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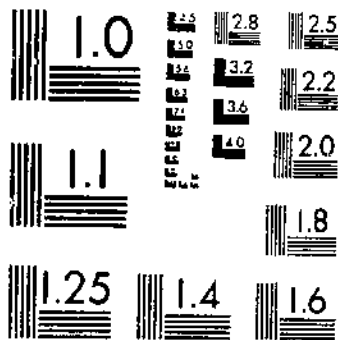
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MILLING AND BAKING EXPERIMENTS WITH WHEAT VARIETIES GROWN IN WESTERN

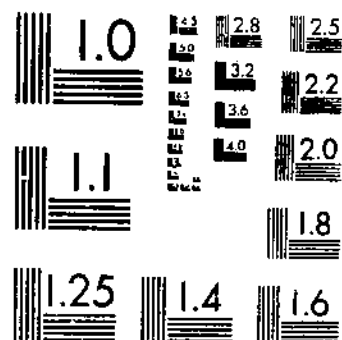
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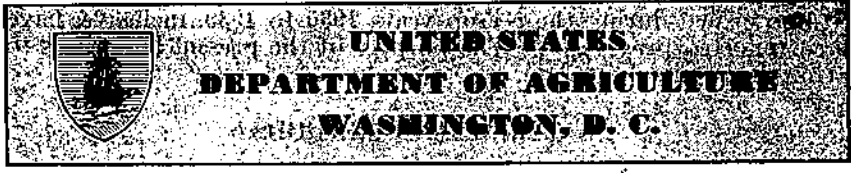
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STACKE



# Milling and Baking Experiments With Wheat Varieties Grown in Western United States, 1936-45<sup>1,2</sup>

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Samples of standard varieties and many new strains of wheat grown in cooperative experiments in the western United States are milled each year and the flour baked into bread, cake, and cookies to determine their quality characteristics. Chemical and physical tests are

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<sup>2</sup> The experiments herein reported were made in the laboratories of the Grain Branch, Production and Marketing Administration, in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration. The experiments from which the grain for these studies was obtained were conducted in cooperation with several State agricultural experiment stations in the region.

<sup>3</sup> The authors wish to express their appreciation to the following personnel at the various State agricultural experiment stations who participated in assembling the wheat varieties used in these experiments: C. A. Suneson, Davis, Calif., regional coordinator; O. A. Vogel and O. E. Barbee, Pullman, Wash.; H. Jacquot and C. L. Seely, Lind, Wash.; H. P. Singleton, Prosser, Wash.; D. E. Stephens and M. M. Oveson, Moro, Oreg.; J. F. Martin, Pendleton, Oreg.; D. E. Richards, Union, Oreg.; O. Shatruck, Burns, Oreg.; C. A. Michels, Moscow, Idaho; H. Stevens, Aberdeen, Idaho; W. A. Moss, Teton, Idaho; R. E. Knight, Sandpoint, Idaho; R. W. Woodward, Logan, Utah; D. C. Tingey, Clarkston, Utah; R. H. Bamberg and W. H. Nelson, Bozeman, Mont.; A. T. Bartel, Mesa, Ariz.; and D. W. Koonce, Hesperus, Colo.

also made of the grain and flour. The quality results and the interrelations of many of the quality characteristics for 44 varieties and strains grown during the 5 crop years 1935 to 1939, inclusive, have been reported previously.\* The purpose of the present bulletin is to bring the results up to date.

### MATERIAL AND METHODS

All classes of wheat except durum and red durum are represented. All samples were grown in experimental field or nursery plots. The winter wheats were grown without irrigation, and the spring wheats both with and without irrigation. The use of composite samples was necessary for varieties grown in the nursery because insufficient quantities of grain were available from the individual stations. When composite samples were used they were made by bulking grain of each variety from a group of stations, the quantity from each station being the same for all varieties. Only sound grain of good test weight was used.

In a previous study, it was found that grain grown under irrigation was substantially the same with respect to protein content and bread and pastry qualities as that grown without irrigation. The spring varieties grown on irrigated and dry land were not kept separate but were averaged in this study.

The quality determinations made on these samples are essentially the same as outlined and fully discussed in United States Department of Agriculture Technical Bulletin No. 887. Hence the discussion of methods will not be repeated here. Among the determinations made on each sample were those for test weight, flour yield, carotenoid content, particle-size index, dough-ball time, ash content of flour, and protein content of wheat and flour. Yellow loaf cake, cookies, and bread were made from the flour as an indication of the baking quality.

All test weights were determined in the laboratory on a dockage-free basis. The protein and ash contents are reported on a 14.0-percent moisture basis and the yield of flour on a moisture-free basis. The carotenoid content is expressed as carotene parts per million; naphthalalcohol extract.

Average results only for each of the varieties and strains are given in the tables in comparison with a variety of known and recognized quality grown under comparable conditions in the same tests. The varieties chosen as standards for comparative purposes are Golden for the soft-textured varieties, fall-seeded (white, white club, and soft red, winter); Turkey (C. I. 1442)<sup>2</sup> for the hard red winter wheats; spring-seeded Federation for the soft-textured spring-seeded white wheat; and White Federation for the hard red spring and white varieties with hard-textured grain. These varieties were chosen as standards because they were included in all experimental nursery trials and their quality characteristics are, in general, well known.

\* EFIELD, C. C., BODE, C. E., FELLOWS, H. C., and others. QUALITY CHARACTERISTICS OF WHEAT VARIETIES GROWN IN THE WESTERN UNITED STATES. U. S. Dept. Agr. Tech. Bul. 887, 35 pp., illus. 1945.

<sup>2</sup> C. I. refers to accession number of the Division of Cereal Crops and Diseases.

## EXPERIMENTAL RESULTS

## WINTER VARIETIES WITH SOFT TEXTURE

Thirteen varieties of soft-textured winter wheats were included in this study. They include seven varieties, Golden, Athena, Brevon, Goldcoin, Orfed, Requa, and Rex, that are usually graded on the market as soft white; five white club varieties Albit, Jenkin, Elgin, Hybrid 128, and Hymar; and one western red variety, Triplet. The results on these varieties are given in tables 1 and 2 and are shown graphically in figure 1.

