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The first essential in disease prevention or control in range turkeys as well as birds in the brooder is sanitation. Birds must be moved frequently and feeding and watering equipment kept clean and disinfected. All dead birds should be immediately disposed of, and sick birds isolated from the main flocks. Specific curative methods have not yet been discovered for many of the most common turkey diseases, however good sanitation, adequate feed, and proper management practices should do much to keep disease to a minimum.

It is not surprising that diseases of turkeys about which least is known are the ones that cause the greatest death loss on the range. Since many turkey growers do not keep accurate records of losses after the birds leave the brooders, the relative amount of damage done by each disease can only be estimated by the number of flocks in which each is found. From this standpoint then, the survey of turkey diseases in Sanpete County in 1944 showed that staphylococcosis (synovitis) caused the greatest number of deaths, as it was found in 39 percent of the flocks. Possibly this disease also causes the largest economic loss for it attacks birds as they near maturity. Infectious sinusitis and hexamitiasis are the next two most prevalent turkey range diseases.

These three diseases were found in some flocks as the only cause of trouble, but quite frequently they were found in combination with one or both of the other or with some of the other range diseases. In 70 percent of the flocks, one or more of these three diseases was found.

A brief description of each of the diseases listed in the accompanying chart may help the turkey grower to understand what diseases may be introduced into his flock this summer and fall. With such understanding he may be able to prevent death losses. On the range, as in the brooder, time and money spent to keep disease out of the flock gives the greatest return.

**Staphylococcosis**

Staphylococcosis, which may affect only a few birds or upwards of a fourth of the flock, is known variously as “synovitis,” “arthritis,” or “leg weakness.” The last of these names is very apt for it describes the most prominent symptom. Birds in prime flesh will be noticed to become weak in one or both legs with a disinclination to move, and, when forced to move, do so with difficulty. The cause of this weakness in most cases is a painful swelling around the tendons above the hock joint. In acute cases no swelling may be evident, yet the birds show such leg weakness and die within 24 to 48 hours. Another prominent symptom is the watery, yellowish droppings which are indistinguishable from the similar droppings of blackhead and fowl typhoid.

The name, staphylococcosis, is used because almost invariably staphylococci can be found within the tendon sheath, in the blood stream, or in other affected parts of the body. It is assumed that this is the primary cause. What part nutrition, especially the vitamins and minerals, and what part breeding, especially the size of the bird, play as causative factors, are not known.

How the disease spreads within the flock, or how the organism enters the body of the turkey is not definitely known. It is plausible to think that injury plays an important role. Over half the birds examined show evidence of injury of the skin and resultant subcutaneous abscesses. Such abscesses are most frequently found in the pads of the foot (bumble-foot) and under the skin over the keel bone. The injuries to these parts of the birds may be owing to rocky ground, especially sharp rocks; to roosts, especially those with sharp corners or sharp projections; to barb wire fences; and to fighting among toms (Continued on page 14)
President Elmer George Peterson

Dr. E. G. PETERSON has been associated with the Utah State Agricultural College almost continuously since 1900, first as a student, then as assistant entomologist in the Experiment Station, head of the Department of Bacteriology, director of the Extension Service, and finally as president. He has served the Institution as president for 29 years, or more than half the time since its founding in 1888. After this brilliant and faithful record of service he will retire on June 30 of this year and become president emeritus.

President Peterson has been the guiding power in the Institution during the period of its greatest development. In this period it has been built upon a broad foundation and upon sound educational principles. It has attained eminence in the field of education, along with the better institutions of higher learning in America.

The success to which the College has attained is due in large measure to President Peterson’s skillful leadership, his exceptional ability to see into the future, and his dynamic energy in activating and bringing to fruition his well-laid plans for a great institution. He has been a great idealist and he has set and maintained a high standard of morality in the student body and among the faculty. His influence for good has not only pervaded the campus, but it has reached into the homes in the remotest places in the state. As a great teacher he has influenced for good the lives of innumerable young men and women who have gone out from the College to make a place for themselves throughout the nation and in many foreign lands. No nobler service can one perform.

Under President Peterson’s leadership great strides of progress in research have been made by the agricultural scientists in the Experiment Station. His untiring devotion to truth and his interest in the development of new knowledge for the benefit of agriculture and the people of this state have been the activating forces in these advancements in scientific agriculture.

Staff members, both past and present, join in paying honor and respect to their friend and leader.—R.H.W.
The Problem of Virus Diseases in Stone Fruits in Utah

FRUIT growing in Utah is in general greatly simplified by the absence of the large number of destructive bacterial and fungus diseases so prevalent in the more humid fruit growing areas of the United States, Canada, and Mexico. Of late, however, there has been a growing realization that all too frequently in certain areas, and particularly among stone fruits, large numbers of trees prove more or less short-lived and unproductive. Peach trees, for example, turn yellow and become misshapen and scraggly in appearance. The fruit ripens early, is under-sized and of poor quality. In the sweet and sour cherry orchards, trees frequently wilt and die in early summer or they may turn yellow and remain unproductive.

Peach, cherry, and prune orchards quite frequently become relatively unprofitable at the age when they should be most productive. This decline in vigor and productiveness of trees has been attributed to a great diversity of causes such as drought, winter injury, self sterility, inadequate cross pollination, low fertility, and general unfavorable soil conditions, as well as to insect and fungus diseases. The fact is, however, that after all these various factors have been evaluated or their influence determined, there still remains a group of diseases of obscure origin.

Only very recently has it been shown that in the West various kinds of fruit trees may be invaded by ultra-microscopic viruses more or less identical in nature with those which produce such contagious diseases as hog cholera, distemper, and fowl pox in animals; measles, mumps, infantile paralysis, and smallpox in human beings; and mosaics, leaf rolls, and yellows in herbaceous plants. Investigations during the past five years have shown that these various obscure types of trouble of stone fruits and those most generally responsible for orchard degeneration in Utah are of a virus nature.

In Utah, 3 virus diseases are now known in the peach (mosaic, western “X,” and asteroid spot); 5 on the sweet cherry (rusty mottle, rasp leaf, lace leaf, ring spot, and wilt); 1 on the sour cherry (dieback or decline); and 1 on the chokecherry which may be transmitted to sweet and sour cherry by budding. Two virus-like bud perpetuated diseases are known on the sweet cherry (leaf crinkle and deep suture), and 2 on the Italian prune (leaf spot and leaf mottle).

