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Winter Wheat Production in Colorado

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Colorado Agricultural Experiment Station
Colorado State Colorado
Fort Collins

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In Colorado an average of about 10,722,500 bushels of wheat was produced for the 6-year period 1933-1938.[2] Of this average production 44 percent was spring wheat and the remainder winter wheat. The average acreage harvested for the 6-year period was 861,300 acres. More than 56 percent[3] of the total wheat produced in Colorado in the 6-year period was produced without irrigation. The 10 highest counties in order of production[3] were: Weld, Adams, Logan, Yuma, Larimer, Phillips, Boulder, Arapahoe, Jefferson, and Washington.

Wheat-Producing Area

There is considerable variation in the climate of Colorado; extremes in both temperature and rainfall are frequent. In some sections less than 10 inches of moisture fall in a year, while in others the precipitation is 20 inches or more. In the wheat-growing sections the rainfall varies from 10 to 20 inches, and the altitude from below 4,000 to above 7,000 feet. Wheat production in Colorado is divided into two general types, the irrigated and the nonirrigated. The highest percentage of winter wheat is produced on the nonirrigated or dry land. The irrigated sections comprise those areas lying along the various water courses where the natural rainfall can be supplemented.

Location of Variety Tests

Variety tests with winter wheat are being conducted in three locations in Colorado.

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[2] Colorado Agricultural Statistics 1938. Issued cooperatively by Bureau of Agricultural Economics, Division of Crop and Livestock Estimates, U. S. D. A., and the Colorado State Planning Commission.

[3] Colorado Yearbooks from 1933 to 1935 and Colorado Agricultural Statistics from 1935 to 1938.

Fort Collins Station

The central station is located at Fort Collins[4] in the north central part of the State. At this station varietal tests are conducted under irrigation. The type of soil, elevation, and climatic conditions make it fairly representative of the irrigated sections in the northeastern part of the State.

The climate at Fort Collins is suitable for the production of small grains. There is sufficient rainfall on the average to start a fall-sown winter wheat crop and carry it through successfully until spring irrigation can be applied. With few exceptions sufficient rainfall comes in the months of March and April[5] to start a spring wheat crop.

Wheat overwinters with but little killing in the Fort Collins area, but some damage is done in the spring by dry winds and dry soil which often reduces the stands of some of the less hardy varieties.

Fort Lewis Substation

The Fort Lewis substation is located in the San Juan Basin in the southwestern part of the State. The experimental work is conducted by the Agronomy Section of the Colorado Agricultural Experiment Station[6] in cooperation with the Fort Lewis branch of the Colorado State College of Agriculture and Mechanic Arts.

Because of the high altitude (7,610 feet) the growing season at Fort Lewis is relatively short. The frost-free period, in which slight frosts are not considered, is about 110 days. However, because of late fall frosts, the frost-free period for the past 7 years has been 119 days. The temperature is not extremely high in summer nor very low in winter. The coldest months are December and January, while the warmest are July and August. The average yearly mean is about 43° F.

The average annual rainfall is about 18 inches (appendix table 1). The rainfall of May and June is usually low. From 35 to 40 percent of the annual precipitation occurs in July, August, and September. A heavy snowfall equivalent to about 5 or 6 inches of water covers the ground from December until April, furnishing considerable spring moisture.

[4] The winter wheat experiments are conducted in cooperation with the Office of Cereal Crops and Diseases, U. S. D. A.

[5] Parshall, M. Analysis of Fifty Years Record of Meteorological Data (taken at the Colorado Experiment Station, Fort Collins, Colorado.) Colo. Agr. Exp. Sta. Bul. 456, 1939.

[6] Dwight Koonce, associate agronomist, Colo. Agr. Exp. Sta., is in charge of the experimental work at Fort Lewis.

United States Dry Land Field Station

The United States Dry Land Field Station[7] is located about 4.5 miles east of Akron, in Washington County, Colo.

The soil of the farm is naturally fertile and varies in texture from a friable loam to silt loam. It is locally called "hard land" and differs from the so-called sandy land in that it contains more silt and clay. The topography is nearly level to gently sloping.

The climatic conditions at Akron are similar to those of other parts of eastern Colorado. The nature and distribution of the precipitation are often limiting factors in crop production. Occasionally injury from frost, low winter temperature, low winter precipitation, soil blowing, or hail cause serious crop losses. The monthly annual and seasonal precipitation for the 7-year period, 1933-1939, are given in appendix table 3. The data obtained from the experiments conducted on the dry-land station at Akron are believed to be generally applicable to nearly all dry-land sections in the Plains area of Colorado except the sandy lands, and to adjacent portions of western Kansas, southwestern Nebraska, and southeastern Wyoming.

Production on Dry Land

Preparation of the Soil

Several methods of preparation may be used, depending on rainfall and type of soil.

Fallow is the most certain tillage practice for producing winter wheat on the "hard" lands of the plains of Colorado. These so-called "hard" lands constitute fully 75 percent of the surface area of eastern Colorado. Extremely sandy land should never be broken for nonirrigated farming. The so-called "hard" lands and the sandy loams can be handled to prevent blowing. The essential feature of such handling is to keep a "small cloddy" surface (fig. 1) and leave as much trash on the surface as possible.

Good summer fallow is land clean cultivated throughout one entire crop season and until the time of seeding the succeeding crop. The purpose of fallow is to store the precipitation in the soil for the use of the succeeding crop. Thus any means that will aid percolation of the rainfall into the soil is one of the prime requisites. Another is the prevention of loss of moisture after it is stored in the soil. Experimental work has shown that growing

[7] U. S. Dry Land Field Station, Akron, Colo., is operated by the Division of Dry Land Agriculture, Bureau of Plant Industry, U. S. D. A., with the Colo. Agr. Exp. Sta. cooperating. The cereal experiments were conducted in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, from 1907 to 1924 and 1930 to 1940.

