits 27(3):104-107 (joint author)
Production and quality of cherry raisins and pickles 29(4):100-102 (joint author)

Sanders, David L.
Early triers of new food products—powerful consumers 28(4):114-115 (joint author)

Scotter, George W.
Range resources and big game management 28(3):82-83, 96
Seasonal forage use by pronghorn antelope in western Utah 29(1):3-6, 16 (joint author)

Sigler, William F.
Uranium mill wastes as stream pollutants 28(2):47-49
Using automobile bodies as fish cover in Bear Lake 28(3):103, 107 (joint author)
How to write a model life history of a fish 29(1):24-28

Skogerboe, Gaylord V.
The Great Salt Lake—hub of Utah's water development 28(1):14-20 (joint author)

Southard, A. R.
A new soil classification system 28(4):130-131 (joint author)

Spillett, J. Juan
The reluctant jumpers 29(2):41-42 (joint author)

Steffen, Hyrum
Heavy pigs benefit from protein supplements 28(4):111-113

Stoddard, George E.
Calcium: phosphorous ratios for dairy cows 27(3):113-115
Meeting the protein needs of dairy animals 28(3):84-87 (joint author)

Stoddart, L. A.
Utah's range resources and their management 27(4):147-149

Street, Joseph C.
Insecticides in animals—their storage and interactions 27(2):52-54

Sudweeks, Earl M.
Precondition feeder calves for greater returns 28(3):100

Suthivanit, N.
Production and quality of cherry raisins and pickles 29(4):99-102 (joint author)

Taylor, S. A.
Inexpensive methods for measuring soil moisture 27(3):98-103

Thorne, J. P.
10 years of soil testing in Utah 28(3):104-107

Tingey, D. C.
Farm planning for weed control 29(4):114-116

Tu, Anthony T.
Researching the chemistry of snake venom 27(1):24-28, 31 (joint author)

Tuom, Paul M.
Researching the chemistry of snake venom 27(1):24-28, 31 (joint author)

Van Epps, Gordon E.
Native browse and broadleaf herb seed production—on cultivated land 27(2):59-63
Fertilizing winter wheat in Utah 27(2):68-71 (joint author)

Van Kampen, Kent R.
Combating rangeland cripplers 29(1):20-25 (joint author)

Wadley, Bryce N.
X-disease of sweet cherries 29(4):108-110, 113 (joint author)

Walker, David R.
Training fruit trees is important 27(1):32-35 (joint author)
Pruning bearing trees and rejuvenating old trees 27(3):55-58 (joint author)
Destructive animals in Utah fruit orchards 27(3):93-97 (joint author)

Wankier, B. N.
Maintaining quality in fresh produce 27(2):62-65 (joint author)

Wennergren, E. Boyd
What is the value of Utah’s deer hunting resource? 29(2):55-59

Wesenberg, Bernard G.
Greens for houses 27(1):3-5, 96
Ornamentally yours 27(4):132-134

Wilcox, Ethelwyn B.
The mysteries of nutrition 27(4):135

Wilson, Millard E.
Llama reproduction—a South American problem 29(2):43-45 (joint author)

Wilson, Lanny
Help for the desert bighorn 29(2):34-36 (joint author)

Wilson, LeMoyne
A new soil classification system 28(4):130-131 (joint author)

Workman, Gar W.
Using automobile bodies as fish cover in Bear Lake 28(3):103, 107 (joint author)

Workman, John P.
Grazing vs. wheat production on marginal Utah cropland 29(2):32-33, 60 (joint author)

---

**SUBJECT INDEX**

**Index Volumes 27-29, 1966-1968**

A
Agathangelides, Demetrios 29:103-107, 124

Agricultural Economics
food prices 29:63, 79, 92
land pricing 29:37-41; 29:95-98
land use 27:82-83; 28:62-64; 29:32-33, 60
livestock prices 27:29-31

Agricultural Experiment Station
assistant director retires 28:57
new director 27:87
service 27:119
what is 27:88-89