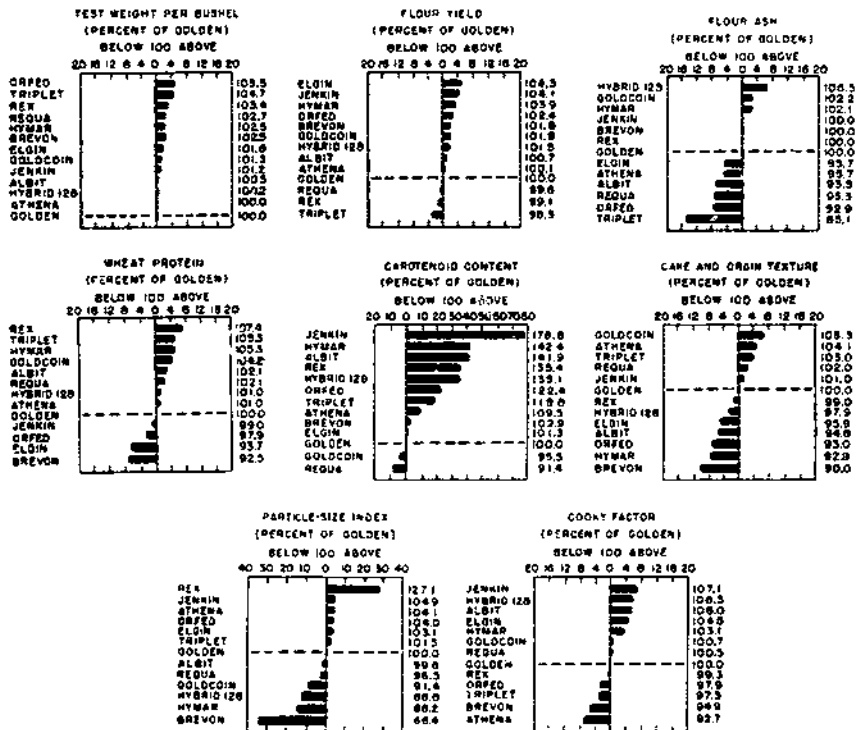


FIGURE 1—A comparison of some quality characteristics of soft-textured winter varieties in percentage of Golden grown under comparable conditions.

## GOLDEN

The Golden variety (C. I. 10063) has been chosen as the standard of comparison for 12 other varieties and strains of white and soft red winter wheat. It is a selection from Goldcoin (Fortyfold) made at the Sherman Branch Experiment Station, Moro, Oreg., and distributed to farmers in 1930. It is similar to Goldcoin in most quality characteristics. Golden is grown in Washington, Oregon, and Idaho, its greatest acreage being in southeastern Washington. Tests were made on a composite sample of Golden grown in each of the crop years 1936-45. These composites represent 56 station-years.

TABLE 1.—Quality characteristics of varieties of soft-textured winter wheats in several locations<sup>1</sup> in the Northwest, 1936-45

Variety and years grown	C. I. No. <sup>2</sup>	Sam- ples ana- lyzed	Yield per acre	Test weight <sup>3</sup>	Flour yield <sup>4</sup>	Ash con- tent of flour <sup>5</sup>	Protein con- tent of <sup>6</sup> —		Caro- tenoid con- tent of wheat <sup>6</sup>	Parti- cle- size index	Dough- ball time	Yellow-loaf cake		Cooky factor	Water absorp- tion of flour	Bread		
							Wheat	Flour				Loaf vol- ume	Grain and tex- ture			Loaf vol- ume	Grain and tex- ture	Crumb color
1936-45:		No.	Bu.	Lb.	Pct.	Pct.	Pct.	Pct.	P.p.m.	Pct.	Min.	Cc.	Score	W/T <sup>7</sup>	Pct.	Cc.	Score	Score
Rex.....	11689	10	48.7	61.7	68.4	.47	10.2	8.8	3.10	33.3	156	963	97	5.49	54	566	67	68
Triplet.....	6408	10	48.0	62.5	67.8	.49	10.0	8.7	2.72	26.6	54	956	101	5.38	56	561	69	74
Hymar.....	11605	10	47.1	61.2	71.7	.48	10.0	8.8	3.26	23.1	46	948	91	5.70	55	553	66	63
Elgin.....	11755	10	53.5	65.8	72.0	.45	8.9	7.8	2.32	27.0	29	929	94	5.78	54	491	53	67
Golden.....	10063	10	46.5	59.7	69.0	.47	9.5	8.5	2.29	26.2	31	940	98	5.53	55	467	48	60
1936-40:																		
Albit.....	8275	5	44.8	60.3	68.3	.43	9.9	8.7	3.15	26.6	36	964	92	5.85	55	541	57	58
Athens.....	11693	5	44.8	60.0	67.9	.44	9.8	8.4	2.43	27.8	38	951	101	5.12	55	502	56	70
Hybrid 128.....	4512	5	44.5	60.1	68.8	.49	9.8	9.1	3.00	23.7	29	940	95	5.87	57	518	54	59
Jenkin.....	5177	5	42.9	60.7	70.6	.46	9.6	8.5	3.97	28.0	28	959	98	5.91	54	516	50	50
Golden.....	10063	5	44.5	60.0	67.8	.46	9.7	8.4	2.22	26.7	30	931	97	5.52	55	468	47	57
1936-39:																		
Goldcoin (Fortyfold).....	4156	4	39.9	61.0	68.7	.47	10.0	9.0	2.11	24.4	31	963	101	5.54	55	470	46	63
Golden.....	10063	4	45.1	60.2	67.4	.46	9.6	8.5	2.21	26.7	29	931	95	5.50	55	469	48	59
1942-44:																		
Regata.....	11554	3	52.1	61.1	69.7	.42	9.6	8.2	2.01	24.7	36	943	102	5.68	54	469	53	67
Golden.....	10063	3	50.8	59.5	70.0	.45	9.4	8.1	2.20	25.6	33	939	100	5.65	54	467	48	63
1943-45:																		
Orfed.....	11913	3	50.4	62.8	71.6	.39	9.5	8.3	2.57	25.7	78	1011	93	5.65	54	560	77	80
Golden.....	10063	3	46.7	59.5	69.9	.42	9.7	8.3	2.10	24.7	35	967	100	5.77	54	500	55	67
1940-44:																		
Brevon.....	11912	5	54.6	60.9	71.6	.49	8.6	7.4	2.51	17.0	59	943	90	5.25	58	498	57	62
Golden.....	10363	5	49.0	59.4	70.2	.49	9.3	8.0	2.44	25.6	32	928	100	5.53	54	459	45	59

<sup>1</sup> The grain of each variety used in these studies was grown at several locations each year and thoroughly mixed or composited by variety before milling. In each composite the quantity of grain from each location was the same for all varieties, but because of limited supplies not always the same for each location. The grain was grown at the following places: 1936, Pullman, Pomeroy, and Walla Walla, Wash., and Pendleton, Oreg.; 1937, Pullman, Wash., and Pendleton, Oreg.; 1938, Pullman, Pomeroy, Walla Walla, and Lind, Wash., Tetonia, Idaho, and Clarkston, Utah; 1939, Pullman, Pomeroy, and Walla Walla, Wash., Moro, Oreg., and Moscow and Sandpoint, Idaho; 1940, Pullman, Walla Walla, and Pomeroy, Wash., Union, Oreg., Rockland and Tetonia, Idaho; 1941, Pullman and Walla Walla, Wash., Pendleton and Union, Oreg.; 1942, Lind, Pullman, Pomeroy, and Walla Walla, Wash., Moro, Oreg., and Moscow, Idaho; 1943,

Pullman and Walla Walla, Wash., Moro and Pendleton, Oreg., Moscow, Idaho, and Logan, Utah; 1944, Pullman, Walla Walla, and Pomeroy, Wash., Moro and Pendleton, Oreg., Moscow, Idaho, and Logan, Utah, 1945, Moscow and Sandpoint, Idaho, Union and Pendleton, Oreg., and Walla Walla, Wash.