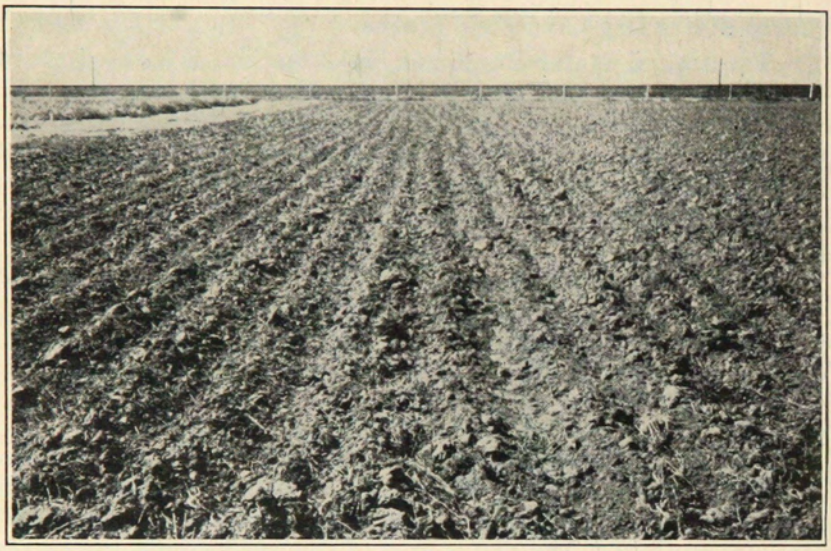

Figure 1.—Summer fallow showing a rough surface. Such a surface is desired for prevention of blowing.

plants are the most important single cause of loss of stored soil moisture in the fallow; consequently they should be kept off the summer fallow during the season of storage. At Akron 75 percent of the annual precipitation falls as rain from April 1 through September. Therefore, moisture control operations should begin no later than when the first weeds become green and should continue long enough to keep them from establishing themselves. It is well to bear in mind that every pound of dry weed material allowed to develop on fallow, or any other land for that matter, will have used 500 or more pounds of soil moisture, which would be enough to produce about the same amount of wheat.

A high percentage of the summer precipitation comes in the form of hard beating rains in eastern Colorado and is often lost by run-off if essential weed control cultivations do not leave the surface in condition to hold moisture long enough to allow it to percolate into the soil. Basin listing or cultivation and cropping on the contour presents a method of retarding run-off. Incorporation of stubble debris in the surface of fallow land also aids in preventing run-off. Just previous to planting, some cultivation which tends to bring the soil moisture to the surface should be made. This enables the farmer to plant his seed in moist soil and insures immediate germination.

Soil blowing may become a serious hazard when summer cultivations have not left the surface sufficiently cloddy. Stubble debris in the surface aids in the control of winter soil blowing.

In studies to determine the best date of initially working stubble land at Akron from 1923 to 1938, it is shown that unless weed growth appears in the fall little is to be gained from fall working stubble land for fallow. The latest desirable date for spring working of stubble land to conserve moisture was found to be about June 1. When weeds and volunteer grain were allowed to grow 1 month longer to July 3, a loss of 41 percent in the yield of the succeeding crop was observed. This indicates that preventing the use of soil moisture by plant growth is a major factor in good fallow practice and that spring working of stubble land should start with the first weed growth.

In a more recent study, 1928-1938, to determine the effect of different cultural implements on the surface preparation of stubble in the fall and spring, it was shown that the type of implement used in the initial workings had no influence on the moisture stored and that plots timely worked but never moldboard plowed produced as good yields as did those that were moldboard plowed. Initial working implements in this study were the lister, the duck-foot cultivator, the disk in the fall and spring, and the moldboard plow in the spring.

Corn or small grain stubble land should never be seeded to winter wheat unless the soil is moist to a depth of 30 inches. When wheat is seeded in corn stubble, the usual practice is to drill between the corn rows before the corn is harvested. The corn stalks remaining in this case act as protection against soil blowing. This practice is particularly adapted to the sandy lands which are subject to blowing. On some of the more sandy land fall wheat may be sown on proso millet stubble. Proso millet has a short growing season, and the stubble provides a good surface cover when it is not cut too short. This type of cover aids in preventing soil blowing on land which was fallowed early in the season.

Rate and Date of Seeding

From studies made at Akron between 1920 and 1939 on both summer fallow and corn stubble, it was found that seedings before September 1 and after October 1 reduced the yields of winter wheat.[8] The best date to sow winter wheat on either corn land or summer fallow was found to be between September 1 and 15. Early-planted winter wheat suffered severely from dryland foot rot.

Different rates of seeding were made at the different dates on well-prepared summer fallow and corn stubble land. The rates

[8] Rate and Date of Seeding Winter Wheat in Eastern Colorado. D. W. Robertson, J. F. Brandon, H. Fellows, O. H. Coleman, and J. J. Curtis. Colo. Agr. Exp. Sta. Bul. (in press).

used in the study were 1 peck, 2 pecks, 3 pecks, 4 pecks, 5 pecks, and 6 pecks. When wheat was sown at the recommended dates on well-prepared summer fallow, 2 pecks or more of seed gave the highest yields. However, the increase of the rate over 2 pecks did not justify the use of the additional seed. On corn land where the soil moisture storage was less efficient, there was little gain by sowing more than 1 peck. Under conditions favorable to soil blowing a good cover of wheat is desirable before the grain goes into the winter. In "out of date" late plantings a heavier rate may give a slight increase in yield.

Method of Seeding

The furrow drill is recommended for planting winter wheat, even though the results of tests at Akron show only a slight advantage of 0.8 of a bushel in yield per acre in favor of it. The plots seeded with a furrow drill in comparison with those seeded with a surface drill outyielded the latter 10 years out of 11 between 1928 and 1938, inclusive. The furrow drill places the seed deeper and in a dry fallow may enable it to reach stored soil moisture. It also throws up a higher ridge between the rows, which offers additional resistance to soil blowing. These rough top ridges and the deeper furrows are also effective in catching a larger part of the drifting snow during the winter.

