Which method of irrigation, by D. C. Strong .......... 26
Delmar, a new, hard red winter wheat, 
by W. G. Dewey .................................. 28
Amino acid balance in chick diets, 
by J. O. Anderson .................................... 31
Enzymes . . . life catalysts, by G. W. Miller .......... 32
Plan ahead to beat the drought, 
by R. F. Nielson and G. Owens ..................... 34
Rural-urban population changes in Utah, 
by T. R. Black and D. Poplin .......................... 36
Contract production for farm feeding 
enterprises, by L. H. Davis .......................... 38
Veterinary diagnostic laboratories, 
by M. L. Miner ....................................... 40
Barley for fattening lambs, by J. E. Butcher, 
J. C. Street, and W. C. Foote .......................... 44
Needs of Utah's irrigated soils for phosphorus 
and potassium, by R. F. Nielson, 
G. A. Van Epps, and J. P. Thorne .............. 46
Research notes ........................................ 55

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UTAH STATE UNIVERSITY • LOGAN • AGRICULTURAL EXPERIMENT STAnON
Which Method of Irrigation?

Feasibility of a particular method influenced by wide variety of physical and economic situations. No one method will meet all farmers' needs and the technical requirements of modern irrigation.

DOUGLAS C. STRONG

Basically, there are two methods of irrigation, surface and sprinkler, but within these methods are numerous alternative means of conveying and applying water to land. Recent developments in ditch linings, aluminum gated-pipe, steel and concrete pipe, siphons, and siphons have increased the importance of new surface methods of irrigation over old and inefficient systems. Likewise, widespread availability of electric power, improvements and new developments in pumps, motors, aluminum tubing, and quick couplers have contributed to the increased importance of sprinkler irrigation and the number of alternative methods of irrigation.

Increasing demands for our limited water supplies for domestic, industrial, and agricultural uses are influencing efforts to improve ways of increasing the efficiency of water use. Whether old systems on presently irrigated land are being "modernized" to meet the need of improved irrigation practices, or new land is being developed for irrigation, the answer to the question of which is the most feasible method among numerous alternatives is becoming increasingly more important.

Economic feasibility depends upon over-all costs and returns.

The economic feasibility of a particular method of irrigation must be established on the basis of its total effect on gross crop returns as well as on the costs of installation and operation. Generally, alternative methods are evaluated on the sole basis of costs while differences in returns due to factors such as production "lost" because of land used for ditches, intensity of land use, crop yields, land use efficiency, and amount of water required are not given due consideration. Frequently, these differences are sufficiently large to cause a system with the lowest operating
costs to actually be the least feasible when all things are considered.

Methods of irrigation studied

A wide variety of physical and economic factors causes extreme variations in costs and returns among different methods of irrigation on individual farms. Research was conducted to determine conditions under which one method would have an economic advantage over another for a wide range of physical land situations. The following methods of irrigation were evaluated: 1) unlined and concrete-lined ditches, 2) sprinklers, and 3) gated-pipe. The sprinkler system was modified by assuming that water was conveyed to the laterals either by permanently installed steel pipe or by portable aluminum pipe, and that pressure for sprinkling was provided by irrigation engineering specialists. From these sources recommended lengths of irrigation runs were established for the surface systems for each soil grouping and land gradient for which costs and returns were computed (table 1). Similarly, costs and returns were computed for a sprinkler system for each physical situation to determine conditions under which one method may be more feasible than another.

The basic data uses in the analyses were obtained from 42 sprinklers and 96 surface irrigation systems in Cache, Box Elder, Wasatch and Iron Counties, Utah. The field data were augmented with data from studies by the Bureau of Reclamation, the Soil Conservation Service, and the Utah Agricultural Experiment Station.

Economic factors influencing most desirable method

In addition to physical land situations, various economic conditions influence the feasibility of a particular method of irrigation for an individual farmer. For instance, lack of capital may prevent him from installing the most efficient system because of high initial costs, yet annual operation and maintenance costs might be lower. A major economic factor influencing the choice of a particular system (Continued on page 48)

Table 1. Specified lengths of irrigation run for varying slopes of land and textures of soil

<table>
<thead>
<tr>
<th>Slope of land</th>
<th>Soil textural groupings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fine</td>
</tr>
<tr>
<td>percent</td>
<td></td>
</tr>
<tr>
<td>Less than 1.4</td>
<td>880</td>
</tr>
<tr>
<td>1.5 to 2.9</td>
<td>660</td>
</tr>
<tr>
<td>3.0 to 5.9</td>
<td>330</td>
</tr>
<tr>
<td>6.0 to 9.0</td>
<td>165</td>
</tr>
</tbody>
</table>

Either diesel, gasoline, or electric power.

Each method designed for a specific land situation

Each of these methods was designed for physical land situations of: 1) uniform slopes of less than 1.4 percent, 1.5 to 2.9 percent, 3.0 to 5.9 percent, and 6.0 to 9.0 percent; 2) soil textural groupings of fine, medium, and coarse; and 3) farm sizes of 40, 80, and 160 acres.

To insure properly designed systems for each physical situation, irrigation specifications were determined from Soil Conservation District technical guides and from recommendations of soil and irri-
Delmar
A New
Hard Red
Winter
Wheat

Combines high yield, smut resistance, stiff straw with good baking quality and strong mixing properties

WADE G. DEWEY

Delmar is a new hard red winter wheat variety developed at the Utah Agricultural Experiment Station for the dryland wheat areas of the state. It was bred in response to demands by the milling and baking industries for wheat varieties with greater mixing tolerance and better baking qualities than are found in Cache and Walton.

DR. WADE G. DEWEY is assistant professor of agronomy. He is working in the winter wheat breeding program.

Delmar wheat was developed at the Utah Station and tested in cooperation with the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture. Appreciation is expressed to the following organizations for their cooperation and assistance in the development and testing of this variety: Ogden Grain Exchange; Sperry Operations of General Mills Inc., Ogden; Regional Smut Research Laboratory, Pullman, Washington; and the Western Wheat Quality Laboratory, also at Pullman. The cooperation of the following growers who provided land for off-station testing is also appreciated: Victor Rasmussen, Clarkston; Dick Allen, Jangle Valley; Lawrence Whitney, Pocatello Valley; Don Cummings, Fillmore; and James Crowley, Monticello.

Development

Delmar (C. I. 13442) resulted from a cross made by D. C. Tinge in 1949 between Utah Kanred and Brevor. Utah Kanred is an old, well adapted hard red variety which is high yielding but highly susceptible to common and dwarf bunt (covered or stinking smut). It has poor mixing tolerance but bakes into an excellent loaf. The Brevor parent is a soft white winter variety from the Pacific Northwest. It is high yielding, has relatively short stiff straw, and possesses good bunt resistance.

Delmar, which was designated as selection 208-63-2-1 throughout its development and testing period, represents an unusual transgressive segregate from this cross, in that it possesses quality characteristics which are not found in either parent. It combines the high yield, smut resistance, and stiff straw of Brevor with the baking quality of Utah Kanred, plus strong mixing properties which are not exhibited by either parent.

Description

Delmar is a white-chaffed, bearded wheat with an erect semi-compact head which, except for the beards, somewhat resembles its Brevor parent. It has a relatively long, hard red kernel characteristic of Utah Kanred and tends to be slightly lower in test weight than such varieties as Itana and Columbia. Delmar is medium in height, usually averaging slightly shorter than Itana and slightly taller than Columbia. Straw strength is excellent and lodging is seldom a problem even under irrigation.

Smut resistance

Bunt or stinking smut is one of the most serious threats to winter wheat production in Utah and the

FARM AND HOME SCIENCE
Intermountain area. So serious was the bunt problem before the development and extensive use of resistant varieties that in some years three-fourths of the carloads of wheat arriving at the Ogden and Salt Lake terminals graded smutty. Although annual losses to bunt have been greatly reduced through the use of resistant varieties, varieties do not remain resistant to smut indefinitely. The smut organism is capable of producing new forms or races which can attack presently resistant varieties; consequently, we are always open to future outbreaks. A constant effort must be made to provide new sources and combinations of bunt resistance in the wheat varieties available to Intermountain growers if we are to stay ahead of the bunt problem.

The variety Delmar exhibits high resistance to most races of common and dwarf bunt. It is considerably more resistant to the common bunt races than is Itana, and although it is not completely resistant to the newer more virulent races of dwarf bunt, it possesses greater resistance to these races than do either Itana or Columbia. Comparative smut reactions of several varieties to race D-3 of dwarf bunt and to a composite of common bunt races are shown in table 1.

**Quality characteristics**

The baking industry in recent years has emphasized the mixing characteristics of bread wheats. The present standard varieties in Utah, Cache and Wasatch, show relatively poor tolerance to the mechanical mixing methods used in modern bakeries. The farinograph is one of the instruments used to measure the mixing characteristics of bread wheats. This device records graphically a curve which describes various characteristics of a given dough sample as it is subjected to mixing. Typical farinograph curves for strong, weak, and very weak wheat varieties are shown in fig. 1.

Delmar was developed to help meet the need in the Intermountain area for bread wheats with strong mixing characteristics. Before the recent releases of Itana, Columbia, and Tendoy, all of the strong wheats used by Utah's milling industry to blend with weaker varieties such as Cache and Wasatch had to be shipped in from Montana or the Midwest. It is expected that Delmar, along with these other new varieties, will alleviate the need for local mills to obtain strong mixing wheats outside the Utah and southern Idaho area.