<sup>2</sup> C. I. refers to accession number of the Division of Cereal Crops and Diseases.

<sup>3</sup> Dockage-free.

<sup>4</sup> Moisture-free basis.

<sup>5</sup> 14.0-percent-moisture basis.

<sup>6</sup> Carotenoid content expressed as carotene parts per million; naphtha-alcohol extract.

<sup>7</sup> W/T = ratio of width to thickness.

TABLE 2—Quality characteristics of soft-textured winter varieties, expressed as a percentage of Golden, in the same tests as shown in table 1, 1936-45

Variety	C. I. No.	Samples analyzed	Station years represented	Yield per acre	Test weight	Flour yield	Ash content of flour	Protein content of—		Carotenoid content of wheat	Particle-size index	Dough-ball time	Yellow-leaf cake		Cooky factor	Water absorption of flour	Bread			
								Wheat	Flour				Leaf volume	Grain and texture			Leaf volume	Grain and texture	Crumb color	
Golden	10003			100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rex	11080	10	50	104.7	103.4	99.1	100.0	107.4	106.0	135.4	127.1	503.2	102.4	99.0	99.3	98.2	121.2	139.0	113.3	
Triplet	5408	10	50	103.2	104.7	98.3	85.1	105.3	104.8	118.8	101.5	174.2	101.7	103.0	97.3	101.8	120.1	143.8	123.3	
Hymar	11605	10	50	101.3	102.5	103.9	102.1	105.3	106.0	142.1	88.2	148.4	100.9	92.9	103.1	100.0	118.4	137.5	105.0	
Golden (Fortyfold)	4150	4	25	88.5	101.3	101.9	102.2	104.2	105.9	95.5	91.4	106.9	103.4	106.3	106.7	100.0	100.2	95.8	106.8	
Albit	8275	5	27	100.7	100.5	100.7	93.5	102.1	103.6	141.9	99.6	120.0	103.5	94.8	106.0	100.0	115.6	121.3	101.8	
Regua	11554	3	19	102.6	102.7	99.6	93.3	102.1	101.2	91.4	96.5	109.1	100.4	102.0	100.5	100.0	100.4	110.4	106.3	
Hybrid 128	4512	5	27	100.0	100.2	101.5	106.5	101.0	108.3	135.1	88.8	96.7	101.0	97.9	106.5	100.0	100.4	110.4	106.3	
Athana	11693	5	27	100.7	100.0	100.1	95.7	101.0	100.0	109.5	104.1	126.7	102.5	104.1	92.7	100.0	107.3	119.1	122.8	
Jenkin	5177	5	27	96.4	101.2	104.1	100.0	99.0	101.2	178.8	104.9	93.3	103.0	101.0	107.1	98.2	110.3	106.4	87.7	
Orford	11913	3	18	107.9	105.5	102.4	92.9	97.9	100.0	122.4	104.0	222.9	104.6	93.0	97.9	100.0	112.0	140.0	119.4	
Elgin	11755	10	50	115.1	101.8	104.3	95.7	93.7	94.0	101.3	103.1	93.5	98.8	95.9	104.5	98.2	105.1	110.4	111.7	
Devon	11912	5	29	111.4	102.5	101.9	100.0	92.5	92.5	102.9	66.4	184.4	101.6	90.0	94.9	107.4	108.5	123.9	105.1	



The protein content of the farm-grown crop of Golden is generally low, partly because it is grown in the higher rainfall areas where yields are relatively high and the protein content of all varieties is low. It ranked medium to low in wheat and flour protein among the 13 wheats compared, indicating that it is also inherently low in protein. The milling characteristics of Golden are good. The flour yield is medium low but higher than would be expected, considering its relatively low test weight. It is low in carotenoid content. The flour is creamy white in color and soft in granulation or texture. It is medium to high in particle-size index. The dough-ball time is short. Generally this indicates a soft, pliable gluten. The flour is medium in ash.

In the baking trials Golden makes uniformly good cake and good cookies, the latter generally equal to those from Triplet and Hymar. It is low in water absorption and produces bread that is low in loaf volume and unsatisfactory in grain and texture. It is lowest in bread-loaf volume of the 13 varieties compared. Golden is generally considered by the trade as a satisfactory variety for cake and pastries but not for bread.

#### ALBIT

Albit (C. I. 8275), a cross between Hybrid 128 and White Odessa, was distributed from the Washington Agricultural Experiment Station in 1926. Tests were made on a composite sample of Albit grown in each of the crop years 1936-40, along with comparable samples of Golden. These composites represent 27 station-years.

The grain of Albit is soft-textured. It averaged about the same in test weight per bushel, flour yield, particle-size index, and dough-ball time as comparably grown samples of Golden, but was slightly higher in protein content of wheat and flour. The milling characteristics were good. It was slightly lower in ash content of flour than Golden. The carotenoid content of Albit averaged much higher than Golden and slightly exceeded Rex.

Albit made fair cakes and excellent cookies. Cookies made from its flour were consistently good, regardless of season or environment and were exceeded only by the Jenkin and Hybrid 128 varieties. Bread made from Albit was poor, although somewhat better than that from Golden.

#### ATHENA

Athena (C. I. 11693), a cross between Goldcoin  $\times$  Federation, was developed in cooperative investigations at the Sherman Branch Experiment Station, Moro, Oreg. It was released in 1930, but since it was found not pure for growth habit a reselection was released from the Pendleton Branch Experiment Station in 1931. Tests were made on a composite sample of Athena grown in each of the crop years 1936-40, with comparable samples of Golden. These composites represent 27 station years. Athena was similar to Golden in test weight, flour yield, carotenoid content, particle-size index, protein content, and ash content of flour. It averaged only slightly longer than Golden in dough-ball time.

It made very good cake, better than Golden, but cookies that were inferior to those from Golden. The bread was poor, only slightly better than that from Golden. In general, Athena is a good quality soft-textured wheat similar to Golden.

## BREVON

Brevon (C. I. 11912) was developed from a cross (Turkey-Florence × Fortyfold-Federation) at the Idaho Agricultural Experiment Station, Moscow, in 1931. A selection made at the Washington Agricultural Experiment Station, Pullman, resulted in the Brevon variety. A composite sample of Brevon grown in each of the crop years 1940-44 was tested with comparable samples of Golden. These composites represent 29 station-years.

Brevon was higher in test weight per bushel and flour yield and lower in protein content of wheat and flour than Golden. It was about equal in carotenoid content of wheat and ash content of flour and had a somewhat longer dough-ball time than Golden. Brevon ranked lowest in protein content of wheat and in particle-size index of the 13 soft-textured winter varieties. Its low protein content probably is a result of its high yield of grain. Although Brevon usually grades as soft white on the market, it produces a semigranular flour similar to the flour generally obtained from hard-textured winter wheats grown in the Pacific Northwest.