Care after Planting

In some seasons, particularly on the lighter soils, blowing may damage the crop in the fall or early spring. When the possibility of such blowing presents itself, it may be necessary to cultivate or list strips through the wheat at right angles to the direction of the prevailing winds. However, furrow-drill seeding should give adequate protection if good growth starts in the fall.

Treatment of Seed[9]

Wheat smut (bunt) is prevalent in Colorado. Accordingly, all seed should be treated before planting. Some varieties are more susceptible to bunt attack than others. So far none of the varieties recommended is entirely immune to bunt.

Treatments for control of stinking smut of wheat are inexpensive, easily applied, and effective. Several commercial fungicides are obtainable for the purpose, but the dust treatments have been found most satisfactory, particularly the mercury compounds.

The use of a dust treatment has certain advantages over the old wet treatments; the dust is easy to apply and there is no swelling of the grain. The process of drying the grain is

[9] L. W. Durrell, Botany and Plant Pathology Section, Colo. Agr. Exp. Sta.

eliminated, there is no danger of freezing, and treating may be done a month or so prior to seeding.

Mercury compounds have proved most effective. They have the advantage of quickly and thoroughly covering the seed, and give off a fungicidal gas that penetrates rapidly through the treated grain and to some extent penetrates the seed coat. It does not clog the grain drill. The mercury dusts can be purchased at most seed stores and nearly all drug stores. The cost of treating with this dust is about 2 cents per bushel.

HOW TO TREAT WHEAT WITH A DUST FUNGICIDE.—Wheat to be used for seed should first be carefully cleaned to remove weed seed, dirt, and unbroken smut balls. Badly smutted wheat should not be used for seed. Seed should be dusted with organic mercury compound at the recommended rate per bushel of seed. An excess amount may cause injury to germination.

In treating with organic mercury compounds, which give off gas, it is best to treat the seed at least 24 hours prior to seeding and leave the grain in sacks, pile, wagon box, or dry bin. However, seed should not be treated more than 2 months prior to seeding and if stored for any length of time it should be in a dry room or bin.

Treating may be done in a barrel or steel drum mixer or in one of the gravity treaters such as the "Minnesota Seed Grain Treater."[10]

All organic mercury dusts are poisonous, and therefore the user should always cover his nose and mouth with a dust mask or a dry cloth to avoid inhaling the chemical. Treated grain must not be fed to animals.

Harvesting and Storage

Three methods of harvesting wheat are common to eastern Colorado. Wheat may be harvested with the binder, the header, or the combine harvester. The binder may be used when the straw is long; it is not used extensively on the dry land in eastern Colorado. Grain can be cut with the binder when the straw is yellow and when the grain contains considerable moisture and is in the tough dough stage. It should be placed in shocks of about 8 to 10 sheaves to the shock. It is then left in the shock to go through the sweat or after-ripening stage before it is ready to thresh. The moisture content of the grain should be less than 14 percent before it is threshed and stored. If it is stored at a higher moisture content, the grain is liable to heat, and damaged wheat will result. The curing period in the shock takes

[10] Moore, M. B. The Minnesota Seed Grain Treater. U. S. D. A. Miscellaneous Publication No. 330. 1938.

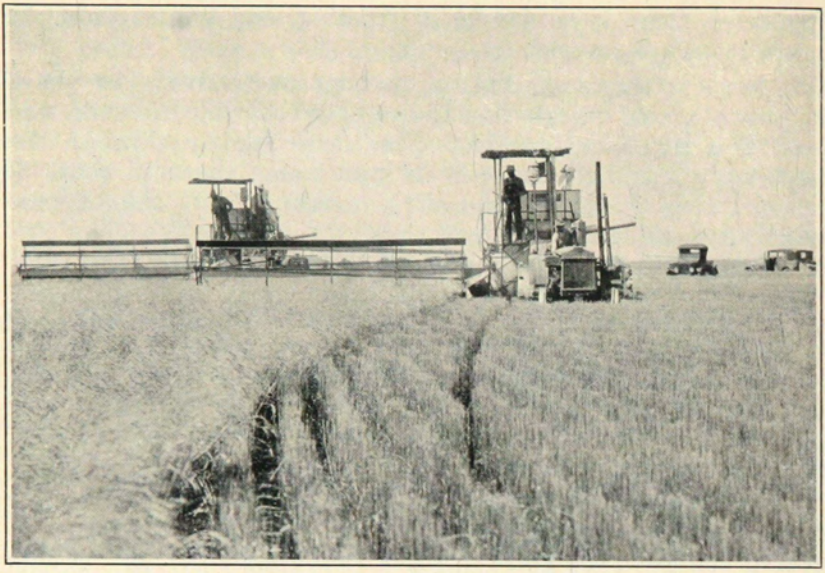

Figure 2.—Harvesting winter wheat in eastern Colorado.

about 2 weeks or more in a normal dry season. If the weather is wet or damp, a longer period may be necessary. The following statement regarding heat-damaged wheat is taken from the "Grain Grading Primer":[11] "Heat damage in wheat is perhaps more objectionable than any other, because wheat so injured produces a flour poor in color and of unsatisfactory bread-making properties. Bread from such flour is small in volume, the crumb is discolored, the texture is very poor, the bread has an offensive odor and usually tastes bad."

The header-barge method is in common use in the dry-land sections. It can be used when the straw is too short for binding. When the header is used, the heads are stacked in long, low stacks in the field and allowed to go through the sweat in the stack. The grain should be a little riper than is necessary when the binder is used. After curing in the stack the grain is threshed and stored as in the case of wheat harvested with the binder. The moisture content should not be more than 14 percent when the grain is threshed.

When the combine harvester is used, the grain should go through the after-ripening period before it is cut. This means that it is exposed to the dangers of the weather for 10 or more days longer than is necessary for header harvesting. As in the case of the other methods of harvest, the moisture in the grain

[11] U. S. D. A. Misc. Publication 325.

should be 14 percent or less before it is threshed and stored. Weedy grain should not be combined. If a combine is the only method of harvesting, such grain should be first windrowed. After the weeds have dried out, the windrows may be combined with a windrow pickup attachment. Too many pieces of broken up green weeds increase the moisture content of the stored grain and may cause it to heat in the bin.