The comparative quality characteristics of Delmar and four of the leading bread wheat varieties...
Table 2. Comparative mixing and baking characteristics of 5 winter wheat varieties, 1957-1960
(Data provided by Sperry Division of General Mills Inc. Ogden, Utah)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>Wheat protein</th>
<th>Flour extraction</th>
<th>Stability to mixing</th>
<th>M. T. I.</th>
<th>Farinograph absorption</th>
<th>Leaf volume</th>
<th>Over-all baking rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>percent</td>
<td>percent</td>
<td>minutes</td>
<td></td>
<td>c.c.'s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cache</td>
<td>1957</td>
<td>14.9</td>
<td>69.4</td>
<td>2.5</td>
<td>80</td>
<td>69.0</td>
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<td></td>
<td>1958</td>
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<td>61.4</td>
<td>5.5</td>
<td>40</td>
<td>71.6</td>
<td>2500</td>
<td>fair</td>
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<tr>
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<td>10.9</td>
<td>62.1</td>
<td>4.0</td>
<td>65</td>
<td>70.4</td>
<td>2575</td>
<td>poor</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>14.3</td>
<td>61.7</td>
<td>11.0</td>
<td>40</td>
<td>67.1</td>
<td>2975</td>
<td>good-</td>
</tr>
<tr>
<td>4 yr. average</td>
<td></td>
<td>12.7</td>
<td>63.7</td>
<td>5.8</td>
<td>56</td>
<td>69.5</td>
<td>2700</td>
<td></td>
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<tr>
<td>Wasatch</td>
<td>1957</td>
<td>14.7</td>
<td>68.4</td>
<td>2.0</td>
<td>90</td>
<td>66.4</td>
<td>2450</td>
<td>poor</td>
</tr>
<tr>
<td></td>
<td>1958</td>
<td>11.2</td>
<td>62.2</td>
<td>4.0</td>
<td>60</td>
<td>70.4</td>
<td>2500</td>
<td>fair</td>
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<tr>
<td></td>
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<td>62.7</td>
<td>4.0</td>
<td>75</td>
<td>70.0</td>
<td>2575</td>
<td>fair-</td>
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<tr>
<td></td>
<td>1960</td>
<td>14.3</td>
<td>62.8</td>
<td>4.5</td>
<td>70</td>
<td>66.6</td>
<td>3000</td>
<td>fair</td>
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<tr>
<td>4 yr. average</td>
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<td>12.6</td>
<td>64.0</td>
<td>3.6</td>
<td>74</td>
<td>68.4</td>
<td>2631</td>
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<tr>
<td>Itana</td>
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<td>13.2</td>
<td>68.2</td>
<td>7.5</td>
<td>50</td>
<td>63.6</td>
<td>2600</td>
<td>fair-</td>
</tr>
<tr>
<td></td>
<td>1958</td>
<td>10.6</td>
<td>66.4</td>
<td>10.0</td>
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<tr>
<td></td>
<td>1959</td>
<td>9.3</td>
<td>†</td>
<td>†</td>
<td>†</td>
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<td>†</td>
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<td></td>
<td>1960</td>
<td>13.3</td>
<td>63.7</td>
<td>15+</td>
<td>25</td>
<td>63.2</td>
<td>2900</td>
<td>good</td>
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<tr>
<td>4 yr. average</td>
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<td>66.1</td>
<td>10.8</td>
<td>32</td>
<td>63.3</td>
<td>2666</td>
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<tr>
<td>Columbia</td>
<td>1957</td>
<td>14.0</td>
<td>68.8</td>
<td>6.5</td>
<td>50</td>
<td>67.3</td>
<td>2775</td>
<td>fair</td>
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<tr>
<td></td>
<td>1958</td>
<td>11.2</td>
<td>60.8</td>
<td>18.0</td>
<td>10</td>
<td>67.8</td>
<td>2475</td>
<td>good</td>
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<tr>
<td></td>
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<td>10.7</td>
<td>61.4</td>
<td>5.0</td>
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<td>66.1</td>
<td>2550</td>
<td>poor</td>
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<tr>
<td></td>
<td>1960</td>
<td>13.9</td>
<td>61.9</td>
<td>15+</td>
<td>35</td>
<td>65.9</td>
<td>3000</td>
<td>good</td>
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<tr>
<td>4 yr. average</td>
<td></td>
<td>12.5</td>
<td>63.2</td>
<td>11.1</td>
<td>33</td>
<td>66.8</td>
<td>2700</td>
<td></td>
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<tr>
<td>Delmar</td>
<td>1957</td>
<td>13.5</td>
<td>70.5</td>
<td>14.0</td>
<td>20</td>
<td>65.5</td>
<td>2875</td>
<td>good-</td>
</tr>
<tr>
<td></td>
<td>1958</td>
<td>11.6</td>
<td>66.3</td>
<td>27.0</td>
<td>5</td>
<td>68.3</td>
<td>2675</td>
<td>good</td>
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<tr>
<td></td>
<td>1959</td>
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<td>66.1</td>
<td>4.5</td>
<td>50</td>
<td>67.5</td>
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</tr>
<tr>
<td></td>
<td>1960</td>
<td>14.5</td>
<td>64.7</td>
<td>15+</td>
<td>-15</td>
<td>69.0</td>
<td>3075</td>
<td>good-</td>
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<tr>
<td>4 yr. average</td>
<td></td>
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<td>66.9</td>
<td>15.1</td>
<td>15</td>
<td>67.6</td>
<td>2806</td>
<td></td>
</tr>
</tbody>
</table>

All varieties were grown under comparable conditions in the same dryland nursery at Clarkston, Utah. *Mixing tolerance index (the lower the number, the stronger the flour). †Amount of water absorbed by the flour to bring it to proper mixing consistency for farinograph readings. ‡Itana's protein content was too low in 1959 to give valid farinograph and baking readings.

Yield performance

Yield of Delmar in comparison with other dryland, hard red winter wheat varieties grown in the Intermountain region is shown in table 2. Four of the five were essentially identical in average protein content, while Itana averaged approximately one percent lower. Delmar ranked relatively high in flour extraction and was at least equal to Itana and Columbia in mixing strength. It exceeded the other varieties in loaf volume and averaged out with the best over-all baking rating. Loaf volumes of Delmar (208-63-2-1) and several other varieties and breeding selections for the 1960 crop are shown in fig. 2.

Yield performance

Yield of Delmar in comparison with other dryland, hard red winter wheat varieties grown in the Intermountain region is shown in table 3. Over the five year period from 1956-1960 it has averaged 4 to 5 bushels per acre higher than Cache and Wasatch in test plots at Clarkston. It has also yielded comparatively well at other locations throughout the state, as is evidenced by the average yields shown in table 4. Delmar ranks with the top yielding varieties entered in the Western Regional Hard Red Winter Wheat Nursery when averaged over all locations during the two years it has been in this test (table 5).

Delmar appears at most locations (Continued on page 51)

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Formulating chick rations with the best protein mixture for fast growth is in many ways similar to ordering materials for the construction of a new building. Both the protein of the chick and the building are made of smaller units which will be joined to make the final product. The sand, cement, bricks, steel, wood, glass, and other materials are the units used to construct the building; the units used by the chick to construct protein for growth are known as amino acids. In both cases it is either necessary or most practicable to supply certain of the basic building units ready made. Sometimes certain units can be made from other materials if necessary. If excessive quantities of certain materials are brought to the building site, they may be wasted or it will be necessary to return them. In either case the process will be less efficient. We are beginning to realize that in feeding chicks we must not only

**AMINO ACID BALANCE IN CHICK DIETS**

**JAY O. ANDERSON**

supply adequate protein, but each essential amino acid must be found in this protein in balanced proportion with other amino acids for fastest and most efficient growth. The proteins needed for growth of the chick contain about 20 different amino acids. Ten of these are required in the diet because the chick has little if any ability to synthesize them from other materials. Two more amino acids can be made, but only by using two of the required amino acids. The remaining amino acids can be made from other materials if these are found in the diet. When they are found in excessive quantities they can be easily converted to other materials. Balance among these nonessential amino acids in the diet is less important than balance among the essential ones.

**Minimum requirements**

The National Research Council (NRC) has published minimum amino acid requirements for chicks. These values were decided after considering the results of numerous experiments conducted to define them. The poultry industry uses them as a guide in formulating the rations for chicks. When a nutritionist formulates a feed, he selects the ingredients in such a way that

(Continued on page 50)
ENZYMES...  

DR. GENE W. MILLER is assistant professor of botany. He is doing research on plant enzymes in relation to fluorine poisoning and chlorosis. Dr. Miller has been granted a National Science Foundation fellowship for the coming school year. He will study enzyme systems of salt loving plants at the University of Münster, Germany.

Fig. 1. The surface of the molecules of glucose and fructose fit into the specific surface of the enzyme. Reaction is speeded up since the two molecule constituents of sucrose are brought in close proximity and bonding occurs more rapidly than through non-enzymatic chance collisions. When sucrose is formed the enzyme is free to catalyze the same reaction again.

Properties of enzymes

Enzymes are unaffected by the reactions they produce. They are destroyed only by the action of other enzymes or rendered inactive by certain poisons. A single cell may contain a specific enzyme for each of the over 1000 chemical reactions taking place. A single molecule of an enzyme that splits hydrogen peroxide into water and oxygen can convert more than 5 million peroxide molecules a minute. Other enzymes can convert from 1000 to 500,000 molecules in the same time.

All enzymes that have been isolated are composed of protein. These protein catalysts reside in the protoplasm of the cells and speed up the rate of chemical reactions taking place. Without these, chemical reactions at ordinary temperatures would not be fast enough to sustain life. Thus enzymes are the supplement to thermal agitation and a device through which reactions requiring high temperatures in the test tube occur at low temperatures in the protoplasm.

How does an enzyme work? Best evidence indicates that it combines temporarily with the reacting molecules. Mutual contact of these molecules, which is necessary for the reaction to take place, is no longer a matter of chance, but a
matter of certainty. Hence, fast reaction occurs. The protein nature of an enzyme is essential for this reaction-accelerating effect. Proteins are huge molecules composed of long chains of joined, variously-arranged amino acids. Thus the physical structure and shape of a protein molecule depend on the type and arrangement of amino acids. Each protein molecule has a distinct geometric surface distinguishing it from other proteins. The nature of the surface appears to be the key to enzyme action. Consider the following over-simplified reaction:

\[ \text{glucose} + \text{fructose} \xrightarrow{\text{enzyme}} \text{sucrose} \]

Glucose has a given unique surface geometry as has fructose. Enzymatic acceleration of this reaction may occur if a protein molecule is present which contains a surface configuration to bring both glucose and fructose molecules close enough together to react. This is illustrated in fig. 1.

In enzyme accelerated reactions, it is common to speak of reaction molecules such as glucose and fructose as substrates. When substrate molecules are attached to the enzyme, the whole is referred to as a substrate-enzyme complex. Formation of such complexes may be thought of as a lock and key arrangement as only specific keys fit particularly shaped locks. Just so only certain molecules will fit certain enzymes. In fig. 1 glucose and fructose possess the proper configuration to fit the specific enzyme present. However, as shown in fig. 2, the enzyme catalyzing the synthesis of sucrose would not have the proper surface configuration to catalyze the reaction of a glucose and a galactose molecule (formation of lactose, prominent sugar in milk).

Enzymes may be classified according to the substrate on which they react. Thus carbohydrases would be the class of enzymes affecting carbohydrates. Analogously, proteinases and lipases affect proteins and fats, respectively. A suffix -ase always signifies that the substance in question is an enzyme. All names of enzymes do not necessarily end in -ase, such as papain, a proteinase found in the fruit of the papaya and used as a meat tenderizer, or trypsin and pepsin, which are proteinase enzymes found in the stomach.

**Metal and organic acid requirements**

Chemical changes do not necessarily take place simply because a substance molecule has fitted itself into the enzyme mold and has been activated. More often than not a third substance (non protein) other than substrate and enzyme is an added requirement before the reaction proceeds. Some enzymes require the presence of specific metals such as iron, copper, magnesium, manganese, zinc, or molybdenum in order to catalyze the reaction. Enolase, an important enzyme in respiration and fermentation, requires the presence of magnesium and potassium. Cytochrome oxidase, a terminal enzyme in respiration, requires iron (and perhaps also copper) to function properly.