Cakes made from Brevon were materially inferior to those from Golden and, in fact, were the poorest of the 13 soft-textured winter varieties compared. It ranked twelfth in cooky quality. Bread was poor, being about the same in quality as that from Golden. On the whole, it is inferior to or no better than Golden with respect to all quality characteristics.

## ELGIN

Elgin (C. I. 11755) originated at the Pendleton (Oreg.) Branch Experiment Station in 1932 by selection from Alicel, which resulted from a cross between Goldcoin and Hybrid 128. A composite sample of Elgin grown in each of the crop years 1936-45, with comparable samples of Golden was tested. These composites represent 56 station-years. The grain of Elgin is soft in texture. It averaged materially higher in flour yield, somewhat higher in test weight per bushel, but slightly lower in ash content of flour and considerably lower in protein content of wheat and flour than Golden. The particle-size index, carotenoid content, and dough-ball time of the two varieties were similar. Elgin made white flour and milled satisfactorily. It ranked first in flour yield of the 13 soft-textured winter varieties compared. Its low protein content is probably due to its high yield of grain per acre.

Elgin made slightly poorer cakes than Golden, excellent cookies, and poor bread. Like Albit, it made consistently good cookies from season to season. The outstanding characteristics of Elgin are high yield of flour and excellent cooky quality. It is a good quality soft-textured white wheat and was consistent in quality performance during the 10 years it was tested.

## GOLDCOIN

The exact origin of Goldcoin (Fortyfold) (C. I. 4156) is unknown, but it was grown early in the nineteenth century in the northeastern United States. A composite sample of Goldcoin grown in each of the

crop years 1936-39 was tested. These composites represent 22 station-years.

Goldcoin slightly exceeded Golden in test weight, flour yield, and protein content of wheat and flour. It was similar to Golden in dough-ball time and ash content of flour, but was slightly lower in particle-size index and in carotenoid content. The flour was white in color. Its milling characteristics are good and it produces a soft velvety flour of the kind usually found satisfactory for pastry purposes. Baking tests show that Goldcoin made the best cake of the 13 soft-textured winter varieties, being materially better than Golden. The cookies were equal to those from Golden. It made very poor bread, as would be expected from a soft, low-protein wheat. Goldcoin appears to be similar in most respects to Golden.

#### HYBRID 128

Hybrid 128 (C. I. 4512) was selected from a cross between Jones Winter Fife and Little Club at the Washington Agricultural Experiment Station and was released to farmers in 1907. Tests were made on a composite sample of Hybrid 128 grown in each of the crop years 1936-40. These composites represent 27 station-years.

Hybrid 128 was slightly higher in flour yield and ash content of flour than Golden and about the same in test weight per bushel and dough-ball time. It averaged lower in particle-size index. It ranked highest in flour ash and fifth in carotenoid content of the 13 soft-textured winter varieties compared and was materially higher in flour protein. The spread between the wheat protein and flour protein was much less for Hybrid 128 than for Golden. Hybrid 128 has good milling characteristics and very good cooky quality. It made slightly poorer cake, but much better cookies than Golden. The bread was poor and similar to that from Golden.

#### HYMAR

Hymar (C. I. 11605) resulted from a cross between Hybrid 128 and Martin made in 1923 at the Washington Agricultural Experiment Station, Pullman, and was distributed for commercial production in 1935. Tests were made on a composite sample of Hymar grown in each of the crop years 1936-45 with comparable samples of Golden. These composites represent 56 station-years.

Hymar was materially higher than Golden in test weight per bushel and flour yield, somewhat higher in protein content of wheat and flour, and about equal in ash content of flour. It was lower in particle-size index and had a longer dough-ball time than Golden, but the difference was not considered significant. Flour from Hymar was much higher in carotenoid content than that from Golden. Some difficulty is encountered in tempering Hymar for milling, because of a tendency for the grain in certain lots to vary from soft chalky to a semihard vitreous texture. Hymar made fair cakes that were much inferior to Golden and more variable in quality from season to season. Cookies made from it were very good. Flour absorption was low and bread made from it was poor.

#### JENKIN

The origin of Jenkin (C. I. 5177) is not known. It has been grown in eastern Washington at least since 1895. A composite sample of

Jenkin grown from fall seeding in each of the crop years 1936-40 was tested. These composites represent 27 station-years. Results on samples grown from spring seeding are discussed in comparison with Federation in the section dealing with the white spring-seeded varieties.

Jenkin was similar to Golden in protein content of wheat and flour, ash content of flour, and dough-ball time; slightly higher in test weight per bushel and particle-size index; and much higher in flour yield. The flour from Jenkin was yellow in color, as would be expected from its very high carotenoid content. This has generally been true regardless of location or year of growth.

Jenkin has consistently made excellent cookies and has excelled all the other varieties. It was slightly better than Golden in cake quality. Jenkin made poor but somewhat better bread than Golden.

#### ORFED

Orfed (C. I. 11913) was selected from a cross between Oro and Federation, in cooperative investigations with the Washington and Idaho Agricultural Experiment Stations and the Division of Cereal Crops and Diseases. It was released for commercial growing in 1943 from the Washington station. Tests were made on a composite sample of Orfed grown in each of the crop years 1943-45 with comparable samples of Golden. These composites represent 18 station-years.

Orfed averaged materially higher than Golden in test weight per bushel and carotenoid content, somewhat higher in dough-ball time and flour yield, and about the same in particle-size index and in protein content of wheat and flour. It was lower in ash content of flour. The carotenoid content of Orfed was low to medium and approximately equal to Triplet and Hybrid 128. The flour from Orfed appeared to be slightly softer than that from Golden. Some samples have not always bolted as freely or yielded as high a percentage of flour as Golden because of the very soft and fluffy characteristics of the flour. Orfed ranked first of the 13 soft-textured winter varieties in test weight per bushel. It was low in protein content of grain, as might be expected considering its high yield per acre. Orfed made good cookies, generally equal to those from Golden. It also made good cake, being equal to Elgin but slightly poorer than Golden. Orfed made exceptionally good bread for the quantity of protein it contained, indicating a somewhat stronger gluten than in most soft-textured white wheats. The loaf volume averaged high and the grain and texture and crumb color were good, being equal to the hard-textured winter wheats of similar protein content. It was, however, low in water absorption of flour, resembling Hymar and Golden in this respect.

The outstanding characteristics of Orfed are its high test weight, low flour ash, satisfactory cookie and cake quality, and very good bread quality, considering its protein content.

#### REQUA

Requa (C. I. 11554) was selected from a farmer's field of Turkey and is thought to have resulted from a natural cross between Turkey and Golden. A selection with white grain was distributed about 1935 under this name. A composite sample of Requa grown in each

of the crop years 1942-44 with a comparable sample of Golden was tested. These composites represent 19 station-years.