Agricultural research serves nation 29:102

Alfalfa weevil now found in 41 states 28:42

Allred, Keith R. 27:45-51; 27:110-112, 116
Air, dirty air 28:53-57, 64
Andrews, Wade H. 28:5-6
Animals destructive in Utah fruit orchards 27:93-97
insecticides in 27:52-54

Antelope
reluctant jumpers 29:41
seasonal forage use by 29:3-6, 16
Apples
production 29:103-107
ultraviolet treated juice 28:75

Art and science of relocating birds—ecology in action 29:84-87
Ashley Valley, community water development 27:18-23
Assessing farm land according to its value for agricultural use 29:37-41
Auction, Utah livestock prices 27:29-31
Automobile, use as fish cover 28:103

MARCH 1969

19
Beale, Donald M. 29:3-6, 16
Beef, how to care for 28:65-67
Best fruit varieties for processing
Barfuss, Brent W. 28:22-25
Beal, Donald M. 27:11-17; 27:104-107
Birdsfoot trefoil, upgrading irrigated pastures
Bighorn, help for 29:34-46
Balls, Lew Dell 29:20-25
Bagley, Jay M. 27:18-23
Baller, J. Clark 27:72-77
Balfors, Brent W. 28:22-25
Beale, Donald M. 29:3-6, 16
Bee, how to care for 28:65-67
Bioclimatology

**B**

Bagley, Jay M. 27:11-17; 28:14-20
Ballard, J. Clark 27:72-77
Balls, Lew Dell 29:20-25
Barfuss, Brent W. 28:22-25
Beale, Donald M. 29:3-6, 16
Bee, how to care for 28:65-67
Bees

biological clock influences 28:81
breeding 29:46-48, 60
fed pathogens 27:58
fungation prevents foulbrood recurrence 29:54

Bennett, James A. 27:144-146
Best fruit varieties for processing 27:107-109
Bighorn, help for 29:34-46
Binns, Wayne

Birch, Eric 29:64-68, 83
Bolt, Wayne H. 29:84-87; 29:117-123
Bolivia, resource development 27:72-77

**C**

Calcium: phosphorus ratios for dairy cows 27:113-115
Calves

precondition feeder 28:100-102, 107
sex hormones and growth of while nursing 28:97-99

Catchments, harvesting water with 28:30-31
Cattle

feed efficiency 28:28-29; 28:50-52
gain 27:150
Chacín, Kazuo 27:62-65
Chadwick, Duane G. 28:11-13
Chase, Daryl, retires 29:31
Chemistry

researching snake venom 27:24-28, 31
speeds leaf drop 27:151

Cherries

chemical may aid mechanical harvesting of 29:111-113
oxygen controls scald 28:13
raisins and pickles 29:99-102
X-disease 29:108-110

Christensen, Rondo A., 27:6-8, 17; 29:37-41: 129-64, 68, 81

Climate—the pulse of life 28:18-23

Cook, C. Wayne 27:9-10, 23; 28:38-42
Computers serve the dairymen 28:67-69
Consumers

early triers of new food products 28:114-115
response to use of turkey 28:121-123, 129
sentiment and Utah's out-of-state visitor 28:119-120
Dairy

calcium; phosphorous ratios 27:113-115
computers 28:67-69
feed efficiency 28:28-29; 28:50-52
growth rates for 29:75-79
protein needs of 28:84-87
record keeping 28:75
reproductive performance on all forage ration 27:66-67
Davis, Donald W. 28:26-27
Deer, value as hunting resource 29:55-59

Degiorgio, Fred 29:64-68, 83

Deer, value as hunting resource 29:55-59

Desert

bees 28:81
Birds

exotic birds in Utah's future 29:117-123
relocating 29:84-87

Birdfoot trefoil, upgrading irrigated pastures 27:110-112, 116
Bishop, A. Alvin 27:124-126
Bishop, Clynn S. 27:36-38
Black light lures insects to serilant 27:71
Black, Thoral R. 27:127-128
Blake, Joseph T. 28:97-99
Bluebell, an important forage plant on aspen range 29:17-19, 23