Experiments on Dry Lands

The methods of conducting the winter wheat experiments on the Akron experiment station are similar to those reported in previous publications. The results reported in this bulletin cover variety tests made since 1933. Results previous to this date will be found in Colorado Agricultural Experiment Station Bulletins 329 and 404 (out of print).

Experimental Results

The yields in 1933, 1934, and 1940 were low. The months of August, September, and October of 1932 were unusually deficient in precipitation. As a result of this lack of moisture in the fall of 1932 and a rather cold winter there was a poor stand on the fallow plots and an insufficient start to compete with the weeds on the corn land. These conditions account for the low yields on fallow and the failure on corn stubble land. In 1934 the spring and early summer were exceptionally dry. This dry period continued to the middle of June, and by this time the wheat had suffered so badly from drought that it failed to recover. Low yields were obtained both on fallow and corn land. The fall of 1939 was exceptionally dry, and poor stands were obtained. These stands suffered further damage from a dry spring, which accounts for the very low yield which was obtained in 1940 on fallow and the complete failure on the corn stubble land.

The average yields of all varieties tested for 2 years or more are listed in table 1. This table shows that several varieties equal or outyield the standard Kharkof C. I. 1583. Of the varieties tested for the entire 8-year period, Kanred C. I. 5146, Tenmarq C. I. 6936, Cheyenne C. I. 8885, Blackhull C. I. 6251, and Early Blackhull C. I. 8856 all yield higher than the standard Kharkof C. I. 1583. Of the varieties tested for shorter periods Nebred C. I. 10094, Turkey Selection 10098, and Akron 7, C. I. 11660 all outyield the check by better than 10 percent. Of the latter three only Nebred C. I. 10094 is in commercial production. The other two varieties are not recommended, since other undesirable characteristics eliminate them from commercial use. Several other varieties tested for 3 years or less show promise, but further testing is necessary before they can be recommend-

TABLE 1.—*Average yield of winter wheat grown at the Akron Field Station for varying periods from 1933 to 1940, inclusive.*

Variety	C. I. No.	Akron No.	Yield in bushels per acre								Years grown	Ave. yield	Yield Kharkof same yrs.	Pct. Khar.
			1933	1934	1935	1936	1937	1938	1939	1940				
Early Blackhull	8856		5.1	3.7	19.5	25.2	11.3	23.6	8.9	0.6	8	12.2	11.1	110.6
Blackhull	6251		5.6	3.5	18.0	22.3	14.1	22.5	8.7	0.7	8	11.9	11.1	107.8
Tenmarq	6936		4.3	3.2	17.9	24.9	15.1	21.4	8.9	0.7	8	12.0	11.1	108.9
Turkey Selection	10016		5.3	2.2	20.0	25.8	13.1	20.8	8.7	0.5	8	12.0	11.1	108.9
Kanred	5146		4.4	2.2	19.0	21.1	16.0	20.5	8.2	0.4	8	11.5	11.1	103.7
Oro	8220		4.0	2.9	20.2	19.0	16.4	20.5	7.9	0.4	8	11.4	11.1	103.2
Yogo	8033		3.1	2.4	14.9	10.7	13.7	20.8	5.3	0.4	8	8.9	11.1	81.1
Cheyenne	8885		3.0	3.3	18.7	22.7	15.4	22.4	8.4	0.6	8	11.8	11.1	106.8
Kharkof	1442		2.9	2.1	15.3	19.5	14.7	21.1	6.5	0.8	8	10.4	11.1	93.6
Kharkof	1583		3.3	2.9	16.2	19.1	15.5	22.9	7.8	0.8	8	11.1	11.1	100.0
Alton	1438		2.5	2.1	13.5	13.1	15.5	17.6	5.4	0.6	8	8.8	11.1	79.4
Minturki	6155		2.3	2.2	14.5	19.1	13.3	21.4	6.0	0.4	8	9.9	11.1	89.5
Akron 7	11660	7		3.4	24.6	24.1	15.6	24.8	9.6	0.7	7	14.7	12.2	120.7
Turkey Selection	10098			2.7	22.7	23.8	13.3	22.5	8.8	0.4	7	13.5	12.2	110.6
Nebred	10094					24.1	15.4	25.6	9.1	0.7	5	15.0	13.2	113.3
Chiefkan	11754							18.6	9.8	0.8	3	9.7	10.5	92.7
Oro x Tenmarq	11673							24.4	8.5	0.8	3	11.2	10.5	107.0
Kawvale x Tenmarq	11669							30.5	6.7	0.7	3	12.6	10.5	120.3
(Kanred x Hd. Fed.) (Minhardi x Minturki)		130						23.5	10.0	0.7	3	11.4	10.5	108.6
Kanred x Marquis		44						23.6	8.4	0.7	3	10.9	10.5	103.8
Minturki x Marquis		85							9.2	0.6	2	4.9	4.3	114.0
Nebraska 60	6250		3.2	2.6	16.5	19.3	14.4				5	11.2	11.4	98.2
Turkey Selection	11375			2.1	15.9	18.3	14.5				4	12.7	13.4	94.6
Quivira	8886		5.0	4.2	18.4						3	9.2	7.5	123.2
Kanred Sel. 0166	10099		4.7	2.5	20.7						3	9.3	7.5	124.6
Turkey Sel. 159	10100		4.3	3.3	2.08						3	9.5	7.5	126.8
Turkey x Marquis	11747					24.8	15.1	22.4			3	20.8	19.2	108.3
Yogo Selection		10		3.4	18.6						2	11.0	9.6	115.2
Kanred x Marquis	11746					20.7	14.7				2	17.7	17.3	102.3

ed. Tenmarq, Kanred, and Nebred have high enough yields, and are desirable milling wheats, and are therefore recommended. Tenmarq, however, is less winter-hardy than Kanred and may be damaged by winter-killing in severe winters.