Requa was similar to Golden in protein content of wheat and flour, dough-ball time, carotenoid content, and particle-size index, but exceeded Golden in test weight per bushel. The yield of flour was somewhat low when considered in relation to the test weight of the grain. Ash content of the flour was low. Flour from Requa is white, being lowest in carotenoid content of the 13 soft-textured winter varieties. It was equal in cooky quality and slightly better for cake than Golden. It made poor bread, being similar to Golden in this respect. Requa appears, from the few samples tested, to be similar to Golden and satisfactory for chemically leavened, sweet, baked products.

#### REX

Rex (C. I. 11689) was selected from a cross between White Odessa and Hard Federation made at the Sherman Branch Experiment Station, Moro, Oreg. The variety was first released for commercial production in 1933, and the purified selection now grown was released in 1938. Tests were made on a composite sample of Rex grown in each of the crop years 1936-45 with comparable samples of Golden. These composites represent 56 station-years.

Rex averaged materially higher than Golden in test weight per bushel, protein content of wheat and flour, carotenoid content, particle-size index, and dough-ball time, but both had the same ash content of flour. Although higher in test weight, the yield of flour from Rex was lower than that from Golden. Rex ranked third in test weight per bushel, twelfth in flour yield, and highest in protein content of wheat and particle-size index of the 13 soft-textured winter varieties.

Rex is usually extremely soft in texture, as indicated by the high particle-size index, and mills into a flour of very small particles. The flour is also very soft and fluffy and bolts with difficulty. These properties of Rex tend to reduce the capacity of a mill and the yield of flour, thus making the variety undesirable from the viewpoint of the miller. The flour from Rex is creamy yellow in color, being somewhat more highly pigmented than other soft white wheats.

Rex made good cake and cookies similar in quality to those from Golden. Of the 13 varieties of soft winter wheats, it ranked seventh in cake quality and ninth in cooky quality. In relation to its protein content, it made better bread than other soft-textured white varieties except Orfed. The long dough-ball time and bread-baking quality indicate that Rex has somewhat stronger gluten properties than many of the other soft white wheats of comparable protein level.

Comparisons were made on a composite sample of Rex (C. I. 10065) grown in each of the crop years 1936-40 with Rex (C. I. 11689). These composites represent 27 station-years. All quality characteristics were found to be similar in both varieties.

#### TRIPLET

Triplet (C. I. 5408) was selected from a cross between two unnamed selections, one from a cross between Jones Fife and Little Club and the other a cross between Jones Fife and Turkey. It is the only soft red winter variety included in this study. It grades western red on the market. It was released for commercial production in 1918.

A composite sample of Triplet grown in each of the crop years 1936-45 was compared with Golden. These composites represent 56 station-years.

Triplet had the highest average test weight, except Orfed, and was the lowest in flour yield and ash content of flour of the soft-textured winter varieties. It also averaged slightly higher in dough-ball time and somewhat higher in carotenoid content and protein content of wheat and flour, but was similar in particle-size index as compared with Golden. The flour from Triplet was soft and similar to Golden in granulation. It made excellent cakes, materially better than those from Golden. The cookies were fair but somewhat poorer than the cookies from Golden. Poor bread was made from Triplet, although it was much better than that from Golden.

The outstanding characteristics of Triplet are its high test weight, low ash content of flour, and excellent cake quality. Cake quality was uniformly good in all years tested. No other variety was so consistent in this respect. It does, however, yield a low percentage of flour in relation to its test weight.

### HARD RED WINTER VARIETIES

Ten varieties of hard red winter wheats were included in these experiments. In general, they were typical of this market class. Although varieties in this class are generally and properly regarded as unsuited for pastry purposes, cakes and cookies were made from all composite samples. They were uniformly poor as was expected. The results are presented in tables 3 and 4 and in figure 2.

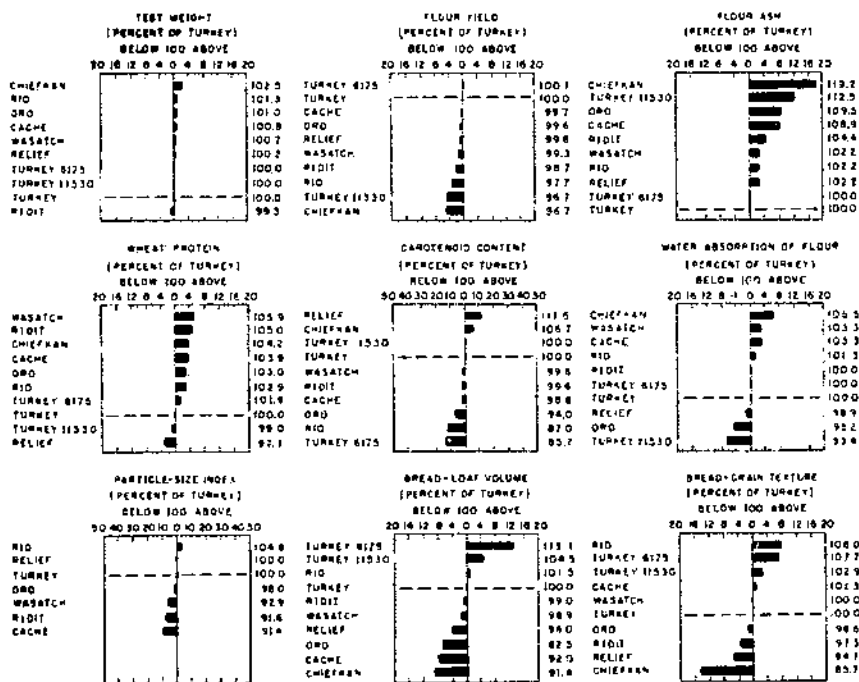


TABLE 3.—Quality characteristics of varieties of hard red winter wheat<sup>1</sup> in the northwestern United States, 1936-45