Many enzymes require the presence of a specific organic molecule known as a coenzyme before they are active. Vitamins serve as coenzymes in both plants and animals.

(Continued on page 43)
PLAN AHEAD
TO BEAT THE DROUGHT

The flow of the Sevier River at Hatch shows that drought has prevailed during most of the period.

Panguitch Lake Reservoir is empty, a situation all too common with many of our reservoirs throughout Utah.

Land leveling, efficient use of water, fall plowing, early spring planting, adequate fertility, practices that reduce effects of drought.

Land leveling is of major importance in preparing for efficient irrigation.

Land with a side slope can be leveled in terraces for effective control of irrigation water.
Where drop structures are not used, large streams on sloping land can soon develop gullies

Effective drop structures can be constructed with relative ease at reasonable cost by using cement blocks

REX F. NIELSON
GREW OWENS

The problem of limited water supplies has plagued the farmers of Utah for many years and will probably continue to do so. This situation is further aggravated in that cycles of severe drought occur periodically and drastically affect agricultural production. Since it is not possible to avoid drought, it becomes necessary to adapt farming practices such that these adverse effects are minimized.

A program was initiated at the Panguitch Experimental Farm in 1952 to determine which farm practices are most effective in making efficient use of limited water supplies. The results from this program have been impressive. The total production has more than doubled during the past ten years as a result of land leveling, changing the irrigation system, and following water conserving cultural practices. The yield of alfalfa has increased from slightly more than one ton per acre to more than 3½ tons. In favorable years yields have been in excess of 4 tons. This increase in production has occurred during years when drought has been the most severe in the history of the area.

Efficiency of irrigation has been (Continued on page 54)

REX F. NIELSON, assistant professor of agronomy, supervises the program of the Panquitch farm. GREW OWENS is the farm manager.
The type of community in which you live has a profound meaning to you and your family

Atttitudes, values, and systems of behavior spring from many and oftentimes diversified sources. They are the direct result of the interaction of such institutions as the family, peer group, school, church, and government. Each of these is, in turn, a part of a more all-embracing institution, the community, and as such is greatly affected by it. Any appraisal of the individual must occur in the community context. Even the seemingly simple fact that a community is "rural" or "urban" has profound meaning for the individual and multiple ramifications in terms of the general character and design of the entire social environment.

What kind of community do you live in? Is it urban or rural? These tips may help you answer this question: There are thirty-nine urban communities in Utah within which live three fourths of the state's total population. The remaining quarter of the population is found scattered throughout the state in.

DR. THEREL R. BLACK is associate professor of sociology. DENNIS POPLIN is a graduate student in sociology.
What is an urban community?

The answer to this question is by no means simple. The U. S. Bureau of the Census has been struggling with it for many years. Before the collection of data in 1950, this agency carried out an extensive program of redefining and delineating urban places. It designed five criteria, only two of which apply to the present Utah situation: 1) Any place with 2,500 people or more which is incorporated, and 2) all the population living in the urban-fringe area and in unincorporated places of 2,500 or more. There are three unincorporated communities which fall under this second classification: Dragerton, Magna, and Kearns. Salt Lake City (189,454) is the largest urban community in Utah while the smallest is Smithfield (2,512).

Below the figure of 2,500, all places are considered rural. Such a figure is, of course, completely arbitrary. Is Helper with a population of 2,459 actually qualitatively different than Smithfield because of the minor differences in population numbers involved? Or might it be that Smithfield with its agrcultural orientation is even more rural than Helper, a mining community? There is much more implied in the dichotomous conditions being discussed than sheer numbers. Attitudes, value systems, and patterns of behavior all help to determine whether a community is "urban" or "rural." However, for practical purposes, the figure of 2,500 seems to be a satisfactory division point.

100 years of urban growth in Utah

In 1860, the Utah Territory included parts of the present states of Nevada and Wyoming and had a total population of 40,273. Because of religious, governmental, economic, and social functions, Salt Lake City had achieved the status of "urban" in the preceding decade. However in 1860, 79.5 percent of the early settlers were still rural dwellers. This was a matter of sheer necessity. One hundred years ago, even the best and most efficient of farming methods couldn't produce enough surplus to sustain many nontillers of the soil. It was during the ten-year period under consideration that the present borders of Utah were established. During the same ten years, Ogden became the second urban place in Utah.

By 1870, Utah had gathered a population of 86,756. The percentage of rural dwellers had climbed to 81.6, an all-time high. Since that date, some ninety years ago, this percentage has been declining at a rather steady rate. The downward trend was clearly apparent at the beginning of the 1880 decade when the proportion of rural dwellers had dropped to 76.6 percent of the total population, and in 1890 when it was barely over 64 percent. By 1890, the list of urban communities contained four new ones in addition to Salt Lake City and Ogden: Logan and Provo, which reached the crucial 2,500 mark in the 1870 decade, and Spanish Fork and Springville, which became urban places between 1850 and 1890.

Such trends, which began early in the history of Utah, do not necessarily imply that people were ceasing to farm: It merely indicates that they were beginning to clump together in increasingly large units which became the nucleus for the cities and urban places of today. The modern city is supported by goods coming from smaller communities and the open country. The "big" city as it is now conceived is not designed for crop and livestock production. The most it can do is process and transform these goods, not produce them. The latter is the role of the rural dweller, and directly or indirectly, the role of the small community as a socio-economic institution.

The downward trend in the percentage of rural dwellers continued through the decades following 1890. By 1930, it had dropped below 50 percent and twenty-one urban places had emerged. In 1940, 44.5 percent of Utah's people lived in rural communities, in 1950, 34.7 percent. The last decade saw this percentage decrease to the extent that now only one quarter of the state's 890,627 people live in rural communities.

This trend may well continue. If such is the case, it does not indicate that the rural producer and dweller is losing status or function in our multi-faceted economy. Rather, it would seem to suggest that his success is more crucial to the welfare of the entire economy. If his numbers drop to 10 percent of the total population, then his role is no longer just important; it is critical. No factory, regardless of the cleverness of its engineering department, can yet produce milk, meat, vegetables, lumber, oil, and coal. To say that the farmer and ruralite are not key figures in the socio-economic setting is to say that food, housing, clothing, and fuel are not key products.

Why do communities change?

Community patterns have never been static nor particularly stable in Utah. Instead, they have been dynamic—some units growing, some declining—since the beginning of the state's history more than 100 years ago. The last decade was especially dramatic in this respect. Two urban towns disappeared, that is, they dropped below the 2,500 mark used to distinguish urban. These two were Bingham Canyon and Helper. Nine others joined the ranks of urban communities: Kaysville, Kearns, Moab, North Ogden, (Continued on page 50)
Factors affecting broiler production differ from those of other feeding enterprises

Contract Production for Farm Feeding Enterprises

LYNN H. DAVIS

People interested in the future of agriculture have expressed considerable interest in the growth of production by contract. The recent development of contract production methods in broiler production has given rise to most of this interest. The possibility that similar contracts will be used in other farm enterprises has also generated interest. Some have concluded that we are approaching a new era when the farmer will produce according to predetermined time schedules and specifications.

DR. LYNN H. DAVIS is associate professor of agricultural economics. This article is based on the research he did for his doctoral dissertation at Oregon State University. Dr. Davis received his PhD degree from that institution during the past year.

Development of contract production

The broiler industry has developed in such a way that about 95 percent of the broilers are produced under some contract arrangement between the grower and the feed company, processor, or hatchery. What forces have brought about this change? This article points out six factors that influenced the adoption of contracts in the broiler industry and discusses the effect these factors may have on contract production in the following farm enterprises: 1) commercial laying flocks, 2) turkey growing, 3) swine fattening, 4) cattle fattening, 5) lamb fattening. These enterprises were considered because: a) they all involve the feeding of poultry or livestock to produce a marketable product rather than for
breeding purposes, and b) they are enterprises that are frequently mentioned as adaptable to contract production.

These enterprises have all been subject to sales contracts in the past. The contracts were usually short term and were signed as marketing time drew near. Important terms of the contracts were time of delivery and price. Eggs from commercial laying flocks have been delivered to independent buyers or cooperatives frequently under some contract arrangement wherein the grower knew what price he would receive relative to market prices established at centers of trade. Turkeys, hogs, beef cattle, and lambs have been sold on the basis of a contract price at a specified delivery date.

Contracts used at present in broiler production differ from those that have been used in other feeding enterprises in that production is according to specified practices and time schedules. Part of the management decisions are made for the grower. The price he will receive is not always stated in the contract. He is usually assured a minimum price if he achieves a specified level of efficiency. Frequently he only invests his labor, his buildings, and his equipment so the amount received is a payment for the use of these items of production.

Will livestock and additional poultry enterprises be organized under similar contractual arrangements? Let us consider a number of factors that will influence the adoption of similar production plans in other enterprises.

1) Rapid technological advance

Rapid technological advance in all phases of broiler production was important in the development of contracts in this industry. New strains and crosses of meat-type chicks increased the gaining ability, uniformity, and the quality of the finished broiler with lower unit costs which led to the production of greater numbers even at a lower selling price. More uniformity of size, more meat in relation to carcass weight, and lower selling prices were favorable to an increased consumption of broilers. Research findings provided the industry with feed formulas which gave a faster as well as a more efficient rate of growth.

New feed developments coupled with breeding advances have provided a more even degree of finish in a shorter feeding time making it possible to market a younger, but well developed bird. Although there may be a point beyond which younger birds are of lower eating quality, consumers agree that quality has been improved by the younger selling age. Changes in processing to market a ready-to-cook broiler have resulted in greater ease of preparation at the time of cooking. Packaging of the ready-to-cook bird has made self-service retailing of broilers possible. All of these innovations have resulted in essentially a new product. The

(Continued on page 52)
Microscopic examination of tissues: 3) Cutting of tissues fixed in formalin to small pieces preparatory to embedding. 4) Putting receptacle of tissue pieces in automatic changing machine that dehydrates, clears, and embeds tissues in wax. 5) Cutting thin (7 microns thick) section of tissue in wax. 6) Staining tissue sections attached to slides. 7) Examining stained tissue section for pathological changes.

Culture for bacteria: 8) Beginning a post-mortem examination to collect tissues for bacterial culture. 9) Transferring bacterial cultures to determine biochemical characteristics. 10) Examining culture tubes in aerobic incubation. 11) Preparing bacterial cultures for anaerobic incubation. 12) Guinea pigs used to test disease-producing ability of bacteria.