Moreover, it is well known that many of these tree viruses may affect more than one member of the stone fruits and a considerable number affect several. For example, peach mosaic virus, in addition to all varieties of peach, affects Pottawattamie plums and is graft-transmissible to almonds, apricots, plums, and prunes, but may show no symptoms in these fruits except in certain varieties of plums and prunes. The red leaf virus in chokecherry may be (Continued on page 12)

Wilt of Royal Ann cherry trees induced by the red leaf chokecherry virus. Trees two and four show the disease in mild form

for June 1945
THE AUTHORS

This is the second article on turkey diseases written for Farm and Home Science by Dr. Merthyr L. Miner in charge of the Veterinary Laboratory at Provo. The first article on diseases of turkeys in the brooder appeared in the March issue.

Dr. Bert Lorin Richards has been on the staff since 1913, and head of the Botany Department since 1924. His major research has been with virus diseases of farm crops. Dr. Arthur S. Rhoads is employed by the U. S. Bureau of Plant Industry, Soils and Agricultural Engineering on plant disease survey work in the state. Dr. Rhoads came to Utah from Florida just over a year ago.

For a number of years Dr. Laurence A. Stoddart, research professor of range management, has been attempting to find the nutritive value of the various forages eaten by livestock on the range in order to determine in what food elements the diet is deficient. The article in this issue discusses the nutritive value of bunch heatgrass at different seasons of the year.

Rollo W. Woodward has been connected with the cereal breeding work at the Utah Station since 1930. He is employed by the Bureau of Plant Industry, Soils and Agricultural Engineering. His most outstanding contribution has been the development of Velvon barley, a smooth-awned variety with relatively stiff straw and a high degree of resistance to covered smut. Mr. Woodward works with Prof. D. C. Tingley of the Station staff.

Dr. Orson W. Israelen represents the Utah Station, J. Howard Maughan, the Soil Conservation Service, and George P. Smith, the State Department of Publicity and Industrial Development, in the survey of irrigation companies in the state.

George Q. Bateman writes another article to point out the value of well managed pastures in the profitable production of milk and butterfat. J. Elma Packer is assistant at the Dairy Experimental Farm.

In his collection trips throughout the state, Arthur H. Holmgren often finds a plant that has not previously been reported in Utah. Sometimes these plants are poisonous or weeds that may become noxious if allowed to spread. If control measures are adopted before such plants increase over wide areas, farmers and the state may be saved serious losses. Short notes on such plants will appear in Farm and Home Science from time to time.

ALMEDA PERRY BROWN

ALMEDA PERRY BROWN, for the past two years acting dean of the School of Home Economics and a member of the Station staff since 1926, will retire June 30th with the honorary rank of professor emeritus. Dean Brown, since her graduation from Utah State in 1901, has been a leader in the fields of nutrition and home economics in various communities throughout the state in the capacity of teacher, home demonstration agent, and research worker. While rearing a family of a son, Captain Charles Brown, with the U. S. Army; and a daughter, Mrs. Almeda Christensen, Mrs. Brown found time to take the lead in working for better homes and nutritional standards in Utah. Her leadership in the field of better living for rural Utah is outstanding and has resulted in many improvements.

Mrs. Brown's research work has been in the field of nutrition. A brief summary of some of the outstanding contributions that she has made follows:

Analysis of the diets of forty-three farm families in Utah over a year period showed that for tomatoes picked at the same time from adjacent vines that were not supplemented. Stone tomatoes grown in the greenhouse showed a mean vitamin C value approximately one-half as great as that of the same variety grown in an outdoor plot near the greenhouse. Mrs. Brown received her B.S. degree from Utah State in 1901 and her M.A. from Columbia in 1915. She became assistant professor of home economics in 1926 and associate professor in 1937.
The most abundant native grass on lower-elevation ranges of northern Utah is the bunch wheatgrass Agropyron spicatum (fig. 1). This grass occurs on both winter and summer ranges, but is most abundant on foothill ranges grazed during the spring and again in the fall.

The Utah Agricultural Experiment Station has under way an investigation on the chemistry of the wheatgrass, preliminary results of which are presented here. Since the spring and fall ranges fit into a year-long seasonal grazing pattern in Utah, the study was designed to measure variation in the chemical composition of the forage during the spring and the fall period.

Samples were composed of 40 bunches selected schematically from a large plot of native grassland on the foothill range near Logan. These were clipped one-half inch above ground level and dried in the laboratory. Bunches were not recropped, but each sample consisted of 40 new bunches. Harvesting was begun in mid-April when growth is just starting and continued at 2-week intervals until mid-June when growth had ceased and animals had left for summer range (fig. 2). An additional sampling was made in mid-September, at which time animals begin to return to the foothill range. Fall samples did not contain green material but only matured spring growth.

Samples were analyzed for crude protein, fat, ash, phosphorus, cellulose, and "other carbohydrates," sometimes referred to as "soluble carbohydrates," which are essentially sugar and starch. Results are shown in table 1 and figure 3.

Usual analyses divide carbohydrates into fiber and nitrogen-free extract, the former being considered relatively non-available to animals and the latter available. In reality, digestion studies show but little difference in availability of the two, the fiber actually being more highly digestible in some feeds than is the nitrogen-free extract.

The analysis made in this study divided carbohydrates into lignin, cellulose, and "other." Lignin is considered virtually non-digestible, cellulose partly digestible, and the other carbohydrates almost wholly digestible. Lignin is believed to be the best single chemical index to digestibility of forage, high lignin indicating low digestibility. Not only is lignin itself very low in digestibility, but also deposition of lignin within the plant appears to prevent ready digestion of other constituents, especially cellulose. Because of this relationship, the cellulose-to-lignin ratio has been proposed as an even better index to forage value than is lignin alone. Table 2 shows some relationships found between various fractions of the carbohydrates in wheatgrass at various seasons.

The carbohydrate levels and relationships all suggest rapid decline in digestibility and feeding value of wheatgrass forage as the season progresses. Protein content was very high in early growth stages but, by fall, the protein was deficient for all grazing animals. Spring levels of protein are high enough to supply adequate quantity even to young animals during the normal spring grazing season. Phosphorus, which is doubtless the mineral most likely to be lacking in Utah forages, is high in wheatgrass during the spring. Generally, levels of about 0.15 to 0.20 are considered minimum for grazing animals. Since the phosphorus content of wheatgrass reached levels of 0.19 in late spring and 0.17 in fall, there is indication of phosphorus deficiency after the grass matures, especially for young animals.