Bahi, Wayne H. 29:84-87; 29:117-123
Bolivia, resource development 27:72-77
Bolin, H. R. 27:99-102
Breeding

bees 29:46-48, 60
dairy cattle 28:28-29; 28:50-52
Brown, Perry J. 28:119-120
Brucellosis, stamping out in Western States 27:109
Burgoyn, David A., retires 28:57
Bylund, Bruce 28:114-115

Duck"
G

Game Animals     29:3-6, 16; 29:41-42
antelope 29:3-6, 16; 29:41-42
birds 29:84-87; 29:117-123
deer 29:55-59
desert bighorn 29:43-46
fish 28:4; 28:103; 29:24-28
management 28:82-83, 96
Gardner, B. Delworth 27:78-81
Gifford, Gerald 29:90-91

Girdling, effects on Thompson Seedless grapes 28:116-118
Glenn, McNeil 27:29-31
Golf, new tanning helps 27:123
Good pastures are possible—even high and dry 28:43-46
Grapes, effects of girdling and gibberellic acid treatments on 28:116-118
Grazing vs. wheat production on marginal Utah cropland 29:32-33, 60
Great Salt Lake—Hub of Utah's water development 28:14-20
Green Belt Amendment, its probable impact in Salt Lake County 29:64-68, 83
Greens for houses 27:3-5
Griffin, Richard E. 27:18-23
Grisham, Paul 28:100-102, 107

Growth rates for dairy herd replacements 29:75-99

H

Harvesting, new chemical aid for cherry harvest 29:111-113
Heavy pigs benefit from protein supplements 28:111-113
Help for the desert bighorn 29:43-46
Herbicide control of rabbitbrush and sagebrush in mixed stands 27:9-10, 23
Higgins, Donna 28:14-20
station receives new director 27:87
Hog Cholera
in unborn pigs 27:115-116
Utah free from 29:124
Hogs
miniatures for drug tests 27:43
protein supplements for 28:111
Hooper, Jack 29:32-33, 60
Hormones, and the growth of nursing calves 28:97-99
Horticulture 27:3-5; 27:132-134
How to develop and use water—Utah’s life blood 27:124-126
How to write a model life history of a fish 29:24-28
Huber, Don 27:39-41; 28:116-118
Hungry? Just plug it in 29:83
Hunt, John D. 27:36-38; 28:119-120

I

Increased capacity through better distribution on mountain ranges 28:39-42
Inexpensive methods for measuring soil moisture 27:98-103
Influence of sire and ration on differences in gross feed efficiency 28:30-52
Insects and insect control
black light lures 27:71
dermestid beetles 29:59
eat only weeds 28:46
insecticides in animals 27:52-54

Insects and insect control
black light lures 27:71
dermestid beetles 29:59
eat only weeds 28:46
insecticides in animals 27:52-54

Nematodes may aid fight against 28:75
nitrogen-carbon dioxide kill 27:103
paper pulp waste product prevents development 27:151
time capsules fight 28:118
Insulation, corn starch used for 27:43
Irrigation
canal sealer 27:51
catchments 28:30-31
plastic liners 27:90-92

J

James, Lynn F., 29:20-25
Johnson, A. Earl, 29:20-25
Johnson, Walter H., 28:70-74
Jones, Norman B., 28:7-10, 31

K

Keeler, Richard F. 29:20-25
Keetch, Russell R. 27:82-83
Keller, Jack 28:93-96
Kim, Yun 27:127-128