Exotic diseases are becoming a greater threat to animal production because of increased intercontinental transportation. Africa has long had a group of horse, cattle, and sheep diseases peculiar to itself. Today these diseases are spreading across that continent to other continents. In 1952 workers in Texas reported a sore-muzzle condition in sheep. In 1953 sheep with swollen lips and lameness...
were reported in Sanpete and Box Elder Counties in Utah. Detailed investigation over several months resulted in the isolation of a virus which experimentally would cause the same condition as seen in the field. In 1954 veterinary pathologists in Utah, Texas, and California simultaneously reported the finding of the virus which later proved to be the cause of blue tongue of sheep, a disease which previously had been known only to South Africa. This is one of the services performed by the state veterinary diagnostic laboratories.

The Utah legislature, in 1928, established this service in the Agricultural Experiment Station of the University. Until 1944 all the work was done at Logan. In the previous year the legislature appropriated funds to establish the Branch Veterinary Laboratory at Provo.

Two types of services

The work in the laboratories falls into two distinct categories. One consists of diagnostic tests on specimens (entire animals, parts of animals, blood, exudates, milk) sent to the laboratory by livestockmen, poultrymen, or veterinarians. The other consists of running blood tests for organized disease eradication programs. Under both of these categories 128,710 individual tests were made in 1960; most are routine tests but some are complicated and time consuming.

It would be physically impossible and too costly for the state diagnostic service to examine all the animals that die or even those that die on farms when an epidemic occurs. Thus the most desirable approach is for the livestockman or poultryman to call his private or company veterinarian. Quite often the veterinarian can make the ne-

SUGGESTION FOR EFFICIENT USE OF THE DIAGNOSTIC LABORATORIES

1) Consult your veterinarian about animal health problems and animal disease control programs.

2) Specimens submitted must be the right kind for specific tests, properly collected, identified, and preserved. Contaminated or decomposed specimens are of little diagnostic value.

3) Specimens should be presented to either laboratory from 8:00 to 11:30 a.m. A veterinarian will be available for consultation during these hours. In the afternoon he may be in the field or performing other assigned duties.

4) In the organized disease control programs, specimens are to be submitted only to authorized persons.

Diagnostic laboratories are located at:
Department of Veterinary Science, Utah State University, Logan Branch Veterinary Laboratory, 1201 West Center, Provo
cessary diagnosis or at least a tentative diagnosis on which treatment or control can be based. If laboratory tests are required, he can select the right tissues and properly prepare and preserve them for laboratory examination.

This type of diagnostic service takes up much of the day-to-day time of the laboratory personnel; yet they are ready when required to make a full appraisal of an outbreak of a highly contagious disease. They examine animals on the farm and personally collect necessary specimens. Also when new or unusual disease conditions occur, the diagnosticians will make an extended investigation — sometimes involving preliminary experiments.

In 1960 with this type of service 1,921 consignments were received and 12,000 individual examinations were made. These examinations consist of necropsies; microscopic examinations of blood, milk, tissues, and exudates; cultures for bacteria, viruses, and fungi; animal inoculations; blood tests; chemical analyses, and x-rays. Many of these tests take time (days and weeks) to complete, thus the diagnosis is not always for immediate use in treatment. Quite often the veterinarian or owner has started treatment of a herd before material is brought to the laboratory.

The value of the laboratory diagnosis is manyfold. If a wrong tentative clinical diagnosis was made, treatment can be changed to conform with the definite diagnosis. More often, however, the laboratory results confirm the clinical diagnosis making any further steps of control more sure of success. Since the Utah State Department of Agriculture, through the state veterinarian, is responsible for the control of spread of disease, the findings of contagious diseases are reported to him. Last year 84 different disease conditions were found in poultry and 124 in livestock. These findings also help the researchers to understand the disease problems in the state. Some of the research projects in the Veterinary Science Department were developed as a result of the accumulated records of the diagnostic services.

Another value of the service is illustrated above with the finding of blue tongue in sheep in Utah. New and unusual disease conditions must be identified. In doing this the diagnostician often obtains the assistance of specialists in the University as well as those in the Veterinary Science Department. An entomologist helped identify the scabies mite of cattle found in Box Elder County last year, the first case in Utah for decades. A biochemist was instrumental in first recognizing fluorosis in Utah County. This led to an extensive research project. Plant taxonomists are helpful in identifying poisonous plants. The Animal Husbandry Nutritional Laboratory is most helpful in identifying poisons in animal tissues. With the increased use of pesticides and herbicides, loss from such poisonings is becoming a major animal health problem.

Cooperation with other agencies

In the second category of work involving disease eradication programs, the diagnostic laboratory works in cooperation with the Utah State Department of Agriculture and the Animal Disease Eradication Branch (ADE) of the United States Department of Agriculture. The brucellosis eradication program has been under way since 1935. Brucellosis is a disease of cattle causing contagious abortion. In man it causes a serious chronic (sometimes acute) infection characterized by undulating fever. The program has almost eliminated the disease from Utah cattle, but continual check-testing is necessary. The laboratory tests are made by a technician of the ADE at the Provo laboratory. Last year under the brucellosis program 29,545 bovine blood tests and 21,156 milk ring tests were run. In addition, at that laboratory 910 complement fixation tests for anaplasmosis of cattle and 1,508 agglutination tests for leptospirosis of cattle were made to determine the incidence of these two diseases in Utah. Both are of low incidence but quite widespread particularly in northern Utah.

The pullorum disease eradication program of poultry is a state program initiated by state law in 1943. Pullorum disease, a highly fatal disease of baby chicks and pullets, is transmitted by the hen through the egg to the offspring. Thus every commercial breeder hen (chicken, turkey, duck, or pheasant) must be tested and found free of pullorum infection. Last year 12,356 chick and 56,235 turkey blood tests were run under the program. The disease has been eliminated from Utah turkey pullets for years and is practically eliminated from chickens. This program is the responsibility of the State Department of Agriculture but is immediately supervised by the University extension veterinarian.

A few years ago in the cattle tuberculosis eradication program in Cache Valley, there were many reactors to the skin test. Probably the tuberculosis organism did not cause the reaction but some other closely related bacterium. The ADE is investigating this. The diagnostic laboratory is examining duplicate samples from reactor cows along with the National Animal Disease Laboratory at Ames, Iowa.

In addition to making these routine tests, personnel of the laboratory are continually using research results to develop new diagnostic techniques and programs. There are two diseases, mastitis of dairy cows and PPLO infection of poultry (infection sinusitis of turkeys and chronic respiratory disease of chickens) for which techniques can be used to develop eradication programs.

Who pays the costs

The cost of these diagnostic services is borne by the state and the livestock owners. Most of the services are without charge for Utah residents. There are fees for x-ray
examination and pregnancy tests because they are costly and are clinical procedures that could be performed by other veterinary services. In the disease eradication programs the livestockmen and poultrymen pay some of the cost. With brucellosis the dairymen have taxed themselves, paying a tax for each cow in the herd. In the pullorum disease program, the breeder pays a fee for each blood sample tested.

**ENZYMES**

(Continued from page 33)

without which certain important enzyme-catalyzed reactions would not proceed. Enzyme systems in plants and animals are remarkably similar and require, in general, the same vitamin coenzymes. Plants, however, contain the metabolic capacity to synthesize all vitamins. Thus, plants do not suffer from avitaminosis. Animals must obtain most vitamins originally from plant sources or vitamin deficiency results. The chief function of vitamins in an organism is to serve as a coenzyme, of which only trace amounts are required, which can be reused many times.

A form of riboflavin (vitamin B₂), is used as a coenzyme in photosynthesis in plants and in conservation of energy in plants and animals. Thiamine (vitamin B₁), vitamin D, niacinic acid, and folic acid serve as coenzymes in chemical reactions. Deficiencies in humans result in maladies such as beriberi, Pellagra, and rickets.

**Enzyme application**

The part played by vitamins and trace elements in enzyme reactions has much practical value. Thousands of sheep on Australian ranges died of "bush sickness" before 1900. Careful examination revealed that trace amounts of cobalt added to the daily supplement of the sheep prevented this malady. Cobalt is required for enzymatic reactions. The forage crop production of ranges in Australia was increased many fold by the addition of trace amounts of molybdenum to the soil. Molybdenum is required by enzymes that convert the nitrate of the soil to a form usable by plants for conversion to amino acids and proteins. By breeding improved strains of microorganisms and investigating their enzymes, research workers have increased the efficiency of alcoholic fermentation in the beer, wine, and liquor industries.

Enzymes are also used to obtain heating gas, fertilizer, and many other valuable materials from sewage and industrial waste products. Enzymes tenderize meats, tan leather, turn cornstarch into sirup and sugars, and help in the making of dozens of products in the cosmetic, textile, and baking industries.

Enzyme research is an important medical tool. Enzymes are now being used to dissolve blood clots that previously would have resulted in fatal coronary occlusions. The action of sulfa drugs is related to enzymatic controlled reactions. There are certain diseases of man (perhaps also of plants) that are due to the deficiency of single enzymes.

**NEW PUBLICATIONS**

**Bul. 425. Biennial report 1958-60. 46 p.**

A statistical report of the operation of the Utah Agricultural Experiment Station during the 1958-60 biennium. The report lists the research projects, the grants, service activities, publications, and staff and contains a financial statement.


Evaluation of several different methods of measuring soil water relations.

**Bul. 427. Use of turkey in Utah’s public eating places, by E. Boyd Wennergren, Department of Agricultural Economics. 16 p.**

This study was made to ascertain the extent of the use of turkey in public eating places, to compare prices and price policies for turkey meals with those of other meats, and to discover the factors limiting the use of turkey in restaurants. The information is suggested as the basis for an effective program of increasing the use of turkey.

Current research at USU on enzymes in higher plants

Much of the Western United States, including most of Utah, contains soils high in lime. The accumulation of lime in the soil has created many various and peculiar problems. This is basically because certain plants are sensitive to lime. One such problem involves the presence of bicarbonate in these soils which creates chlorotic conditions in many plants. This disease is prevalent throughout Utah and is characterized by a yellowing of the leaves, destruction of chlorophyl, and eventual death of the plant. Protein synthesis is known to be affected and an effect on the amino acid and organic acid metabolism is manifested. Bicarbonate has a detrimental effect on the cytochrome system (enzymes of vital importance since they function in the respiration and energy system).

Further research is now in progress to determine the sensitivity of these enzymes to bicarbonate.

Industrial areas in Utah are subjected to air pollution involving fluorine compounds. Experiments have indicated that under certain laboratory conditions metabolic disturbances may be manifested in fluoride injured plants before visual injury is evident (abnormal carbohydrate and organic acid metabolism). Injured plants show low sucrose and high reducing sugar concentrations. In vitro experiments indicate that phosphoglucomutase, an enzyme mediating the syntheses of sucrose from reducing sugars, is sensitive to fluoride. Further experiments are in progress to determine whether this enzyme and others are responsible for metabolic changes in fluoride-treated plants which cause injury.