(Continued on page 15)
HOW NEW VARIETIES OF SMALL GRAINS ARE PRODUCED

By R. W. WOODWARD

MANY varieties of wheat, oats, and barley were introduced to this country soon after its first settlement. All crop plants were originally domesticated from native plants growing wild in various regions of the world. Over long periods of time such crops have been gradually improved through selection. Often the largest heads or kernels were selected, frequently with disappointing results. Progress at best was slow because nothing was known about the laws governing heredity. Nature from the beginning has been producing variations in plants and subjecting them to rigorous tests of survival. Man could and did assist nature by his picking promising plant types from fields. Most of the varieties growing in 1900 and before owed their existence to this mode of selection. Many of these old varieties continued to be important until quite recently, with a few still unsurpassed by products of the present plant breeders.

With the discovery in 1900 of Mendel’s law of heredity, which placed the behavior of plants on a predictable basis rather than on one of mystery, rapid progress has been made in cereal improvement. Mendel established three laws important to the breeder, (1) that there are factors or hereditary units in the germ plasm responsible for the expression of characters, such as color of kernel, straw strength, height, beards, etc.; (2) that some characters are dominant to others, for example, red grain is dominant to white and when both are present together the grain will be red; (3) that when crosses are made, segregation takes place in the second generation following the cross in which all combinations of the two parent lines will arise in approximate ratios for each character.

More and more technical knowledge has been added each year by the geneticists, cytologists, plant breeders, and pathologists, all of whom have furnished equipment for further practical improvements.

Present Programs of Producing New Varieties

In states where small grains are of economic importance there is at least one federal employee devoting full time to the job of breeding improved new varieties. In many cases a plant breeder employed by the federal government either assists the state leader or is leader of a cooperative project. Local, regional, and national interests are served by this cooperation.

Three methods are now generally used in the systematic breeding of new and improved varieties. Each or all methods may be used by the same breeder at the same time. These methods are (1) introduction, (2) selection, and (3) hybridization followed by selection.

Introductions

A new cereal improvement program usually commences by obtaining numerous introductions from a wide range of countries and climates. From 3,000 to 9,000 varieties and strains each of wheat, oats, and barley are now in stock at Beltsville, Maryland. Many of these were obtained through explorations to all the principal grain-growing countries of the world. From this enormous stock each state station worker can get an abundant assortment of strains from which to choose a new variety, or a parent which will transmit the desired characteristics to its progeny.

Each variety is first grown for observation. Promising ones are then properly tested for yield, survival, disease and insect resistance, as well as for numerous other qualities.

Examples of important varieties found through introduction are Turkey Red and Federation wheat, one coming from eastern Europe and Asia, the other from Australia. The hard spring wheat industry of our country and Canada was founded on the introduction of Red Fife. This variety alone has meant millions of dollars to each country annually. Likewise, the durum wheat industry of the northern Great Plains developed only after the introduction of suitable varieties from Russia in about 1900. Many other introductions were important for a time and were responsible for the new varieties which replaced them either as head selection or through hybridization.

Selections

For centuries the better heads, kernels, or plants, have been selected and bulked as a new source of seed. This method worked well for a time, but soon
reached its limits. Since 1903 we have known that selections within a pure line accomplish nothing. Thus, large kernels from a pure line produce offspring that are no different from those from medium or small kernels. Since most varieties are not pure to begin with, or if pure varieties become contaminated by natural crossing or mechanical mixtures during the years, selection continually offers a means of isolating improved strains of small grains. Once a promising isolation is made the processes of testing already mentioned must be followed until sufficient information is obtained to establish the superior qualities of a new strain before it is released as a new variety.

Varieties of importance to this region arising as a result of selection are Trebi and Atlas barley, Kanred and Dicklow wheat, and Markton oats. Many others of even greater importance are found in other sections of this country as well as in other grain growing countries.

**Hybridization**

For some 30 or more years plant breeders have carefully chosen parent varieties and made crosses from which new varieties with the desired combination of characters could be selected. At present hybridization is the primary means of grain improvement. This procedure usually follows one of three lines of attack: (1) the pedigree, (2) the bulk or, (3) the backcross method. In all cases the same general scheme is followed. A problem or need usually exists such as, for example, was the case in winter wheat prior to 1935. All commercial varieties then grown were highly susceptible to a dwarf smut found in northern Utah and southern Idaho. No single introduction was satisfactory for all desired characters including yield, quality, and resistance to smut, although all the desired factors were available in different varieties and could be bred into a single variety.

Generally the best standard variety is crossed with one possessing the highly desired characters not present in the standard variety. In the case just mentioned, Utah Kanred, a high yielding, good quality variety, highly susceptible to smut, was crossed to Hussar, a rather poor type but with resistance to the dwarf smut causing the major loss in Utah’s winter wheat crop.

**The Mechanics of Crossing**

In small grains both the male and female parts are found enclosed in the same glumes. A separate fertilization must take place for each kernel on a plant. Normally within the glumes of a single flower the pollen drops on the female receptive parts which resemble a branched feather. This type of plant is self-fertilized and normally breeds true.

When a cross is to be made the three pollen-bearing anthers must be removed from each flower of the female parent. These male organs must be taken out just before they are ready to break open, otherwise self-fertilization might result. Heads are covered or wrapped up for 1 to 3 days after being emasculated, then yellow ripe pollen from flowers of the male parent is dusted on the feathery female parts of each flower. After pollination the head is again wrapped and labeled, awaiting ripening of the kernels. About 40 to 50 percent seed set in these crossed heads is considered good.

**Hybrid Generations**

It is desirable to obtain 30 or more seeds from the original cross, from which 15 to 20 F₁ or first generation plants are grown. These first generation plants are usually more or less intermediate between the parents in appearance. The plants are given considerable space so that some 500 or more seeds are produced from each. The F₂ or second generation, if the pedigree method is followed, would consist of 10,000 to 15,000 plants spaced 3 to 5 inches apart in rows allowing individual plant study. If the two parents differ by only 5 characters, 1,024 progeny are required in order to get one dominant true breeding individual. If they differ by 8 factors, then 65,538 progeny are required from self-fertilized F₁ plants in order to get a true breeding plant with a particular combination of characters. Characters common in barley, for instance, are color of chaff, color of kernel, height of plant, presence or absence of awns and hoods, smoothness of awns.

The problem then is to identify the plant with the desired characters among the many thousands. Since the parents in most matings differ by many characters, the necessity for large populations and care in making selections is obvious if the desired combination of characters is to be expected.

One thousand or more of the better second (F₂) generation plants should be chosen and at least 50 plants of each grown for further study in the third (F₃) generation. The breeding behavior of each F₃ plant is determined from the

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land of the state, or roughly 1,000,000 acres, is served by about 700 companies. The average area per company is approximately 1400 acres. More than 200 companies serve less than 300 acres each and about 500 each serve more than 300 acres.

A study is now being made of these irrigation companies to report their activities, problems, and needs. Participating in this study with the Experiment Station and Extension Service are the Division of Irrigation, Soil Conservation Service; State Department of Publicity and Industrial Development; other agencies interested in water utilization in Utah; and the irrigation companies.