The agronomic data of 11 varieties tested for 7 years are given in table 2. There is little difference in maturity and height of straw in the high-yielding varieties. Early Blackhull, however, is an exception. It is several days earlier and has shorter straw than the other varieties.

TABLE 2.—*Agronomic data on winter wheat varieties grown at Akron, Colo., for varying periods from* 1933 *to* 1939, *inclusive.*

Variety	C. I. No.	Date headed	Date mature	Height	Years grown
Alton	1438	6-4	7-11	28	7
Blackhull	6251	5-29	7-6	28	7
Kanred	5146	6-1	7-8	28	7
Kharkof	1583	6-3	7-9	28	7
Kharkof	1442	6-3	7-10	28	7
Tenmarq	6936	5-29	7-6	28	7
Minturki	6155	6-5	7-11	28	7
Oro	8220	6-2	7-9	28	7
Yogo	8033	6-5	7-11	28	7
Earl Blackhull	8856	5-25	7-4	26	7
Cheyenne	8885	6-1	7-9	27	7

Comparison of Fallow and Corn Stubble Land

Work with some of the better-yielding varieties of wheat on summer fallow and on corn stubble land shows that the summer fallow outyielded the corn stubble land by about 9.5 bushels. When fallow is used, each wheat crop must bear almost the entire expense of soil preparation, interest on land, the interest and depreciation on equipment for 2 years, and the cost of seeding and harvest for 1 year. When wheat is grown after corn, the wheat crop carries a lower charge for soil preparation, an equal charge for seeding, at least no greater for harvesting, and interest and depreciation for 1 year only. In determining the best method of preparation for winter wheat one should consider the yield of both wheat and corn. When the corn value is added to that of the wheat grown on the corn stubble land, the disadvantage or advantage of the fallow system for conditions similar to those at Akron may be determined.

Assuming that it takes 8.0[12] bushels to return the cost of

[12] R. C. Whitney, formerly assistant economist, Colo. Agr. Exp. Sta., calculated from studies made on dry-land farms that it required 7.59 bushels on fallow to pay for the cost of production and 4.42 bushels on stubble preparation. The figures are based on the average July and August price for 1930 to 1939.

TABLE 3.—*Yields of winter wheat grown on duplicate plots on both fallow and corn land at the Akron Field Station for the 8-year period, 1933 to 1940, inclusive.*

Variety	C. I. No.	Bushels per acre								
		1933	1934	1935	1936	1937	1938	1939	1940	Ave. yield
Fallow										
Blackhull	6251	11.3	3.9	27.0	30.6	19.7	30.4	12.8	1.4	17.1
Kanred	5146	8.8	1.9	25.0	31.8	22.2	25.6	11.8	0.8	16.0
Kharkof	1583	6.5	2.6	26.0	27.4	21.3	30.0	11.0	1.6	15.8
Tenmarq	6936	8.6	2.9	26.5	34.5	21.2	28.7	11.6	1.4	16.9
Cheyenne	8885	6.0	3.0	27.8	32.3	21.7	28.0	12.1	1.2	16.5
Oro	8220	8.1	3.2	28.6	27.7	22.9	26.0	11.5	0.8	16.1
	Average									16.4
Corn Land										
Blackhull	6251	0	3.2	8.9	14.0	14.1	14.7	4.6	0	7.4
Kanred	5146	0	2.5	13.0	10.4	9.8	15.4	4.4	0	6.9
Kharkof	1583	0	3.3	6.4	10.8	9.7	15.8	4.6	0	6.3
Tenmarq	6936	0	3.5	9.2	15.2	9.1	14.2	6.3	0	7.2
Cheyenne	8885	0	3.7	9.6	13.2	9.2	16.7	4.8	0	7.1
Oro	8220	0	2.7	11.9	10.3	9.9	15.0	4.2	0	6.8
	Average									6.9

production on summer fallow, wheat failed to pay this cost 2 years out of the 8, while the average yield for all varieties outyielded this figure by 8.4 bushels. Assuming on a similar basis that it required 4.5 bushels to return the cost of production on corn stubble land, there are 3 years out of the 8 in which the crop failed. In 2 of these years the crop was a complete failure. The average yield for all varieties was 2.4 bushels higher than the yield necessary to meet the cost of production. With fallow higher yields were obtained throughout the test, and even with the increase in cost of production, the yields were high enough to make fallow the preferable method.

Recommended Varieties on Dry Land

Tenmarq C. I. 6936, Kanred C. I. 5146, and Nebred C. I. 10094 are recommended as adapted wheats for eastern Colorado. All these varieties are of good milling quality. Tenmarq, however, is not as winter-hardy as Kanred and may suffer from winterkilling in severe winters.

Production under Irrigation at 5,000 Feet Altitude[13]

Soil Preparation under Irrigation

The growing of winter wheat on irrigated land is not a general practice since the crop is difficult to fit into the usual crop sequence. If winter wheat is grown to any extent it is usually planted on land not included in the general cropping sequence and methods used in preparing the soil are similar to those used on nonirrigated land. In preparing land for winter wheat a clean, firm seedbed prepared with the minimum of cost is desired.

Winter wheat grown under irrigation should be seeded at about 60 pounds per acre. It should be planted in the early part of September to take advantage of as much of the fall moisture as possible.

If wheat is planted on small grain stubble or following corn, one irrigation at the time the plants are jointing should be sufficient to produce a normal crop on the heavier soils. An earlier irrigation may be desirable on light or thin soils. Later irrigations tend to cause lodging in winter wheat since the varieties have weaker straw than most of the recommended spring wheats.

Under irrigation the binder is usually used in harvesting wheat. The sheaves should be placed in small, round shocks of about 8 sheaves and should be capped, thus enabling the straw and grain to cure and produce better quality. Grain in uncapped shocks will bleach under the usual weather conditions at this time of the year.

[13] The experiments under irrigation at Fort Collins were conducted by D. W. Robertson, O. H. Coleman, and J. J. Curtis.