Enzymes bring us to the catalytic reactions in the cell, and to the core of all biological problems. The solution of these problems depends on greater understanding of the action, function, synthesis, and control of enzymes in biological systems.
Grains or concentrate feeds are more valuable as energy sources per unit of gross weight than alfalfa hay. When there is a small differential in the costs of alfalfa and grain, the grain may be the cheaper source of energy. The cost of hay has been high in relation to the cost of barley in Utah in recent years. High concentrate rations using barley have become popular for fattening cattle. Studies at the Utah Station have demonstrated that lambs also can be successfully fattened on a high concentrate diet if they can be kept on feed.

We found that it is essential to have feed available at all times. Pelleted feed is desirable to prevent the sorting of the feed which may lead to reduced intakes and nutrient imbalance with resulting illness.

Advantage of high barley diet

Feed use and carcass yield of the lambs in the study are shown in Table 1. A significant advantage of the high barley diet was the reduced feed consumption for the same gain with a resulting improvement in feed efficiency. The significant increase in dressing percentage or carcass yield for the high barley diet further emphasizes its superiority over the conventional diet. There was a trend for the heavier lambs to show greater response to the high barley diet than the lighter lambs.

Work currently under way at this Station indicates that develop-

BARLEY FOR FATTENING LAMBS

Lambs can be fattened successfully on high concentrate diets if they can be kept on feed. Pelleted feed should be available at all times to maintain maximum intake and prevent sorting.

JOHN E. BUTCHER, JOSEPH C. STREET, and WARREN C. FOOTE

FARM AND HOME SCIENCE
ment of bone and muscle as well as fat can be influenced by the way lambs are fed during the post-weaning period, and that these changes are often reflected in carcass quality. In this study of a high concentrate diet, certain aspects of growth were compared between lambs fattened on a high concentrate and on a roughage diet. The measurements taken are summarized in table 2.

There were no detrimental effects of the high concentrate diet on any of the carcass characteristics studied. Greater development of the skeleton occurred in lambs receiving the conventional roughage diet as indicated by greater carcass length, metacarpus length, and circumference, and some indication of increased metatarsus length compared to lambs on the concentrate diet. The lesser skeletal development of the lambs on the high concentrate diet might be considered an advantage since a decrease in bone development might also decrease the inedible portion of the lamb carcass.

**How the study was made**

For the study, 26 Rambouillet lambs ranging in weight from 40 to 90 pounds were divided into pairs by sex, age, and body weight. One lamb from each pair was randomly assigned to the high barley or the conventional diet (table 3). For the first 40 days the diets were not pelleted; chopped alfalfa and rolled barley were used. After this they were pelleted because of the problem of sorting and selection of the mixed feed by the lambs. The four heaviest pairs were fed for 71 days and the remainder for 111 days. The feeding period was based on the time it took the lambs to attain choice grade.

The lambs on high roughage were started on the conventional diet on the first day, but the high barley diet was diluted with hay in decreasing amounts during the first two weeks. The lambs were individually penned and fed in 4 x 5 foot pens in a ventilated barn. Feed and water were available at all times. Wood shavings were used for bedding. All lambs were vaccinated for overeating disease and treated with phenothiazine for worms during the first two weeks of the experiment.

Four pairs of lambs were dropped from the test because the lamb on the high barley diet went off feed, showed lameness, tender feet, and other symptoms of founder. It seemed that their sorting through the mixed feed was associated with this condition. Analysis of blood from two lambs showing these symptoms revealed severely depressed calcium levels (4.7 and 5.0 percent serum calcium compared to a normal value of 10.0); calcium tetany would be expected from such values.

(Continued on page 53)

### Table 1. Feed use and carcass yield

<table>
<thead>
<tr>
<th>Diet</th>
<th>Avg. daily gain</th>
<th>Avg. daily feed</th>
<th>Feed per lb. gain</th>
<th>TDN/lb. gain</th>
<th>Carcass*</th>
<th>TDN† index</th>
<th>Feed† index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>0.38</td>
<td>3.16†</td>
<td>8.54‡</td>
<td>5.14</td>
<td>47.9‡</td>
<td>10.7</td>
<td>17.8</td>
</tr>
<tr>
<td>High barley</td>
<td>0.37</td>
<td>2.39</td>
<td>6.47</td>
<td>4.87</td>
<td>51.2</td>
<td>9.5</td>
<td>12.6</td>
</tr>
</tbody>
</table>

*Unshrink live weight was used. 4 percent shrink would increase both values approximately 2 percent.
†Index = pounds feed or TDN per pound gain divided by the dressing percentage.
‡Significant differences.

### Table 2. Carcass measurements

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Conventional diet</th>
<th>High barley diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metatarsus length, cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live animal</td>
<td>22.5</td>
<td>21.8†</td>
</tr>
<tr>
<td>Carcass</td>
<td>21.2</td>
<td>20.9</td>
</tr>
<tr>
<td>Metacarpus, carcass length, cm</td>
<td>11.5</td>
<td>11.0†</td>
</tr>
<tr>
<td>Circumference, cm</td>
<td>4.7</td>
<td>4.5†</td>
</tr>
<tr>
<td>Cool carcass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight, lbs.</td>
<td>47.5</td>
<td>47.8</td>
</tr>
<tr>
<td>Length, cm</td>
<td>65.9</td>
<td>63.5†</td>
</tr>
<tr>
<td>Fore saddle weight, lbs.</td>
<td>23.3</td>
<td>23.4</td>
</tr>
<tr>
<td>Hind saddle weight, lbs.‡</td>
<td>23.3</td>
<td>22.3</td>
</tr>
<tr>
<td>Federal carcass grade§</td>
<td>4.0</td>
<td>4.2</td>
</tr>
</tbody>
</table>

### Table 3. Composition of diets fed

<table>
<thead>
<tr>
<th>Feeds</th>
<th>Conventional</th>
<th>High barley</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>percent</td>
<td>percent</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>60.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Barley</td>
<td>27.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Beet pulp</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Soybean oil meal</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Iodized salt</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Note:** Each diet was fortified with 400 I.U. vitamin A and 40 I.U. vitamin D per pound of feed.
Filtrating soil extracts for measurement of available phosphorus

Measuring the potassium content of soil extracts using the flame photometer

The majority of the irrigated soils of Utah are well supplied with potassium

What is the phosphorus and potash status of Utah's irrigated soils? This is a question for which answers have been sought for a number of years. Field trials with commercial fertilizer have been carried out on most crops with many soils. These trials have provided considerable information and have been the basis for fertilizer recommendations. Since it has not been possible to conduct replicated field trials on all the soils of the state, the next best approach involved an extensive sampling program including both the soil and the crop growing on it. Such a sampling project has been in progress since 1952.

All the major irrigated soils sampled

During the course of the investigation, samples were collected from some 617 different locations representing all the major irrigated soils. The study was restricted to alfalfa fields where a paired soil and plant sample was collected. The area sampled approximated a rod square from which three soil samples of 0 to 6 inches in depth were composited. The entire above-ground portion of the alfalfa plant was collected from the immediate vicinity of the soil sam-

Needs of Utah's Irrigated Soils for Phosphorus and Potassium

R. F. Nielsen
G. A. Van Epps
J. P. Thorne
ple. All sites were sampled just before the first cutting for hay. As samples were collected, notes were made on condition of the crop, soils series (where known), soil texture, and sample site location. Soil series is the basic unit of soil classification and is made up of soils that are alike in many ways.

Soil samples were analyzed for bicarbonate-soluble phosphorus and ammonium-acetate-soluble potash. The alfalfa was analyzed for total phosphorus and potassium.

The amount of phosphate found in some soil series varied considerably from that found in others. In many instances, however, this difference is merely a reflection of farming intensity and fertilizer practices and does not reflect natural soil differences.

The data were grouped on a geographical basis, by counties and by groups of counties which are climatically similar. Such comparisons showed that there was little

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Detailed information on this study is reported in Utah Resources Series 9—Phosphorus and potassium status of the irrigated soils of Utah, by the same authors.

The correlation between these geographical groupings and the phosphorus or potash content of the soils.

The data were also tabulated on the basis of soil texture. A close correlation was found between soil texture and the potassium-supplying powers of the soil. The fine textured soils supply considerably more potassium than the coarse soils. The correlation between texture and phosphorus content of the soil was poor.

Phosphorus content determined

Other groupings of data were made and the relation can be readily observed in the drawings. The percent of the total samples grouped according to P₂O₅ content, and the percent of samples in each group containing less than .18 percent P in the plant material are shown in fig. 1. It is generally accepted that alfalfa at about one-third bloom which contains less than about .18 percent of P is deficient in that element. It has been suggested by a number of workers that soils that contain greater than 50 pounds bicarbonate-soluble P₂O₅ probably are adequately supplied. Soils that contain between 25 to 50 pounds of P₂O₅ will probably show a response to phosphorus fertilizer, while those below 25 pounds are most likely to respond to additional phosphorus.

It should be noted that at nearly 50 percent of the sites there was adequate phosphorus in the soil and plant material. Less than 25 percent of the sites were highly deficient based on the soil test. More than 50 percent of the samples that indicated a probable deficiency in the soil had adequate phosphorus in the plant material. This apparent discrepancy between the soil test and phosphorus content of the alfalfa can be explained on some sites by the fact the phosphorus content of the soil at a depth below 6 inches was found at a later sampling to contain more phosphorus than at the 0 to 6 inch depth. This condition was not present, however, in all nonconforming samples.

Potassium deficient soils rare in Utah

The potassium content of soil and plant samples is shown in fig. 2 and 3. Less than 1 percent of the soil samples contained below 75 ppm acetate soluble K (fig. 2). Although deficiency levels have not been established in Utah, it is likely that soils that contain less than 50 ppm K are in the deficient range. It is of interest to note that nearly
90 percent of the samples contained more than 150 ppm K in the soil. The potassium content of the plant material shown in fig. 3 illustrates that less than 2 percent of the samples approach the deficient level of 1 percent.

The results of this survey suggest that the majority of the irrigated soils in Utah are well supplied with phosphorus. This condition has resulted largely from the use of manures and phosphate fertilizer. A number of soils apparently contain adequate phosphorus in their virgin state. There appears to be no obvious geographical distribution of phosphorus-deficient areas in the state. The deficiencies occur throughout the state on a wide variety of soils. About 10 percent of the sites sampled are highly deficient in phosphorus and would benefit considerably from the application of phosphate fertilizer. It will also be necessary to continue a fertility program on many of the soils now adequately supplied in order to maintain an adequate phosphorus level.

The data indicate that the soils of the state are well supplied with potassium and that deficiencies in field crops are rare at the present time. It is unlikely that widespread deficiencies will occur in the near future as most soils are well supplied with potassium as is also most of the irrigation water. The study shows that if and when a potassium deficiency develops it will probably occur first on the coarse textured soils.