Field work, nearing completion, has included interviews with irrigation company officials to get pertinent information about each company. In addition, data on water supplies and related matters have been compiled from water commissioners, state and federal offices and other sources. The tabulation and analysis of information are now in process. A preliminary check for one county discussed briefly below reveals, in general, the trend of the survey.

Sanpete County
Sanpete County has approximately 87,000 acres of irrigated crop and pasture land. This land area is served by 49 irrigation companies. Data have been collected from 40 of these companies. Each of 28 delivers water to more than 300 acres, and 12 each to less than 300 acres. The 28 larger companies serve a total of 62,315 acres, while the 12 smaller ones supply 2,900 acres.

Each company has from 4 to 12 officials, depending mainly on the number of directors. More than 200 officials serve the 28 larger companies. Of special interest is the employment of attorneys and engineers. Twelve of the 28 companies employ attorneys, while only one company provides regular engineering service.

Method of Water Delivery
Water is delivered by rotation, on demand or call, by continuous flow, or a combination of these. By far the most common method is by rotation. Served by this method are 40,113 acres, or about 64 percent of the 62,315 acres irrigated by the 28 larger companies. The time interval between turns ranges from 7 to 30 days, with an average of 17 days for all companies.
Irrigation System

The survey lists 13 reservoirs with a combined storage capacity of 27,216 acre-feet belonging to six companies in Sanpete County. The needs for additional storage water and plans for the construction of reservoirs have been pointed out. However, the additional water provided by feasible reservoir construction will fall far short of satisfying the needs for supplemental water.

In general, it may be said that irrigation systems in Utah are only in fair working condition. Conveyance losses may not be easily detected and many escape unnoticed unless systematic effort is made to ferret them out. The most satisfactory method is by water measurement—to determine through measurement the diversions to the company and by the same method, the delivery of water to users. Without careful measurements, excessive losses may be sustained indefinitely without detection.

The canals of the 28 larger companies in Sanpete County have an average capacity of 41.3 second-feet, ranging from three to 200 second-feet per company. The combined capacity of all is 1,138 second-feet. The total length of these canals is 138 miles, with an average of 4.9. They range from less than a mile to 20 miles in length. The main laterals under these canals vary in size from 4 to 20 second-feet, and from less than one mile to 30 miles in length. The total length of all is 173 miles.

Irrigation companies report 20 miles of canals and laterals in need of lining to reduce seepage losses and 46 miles requiring major cleaning, enlargement or realignment to place them in adequate working condition. The need of improvements in canal structures is extensive. The diversion, control, and measurement of water in the canal require diversion structures, weirs, siphons, flumes, dividers, gates, and other similar devices built for that purpose. These structures often represent the "critical links" in the distribution system.

Economic Aspects

The irrigation company study reveals that few companies in Sanpete County, or in the state, are in debt. In Sanpete County the annual operation and maintenance costs are usually moderate, but water stocks are highly valued. When the interest on water-stock-shares investment is added to the costs of operation and maintenance, the combined costs are materially increased. The average operation and maintenance costs for the 28 companies are $0.58 per acre. The interest at 4 percent on water stock investment per acre right is $2.07, and the total annual cost is $2.65 per acre. Total annual cost for the 28 companies is $165,700.

When the water rights and irrigation system are capitalized on the basis of price per share of stock, the investment per acre is a significant figure. Likewise, the total investment for the company and for the county is revealing. For the 28 companies irrigating 62,315 acres in Sanpete County, the average investment for water right per acre is $51.90, and the total investment in these companies is $3,234,000.

Sanpete County irrigation conditions are fairly typical of irrigation in Utah. Utah has some well-watered land and much with only second and third-class supplies. Some counties of the state have better irrigation development, and some present less favorable conditions and less opportunities for improvement.

When developments that now appear feasible have been made, Sanpete County will remain an area of adequate water resources to supply fully the areas of good farming land. The principal development of new water hereafter will be from the Colorado River drainage. The most promising future development, however, is in improving the use of present water supplies. It is estimated that 25 percent of the irrigation water is lost through seepage through canal banks and through evaporation, and that other large amounts are lost on the farms of the users by too large or too small streams, causing deep percolation beyond the root-zone of the crop and by other inefficient methods. Improvement can be made by companies through increasing the efficiency of delivering water to the farms, and by the water users, through increasing the efficiency of water application to the land.
CONTRARY to popular opinion in Utah that only poor land that will not grow other crops should be used for pasture, experimental evidence at the Dairy Experimental Farm in Logan shows that pastures seeded on good land yield high returns.

Sixteen acres of good land were fertilized with manure and superphosphate and seeded to pasture. The fertilizer applied per year averaged 4.9 tons of manure containing a high percentage of the liquid portion, and 89 pounds of treble superphosphate. The pasture was divided into four 4-acre plots and grazed in rotation by high producing Holstein cows. The cows, which were producing in excess of 0.75 pound butterfat per day, were fed grain according to production. During the latter part of the pasture season the cows were fed some alfalfa hay as a supplement to the pasture. The experiment has been conducted over a three-year period.

During this period the pasture furnished an average of 253 cow days of grazing per acre (table 1). A standard cow day of grazing is equal to 16 pounds of total digestible nutrients, or the equivalent of the nutrients in 32 pounds of average alfalfa hay. This would be the equivalent of approximately 4 tons of alfalfa hay per acre.

Supplementary Feeds Fed and Milk and Butterfat Produced

During September and October when forage in the pasture was not sufficient to maintain a high level of milk production, supplemental alfalfa hay was fed at the average rate of 1.127 pounds per acre over the three-year period. Grain was fed to the individual cows according to butterfat production throughout the pasture season. The amounts fed average 1,707 pounds per year per acre. When equated on an acre basis the feeds produced a total average milk production of 8,704 pounds, containing an average of 303 pounds of butterfat. It was calculated that the proportion of this butterfat that was from the supplemental feeds averaged 98 pounds for the three years. Subtracting the amount of butterfat produced from the supplemental feeds fed, the amount produced per acre from pasture was 206 pounds.

Value of Butterfat Per Acre From Pasture

At 90 cents per pound the value of the butterfat produced from pasture was calculated to average $185.40 per acre. During this experiment a record was kept on the costs of producing an acre of pasture. These costs averaged $36.01 per acre. Subtracting the production cost per acre from the value of butterfat produced from pasture, the gross returns above feed production cost ranged from $140.33 in 1943 to $162.56 in 1944, or an average of $149.39 for the three years. It should be noted that the figures as given are indicated to be gross return from pasture because the costs associated with milking the cows have not been deducted.