TABLE 4.—*Winter wheat nursery varietal test, Fort Collins, Colo.; average yields in bushels per acre from 1933 to 1940.*

Variety	C. I. No.	Akron No.	1933	1934	1935	1936	1937	1938	1939	1940	No. years grown	Ave.	Ave. Kanred same period	Pct. of Kanred
Ridit x Kanred-Hope		602								44.7	1	44.7	46.2	96.8
Chiefkan	11754									45.9	1	45.9	46.2	99.4
Nebred	10094									47.7	1	47.7	46.2	103.2
F. C. 1143 (Mutant)	11971			69.6	65.0	73.5	62.8	74.4	60.0	52.4	7	65.4	56.0	116.7
Quivira	8886		25.6	75.6	65.2	68.0	59.9	73.5	59.2	46.2	8	59.2	53.5	110.6
Akron No. 7	11660	7	34.1	68.2	64.6	68.0	66.0	65.4	56.5	43.8	8	58.3	53.5	109.1
Mutant 348		910	39.6	69.4	55.9	64.3	60.6	69.8	60.5	49.7	8	58.7	53.5	109.8
Turkey x Marquis	11747	49	34.7	62.1	59.0	62.5	56.7	56.4	57.4	44.8	8	54.2	53.5	101.4
Cheyenne	8885		41.3	73.7	61.0	62.4	64.3	57.5	59.2	47.9	8	58.4	53.5	109.3
Tenmarq	6936		38.1	72.1	58.9	60.3	55.4	53.9	54.1	45.1	8	54.7	53.5	102.4
Turkey Selection	10095				50.4	58.0	60.1	57.1	59.4	45.6	6	55.1	54.6	100.9
Kanred	5146		35.4	64.5	53.1	56.2	58.3	58.8	55.2	46.2	8	53.5	53.5	100.0
Minturki x Marquis	11852	85					60.8	62.1	59.8	48.7	4	57.8	54.6	105.9
(Kanred-Marquis) x (Minhardi-Minturki)		130						58.3	49.4	40.9	3	49.5	53.4	92.7
Kanred x Hope-Hd. Fed.		537						59.7	48.9	41.4	3	50.0	53.4	93.6
(Hd. Fed.-Marquis x Marquis) x Kanred		340							50.6	44.9	2	47.8	50.7	94.3
(Hd. Fed.-Marquis x Prelude) Kanred		348							53.1	48.0	2	50.6	50.7	99.8
Kanred x Hope-Hd. Fed	11975	533							51.5	41.4	2	46.4	50.7	91.5
Kanred x Hope-Hd. Fed.		536							46.3	44.3	2	45.3	50.7	89.3
Kharkof	1442		28.9	54.5	33.3	57.4	54.5	57.0	59.3	46.3	8	48.9		100.0*
Nebred	10094		30.2	59.3	40.3	66.4	60.3	52.3	51.0	43.4	8	50.4		103.1*

*Yields taken from uniform yield nursery.

TABLE 5.—*Agronomic data of winter wheat varieties grown for 5 years or more at Fort Collins from* 1933 *to* 1940, *inclusive.*

Variety	C. I. No.	Akron No.	Date headed	Date ripe	Straw strength	Height inches	Years grown
Mutant F. C. 1143			6-2	7-15	33	45	7
Quivira	8886		6-2	7-15	47	43	8
Akron 7	11660		6-5	7-18	36	44	8
Mutant Col. 348		910	6-5	7-17	39	44	8
Turkey x Marquis	11747	49	6-5	7-18	50	44	8
Cheyenne	8885		6-7	7-19	53	49	8
Tenmarq	6936		6-5	7-18	46	44	8
Turkey Sel.	10095		6-5	7-18	56	43	6
Kanred	5146		6-7	7-19	62	44	8

Experiments under Irrigation

The methods used in conducting the variety tests on winter wheat at Fort Collins were similar to those used in previous tests.[14]

Some 44 varieties have been under test for varying periods of years from 1933 to 1940. Many of those included in the 1933 test have been dropped as undesirable for irrigated conditions in northeastern Colorado.

The following varieties which have been in commercial production and have been dropped are Kharkof C. I. 6686, Oro C. I. 8220, and Early Blackhull C. I. 8856. Several other high-yielding varieties have been left in the test but are not yet thoroughly tested for milling and baking quality. Of the varieties tested for the 8-year period (table 4), Kanred and Tenmarq are recommended as meeting both yield and baking quality requirements.

Under irrigation both varieties show a tendency to lodge, and care should be taken not to overirrigate.

Several other varieties or selections have yielded well (appendix table 4) but fail to meet other requirements necessary for a commercial variety and are, therefore, not recommended to be grown under irrigation.

The agronomic data of the varieties grown for 7 years or more are shown in table 5. It will be noted that most of the varieties mature slightly earlier than Kanred and have stiffer straw than Kanred when grown under irrigation.

[14] Robertson, D. W., et al. Wheat Production in Colorado—1926-1932. Colo. Agr. Exp. Sta. Bul. 404 (out of print).

TABLE 6.—*Yield of fall-sown wheat grown under irrigation at Fort Lewis for varying period of years from 1933 to 1940, inclusive*