IRRIGATION METHODS
(Continued from page 27)

to an individual farmer is the agricultural conservation programs (ACP) of the U. S. Department of Agriculture. These programs provide for cost sharing of approved practices such as reorganization of irrigation systems, grading for more efficient use of water to prevent erosion, farm storage ponds, lining ditches to prevent erosion and to conserve water, and installation of permanent pipe lines for sprinklers. Averaging about 50 percent of the total costs, this assistance increases the feasibility of surface systems requiring land grading and ditch lining, and the permanent sprinkler system relative to the gated-pipe and portable sprinkler systems. Further, this financial assistance is authorized only for approved measures on presently irrigated land. This decreases the feasibility of the portable sprinkler and gated-pipe systems relative to the lined and unlined ditch system for irrigation of new land.

Results of the study

Irrigation specifications based on scientific research, field tests, and local irrigation experiences are needed to determine the "ideal" method for each land situation. Numerous variables preclude a "once-and-for-all" method for every land situation and for every farm operator. Some of the conditions under which one method may have an over-all economic advantage over another as determined in this study are presented below.

Table 2. Total annual per acre charges for installation and operation, and for effect on production of alternative methods of irrigation for different land situations*

<table>
<thead>
<tr>
<th>Irrigation runs and texture of soil</th>
<th>Surface systems</th>
<th>Sprinkler systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>by feet</td>
<td>Unlined ditches</td>
<td>Lined ditches</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Fine-textured soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>880 feet</td>
<td>25.09</td>
<td>31.39</td>
</tr>
<tr>
<td>660</td>
<td>28.07</td>
<td>35.59</td>
</tr>
<tr>
<td>330</td>
<td>36.72</td>
<td>49.92</td>
</tr>
<tr>
<td>165</td>
<td>50.60</td>
<td>71.90</td>
</tr>
<tr>
<td>Medium-textured soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>660</td>
<td>27.15</td>
<td>34.95</td>
</tr>
<tr>
<td>440</td>
<td>33.85</td>
<td>44.44</td>
</tr>
<tr>
<td>330</td>
<td>36.97</td>
<td>50.13</td>
</tr>
<tr>
<td>265</td>
<td>42.44</td>
<td>56.84</td>
</tr>
<tr>
<td>Coarse-textured soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>440</td>
<td>35.05</td>
<td>44.76</td>
</tr>
<tr>
<td>265</td>
<td>44.01</td>
<td>59.82</td>
</tr>
<tr>
<td>120</td>
<td>49.70</td>
<td>71.22</td>
</tr>
<tr>
<td>90</td>
<td>57.39</td>
<td>83.65</td>
</tr>
</tbody>
</table>

*Includes land grading costs against surface systems but not sprinklers.
method where physical situations would specify irrigation runs greater than 220 feet on fine and medium textured soils, and 440 feet on coarse-textured soils. This is because there is no authorized federal assistance for portable sprinklers, and a lesser amount is authorized for the gated-pipe system than for open ditch systems. Not only is the total cost of surface systems reduced for the farmer, but because a higher proportion of the costs for a lined ditch is reimbursable the differences among the surface methods are relatively small, particularly for irrigation runs greater than 330 feet.

3) The economic feasibility of sprinkler and gated-pipe systems is increased significantly compared to ditch systems when the value of production “lost” from land used for ditches, initial reduction in crop yields because of grading, and increased costs of tillage and harvesting operations are included. As irrigation runs are shortened to meet recommended specifications, increasing amounts of land are used for ditches and the costs of field operations are increased due to restrictions on maneuvering farm equipment and the additional turning time required. These “costs” are lowest for the sprinkler system and the highest for the unlined ditch system. Differences in favor of the sprinkler system varied from $1.73 per acre on fine-textured soil on slopes less than 1.5 percent to $10.35 per acre on coarse soil on slopes greater than 6 percent.

4) Fixed costs of interest and depreciation on investment averaged approximately 50 percent of the total irrigation costs on the lined ditch and gated-pipe systems as compared to 21 percent for the unlined ditch and sprinkler system. Average cash costs for annual operation and maintenance were less for these systems than the sprinkler and unlined surface systems. Annual cash costs for sprinklers are higher than for any surface system.

5) In situations such as where grading is already accomplished and a change over to a sprinkler system is considered, the feasibility of all surface systems is increased relative to sprinklers. Under these conditions, the sprinkler method would have an economic advantage over surface systems only when irrigating fine and medium soils on slopes greater than 6 percent and when irrigating coarse soil on slopes greater than 1.5 percent.

The effect of ACP assistance in this situation is to lower the feasibility of the sprinkler system still further relative to the surface systems so that only on relatively steep slopes and coarse textured soils would it have an economic advantage.

6) Both initial investment and annual operating costs per acre are considerably lower for sprinkler systems using electric motors than for systems using either gasoline or diesel motors. Costs are highest for the gasoline powered system with diesel second highest, although the differences between these two are relatively small (table 3).

Table 3. Initial investment and annual costs per acre for portable and permanent mainline sprinkler systems for different kinds of motors irrigating an 80 acre farm

<table>
<thead>
<tr>
<th>Item</th>
<th>Gasoline motor</th>
<th>Diesel motor</th>
<th>Electric motor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dollars</td>
<td>dollars</td>
<td>dollars</td>
</tr>
<tr>
<td>Gasoline motor</td>
<td>75.56</td>
<td>106.62</td>
<td>90.94</td>
</tr>
<tr>
<td>Diesel motor</td>
<td>88.18</td>
<td>119.25</td>
<td>103.25</td>
</tr>
<tr>
<td>Electric motor</td>
<td>62.99</td>
<td>93.39</td>
<td>77.71</td>
</tr>
</tbody>
</table>

Without ACP assistance, the initial investment and annual cost of operation and maintenance would amount to about $81, and $2.30 more per acre, respectively, for the permanent sprinkler than for the portable system. With ACP assistance, these costs would amount to about $15, and $1.25 per acre, more for the permanent than for the portable sprinkler system.

7) Although size of area irrigated has little effect on investment and annual costs for surface methods of irrigation, there is a significant effect on costs for sprinkler systems. Average investment amounted to $54.58 per acre for a 160 acre farm, $62.63 for an 80-acre farm, and $78.29 for a 40-acre farm. Average annual costs amounted to $30.06, $31.99, and $34.15 per acre for the 160, 80, and

Table 4. Net crop income per acre “lost” to surface methods of irrigation because of additional water required over sprinkler irrigation

<table>
<thead>
<tr>
<th>Land gradient (percent)</th>
<th>Soil texture</th>
<th>Lined ditch</th>
<th>Unlined ditch</th>
<th>Permanent sprinkler</th>
<th>Without ACP assistance</th>
<th>With ACP assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>Coarse</td>
<td>7.24</td>
<td>9.70</td>
<td>10.77</td>
<td>10.27</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>Coarse</td>
<td>9.60</td>
<td>11.97</td>
<td>12.92</td>
<td>12.41</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>Medium</td>
<td>3.05</td>
<td>3.05</td>
<td>3.07</td>
<td>3.21</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>Medium</td>
<td>5.99</td>
<td>6.34</td>
<td>6.22</td>
<td>6.03</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Lined ditch</td>
<td>6.10</td>
<td>6.22</td>
<td>8.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Lined ditch</td>
<td>3.02</td>
<td>3.10</td>
<td>5.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Unlined ditch</td>
<td>2.88</td>
<td>3.10</td>
<td>8.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Fine</td>
<td>5.69</td>
<td>6.22</td>
<td>8.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The feasibility of the sprinkler is increased relative to the surface systems by $1.93 per acre for the 160 acre farm but decreased by $4.16 per acre for the 40 acre farm.

8) In most situations, less water is required for sprinkler than for surface irrigation because of better control over losses from deep percolation and surface run-off. Attainable irrigation efficiencies for sprinklers as compared to unlined ditches increased from 10 percent on medium textured soil and slopes of less than 1.5 percent to 30.0 percent on coarse textured soil and slopes over 6.0 percent. Attainable irrigation efficiencies for the lined ditch and gated-pipe systems were 5 percent higher for all land situations than for the unlined ditch.

In terms of water “saved” by sprinklers over unlined ditches, this varied from 4.1 acre-inches on medium soil and slopes less than 1.5 percent to 21.4 inches on coarse soil and slopes over 6 percent. The “cost” of the additional water required because of lower irrigation efficiency by unlined ditches compared to sprinklers in terms of additional production foregone varied from $5.69 per acre when irrigating fine soil with slopes less than 1.5 percent to $12.41 per acre when irrigating coarse soil on slopes over 6.0 percent (table 4).

Table 1. Essential amino acid balance and chick growth rate

<table>
<thead>
<tr>
<th>Protein in ration</th>
<th>Avg. weight gain gms/day—20 days</th>
<th>Feed cons. gms/day</th>
<th>Gain/Feed ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>C11-our balanced values</td>
<td>13.7</td>
<td>22.5</td>
<td>.61</td>
</tr>
<tr>
<td>with minimum of excesses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C14-NRC values with</td>
<td>10.7</td>
<td>18.8</td>
<td>.57</td>
</tr>
<tr>
<td>minimum of excesses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casein and amino acids—exceeds all NRC</td>
<td>9.4</td>
<td>18.4</td>
<td>.51</td>
</tr>
<tr>
<td>values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Defining balanced mixtures

Our experiments indicated that a ration may contain the essential amino acids in the proportions suggested by the NRC, but still not be the best balanced ration. The results of a recent experiment back up this statement (table 1). Each of the rations used contained 19 percent protein: The last one had a higher total level of essential amino acids than the other two and yet produced the lowest growth rate. The highest growth rate and feed efficiency were obtained with mixture C11. This diet represents the best balance among the essential amino acids that we have been able to make so far as a result of many tests.

In this experiment feed consumption per day was highest with the balanced mixture. In other experiments we have found that feed consumption increases as amino acid balance improves.

In many chemical reactions that proceed outside of living materials, the rate of reaction depends on the concentration of the reacting substances. For a given total amount of reacting substances, the rate of reaction is maximum when the reacting substances are found in certain proportions characteristic of the reaction. It is not unreasonable to assume that the growth of chicks would be most rapid when the various amino acids in the diet are in the right proportion for the most effective reaction.

POPULATION CHANGES

(Continued from page 37)

Sandy, Smithfield, Washington Terrace, and West Jordan. Yet two others have completely disappeared from the census records for 1960. These are Tod Park and Garfield. The former is a government defense installation and although people still live there, population data for the community are included only in Tooele County totals. Garfield is a community directly under the control of Kennecott Copper Corporation. Due to recent action of the company it has been closed and is a modern ghost town.