The returns for each dollar expended in the production of an acre of pasture was found to average $5.15. The cost...
of production of pasture feed for each pound of butterfat produced was calculated to average 17.5 cents during the three-year study.

**Gain and Loss in Body Weight**

During the pasture season there was both a gain and a loss in body weight of the individual cows. The losses occurred after freshening, which is to be expected. A summary of weights showed a net gain in the body weight of the cows amounting to 202 pounds per acre of pasture the first year, and 233 and 236 pounds for 1943 and 1944, respectively. This gain in body weight is shown but has not been credited to the cash returns from pasture. These data on gain in body weight are given to show that sufficient nutrients were supplied by the pasture so that the cows made satisfactory weight gains in addition to producing at a high level. The data presented for the three years show that pasture, when planted on fertile soil and well managed, is an economical feed for the production of milk and butterfat and gives a high return per acre when grazed by good dairy cattle.

### Table 1. Per acre returns from pasture (average of 16 acres) for years 1942, 1943, and 1944

<table>
<thead>
<tr>
<th>Item</th>
<th>1942</th>
<th>1943</th>
<th>1944</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard cow days of grazing*</td>
<td>253</td>
<td>246</td>
<td>261</td>
<td>253</td>
</tr>
<tr>
<td>Supplemental feeds fed—alfalfa (lbs.)</td>
<td>862</td>
<td>1,243</td>
<td>1,275</td>
<td>1,127</td>
</tr>
<tr>
<td></td>
<td>grain (lbs.)</td>
<td>1,456</td>
<td>1,692</td>
<td>1,972</td>
</tr>
<tr>
<td>Gain in body weight (lbs.)</td>
<td>202</td>
<td>233</td>
<td>236</td>
<td>224</td>
</tr>
<tr>
<td>Total production milk (lbs.)</td>
<td>8,376</td>
<td>8,234</td>
<td>9,501</td>
<td>8,704</td>
</tr>
<tr>
<td>butterfat (lbs.)</td>
<td>279</td>
<td>296</td>
<td>335</td>
<td>303</td>
</tr>
<tr>
<td>Butterfat produced from supplement feeds fed (lbs.)</td>
<td>79</td>
<td>100</td>
<td>144</td>
<td>98</td>
</tr>
<tr>
<td>Production from pasture—milk (lbs.)</td>
<td>6,006</td>
<td>5,460</td>
<td>6,261</td>
<td>5,909</td>
</tr>
<tr>
<td>butterfat (lbs.)</td>
<td>200</td>
<td>196</td>
<td>221</td>
<td>206</td>
</tr>
<tr>
<td>Value of butterfat produced from pasture</td>
<td>$180.00</td>
<td>$176.40</td>
<td>$198.90</td>
<td>$185.40</td>
</tr>
<tr>
<td>Production cost per acre</td>
<td>$35.63</td>
<td>$36.07</td>
<td>$36.34</td>
<td>$36.01</td>
</tr>
<tr>
<td>Gross returns above feed production cost</td>
<td>$144.37</td>
<td>$140.33</td>
<td>$162.56</td>
<td>$149.39</td>
</tr>
<tr>
<td>Dollars returned for each dollar cost of pasture production</td>
<td>$5.05</td>
<td>$4.89</td>
<td>$5.47</td>
<td>$5.15</td>
</tr>
<tr>
<td>Pasture feed production cost of 1 pound of butterfat (cents)</td>
<td>17.8</td>
<td>18.4</td>
<td>16.4</td>
<td>17.5</td>
</tr>
</tbody>
</table>

* A standard cow day is defined as an animal obtaining 16 pounds of total digestible nutrients from pasture per day.

†Butterfat production was calculated to the nearest pound.

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**TWO POISONOUS MILKWEDS**

**By ARTHUR H. HOLMGREN**

THE most costly livestock losses usually occur on range lands that have been depleted of the more palatable and desirable plants. Fortunately, many of the most toxic plants are not grazed by livestock in sufficient amounts to cause death when good forage is available.

Two species of milkweed seem to be responsible for many of the sheep and cattle losses in southern Utah, where they are becoming common and apparently spreading northward in the state. Neither of these species is palatable to livestock; it is grazed in quantities which may cause death only when choice plants are lacking. It is the purpose of this paper to describe and illustrate these plants and not to discuss range management practices which may prevent poisoning, or the symptoms of poisoned animals, or ways in which poisoned animals may be cured. If the poisonous plants are recognized, farmers and ranchers may avoid some of these devastating losses.

Whorled milkweed (Asclepias galioides H.B.K.) grows in sandy places along roadsides, sheep bed grounds, waste places, open plains and mesas, and in pastures. Whorled milkweed is a perennial and spreads rapidly by seed and rootstocks and is difficult to eradicate if it becomes well established. The slender stems are 1-2 feet high and unbranched at the base with a few branches at the top where most of the flowers appear. The narrow leaves appear in whorls of three or more and are rarely longer than three inches. The greenish white flowers are arranged in umbrella-like clusters. The fruit consists of one or two narrow pods about 2 inches long that split down one side, allowing the many seeds to escape.

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By ARTHUR H. HOLMGREN

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### Fig. 1. Poison milkweed (Asclepias labriformis). A. Photograph of plant. The underground rootstock has been removed. B. Pod showing tufts of hair along open side. C. Seed with tuft of hair.
transmitted to both sweet and sour cherries. The western “X” affects all cultivated varieties of peach and may prove to be the same as the red leaf chokecherry virus. Again the ring spot virus may prove to be carried by most species of the genus Prunus, including many of the cultivated stone fruits.

In addition to these known virus diseases there are a number of other abnormalities affecting commercial, ornamental, and wild species of the genus Prunus, some of which may yet prove to be of virus origin. Collectively, the virus diseases in stone fruits present a bewildering array that will require years to clarify.

Since the science of virology (the study of viruses) is so comparatively new the following discussion is presented for the purpose of familiarizing growers with the general nature of viruses and with the nature of the diseases they cause in plants. It will also serve as an introduction to a series of papers to follow in subsequent issues of Farm and Home Science, each of which will treat one or more of the important virus diseases of stone fruit trees found in Utah or which may be introduced in the state.