L

Lamborn, Ellis W., 27:29-31; 29:14-15
Lambs, medics operate on unborn 27:42
Land Pricing
assessing farm land 29:37-41
research on public land pricing 29:95-98
Lauritzen, C. W. 27:90-92; 28:79-81
Leaf Drop, natural chemical speeds 27:151
LeBaron, Allen 29:88-89, 92
Lee, C. Y. 27:104-107
Legumes, bridlesfoot trefoil 27:110-112, 116
Leukosis 27:134; 28:87
Lighting, helps cattle gain 27:150
Lindsay, Ben W. 27:18-23
Livestock Utah auction prices 27:29-31
Llamas, reproduction—a South American problem 29:43

M

Mackensen, Otto 29:46-48, 60
Maintaining quality in fresh products 27:62-65
Maintaining quality in processed fruits 27:104-107
Man — nature's recalitrant anomaly — bioclimatology—a practical science 29:49-54
McAllister, Devere H. 28:72-77
Matthews, Darrel H. 27:72-77
Matthews, Doyle J. 28:100-102, 107
Matthews, Verl B. 29:17-19, 23
Meat consumption 29:14-15
for an expanding population 27:144-146
Medics operate on unborn lambs 27:42
Meeting the protein needs of dairy animals 28:84-87
Mickelsen, C. H. 27:66-68
Microbes help digest grass 29:28
Mining water in Iran 29:88-89, 92
Mites, McDaniel and the resistance problem 28:26-27, 31
Mohtadi, Malek 29:88-89, 92
Mosquitoes 29:102
Mysteries of nutrition 27:135

N

Native browse and broadleaf herb seed production—on cultivated land 27:59-61
Natural chemical speeds leaf drop 27:151
Nature's unsung middlemen—bioclimatology—a practical science 28:124-129
Nematodes may aid fight against insects 28:75
Neuhold, John M. 28:7-10, 31
New canal sealer clings to concrete 27:51
New chemical may aid mechanical harvesting of sweet cherries 29:111-113
New head appointed for Plant Science Department 27:103
New rules for an old game—bioclimatology—a practical science 29:69-74
New soil classification system 28:130-131
New tanning helps golfers 27:123
New tomato resistant to curly top 27:42
New USU President takes office—as of July 1 29:63
New yearbook of agriculture now printed 27:137
Nielsen, Darwin B. 29:95-98
Nielsen, Rex F. 27:68-71; 28:43-46
Nitrogen-carbon dioxide kill insects 27:103
Now let's get it straight 29:98
Nury, F. S. 27:104-107
Nutrition, mysteries of 27:135
Nye, William P. 29:46-48, 60

O

Oats, wild oats may be foundation for high protein 29:16
Oblivious, soil scientist, department head dies 28:49
Olson, L. E. 27:62-65
Original go power—bioclimatology—the practical science 28:88-93
Ornamentally yours 27:132-134
Osmosis, sugar method for drying fruits 27:84
Oxygen controls cherry scald 28:13

P

Paper pulp waste product prevents insect development 27:151
Pastures
good pastures possible even high and dry 28:43-46
up-grading irrigated pastures 27:47-51; 27:110-112, 116
Peach varieties for Utah's Dixie 27:39-41
People factor and water resources research 28:5-6
Perkes, Loman L. 27:66-68; 29:75-79
Pests
alfalfa weevil 28:42
animals in Utah fruit orchards 27:93-97
caecal worm 29:123
dermestid beetles 29:59
McDaniel mites 28:26-27, 31
Peterson, Howard B. 28:3-4
Plants
ornamental 27:3-5, 44; 27:132-134
pneumonia drugs fight diseases 29:36
space exploration and 27:138-143
Plant Science Department
new head appointed 27:103
plant scientist retires 28:120