The reasons why a place might become urban are several. 1) A community will often grow if it offers advantages to prospective newcomers. If it offers means to make a better living than available in other communities, if the community is in a favorable position geographically or climatically, or if it has numerous other combinations of social, economic, or physical factors in its favor, it will grow. 2) A community may grow because of a “piling up” around a large urban center. This is the much debated and often discussed suburban movement which seems to occur inevitably as a central city reaches a great size. Much of the growth in the peripheral communities of the Ogden, Salt Lake, and Provo-Orem urbanized areas of Utah is the result of such a phenomenon.
8) A community may grow by annexation, the process of absorbing a quantity of territory adjacent to the city or town into its legal complex. Many Utah communities have made population gains in this way.

The reasons why a community might lose population or even become a ghost town are, to a great extent, the negative expression of the factors suggested as conducive to growth. We know that opportunities have increased in the city and in suburban communities. It is equally obvious that a lesser proportion of the total population is needed, or can be provided for, in a rural setting. These are facts leading to the continued growth of cities and stimulative of rural exodus. Such patterns have been manifested in the past and may well continue to happen as Utah people seek the best possible adjustment to a rapidly changing socio-economic complex.

Another important reason why communities die or decrease in population is because the functions or materials on which they depend die or decrease in importance. Such is the case when a mineral vein gives out or a community industry ceases to operate. Finally, communities technically disappear by being annexed or by way of name change. However, this is a statistical technicality which has no real meaning in terms of actual population change or in the study of such phenomena.

Looking at the trends in the past, one might well ask, “What will happen to your community in the future?” There is much disagreement as to what Utah’s population will be at any future date but all projections are for continual growth. What will such a rise mean in terms of the rural-urban distribution? Will more towns become urban, or will the now urban towns just continue to increase in size? If you now live in a rural community, will it be urban twenty years from now? If not, will you choose to remain in it or will it be to your advantage to relocate in a community that is urban? Regardless of what the answers to these questions turn out to be, they are vitally important to you. The type of community in which you live has a profound meaning to you and your family.

**DELMAR WHEAT**

(Continued from page 30)

Several hundred bushels of foundation seed of the new variety will be comparable in yield with the newer varieties such as Itana, Columbia, and Tendoy and generally superior to Cache and Wasatch.

**Availability of seed**

Several hundred bushels of foundation seed of the new variety will be distributed to certified seed growers in the fall of 1961. This will mean that a limited amount of commercial seed will be available by the fall of 1962 and that seed stocks should be in fair supply by the 1963 planting season.

<p>| Table 3. Five year yield summary of 7 dryland winter wheat varieties grown at Clarkston, Utah |</p>
<table>
<thead>
<tr>
<th>Variety</th>
<th>1956</th>
<th>1957</th>
<th>1958</th>
<th>1959</th>
<th>1960</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delmar</td>
<td>26.6</td>
<td>46.1</td>
<td>34.9</td>
<td>44.3</td>
<td>26.9</td>
<td>35.8</td>
</tr>
<tr>
<td>Utah Kanred</td>
<td>24.2</td>
<td>42.6</td>
<td>38.3</td>
<td>47.2</td>
<td>23.9</td>
<td>35.2</td>
</tr>
<tr>
<td>Itana</td>
<td>21.2</td>
<td>46.6</td>
<td>29.3</td>
<td>43.8</td>
<td>27.7</td>
<td>33.7</td>
</tr>
<tr>
<td>Westmont</td>
<td>21.9</td>
<td>46.2</td>
<td>33.1</td>
<td>38.9</td>
<td>25.5</td>
<td>33.1</td>
</tr>
<tr>
<td>Columbia</td>
<td>23.6</td>
<td>39.6</td>
<td>34.2</td>
<td>38.4</td>
<td>24.9</td>
<td>32.1</td>
</tr>
<tr>
<td>Cache</td>
<td>16.0</td>
<td>41.6</td>
<td>33.9</td>
<td>39.5</td>
<td>27.0</td>
<td>31.6</td>
</tr>
<tr>
<td>Wasatch</td>
<td>17.6</td>
<td>41.4</td>
<td>26.6</td>
<td>36.5</td>
<td>27.5</td>
<td>29.9</td>
</tr>
</tbody>
</table>

<p>| Table 4. Yield summary of 7 dryland winter wheat varieties grown in county trials in Utah over a 4-year period |</p>
<table>
<thead>
<tr>
<th>Variety</th>
<th>Nephi</th>
<th>Monticello</th>
<th>Fillmore</th>
<th>Monticello</th>
<th>Pocatello</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delmar</td>
<td>35.3</td>
<td>25.3</td>
<td>11.2</td>
<td>25.7</td>
<td>28.2</td>
<td>25.1</td>
</tr>
<tr>
<td>Utah Kanred</td>
<td>27.9</td>
<td>24.0</td>
<td>11.9</td>
<td>29.2</td>
<td>31.4</td>
<td>24.9</td>
</tr>
<tr>
<td>Itana</td>
<td>26.9</td>
<td>23.7</td>
<td>14.5</td>
<td>24.6</td>
<td>33.9</td>
<td>24.7</td>
</tr>
<tr>
<td>Cache</td>
<td>27.2</td>
<td>27.1</td>
<td>14.9</td>
<td>28.9</td>
<td>23.8</td>
<td>24.4</td>
</tr>
<tr>
<td>Wasatch</td>
<td>25.5</td>
<td>24.6</td>
<td>13.8</td>
<td>25.1</td>
<td>31.1</td>
<td>24.0</td>
</tr>
<tr>
<td>Columbia</td>
<td>22.5</td>
<td>22.6</td>
<td>15.5</td>
<td>24.8</td>
<td>28.4</td>
<td>22.8</td>
</tr>
<tr>
<td>Westmont</td>
<td>27.4</td>
<td>22.9</td>
<td>15.5</td>
<td>22.9</td>
<td>25.5</td>
<td>22.8</td>
</tr>
</tbody>
</table>

<p>| Table 5. Yields of wheat varieties in the U. S. Department of Agriculture Regional Hard Red Winter Wheat Nursery (at locations in Washington, Oregon, Idaho, Montana, and Utah) during 1959 and 1960* |</p>
<table>
<thead>
<tr>
<th>Variety</th>
<th>1959 (Average of 17 trials)</th>
<th>1960 (Average of 13 trials)</th>
<th>2 year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delmar</td>
<td>45.2</td>
<td>47.4</td>
<td>46.3</td>
</tr>
<tr>
<td>Itana</td>
<td>45.6</td>
<td>46.4</td>
<td>46.0</td>
</tr>
<tr>
<td>Westmont</td>
<td>46.0</td>
<td>45.1</td>
<td>45.6</td>
</tr>
<tr>
<td>Cheyenne</td>
<td>42.7</td>
<td>47.8</td>
<td>45.3</td>
</tr>
<tr>
<td>Tendoy</td>
<td>43.0</td>
<td>45.6</td>
<td>44.3</td>
</tr>
<tr>
<td>Columbia</td>
<td>41.6</td>
<td>42.4</td>
<td>42.0</td>
</tr>
<tr>
<td>Kharkof</td>
<td>39.5</td>
<td>42.3</td>
<td>40.9</td>
</tr>
<tr>
<td>Wasatch</td>
<td>38.4</td>
<td>42.0</td>
<td>40.2</td>
</tr>
</tbody>
</table>

broiler the housewife buys today is a different product from that of ten years ago. Broiler quality has been increased while costs per unit have been reduced.

Technological advances in egg production, turkey feeding, swine fattening, cattle feeding, and lamb feeding have not, up to the present time, been as rapid as in broiler production. Amount of feed required to produce a given output has decreased faster for broilers than for other enterprises (Table 1). Processing methods have changed less and quality improvements have not been as pronounced as in the broiler industry. A major technological advance in breeding, nutrition, or processing would encourage the adoption of contract production arrangements.

2) Perishability of Product

One of the factors which influence price variability is perishability of product. Perishable products must be sold when ready for market. Increased quantities usually must be sold at reduced prices.

Consumer acceptance of frozen broilers has been low. Frozen birds have sold at discount compared with freshly processed broilers. The discount plus added costs of freezing and storage makes it desirable that broilers be sold fresh within a short time after they are processed.

Under these circumstances the broiler grower is faced with greater price uncertainty than growers of less perishable products. Prices for products that are storable fluctuate in response to changes in supply but the fluctuations are of smaller magnitude.

Although other products considered in this paper are more perishable than farm products such as grain, they are less perishable than broilers in that some storage is possible, at least during processing. In some instances the fattening process may be slowed down in order to market when it appears prices will be higher. Eggs, if kept under refrigeration and proper conditions of humidity, lose quality slowly. Several processes have been developed to extend the storabe period for eggs. Storage of turkeys aids in preventing the market from becoming glutted and in prices falling to disastrously low levels. Turkeys, formerly, were consumed largely during the holiday season. With storage, they are now available to consumers throughout the year. Usually flexibility is achieved, however, by the longer time period between slaughter and selling to retail stores. This period allows the meat to be transported to more distant markets under refrigeration. In the case of beef, the longer time period improves eating quality. A large proportion of the pork consumed in the United States has been cured and is, therefore, a storable commodity. Meat packers cure large volumes of pork cuts during periods of temporarily depressed prices when the outlook is for higher prices. Cured meats can then be stored until quantities arriving at markets are reduced and prices strengthened.

3) Seasonality and Length of Production Period

Contract arrangements as they have developed in the broiler industry involve year-round production schedules. Each part of the industry is coordinated with other parts by contracts. Hatcheries set eggs to supply growers with chicks which when grown will meet the requirements of the contract between the grower and processor. The processor knows from the time the grower will contact him to be able to sell the broilers to retailers outlets when they are ready for market. Since broilers require only about 65 days to grow to 3.25 pounds live-weight the grower can produce between four and five batches in a 12 month period. By staggering the starting date for the growers selling broilers to a particular processing plant, the plant can have a steady supply available for processing. This procedure also establishes a more constant need for chicks and feed.

The availability of chicks at any time during the year and the length of the production period make the broiler industry different from other enterprises considered here. The constant production possibility with a short time span between the beginning and end of production makes broilers better suited to contract production.

Egg production requires a longer period than broiler production. Chicks may be ordered for delivery at any season of the year, but about six months are required to bring the flock into production. Generally, hens are kept for at least one year after they start to lay. This longer production period would require that the contractor obligate his capital for a longer time period. The amount of capital per hen would be considerably larger than for a broiler so each grower would have a larger sum advanced. This increases the amount of capital required and repayment would be complicated by the fact that income is received over the period of about one year, only part of which could be used to repay the money advanced.

Feeding of turkeys, swine, beef cattle, and lambs differs from broiler growing in another way. Poult or feeder animals are available seasonally and not available on a year round schedule. Cattle and lamb feeding are fall and winter enterprises. Feeder cattle and lambs are available at the close of the summer grazing period. In addition, feed supplies are more plentiful at this time for feeding. Swine could be produced in any month of the year, but the general practice has been to have sows farrow in the spring and fall with market hogs available five to six months later.