Nature and Cause of Virus Diseases in Plants

From a practical point of view a virus may be thought of as an exceedingly minute particle capable of invading plant and animal tissue and of producing recognizable disease symptoms in the invaded susceptible or host. Unlike bacteria and fungi, these infective virus particles are so minute as to be invisible with the most powerful microscope. Viruses are capable of rapid multiplication in host tissues and spread from affected to healthy individuals by mechanical means or by insects. Individually or in combination, viruses cause some of the most destructive and contagious diseases known in the plant or animal world. Viruses often invade only certain parts or local regions of a plant, in which case they are said to be localized; more often, however, they pass to all parts of the plant, in which case they are known as systemic. The systemic expression appears to be the characteristic expression in most virus diseases of fruit trees.
Most of the virus diseases of plants that have been studied have been placed in one of two large groups; the mosaics characterized by a mosaic of chlorotic spots in the leaves, or the yellows type characterized by various gradations of yellowing of the entire leaf. Each of these groups may be further characterized by such additional symptoms as abnormal coloration and early senescence of the leaves, killing of areas of leaf tissue, shot-hole effects, crinkling or other forms of distortion, vein-clearing, rosetting, dwarfing, defoliation, or other abnormalities of various parts of plants. There is now recognized a considerable number of virus diseases of fruit trees that fall into a third group in which the bark is primarily affected. Occasionally, however, the wood and the leaves and fruit also become involved. While some virus diseases cause more or less rapid decline and death of the attacked plant, the majority of them seldom kill plants but merely cause them to become unthrifty and unproductive and lower their resistance to other diseases. The fact that woody plants often are not especially seriously affected by many of these virus diseases explains why such diseases sometimes may exist for years in orchards without causing particular concern to growers.

A wide range of variation occurs in the period of incubation required of various viruses from the time of transmission before symptoms characteristic of the disease express themselves. This period is usually relatively short for annual herbaceous plants in comparison to that required for trees. The period required for symptom expression in fruit trees may vary from several days to a number of weeks with some virus diseases, while others require a number of months or as much as one or two years. Sometimes several years are involved.

Agents of Virus Dissemination

While plant viruses may be spread by various agencies, insects appear to be the most common, if not the only, means of natural spread. In fact, no group of plant diseases is more intimately associated with insects than those induced by viruses. The insects most frequently involved as vectors, or agents of transmission, appear to be sucking insects, particularly aphids, leafhoppers and thrips. Wind and rain, while of great importance in disseminating bacteria and spores of fungi, are of relatively little significance in the spread of plant viruses. The soil in itself, is not an agent of dissemination, though infection may result from insects working underground, or by natural root grafting between trees. Seed transmission of viruses is known to occur in certain vegetable crops, particularly legumes, but is not the rule.

Man is one of the most effective and frequent agents of virus dissemination in plants. He is responsible for dissemination in the processes of budding and grafting of plants by use of budwood from trees that may be infected with virus diseases, and in the sale and distribution of seeds and plant parts. While many plant viruses, particularly of herbaceous plants, are readily transmitted artificially by direct inoculation with expressed juice, artificial transmission of fruit tree viruses has been accomplished only by budding or grafting. Since there is no multiplication of the virus in the absence of living cells, in either plant or insect, it appears that the virus inoculum must come in contact with the protoplasm of the plant cell before infection occurs.

Control

When it is understood that the infectious principle of a virus disease is distributed to all or a vital part of the tissues of affected fruit trees, it will be readily appreciated by growers that it is impossible to combat such a disease by means of external applications of fungicides or by cutting off limbs on which the symptoms first develop. Consequently, when a tree once develops a pronounced case of a dangerous virus disease, there is no known method of effectively treating or curing it, and it should be removed promptly. This is one of the fundamental points of difference between virus diseases and those caused by fungi or bacteria. Diseases of virus origin are not ones to be temporized with, but call for prompt and drastic action. The retention in orchards of trees affected by virus diseases is a dangerous and futile practice. Such trees provide reservoirs of infective material for more or less rapid spread of these diseases to adjacent healthy trees. While considerable research has been done on the value of internal chemotherapy through injections of various organic chemicals into trees to combat fungi or viruses that have become established with the living tissues, or toxins resulting from these diseases, without injuring the trees thus treated, the results as yet obtained are of no practical value to growers.

Owing to the nature of virus diseases and the fact that most of them are systemic, measures for their control must be of an exclusionary or preventive nature. The most effective measures comprise the exercise of care in plant propagation to avoid their transmission and dissemination; a rigid system of inspection for the presence of these diseases, not only in commercial nurseries but also of the trees used as sources of budwood; control of insect vectors; and prompt removal of orchard trees that have become affected.

It has long been common practice for June 1945
among growers and also among many nurserymen to cut budwood from young nonbearing trees, largely because such trees furnish good budwood most readily. However, budwood cannot be selected either wisely or intelligently from young nonbearing trees, since there is always the possibility that such trees may be carrying a virus disease without showing the symptoms. This hazardous practice cannot be too strongly condemned for it has been definitely established that such promiscuous selection of budwood all too commonly serves unwittingly to disseminate to commercial orchards not only dangerous virus diseases but also many off-type and unproductive strains of trees, all of which materially lower average yields and profitableness.

In order to maintain high standards of production and freedom from virus diseases, budwood should be selected only from bearing trees and of known fruit and vegetative characters, production performance, and freedom from diseases. This practice should be adhered to rigidly since it affords a means of (1) eliminating unnecessary multiplication and dissemination of virus diseases, (2) eliminating worthless or undesirable off-type trees, and (3) reducing objectionable diversity within a variety. It is hoped that ultimately some cooperative arrangement can be worked out between state and federal agencies whereby budwood of standard varieties, free from virus or other transmissible diseases, will be made available to commercial propagators and growers.

**DISEASES OF TURKEYS**

(Continued from page 1)

(this may be one reason for the predominance of the disease in toms).

Since staphylococci are found everywhere in association with animals, it is now impossible to say how the disease is introduced into a flock. It could be from other turkeys, other forms of livestock, or even men. This lack of knowledge of the exact cause and the means of spread of this disease makes it difficult to outline a control program. Yet by following good sanitation, adequate feed, proper management, and by eliminating possible sources of injury, it should be possible to reduce the losses to a great extent. No vaccine or drug, including the sulphonamides, has been shown to have curative or preventative powers.

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**Infectious Sinusitis**

This respiratory disease of turkeys, once it has spread quite widely in the flock, causes considerable death loss and produces a considerable number of stunted birds so that only a small percentage of them will dress out as prime. The inflammation of the sinuses with its accumulation of exudate results in the large swelling of the sinus on both sides of the head just beneath the eyes. From this, the disease has been called "roupy" and "swellhead." The sinuses of the head are by no means the only part of the respiratory tract affected. The bronchi, the lungs, and air sacs are quite regularly involved. Usually if the sinuses are affected, then the lungs and other structures are not and vice versa. When pneumonia is present there is a much higher mortality. Birds with bronchitis or pneumonia have a distinct rat-tle in their breathing as a result of the accumulation of mucus in the air passages. If one of these birds is picked up and held head down, it soon dies of suffocation owing to the stoppage of the air passages with mucus.