MARCH 1969
Plastics, liners and farm ponds 27:90-92
Pneumonia drugs fight some plant diseases 29:36
Pollutants, uranium mill wastes in streams 28:47-49
Population
age groups 29:98
meat for expanding 27:144-146
Utah's—past and future 27:127-128
Post, Frederick J. 28:7-10, 31
Precondition feeder calves for greater returns 28:100-102, 107
President Chase retires June 30—Utah State University 29:31
Produce, maintaining quality 27:62-65
Production and quality of cherry raisins and pickles 29:99-102
Protein
needs of dairy animals 28:84
pigs benefit from 28:111
search for protein-rich seed crops 28:38
wild oats, foundation for high protein oats 29:16
Pruning bearing trees and rejuvenating old trees 27:55-58
Public Land, research on pricing policies 29:95-98
R
Rabbitbrush, herbicide control of 27:9-10, 23
Rain traps of steel 28:79
Range management
increased capacity through better distribution 28:39-42
resources and big game management 28:82-83, 96
resources and watershed management 29:90-91
Utah's range resources 27:147-150
Reluctant jumpers 29:41-42
Reproductive performance of dairy cows on an all-forage ration 27:66-68
Research on public land pricing policies at USU 29:95-98
Research contributions to 27:44; 27:83; 27:116; 27:143; 28:42
serves nation 29:102
solid base of agriculture and industry 29:80-83
Researching the chemistry of snake venom 27:24-28; 31
Resources
development on Bolivian Altiplano 27:72-77
range and big game management 28:82-83, 96
range and watershed management 29:90-91
Utah's range 27:147-150
value of Utah's deer hunting 29:55-59
water research 27:3-4; 28:5-6
Retirements
Assistant Director 28:57
plant scientist 28:120
USU president 29:31
Reynolds, George W. 27:129-131
S
Sagebrush, herbicide control of 27:9-10, 23
Salinity, USDA develops gauge 27:44
Salisbury, Frank B. 27:138-43; new head of plant science department 27:103
Saliva, spreads leukosis 27:134
Salmonella, carried by dermestid beetles 28:39
Sanders, David L. 28:114-115
Scientists develop miniature hogs for drug tests 27:43
Scatter, George W. 28:82-83; 96; 29:3-6, 16
Search is on for new protein-rich seed crops 28:35-38
Seasonal forage use by pronghorn antelope in western Utah 29:3-6, 16
Seeds
native browse and broadleaf herb production 27:59-61
new protein-rich crops 28:38
Sewage, to clean water 28:7-10, 31
Sex hormones and the growth of nursing calves on high mountain ranges in Utah 28:97-99
Sigler, William F. 28:47-49; 28:103; 107; 29:24-28
Skogerboe, Gaylord V. 28:14-20
Slaughter, care of a beef 27:123
Snakes, researching chemistry of venom 27:24-28, 31
Sociology, people and water resources research 28:5-6
Sodium carbonate reseals stock ponds 28:118
Soil classification system 28:130-131
methods for measuring moisture 27:98-103
testing 28:104-107
water application on tillth 28:93-96
Soil scientist, department head dies 28:49
Some insects love to eat only weeds 28:46
South America, llama reproduction a problem 29:43
Southard, A. R. 28:130-131
Space, and plant science 27:138-143
Spillett, J. Juan 29:41-42
Stamping out brucellosis — Western States 27:109
Station receives new director 27:87
Station serves us all—editorial 27:119
Steel, rain traps of 28:79
Steffen, Hyrum 28:111-113
Stoddard, George E. 27:113-115; 28:84-87
Stoddart, L. A. 27:147-149
Street, Joseph C. 27:52-54
Sudweeks, Earl M. 28:100
Sugar osmosis — new method for drying fruits 27:84
Suthivinat, N. 29:99-102
T
Taggart, Glen L. new USU President 29:63
Tall bluebell—an important forage plant on aspen range—in Utah 29:17-19, 23
Tanning, helps golfers 27:123
Taxes
Green Belt Amendment and its probable impact 29:64-68, 83