Variety and years grown	C. I. No. <sup>2</sup>	Samples analyzed	Yield per acre	Test weight <sup>3</sup>	Flour yield <sup>4</sup>	Ash content of flour <sup>5</sup>	Protein content of <sup>6</sup>		Carotenoid content of wheat <sup>7</sup>	Particle-size index	Dough-ball time	Yellow-leaf cake		Cooky factor	Water absorption of flour	Bread		
							Wheat	Flour				Loaf volume	Grain and texture			Loaf volume	Grain and texture	Crumb color
1936-45:		No.	Bu.	Lb.	Pct.	Pct.	Pct.	Pct.	P.p.m.	Pct.	Min.	Cc.	Score	W/T <sup>7</sup>	Pct.	Cc.	Score	Score
Rio.....	10061	10	46.6	62.7	69.2	0.46	10.5	9.4	2.40	15.2	176	914	86	4.67	61.8	590	81	81
Relief.....	10082	10	46.7	62.0	70.5	.46	9.9	9.0	3.08	14.5	131	909	88	4.92	60.3	553	71	66
Turkey.....	1442	10	45.6	61.9	70.8	.45	10.2	9.3	2.76	14.5	101	907	85	4.88	61.0	581	75	74
1937-45:																		
Ridit.....	6703	9	43.5	61.6	70.1	.47	10.6	9.8	2.73	13.1	104	918	82	4.85	61.0	579	72	71
Turkey.....	1442	9	46.1	61.9	71.0	.45	10.1	9.3	2.79	14.3	100	914	86	4.85	61.0	585	74	73
1942-45:																		
Wasatch.....	11925	4	46.2	61.9	71.7	.46	10.8	10.0	2.52	13.0	76	929	86	4.65	62.0	607	79	75
Cache.....	11599	4	47.0	62.0	72.0	.49	10.6	9.7	2.50	12.8	109	929	83	4.63	62.0	565	80	76
Turkey.....	1442	4	48.3	61.5	72.2	.45	10.2	9.4	2.53	14.0	102	931	91	4.88	60.0	614	79	80
1936-39:																		
Oro.....	8220	4	46.9	63.3	68.4	.46	10.4	9.5	2.36	14.6	186	885	81	4.51	60.0	520	73	74
Turkey.....	1442	4	44.9	62.7	68.7	.42	10.1	9.3	2.51	14.9	111	865	78	4.90	63.0	562	74	74
1940-41:																		
Turkey.....	11530	2	39.6	61.3	69.9	.54	10.1	9.1	3.20	-----	96	942	88	5.26	57.0	582	70	63
Turkey.....	1442	2	41.8	61.3	72.3	.48	10.2	9.0	3.20	-----	81	942	88	4.83	61.0	557	68	60
1940:																		
Turkey.....	6175	1	41.9	62.0	72.2	.44	11.0	9.6	2.69	-----	-----	896	95	5.17	60.0	654	70	65
Turkey.....	1442	1	42.4	62.0	72.1	.44	10.8	9.3	3.14	-----	-----	914	95	4.81	60.0	578	65	55
1941:																		
Chlefkan.....	11754	1	40.8	62.1	70.1	.62	10.0	9.5	3.48	-----	44	885	65	4.38	65.0	499	60	60
Turkey.....	1442	1	41.2	60.6	72.5	.52	9.6	8.6	3.26	-----	60	970	80	4.84	61.0	535	70	65

<sup>1</sup> The grain of each variety used in these studies was grown at several locations listed in footnote 1, table 1, and thoroughly mixed or composited by variety.

<sup>2</sup> See footnote 2, table 1.

<sup>3</sup> Dockage-free.

<sup>4</sup> Moisture-free basis.

<sup>5</sup> 14.0-percent-moisture basis.

<sup>6</sup> Carotenoid content expressed as carotene parts per million; naphtha-alcohol extract.

<sup>7</sup> W/T= ratio of width to thickness.

TABLE 4.—Quality characteristics of hard red winter varieties, expressed as a percentage of Turkey (C. I. 1442), in the same tests as shown in table 3, 1936-45

Variety	C. I. No.	Sam- ples ana- lyzed	Sta- tion years repre- sented	Yield per acre	Test weight	Flour yield	Ash con- tent of flour	Protein con- tent of—		Caro- tenoid con- tent of wheat	Par- ticle- size index	Dough- ball time	Yellow-loaf cake		Cooky factor	Water absorp- tion of flour	Bread			
								Wheat	Flour				Loaf vol- ume	Grain and tex- ture			Loaf vol- ume	Grain and tex- ture	Crumbs color	
Turkey.....	1442			100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Wasatch.....	11925	4	24	95.7	100.7	99.3	102.2	105.9	106.4	99.6	92.9	74.5	99.8	94.5	95.3	103.3	98.9	100.0	97.3	83.8
Rldt.....	6703	9	52	94.4	99.5	98.7	104.4	105.0	105.4	99.6	91.6	104.0	100.4	85.3	100.0	100.0	99.0	97.3	97.3	
Chiefkan.....	11754	1	5	99.0	102.5	96.7	113.2	104.2	110.5	106.7		73.3	81.2	81.3	90.5	106.6	91.4	85.7	82.3	
Cscho.....	11599	4	24	97.3	100.8	99.7	108.9	103.9	103.2	98.8		81.4	106.9	99.5	91.2	94.9	103.3	92.0	101.3	
Oro.....	8220	4	27	104.5	101.0	99.6	109.5	103.0	102.2	94.0		98.0	167.6	102.3	103.8	92.0	85.2	92.5	83.6	
Rlo.....	10061	10	56	102.2	101.3	97.7	102.2	102.9	101.1	87.0	104.8	174.3	100.8	101.2	95.7	101.3	101.5	105.0	103.5	
Turkey.....	6175	1	5	98.8	100.0	100.1	100.0	101.9	103.2	85.7			98.0	100.0	107.5	106.0	113.1	107.7	113.2	
Turkey.....	11530	2	10	94.7	100.0	96.7	112.5	99.0	101.1	100.0			118.5	100.0	108.9	93.4	104.5	102.9	113.3	
Relief.....	10082	10	56	102.4	100.2	99.6	102.2	97.1	96.8	111.6	100.0	129.7	100.2	103.5	100.8	98.9	96.0	94.7	89.2	



## TURKEY

The variety Turkey (Kharkof, C. I. 1442) has been used as a standard of comparison for nine other varieties and strains of hard red winter wheat. Seed of Turkey was brought to the United States by Russian Mennonite immigrants about 1873. It was first grown in Kansas and later was brought to the Pacific Northwest and the intermountain valleys where it is extensively grown on the dry lands. Tests were made on a composite sample of Turkey grown in each of the crop years 1936-45. These composites represent 56 station-years.

Turkey, depending upon the conditions of growth and rainfall, may vary greatly in the percentage of vitreous kernels. It mills with relative ease and produces higher flour yields than most of the other hard red winter wheats grown in the Pacific Northwest. Turkey is comparatively low in test weight for a hard red winter variety, ranking ninth of the 10 varieties compared. It has a low particle-size index, indicative of a vitreous-grain type that produces a granular flour. The unbleached flour usually is moderately yellow, but the flour has satisfactory color when bleached. The flour is lower in ash content than most of the comparably grown hard red winter varieties. It is low to medium in protein content, but the quality of the gluten is good.

Turkey has long been recognized as one of the better varieties for making bread flour. The flour does not have so high a water absorption as some other hard red winter wheat varieties. It is short to medium long in mixing time. Turkey requires larger quantities of oxidizing agents than most other hard red winter wheats grown in the Pacific Northwest. It bakes into bread having acceptable grain and texture, good crumb color, and a satisfactory loaf volume, considering the protein content.

## CACHE

Cache (C. I. 11599) was developed from a cross between Ridiit  $\times$  Utah Kanred in investigations cooperative with the Utah Agricultural Experiment Station, Logan. It was distributed to farmers in 1942. A composite sample of Cache grown in each of the crop years 1942-45 was tested with comparable samples of Turkey. These composites represent 24 station-years. Cache was similar to Turkey in flour yield, carotenoid content, and dough-ball time, but slightly higher in test weight and protein content of wheat and flour. The flour from Cache was higher in ash content than that from Turkey and Wasatch. The milling characteristics and the particle-size index values were similar to Turkey. The flour was creamy white in color.