It is probable that there is more than one type of this disease with different causative agents, but the one most often seen, and the one that causes the most damage to a flock, is that which starts in the brooder when the birds are three to seven weeks of age.

One of the first symptoms noticed is a watery discharge from the nostrils which, as the diseases progresses, becomes encrusted. Another symptom is a foamy, watery discharge from the eyes. These are followed in a few days with the swelling of the sinuses.

Treatment of birds with swollen sinuses by removal of the exudate with a hypodermic syringe and the injection of 1 cc of 4 percent silver nitrate or of 15 percent argyrol solution usually results in recovery. This treatment causes considerable swelling of the sinus for two or three days. It must be done every few days as new birds become affected, and occasionally the condition recurs in a treated bird. There is no treatment for birds affected in the bronchi or lungs.

Every effort should be made to prevent the infection from entering the flock and, if it does enter, to prevent the spread within the flock. Particular attention must be paid to the waterers, since the exudates from the nose, eyes, and mouth can readily infect the water.

There is a considerable spread of this disease from flock to flock. The survey in Sanpete County showed that only 6.3 percent of the flock exhibited infectious sinusitis in the brooder, whereas 22 percent had it on the range. To control this spread, of infection, careful regulation of movement of persons and equipment from one flock to another must be practiced, only clean (new or sterilized old) sacks must be used in bringing feed to the birds, and if it is necessary to haul birds by truck from one place to another, only crates that have been cleaned and disinfected should be used.

Ordinarily this disease runs a chronic course in a flock with only a few birds having the disease at any one time. Cold, damp, inclement weather will cause an acute flareup with a rapid spread of the disease within the affected flock. Such flocks should be protected against exposure to storms. A ration deficient in vitamin A will predispose birds to this disease.

**Hexamitiasis**

Hexamitiasis is a protozoan infection of the intestine, primarily of young turkeys, but can be found in birds of all ages. The greatest mortality is produced in birds under 16 weeks of age. Most of the outbreaks of this disease in Sanpete County occurred after the birds were put on the range, with the severest death losses in birds between 12 and 14 weeks of age. After that age not so many deaths occur, but the affected birds suffer a setback in growth which requires four or more weeks to regain, if they are not permanently stunted.

In most outbreaks of this disease, the turkey grower thinks that it starts in a large part of the flock at one time. This is not actually true, but only apparently so. As in many protozoan infections, the first birds infected have only a slight case, which may or may not be noticeable. This is because they are infected with a small number of organisms. The next birds infected get a larger number of these one-celled animals. This continues so that at a certain point it appears as if the entire flock is infected at once, because a large number of birds are getting a large amount of infection which produces the noticeable symptoms.

The prominent symptom in birds so affected is a foamy, watery diarrhea, which may be greenish to whitish in color. The poult's are listless; they lose weight rapidly because of improper digestion and loss of water.

There is no specific treatment. Good
husbandry will carry a flock through an outbreak where reliance on drugs will fail. It may be necessary to coax the birds to eat with buttermilk, with wet mashers, and by feeding more often.

To control the disease care must be taken to prevent its introduction in the flock, or, if already present, to prevent its spread between parts of the flock when in the brooder or between flocks of different ages on the same premises. This infection is spread primarily through the droppings of infected carriers. A turkey that has recovered is a carrier, and a possible source of an outbreak. Some believe that it is an inherent weakness. This weakness may be accentuated by providing insufficient shade on hot summer days, causing the birds to over-drink. The crop is distended and, if weak, soon becomes pendulous. Early surgical reduction of the crop will save a high percentage of the turkeys. (This operation was explained in an article by Wayne Binns in Farm and Home Science, v. 2, no. 3, 1941.)

**Pendulous Crop**

This condition of turkeys occasionally reaches serious proportions in some flocks, but usually only a small percentage of the birds in an affected flock are involved. Some believe that it is an inherent weakness. This weakness may be accentuated by providing insufficient shade on hot summer days, causing the birds to over-drink. The crop is distended and, if weak, soon becomes pendulous. Early surgical reduction of the crop will save a high percentage of the turkeys. (This operation was explained in an article by Wayne Binns in Farm and Home Science, v. 2, no. 3, 1941.)

**Trichomoniasis**

Trichomoniasis, another protozoan disease of turkeys, has the lesions which resemble closely those of infectious enterohepatitis. The caecal lesions are indistinguishable, but the liver lesions are yellow, granular, and raised above the surface, as contrasted to those of blackhead. Here again, no specific treatment is known. It does not respond so readily to the control measures applied to blackhead. It requires a longer period of daily moving to clean ground and removal of afflicted birds, and even then the mortality may be high. Drugs and laxatives have been used with varying results.

**Miscellaneous Diseases**

There are other diseases of turkeys on the range which were not encountered in Sanpete County. The most important are coccidiosis, fowl typhoid, and fowl cholera. These, together with paratyphoid infections and the other infectious diseases mentioned above, can be avoided by paying detailed attention to the rules of breeding and sanitation. Sources of infection should be avoided. If disease occurs, the cause should be determined as soon as possible by laboratory diagnosis, for then only can rational control be practiced.

**BUNCH WHEATGRASS**

((Continued from page 5))

The preliminary data presented here show bunch wheatgrass to be an excellent forage for grazing animals in the spring from start of growth until about June 1. Summer and fall grazing on foothill wheatgrass ranges would likely necessitate protein and phosphorus supplement for the most satisfactory results.

**Table 1. Seasonal variation in chemical composition of bunch wheatgrass (Agropyron spicatum) from foothill range near Logan, Utah, in percent***

<table>
<thead>
<tr>
<th>Date</th>
<th>Crude protein</th>
<th>Fat</th>
<th>Total ash</th>
<th>Phosphorus</th>
<th>Lignin</th>
<th>Cellulose</th>
<th>Other carbohydrates percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 15</td>
<td>26.43</td>
<td>2.70</td>
<td>8.62</td>
<td>.49</td>
<td>4.44</td>
<td>24.12</td>
<td>33.69</td>
</tr>
<tr>
<td>May 1</td>
<td>24.75</td>
<td>2.48</td>
<td>8.61</td>
<td>.44</td>
<td>5.19</td>
<td>24.88</td>
<td>34.09</td>
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<tr>
<td>May 15</td>
<td>18.56</td>
<td>2.70</td>
<td>9.12</td>
<td>.34</td>
<td>6.79</td>
<td>30.73</td>
<td>32.10</td>
</tr>
<tr>
<td>June 1</td>
<td>12.44</td>
<td>2.51</td>
<td>6.96</td>
<td>.27</td>
<td>8.34</td>
<td>32.86</td>
<td>36.89</td>
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<tr>
<td>June 15</td>
<td>9.12</td>
<td>2.52</td>
<td>6.80</td>
<td>.19</td>
<td>9.35</td>
<td>33.99</td>
<td>38.22</td>
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<tr>
<td>Sept. 15</td>
<td>3.06</td>
<td>2.89</td>
<td>7.61</td>
<td>.17</td>
<td>13.67</td>
<td>32.17</td>
<td>40.60</td>
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</table>