These seasonal production patterns have developed largely because costs are lowest when they are followed and any deviation has tended to increase costs. For example, feeder cattle can be sold for
a lower price in September after grazing during the summer on low-cost forage than at any other time of the year. The cost of feeder animals is a major item in cattle feeding and over-all profitableness of the enterprise.

4) Market organization

New developments tend to be accepted at a faster rate when they do not replace an established method. Broiler production developed on a commercial scale without market facilities such as those now used for hogs, cattle, sheep, and eggs. Direct methods of marketing were adopted for broilers as specialized processors established processing plants and started purchasing live birds.

Marketing methods for other commodities considered here have been established for many years. Established marketing firms and agencies are frequently bypassed when contractual arrangements are used. Market outlets that may be omitted if contracts develop, attempt to maintain their volume of business by making their services more attractive to farmers.

The number of market outlets available to a cattle, lamb, or swine feeder is greater than for poultry producers. It is possible to ship livestock to the market where it seems possible to obtain the highest net price. This shifting of supplies among markets tends to equalize prices. Livestock feeders will be hesitant to give up their alternative market outlets for a contract which specifies when and where their livestock are to be delivered without quoting a price in advance.

5) Financing in relation to security

Broiler growing is unusual in that a day old chick is not enough security to obtain operating capital through regular credit channels. The fact that many broiler growers buy all their feed adds to the problem. As a result many growers turned to contracts whereby firms in other phases of the industry financed the chicks and feed until the broilers were sold.

Banks and production credit associations will usually extend credit for enterprises such as cattle, lamb, and hog feeding where either the feed or the feeder animal is owned and can be pledged for security. This makes feedlot operators less dependent upon other sources of capital. They will, as a result, be interested in remaining as independent producers.

6) Degree of specialization and source of feed

One of the factors encouraging specialization in the broiler industry is the requirement that practically all feed be specially compounded to obtain high feeding efficiency. This requirement has fostered the development of specialized rations based on research.

Turkeys and commercial laying flocks also require a high proportion of manufactured feeds. Swine fattening rations consist largely of concentrate feeds but the use of grains produced on the farm where the hogs are fed has been much greater than in poultry enterprises.

Cattle and lamb fattening rations require relatively large amounts of farm-produced roughage. Also, many by-products of the processing of agricultural products are used. Roughages and some by-product feeds are bulky relative to their value making it more profitable to locate feeding enterprises near their source rather than transporting feed to a distant area for feeding.

In the Western United States, feeding enterprises have been concentrated in irrigated farming valleys where low cost feeds have been available. Frequently, by-products of sugar beet refineries or canning crop processing plants have been available; these encourage fattening enterprises. Adjacent to these valleys are rangelands which are used as the primary feed source for breeding herds in the production of feeder animals.

BARLEY FOR LAMBS

(Continued from page 45)

Digestion in the rumen

Carbohydrates that are fed to ruminants are largely degraded by rumen microorganisms to acetic, propionic, and butyric acids. In ruminants a large proportion of the dietary energy is wasted as heat. This is due in part to the animal living on energy derived from these fatty acids. The fatty acids are used inefficiently by the animal's tissues and much of the energy value is lost from productive use and dissipated as heat. However, the relative proportions of the various fatty acids produced in the rumen affect their efficiency of use. In general, the more acetic acid produced, relative to propionic and butyric, the less the efficiency. Substitution of concentrate for roughage tends to lower the production of acetic acid relative to the others. Because of this it was of interest to examine the rumen fatty acid mixtures produced on the two diets and compare these to the feed efficiencies observed in fattening lambs.

Six aged wethers, fitted with rumen fistulas to enable sampling of the rumen liquor, were used in this phase of the study and were started on alfalfa. Three of these were fed the conventional roughage diet and the remaining three were fed gradually increasing amounts of barley (50, 75, and finally 85 percent of the diet) allowing 7 days to adjust to each change. Rumen liquor was sampled throughout these periods. The group fed the high barley diet proved difficult to keep on feed and in two separate attempts rumen function apparently ceased soon after the 85 percent barley diet was consumed. The cause of going off feed may have been associated with intermittent feeding. In a third attempt, two continuously fed sheep were successfully kept on the high barley diet for 14 days. Here again, the change from a moderate to a high barley diet appeared to be a severe challenge to the rumen system but recovery
occurred within one or two days.

Results of analyses of rumen liquor for the various fatty acids produced from each diet are shown in Table 4. As the amount of barley in the diet was increased, acetic acid production decreased and propionic acid production increased. Interpretation of this trend indicates that the nutrients absorbed from the barley diets are used more efficiently than an equal quantity of nutrients absorbed from the roughage diets. The feeding data from the lamb fattening trial support this. The figures in Table 1 show that 32 percent more feed was required for each pound of gain from the roughage diet. Comparing TDN requirements in the roughage diet, only 6 percent more were needed. However consideration of the poorer carcass yield leads to a 13 percent disadvantage. These TDN comparisons minimize the disadvantage of the roughage diet as the alfalfa used was probably of better quality than indicated by the TDN value which was an average taken from published tables.

BEAT THE DROUGHT

(Continued from page 35)

nearly doubled; that is, the amount of water required to irrigate any given piece of land has been only half what it was before the land was leveled. In addition, the ease of irrigation has reduced labor costs. One man can handle the same amount of water that it required two to handle before leveling.

By developing long-range programs that will provide for efficient use of irrigation water, farmers of the state can extend their limited water supplies.

Leafhopper control in tomatoes

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Poor emergence in hull-less barley can be overcome

Feeders of livestock and poultry have been looking for a cheaper concentrate feed for several years. A hull-less barley adapted to irrigated lands seemed to be an answer to feeders' needs. The hulls on common barley occupy space and furnish few feed units. A hull-less barley, listed as C. L. 10636, was produced in 1958. This stiff-strawed, new leafy strain yielded well when moisture and fertility were favorable, but failed to meet minimum seedling emergence requirements. This poor emergence was evident under different dates and depths of seeding during each of the three years the tests were conducted. In some strains emergence was as little as 25 percent.

Studies of germinating seed revealed some of the reasons why, with a laboratory germination of over 90 percent, a strain might produce only 65 to 75 percent of emerged vigorous seedlings. Some seed would send out a coleoptile but no green plumule or leaf, other seedlings would show the leaf protruding from the coleoptile near the surface of the soil but fail to make further growth.

Special germination tests revealed susceptibility to seed treatments, soil fungi, cold and wet weather, and deep seeding. The hull-less seed was often badly damaged by severe threshing. The unprotected embryo of hull-less seed is easily knocked off. It is important to have a hull-less barley that is easy to thresh if seed damage is to be avoided.

Many crosses have been made to determine whether all hull-less barleys are inherently weak in seedling emergence. Some of the crosses showed up to 95 percent emergence from bulk seeding indicating that certain hull-less barleys can meet state requirements for seed quality.

—R. W. Woodward

Milk sales through vending machines

Studies of milk vending machines in Utah public schools showed that vender sales were additional, not substitute sales. They did not cause any significant change in consumption of candy or soda water. Vending did, however, increase the amount of milk consumed at school as well as all milk consumed by students. The impact of vending on milk consumption decreased as the length of the vending period increased. Increased milk consumption because of vending dropped from 16 percent during the first month of the two year experiment to 2 percent during the last month.

Increasing the storage life of fresh fruits and vegetables

Experiments to study the effects of prepackaging treatments with several anti-fungal chemicals on the storage life at 40 and 70 degrees F. of peaches, pears, apricots, tomatoes, snap beans, cherries, and strawberries showed that certain chemicals such as mycostatin, captan, and Dowicide A (at 1000 parts per million) and packaging with Mylar films have increased the shelf life at 40 degrees by two to six weeks and at 70 degrees F. by two to four days of many of these crops. This increased shelf life was due to the inactivation of mold growth and to the slowing down of respiration. Studies were also conducted on the effects of beta and gamma radiations on the storage life of peaches. Mold inactivation was noted with the ionizing radiations.

Sucrose sprays on tomatoes

Tomato plants sprayed with 10 percent sucrose produced significantly higher yields than plants not sprayed or plants sprayed with gibberellin at 5, 10, and 15 parts per million.

Which wheatgrass?

In range studies, fall and intermediate wheatgrass produced better calf gains than either crested or pubescent wheatgrass or native sagebrush-grass range, but crested wheatgrass produced the highest cow gains.

Contribution to Research
February 15 to May 1, 1961

Norwich Pharmaceutical Company
National Turkey Federation
Commercial Solvents
Phillips Petroleum Company
Simpot Company

$1,000 (for study of staphylococcosis in turkeys)
300
4 tons of ammonium phosphate for range fertilization studies
2 tons triple superphosphate for fertilizer trials

Insecticides for experimental work have been supplied by the following companies: American Cyanamid Company, California Spray Chemical Corporation, Chemagro Corporation, General Chemical Division, Niagara Chemical Division, S. B. Penick & Company, Rohm and Haas Company, Shell Chemical Corporation, Stauffer Chemical Company, Union Carbide Chemicals Company, Velsicol Chemical Corporation.

FOR JUNE 1961
CONTRIBUTIONS TO RESEARCH
February 15 to May 1, 1961

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Additional contributions on page 55

Peach varieties for Utah

The best peach varieties for Utah conditions, evaluated through tests at North Ogden, are: early July, Springtime (white peach); late July, Hiland and Cardinal; early August, Cornet and Jerseyland; late August, Triogem and Sunhigh; early September, Elberta and Gleason (early Elberta); late September, Candoka, Merrill Splendor, and Rio-Oso-Gem.

Controlling insects on sugar beets

In a sugar beet field plot experiment at Logan, dieldrin seed treatment at 1 ounce per acre or granular dieldrin at 1 pound per acre placed in the drill row with the seed gave 70 percent protection from sugar beet rootmaggot. Phorate seed treatment and phorate granules at the same rates were equally effective. The phorate treatments gave some protection from flea beetle feeding on young seedlings.

In a field plot experiment at Lewiston, parathion at five pounds per acre and methyl parathion at four pounds applied to the soil and plowed under before seeding sugar beets improved the stand of plants 14 percent compared to the untreated check plots. This was attributed to the control of symphyllans. The yield of sugar beets was increased 2.5 tons per acre.

Control of DDT resistant codling moths

 Guthion and Sevin are recommended for the control of DDT resistant codling moths in apple and pear growing areas of Utah.

Dr. N. Keith Roberts, associate professor of agricultural economics, is one of three men appointed by Interior Secretary Stewart L. Udall, to make a major study of grazing fees on public land. The other members of the team are from Oregon State University and Montana State College. President Kennedy has called for more consistent fees on federal lands in his special message on resources.