Cache averaged somewhat higher than Turkey in water absorption and was among the better varieties in this respect. It required only small quantities of oxidizing agents for optimum bread results and had a medium dough-mixing time similar to that of Turkey. Although bread of good grain and texture and crumb color was made from Cache, it was below Turkey in loaf volume. It ranked fourth in grain and texture but ninth in loaf volume of the 10 hard red winter varieties.

## CHIEFKAN

Chiefkan (C. I. 11754) was developed by a Kansas farmer breeder and was first distributed in Kansas in 1935. One composite sample of Chiefkan representing five stations grown in 1941 was tested.

This single sample of Chiefkan was higher than Turkey in test weight per bushel but lower in flour yield. The flour was more granular than from most other hard winter varieties. It is one of the harder and more vitreous varieties, and because of this requires a high percentage of moisture for satisfactory milling. The flour contained more ash and was higher in carotenoid pigments. The dough-ball time was less than that for Turkey.

In the bread-making trials, this single sample of Chiefkan required a short mixing time and was very sensitive to overmixing. Relatively large quantities of an oxidizing agent were required for the best bread, but the response was less than for other hard red winter varieties. With respect to water absorption of flour, it materially exceeded Turkey, and ranked highest of the 10 hard red winter varieties. The bread baked from Chiefkan was lowest in loaf volume and grain and texture, indicating that the quality of the gluten protein was poor. Chiefkan was outstanding in water absorption, but otherwise was deficient in bread-baking properties.

## ORO

Oro (C. I. 8220) was selected from a strain of Turkey in cooperative investigations at the Sherman Branch Experiment Station, Moro, Oreg. It was released for commercial growing in 1927. Tests were made on a composite sample of Oro grown in each of the crop years 1936-39 with comparable samples of Turkey. These composites represent 22 station-years.

Oro averaged slightly higher than Turkey in test weight per bushel and protein content of wheat and flour, but slightly lower in carotenoid content of grain, flour yield, and particle-size index. It milled substantially the same as Turkey and had a materially longer dough-ball time and a higher ash content of flour than Turkey. Oro was one of the hard red winter varieties lowest in carotenoid content and produced a creamy white flour.

Although Oro was slightly higher in protein content, it was somewhat inferior in bread-baking quality and averaged lower in water absorption and loaf volume than Turkey. The crumb color and grain and texture of the bread from Oro was similar to that from Turkey. It had about the same dough-mixing time and required about the same quantity of oxidizing agent for optimum bread as Turkey.

## RELIEF

Relief (C. I. 10082) was developed from a cross made in 1923 between Hussar and a selection from Turkey at the Utah Agricultural Experiment Station, Logan. It was released to farmers in 1934. A composite sample of Relief grown in each of the crop years 1936-45 has been tested with comparable samples of Turkey. These composites represent 56 station-years.

Relief averaged about the same as Turkey in test weight per bushel, flour yield, ash content of flour, and particle-size index; slightly lower in protein content of wheat and flour; and slightly higher in dough-ball time. The flour was somewhat more yellow than that from Turkey and the other hard red winter varieties. It ranked highest in carotenoid content of the 10 varieties. Relief mills satisfactorily, producing a granular flour similar to that from Turkey.

In the bread-making trials, Relief averaged somewhat lower in water absorption, loaf volume, and grain and texture of crumb than Turkey. It was materially poorer in crumb color than Turkey. Only a small quantity of oxidizing agent for the best bread was required. The dough-mixing time was similar to that for Turkey. The variety appears to be somewhat inferior to Turkey for bread making.

## RIDIT

Ridit (C. I. 6703) was developed from a cross between Turkey and Florence at the Washington Agricultural Experiment Station, Pullman, and was distributed for commercial production in 1923. Results presented here are based on a composite sample of Ridit grown in each of the crop years 1937-45. These composites represent 52 station-years.

Ridit averaged slightly lower in test weight per bushel, flour yield, and particle-size index, but was about the same in flour ash, carotenoid content, and dough-ball time as Turkey. The milling characteristics were good. This variety produced a granular-type flour, similar to that from Turkey. It was one of the better varieties in protein content, which may be partly a result of its rather low acre yield.

The bread from Ridit was good and similar to that from comparably grown samples of Turkey. It was equal to Turkey in water absorption and dough-mixing time but required a less quantity of an oxidizing agent than Turkey for the best bread.

## TURKEY (C. I. 11530)

Turkey (C. I. 11530) is a smut-resistant selection from Turkey (C. I. 1442), made at the University Farm, Davis, Calif. It is not grown commercially. A composite sample of this selection grown in each of the crop years 1940-41 was tested with comparable samples of Turkey (C. I. 1442). These composites represent 10 station-years.

Turkey (C. I. 11530) was about the same in test weight per bushel, protein content, dough-ball time, and carotenoid content, but the flour yield was considerably less than for Turkey (C. I. 1442). This selection of Turkey was one of the poorer varieties of the hard red winter wheats in flour yield and one of the highest in flour ash. Bread from Turkey (C. I. 11530) was better than that from Turkey (C. I. 1442), but water absorption was very low for a Turkey wheat.

## TURKEY (C. I. 6175)

Turkey (C. I. 6175) is a selection made from Turkey (C. I. 1442) at the Adams Branch Experiment Station, Lind, Wash. It has been grown extensively in the Big Bend area of central Washington. One

composite sample of Turkey (C. I. 6175), grown in 1940 and representing five stations, was tested with a comparable composite of Turkey (C. I. 1442).

This single sample was about the same in flour yield, wheat and flour protein, test weight per bushel, and ash content, but somewhat lower in carotenoid content than Turkey (C. I. 1442). It produced a granular-type flour, milled satisfactorily, and appeared to be a typical Turkey wheat. The bread quality, however, was better than the standard Turkey with which it was compared in these tests.

#### RIO

Rio (C. I. 10061) was selected from Argentine, a variety of Crimean wheat obtained from France by the United States Department of Agriculture. The selection was made in cooperative investigations at the Sherman Branch Experiment Station at Moro, Oreg., and distributed to farmers in 1931. A composite sample of Rio grown in each of the crop years 1936-45 was tested with comparable samples of Turkey. These composites represent 56 station-years.

The grain of Rio was substantially like Turkey in hardness and had good milling characteristics, but yielded slightly less flour. It averaged slightly higher in test weight per bushel and was about the same as Turkey in protein content of wheat and flour, particle-size index, and ash content of flour. The dough-ball time was much longer. Rio was among the varieties lowest in carotenoid content of the 10 hard red winter wheats compared. It averaged slightly higher than Turkey in water absorption, grain and texture, and crumb color, but about the same in loaf volume of bread. It was among the better varieties in the grain and texture of bread. The dough-mixing time was about the same as for Turkey, but a somewhat smaller amount of oxidizing agent for the best quality bread was required.