who pays 27:6-8, 17
Taylor, Sterling A. 27:98.103
soil scientist, department head dies 28:49
Telemeasuring System, development of a low-cost hydrologic sensing system 28:11-13
Ten years of soil testing in Utah 28:104-107
Thorne, J. P. 28:104-107
Time capsules fight insects 28:118
Tingey 29:114-116
plant scientist retires 28:120
Tomato, resistant to curly top 27:42
Toom, Paul M. 27:24-28, 31
Trees
pruning and rejuvenating 27:55-58
training is important 27:32-35
Utah Christmas tree sales 27:36-38
Training fruit trees is important 27:32-35
Tu, Anthony T. 27:24-28, 31
Turkeys
consumer response to use of 28:121-123, 129
Sanpete co-op talks 28:58-62
U
Ultra violet treated apple juice has fresh juice flavor 28:75
Unseen face of Utah agriculture — four stories on new methods and sound management 28:58-69
Uranium mill wastes as stream pollutants 28:47-49
USDA
developing leaf harvester to strip alfalfa 27:54
develops salinity gauge 27:44
scientists identify avian leukosis virus 28-87
Use alfalfa-intermediate wheatgrass where water is limited—upgrading irrigated pastures 27:47-51
Using automobile bodies as fish cover in Bear Lake 28:103, 107
Utah Center for Water Resources and Research 28:3-4
Utah
agriculture, sound management of 28:58-69
bluebell forage 29:17-19, 23
consumer sentiment in 28:119
fruit 27:39-41; 27:93-97
game 29:55-59; 29:117-123
hog cholera in 29:124
livestock in 27:29-31; 28:97-99
weather 28:22-25
range resources in 27:147-149
soil 28:104-107
trees 27:36-38; 28:70-74
water 27:11-17; 27:78-81; 27:124-126; 28:3-4; 28:14-20
wheat 27:68-71; 29:32-33
V
Van Epps, Gordon E. 27:59-61; 27:68-71
Van Kampen, Kent R. 29:20-25
Vegetables, maintaining fresh quality in 27:62-65
Venom, researching the chemistry of 27:24-28, 31
Virus, scientists identify avian leukosis virus 28:87
W
Wadley, Bryce N. 29:108-110, 113
Wankier, B. N. 27:62-65
Wastes, from uranium mill as stream pollutants 28:47-49
Waters, from sewage to clean 28:7-10, 31
Waters, harvesting with catchments 28:30-31
Waters, low-cost hydrologic sensing-telemetering system 28:11-13
Waters, management—a need for research 29:90-91
Waters, mining in Iran 29:88-89, 92
Waters, people factor and resources research 28:5-6; 27:11-17
Waters, research in Utah 27:78-81; 27:124-126; 28:3-4; 28:14-20
Waters, use alfalfa-intermediate wheatgrass where water is limited 27:47-51
Weather, its origin and destiny in Utah 28:22-25
Weeds, can cause deformities 27:87
Weeds, farm planning for control 29:114-116
Weeds, herbicide control of rabbitbrush and sagebrush 27:9-10, 23
Weeds, some insects love 28:46
Weevils, alfalfa 28:42
Wennergren, E. Boyd 28:55-59
Wennergren, Bernard G. 27:3-5; 27:132-134
What about birdsfoot trefoil—upgrading irrigated pastures 27:110-112, 116
What is the Agricultural Experiment Station editorial 27:88-89
What is the value of Utah’s deer hunting resource? 29:55-59
What is the world of water—a never-ending cycle 28:21
Wheat, fertilizing winter wheat 27:68-71
Wheat, grazing vs. wheat production on marginal cropland 29:32-33, 60
Wheatgrass, use where water is limited 27:47-51
Where and why does Mr. Murphy buy? 27:136-137
Who pays the tax bill? 27:6-8, 17
Wilcox, Ethelwyn B. 27:135
Wildlife, notes 29:98; 29:124
Wild oats may be foundation for high protein oats 29:16
Wilson, Lanny 29:34-36
Wilson, LeMoyne 28:130-131
Workman, Gar W. 28:103, 107
Workman, John P. 29:32-33, 60
World of water—a never-ending cycle 28:21
Y
Yearbook, agricultural 27:137

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MARCH 1969

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