*Growth began about April 1 and leaves were about 2 inches high on April 15. Growth was slow until May 1, at which time leaves were 8 inches long. By May 24, growth was 12-14 inches high, but no heads were showing. On June 1, growth was 14 to 20 inches high and heads were beginning to appear. By June 15, all heads were out of the sheath, but anthesis did not take place until June 22 to July 1. By July 15 seeds were in early dough and growth was 26 inches high. Plants were still green by July 15.

**Table 2. Some carbohydrate relationships found in Agropyron spicatum near Logan, Utah, at various seasons***

<table>
<thead>
<tr>
<th>Date</th>
<th>Total carbohydrates</th>
<th>Percent lignin is of total carbohydrates</th>
<th>Cellulose to lignin ratio</th>
<th>Soluble carbohydrate to lignin ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 15</td>
<td>62.25</td>
<td>7.13</td>
<td>5.43</td>
<td>7.59</td>
</tr>
<tr>
<td>May 1</td>
<td>64.16</td>
<td>8.09</td>
<td>4.79</td>
<td>6.57</td>
</tr>
<tr>
<td>May 15</td>
<td>69.62</td>
<td>9.75</td>
<td>4.53</td>
<td>4.73</td>
</tr>
<tr>
<td>June 1</td>
<td>78.09</td>
<td>10.68</td>
<td>3.94</td>
<td>4.42</td>
</tr>
<tr>
<td>June 15</td>
<td>81.56</td>
<td>11.46</td>
<td>3.64</td>
<td>4.09</td>
</tr>
<tr>
<td>Sept. 15</td>
<td>86.44</td>
<td>15.81</td>
<td>2.35</td>
<td>2.97</td>
</tr>
</tbody>
</table>
NEW VARIETIES OF SMALL GRAINS
(Continued from page 7)

study of the F₃ plants, or, as is often stated, we judge the plant by its offspring.

From the fourth (F₄) generation, promising plants are selected from which the fifth (F₅) generation is grown. Promising strains that appear to breed true are then harvested in readiness for making yield trials. These tests usually take place during the sixth, seventh, and eighth generation, and may consist of 4 rows each, 8 feet long and 1 foot apart for each strain. Replications and the use of statistical analysis make possible a more rapid and accurate comparison of new strains with standard ones. When sufficient seed is available, yield tests are conducted over a wider area and in larger drilled plot tests.

During the testing period each new strain is subjected to artificially produced epidemics of the diseases common to the region. Artificial inoculations with rusts, smuts, etc., are made depending upon the problem under investigation.

It should be realized that for each of the generations from the time a cross is made until sufficient seed is available for drilled plots, seedling, cultivation, and harvesting must be done by hand. In a small grain breeding program not one cross but many different ones are being studied for each of the generations from F₁ to F₅ or F₆. When this is repeated with winter wheat, spring wheat, winter barley, spring barley and oats, the magnitude of the job can be realized. At the Utah Station from 10 to 15 acres of experimental small grain tests are common, ranging from the single spaced plants to 6-foot rows, 4x9 foot plots and finally drilled plots of 1/40 acre or larger with small fields for final increase of seed for distribution. Many thousands of rows must be seeded, labeled, observed, described, harvested, and threshed separately, with accurate records for each.

If a new wheat variety is forthcoming, adequate quality tests must be made when sufficient seed is available in order to know the milling and baking characters of promising lines before they are released. This again means samples from several locations over a two or three-year period, along with two or more standard varieties for comparison.

The bulk method of breeding is somewhat less laborious for the first 5 generations, but from then on it is similar to the pedigree method. Seed from the F₅ plants is bulked and seeded in rows with no regard to spacing. The plants are subjected to competition in the F₆ and successive generations until sufficient homozygosity exists to permit head selections of which many hundreds are made. Each head selection is then grown in rows from which further selections can be made if necessary or if the rows are promising in appearance they can be readily increased for further testing.

Backcrosses are used when a variety is satisfactory in all but one or two simply inherited characters. These characters are added one at a time by some 8 or 9 backcrosses to the desirable parent. For example, if Federation had all the desired characters except rust resistance, then a resistant variety would be crossed onto Federation. Resistant progeny would again be crossed back successively to the Federation parent for at least 8 backcrosses. Each year the progeny must be subjected to rust and the resistant plants used for backcrossing. By this method almost the entire heredity of Federation plus rust resistance would then be found in the resistant offspring.

Some of the results of hybridization in small grains are found in the smut resistant winter wheats, Cache and Watertown, which are predominant in Utah, southern Idaho, and parts of Montana; the smooth awned, stiff strawed, smut resistant Velvon barley grown on over two-thirds of the state's barley acreage, and Uton, a stiff strawed, high yielding, smut resistant oat. All over the continent new improved varieties are replacing old ones as a result of planned hybridization. Many more improved strains are in various stages of investigation. Each region has its newly released varieties which are replacing older ones.

Private breeders prior to the last quarter century produced many new varieties through introduction and selection. Only since about 1890 has any organized program been supported by public funds. During recent years emphasis has been placed on breeding disease-resistant varieties through hybridization. Farmers in general cannot afford to compete with trained breeders in the production of new varieties.

A plant breeder must be trained in his field. In addition he must have a trained eye, as it requires skill to recognize an ideal plant and be able to select it from thousands of others. From 10 to 12 years or more are usually required from the initial cross to the release of a new variety. Cooperation is involved, for a breeder must rely on many others, including pathologists and entomologists, to make tests for him, to send him introductions, etc. Cereal chemists, millers, and others must make quality tests in case of wheat varieties.

Many new strains have been ruined or lost after release because of a lack of proper procedure for keeping them pure. Most states have crop improvement associations which assist the research staff and follow up with a certification program such as is done by the Utah Crop Improvement Association.

A breeding program is slow and requires much patience and skill. These qualities are the only magic involved, plus plenty of hard work. Each state is reaping untold benefits as a result of improved crops. Not only are yields and quality improved, but many of the hazards that made for near failures are largely overcome.

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