Variety	C. I. No.	Yield in bushels per acre								Years grown	Ave.	Percent of Kanred same years
		1933	1934	1935	1936	1937	1938	1939	1940			
Fort Lewis Marquis		61.7	43.6	60.7	67.9	69.6	53.4	46.6	41.4	8	55.6	108.1
Cheyenne	8885	58.1	39.1	63.4	68.4	64.1	54.4	41.8	48.0	8	54.7	106.2
Kanred	5146	55.0	41.6	60.5	61.0	59.2	51.4	45.9	37.0	8	51.5	100.0
Tenmarq	6936	56.2	31.4	64.2	65.5	58.3	51.0	42.0	49.3	8	52.2	101.5
Kharkof	6686	57.5	44.9	58.9	61.6	52.3	44.2	35.8	36.2	8	48.9	95.1
Quivira	8886	51.7	22.0	62.3	56.8	56.1	33.5	45.4	48.0	8	47.0	91.3
Akron No. 7	11660	51.7		69.3	69.4	60.5	58.1	33.8	43.4	7	55.9	106.5
Mutant No. 26				60.8	69.3	65.2	49.0	44.3	45.9	6	55.7	105.9
Mutant No. 348				64.5	59.9	59.8	51.9	35.2	46.5	6	53.0	100.9
Turkey x Marquis	11747			61.9	59.1	62.6	55.1	31.7	39.2	6	51.6	98.3
Marquis Sel. 86					74.2	80.4	65.6	37.7	35.4	5	58.7	115.2
Marquis Sel. 90					76.5	72.9	63.4	42.4	43.2	5	59.7	117.2
Marquis Sel. 67					76.7	69.9	71.1	35.7	48.1	5	60.3	118.5
Marquis Sel. 69					73.1	72.1	68.1	39.3	41.3	5	58.8	115.5
Marquis Sel. 51					63.8	81.0	69.3	34.2	39.0	5	57.5	112.9
Marquis Sel. 5					75.5	69.4	56.6	43.9	46.6	5	58.4	114.7
Marquis Sel. 42					67.5	71.2	66.4	37.1	43.2	5	57.1	112.1
Relief						67.6	52.6	36.8	46.6	4	50.9	105.2
Ridit x Kanred	11597					61.3	54.2	38.2	43.2	4	49.2	101.8
Rio						58.3	49.4	35.3	45.9	4	47.2	97.6
Ridit x Kanred	11599					45.2	58.4	32.6	45.7	4	45.5	94.0
Minhardi x Marquis	255						62.2	37.6	42.6	3	47.3	105.6
Minhardi x Marquis	256						54.3	35.6	40.5	3	43.5	97.0

Experiments at High Altitude

Forty-three varieties and selections have been tested for varying periods of years from 1933 to 1940 at the high altitude station at Fort Lewis.[15] Of the varieties tested for a sufficient length of time to determine their adaptability and quality, the following can be recommended for growing under conditions similar to those found at Fort Lewis (table 6): Kanred, Fort Lewis Marquis, and Tenmarq. Tenmarq, because of its excellent milling and baking quality, is one of the better varieties to grow. Several other varieties showing promise are listed, such as Akron No. 7 and Mutant 26 which have been in the test for 6 years or more. Marquis, while yielding well, is not hardy enough to go through the winter without snow cover. Akron No. 7 and Mutant 26 cannot be recommended since they lack the milling and baking qualities desired. Other strains in the test have not been grown long enough to determine their value and will be tested longer.

Table 7 shows the selections or strains dropped from the test as not meeting all the requirements necessary for a commercial wheat.

TABLE 7.—*Yield of winter wheat varieties dropped from the test since* 1933 *at Fort Lewis*

Variety	C. I. No.	Yield in bushels per acre 1933	1934	1935	1936	1937	Ave.
Colorado 351	11,375	49.5	44.4	57.5	60.6	73.5	57.1
Kanred Sel. 0166	10,099	55.3	42.8	66.9	62.8	57.6	57.1
Montana 36	5,549	43.8	49.8	52.9	61.3	64.8	54.5
Oro	8,220	54.1	40.8	55.8	60.8	60.6	54.4
Newturk			40.4	59.5	60.9	52.8	53.4
Turkey 159	10,100		39.0	56.9	58.3	56.9	52.8
Kanred x Marquis	Ak. 47			63.4	65.9	60.8	63.4
Turkey x Marquis	Ak. 48			63.1	60.1	62.0	61.7
Turkey Sel.	Ak. 38			63.8	60.8	53.8	59.5
Turkey F. C. 28				54.4	59.5	58.6	57.5
Kanred x Marquis	11,746			57.9	57.6	54.5	56.7
Nebraska 60	6,250	57.9	48.3				53.1
Blackhull	6,251	56.4	33.8				45.1
Turkey		39.6	49.9				44.8
Kanmarq	6,937	49.2	39.1				44.2
Early Blackhull	8,856	49.2	28.5				38.9

Description of Varieties

Kanred C. I. 5146[16]

Kanred has the general characteristics of the Crimean group of wheats. The heads are bearded, the chaff is white, and the

[15] Dwight Koonce is in charge of the experiments at Fort Lewis.

[16] Use of U. S. D. A. Farmers' Bul. No. 1806, Hard Red Winter Wheat Varieties, by K. S. Quisenberry and J. A. Clark, has been made in describing the varieties.

grains are hard and dark red. The "beaks" (short beards on the outer chaff) are from one-eighth to 1 inch in length, as compared with one-eighth to three-eighths of an inch for Turkey and Kharkof. It is somewhat more resistant to some forms of leaf and stem rust than Turkey. The straw of this variety is weak.

Tenmarq C. I. 6936

Tenmarq was produced from a hybrid between Marquis spring wheat and P1066 winter wheat, the latter being a sister selection of Kanred made from Crimean wheat. The cross was made at Manhattan, Kans., in 1917. Tenmarq is the result of a selection from a hybrid made in 1921 by John H. Parker. The variety may be distinguished from Turkey by the longer beaks, slightly larger heads, stronger straw, earlier maturity, and shorter, plumper kernels.

Tenmarq is less winter-hardy than Kanred. It is resistant to some but not all forms of stem rust. The milling and baking quality of Tenmarq is very good, being equal to or better than that of Kanred and Turkey. This wheat may have a low test weight and poor color when grown in wet seasons.

Cheyenne C. I. 8885

Cheyenne is the result of a plant selection made from Crimean (the same strain from which Kanred was selected) at the Nebraska Agricultural Experiment Station, Lincoln, Nebr., in 1922. It differs from Turkey in being more winter-hardy, having shorter and stronger straw, denser and more erect heads, wider shoulders, and shorter beaks on the outer glumes.

Nebred C. I. 10094[17]

Nebred is a bunt-resistant wheat of the Turkey type. The spike is awned with glabrous glumes and has hard red kernels. It is rather winter-hardy and has midseason maturity. It was a bunt-resistant selection from Turkey C. I. 3684 made at the Nebraska Station in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture. This wheat is resistant to most forms of covered smut and has good milling and baking quality. The flour is yellow and can be bleached.

Recommended Varieties

Kanred C. I. 5146, Tenmarq C. I. 6936, and Nebred C. I. 10094 are recommended as the best adapted hard red winter wheats for both dry land and irrigated land in Colorado.

[17] Clark, J. A. "Registration of Improved Wheat Varieties XII." Jour. Am. Soc. Agron. 30: 1037-1042. 1938.

APPENDIX TABLE 1.—*Monthly, seasonal, and annual precipitation in inches at Fort Lewis Station, 1933 to 1939, inclusive.*

Year	Jan.	Feb.	Mar.	April	May	June	July	Seasonal*	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1933	1.66	1.32	0.60	1.88	0.72	0.66	1.82	5.68	1.98	2.51	1.21	0.82	1.40	16.58
1934	0.19	2.03	0.08	0.81	1.16	0.25	1.63	3.93	1.75	1.50	0.31	1.74	1.24	12.69
1935	2.11	2.31	3.25	1.48	3.49	0.00	1.16	9.38	2.38	2.57	1.69	1.12	0.67	22.23
1936	0.20	4.32	1.67	0.09	1.76	0.77	0.76	5.05	5.71	2.05	2.17	0.29	1.61	21.40
1937	1.66	2.98	4.29	0.25	0.74	0.16	2.32	7.76	0.74	1.94	0.68	0.32	1.50	17.58
1938	1.67	1.48	4.23	0.78	0.52	2.51	0.71	8.75	1.27	2.81	2.04	0.47	0.63	19.12
1939	1.51	1.38	2.05	0.64	0.17	0.00	1.05	3.91	2.15	4.10	1.26	0.43	0.42	15.16
Average	1.29	2.26	2.31	0.85	1.22	0.62	1.35	6.35	2.28	2.50	1.34	0.74	1.07	17.82
19-year average	0.94	1.73	1.74	1.07	1.01	0.72	2.13	6.61	2.48	2.18	1.31	1.01	1.28	17.60

*Seasonal—March to July, inclusive.

APPENDIX TABLE 2.—*Frost-free period at Fort Lewis,* 1933 *to* 1939, *inclusive.*

	Date of last killing frost	Date of first killing frost	Frost-free period
1933	June 7	October 15	130
1934	June 7	September 26	111
1935	June 1	September 29	120
1936	June 1	September 29	120
1937	June 6	September 25	111
1938	May 23	October 9	139
1939	June 19	September 30	103
7-year average	June 5	October 2	119
17-year average	June 3	September 23	112

APPENDIX TABLE 3.—*Monthly annual and seasonal precipitation for the 7-year period from* 1933 *to* 1939, *inclusive, at the Akron Field Station.*

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Seasonal Apr.-Sept.	Oct.	Nov.	Dec.	Annual
1933	T	.04	.74	4.58	4.15	.92	2.01	4.54	1.13	17.33	T	.04	.75	18.90
1934	.02	.91	.36	.64	1.42	4.14	.31	3.56	.75	10.82	.04	.37	.09	12.61
1935	.01	.23	1.22	3.25	7.35	3.08	.37	.83	2.24	17.12	.21	.26	.04	19.09
1936	.29	.15	.64	2.08	3.51	3.04	1.85	2.17	3.03	15.68	.94	.07	.44	18.21
1937	.16	.19	.82	.33	1.26	2.40	2.38	1.13	1.65	9.15	.08	.32	.63	11.35
1938	.18	.09	1.34	2.10	5.75	1.15	1.77	1.21	.73	12.71	.03	.68	.47	15.50
1939	1.00	.31	1.03	.80	2.11	1.41	1.28	1.00	.23	6.83	.36	T	.40	9.93
31-year average	.27	.41	.79	2.15	2.94	2.36	2.53	2.16	1.44	13.61	.93	.50	.60	17.08

APPENDIX TABLE 4.—*Varieties dropped from the winter wheat test at Fort Collins as not adapted to irrigated conditions in northeastern Colorado.*

Variety	C. I. No.	Akron No.	Yield in bushels per acre					
			1933	1934	1935	1936	1937	1938
Kanred check	5146		35.4	64.5	53.1	52.3	58.3	58.8
Marquis (Fort Lewis)		27	30.7	75.0	49.1	52.4	63.3	54.3
Kharkof (Hayes 2)	6686		40.3	65.6	47.5	51.6	55.2	55.8
Kanred x Marquis	11746	46	30.2	59.7	43.2	52.9	57.0	
Kanred x Marquis		47	42.2	62.6	46.6	57.4		
Turkey x Marquis		48	37.9	61.0	39.9	50.0		
Turkey Sel.		38	38.0	58.2	47.5	52.1		
Turkey Sel. (Col. 351)	11375	3	39.7	56.5	49.5	55.8		
Turkey Sel.			39.3	61.0	56.6	52.4		
Selection 1068-6-18			38.3	68.2	48.3			
Kanred Sel. 0166	10099		34.5	66.9	51.7			
Oro	8220		31.6	64.0	50.9			
Beardless Turkey No. 16			21.8	72.0				
Beardless Turkey No. 17			30.8	74.3				
Beardless Turkey No. 18			28.8	75.5				
Beardless Turkey No. 19			25.6	71.0				
Beardless Turkey No. 20		37	31.8	75.4				
Kanred x Marquis		40	31.9	62.0				
Kanred x Marquis		39	33.4	61.3				
Canadian Hybrid (Col. 359)		28	31.9	60.2				
Early Blackhull	8856		18.8	55.9				
Fully Mediterranean Sel.			25.2	55.6				
Turkey x Marquis			32.1	45.5				

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