#### WASATCH

Wasatch (C. I. 11925) was developed from a cross between Relief × Ridit made at the Utah Agricultural Experiment Station, Logan, and distributed in 1944 for commercial growing. Tests were made on a composite sample of Wasatch grown in each of the crop years 1942-45. These composites represent 24 station-years.

The grain of Wasatch was substantially like that of Turkey in hardness, with good milling characteristics. Wasatch averaged about the same as Turkey in flour yield, carotenoid content, and flour ash; somewhat better in test weight per bushel and in protein content of wheat and flour; and slightly lower in dough-ball time. It was the highest in protein content of grain of the 10 hard red winter varieties compared, possibly due to its slightly lower acre yield.

In the bread-baking tests, Wasatch was similar in loaf volume, grain and texture, and somewhat poorer in crumb color than Turkey. It was one of the better varieties in water absorption, ranking high among the 10 varieties. It required a lesser quantity of an oxidizing agent for the best bread results and had about the same dough-mixing time as Turkey.

WHITE VARIETIES OF SOFT TEXTURE, SPRING-SEADED

Fifteen spring wheat varieties were tested. Two varieties, Jenkin and Union, are club wheats. Some varieties, like Baart, are usually graded as hard white, while some, like Federation, may be graded as soft white or hard white, depending on the conditions under which they were grown, and others, like Irwin Dicklow, grade mostly as soft white, regardless of the cultural conditions under which they are produced.

The results for these varieties are presented in tables 5 and 6 on pages 20 and 21 and in figure 3.

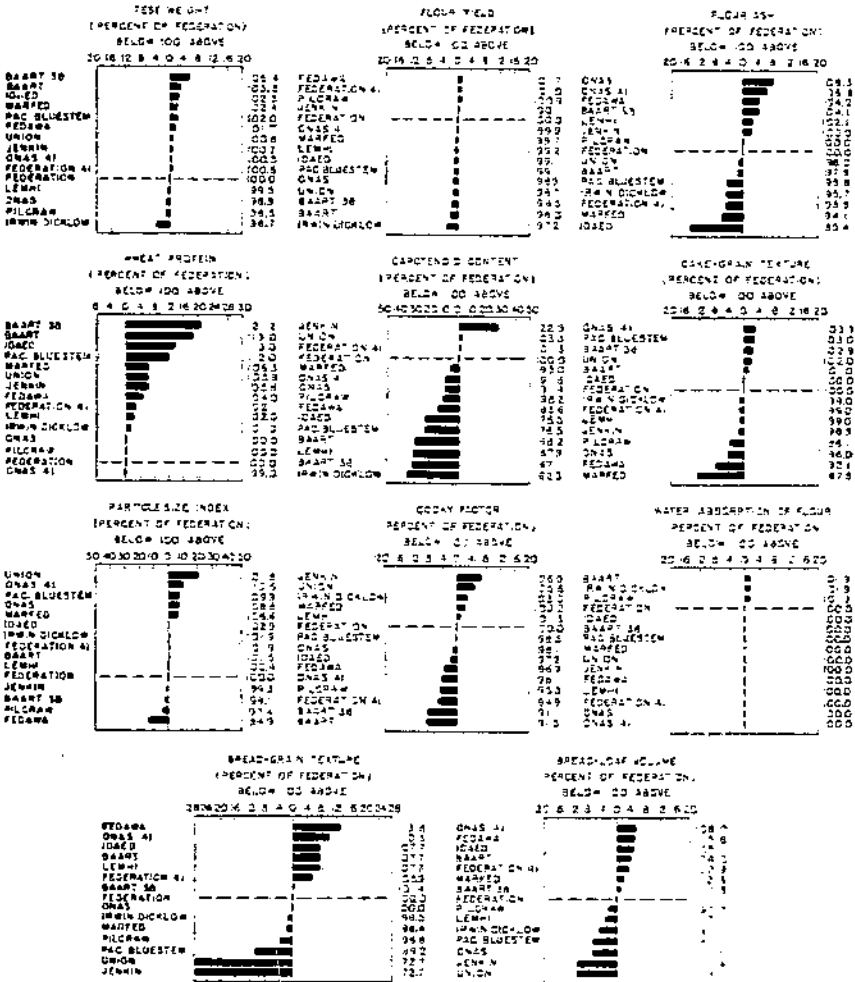


FIGURE 3.—A comparison of some quality characteristics of spring-seeded white varieties of soft texture in percentages of Federation grown under comparable conditions.

## FEDERATION

The Federation variety (C. I. 4734) is used as a standard for comparison of the 14 other varieties and strains of spring-sown white wheat. This variety was introduced into the United States from Australia by the United States Department of Agriculture in 1914. It was released to farmers from the Sherman Branch Experiment Station, Moro, Oreg., in 1920. For many years it was a popular wheat in the Pacific Northwest. It is sown both in the fall and spring, but the grain included in these tests was produced only from spring seeding. Tests were made on 15 composite samples of Federation grown in the crop years 1936-45. These composites represent 72 station-years.

Federation when fall-sown is generally graded soft white, but when spring-sown in the drier areas it usually grades hard white. The test weight of Federation tends to be low, but the milling characteristics are satisfactory. The yield of flour is higher than expected in relation to test weight of the grain. Federation ranked eleventh in test weight per bushel but fifth in flour yield of the 15 soft-textured white wheats. The flour is medium to high in particle-size index, indicating that it is soft in granulation or texture. The unbleached flour is rather yellow, but it has satisfactory color when bleached. It is one of the varieties highest in carotenoid content, exceeded only by Jenkin, Union, and Federation 41. It is intermediate in ash content of flour.

Federation has long been recognized as one of the better varieties for pastry purposes and on account of this is much in demand by the trade. Good family bread can also be made from Federation, but spring-sown grain, which is higher in protein content, is used for this purpose. Federation makes excellent cake and good cookies. It was exceeded in cookie quality only by Lemhi, Marfed, Irwin Dicklow, Union, and Jenkin.

Federation had a short dough-mixing time in the bread test. It needs a somewhat larger quantity of oxidizing agent for optimum results than do most of the white varieties. Like most soft white varieties, it is low in water absorption. It is good in loaf volume of bread, considering the protein content of the grain.

## BAART

Baart (C. I. 1697) was introduced into the United States from Australia by the United States Department of Agriculture in 1900. It was distributed for commercial growing by the Arizona Agricultural Experiment Station prior to 1914 and became an established variety in the Pacific Northwest about 1917. It is the leading variety in acreage of the white wheats grown in the drier areas of the western United States. Partly because it is grown chiefly in the drier areas, commercial Baart is usually relatively high in protein content. Tests were made on 15 composite samples of Baart grown in the crop years 1936-45 and compared with composite samples of Federation. These composites represent 72 station-years.

Baart usually grades hard white. It had a relatively high particle-size index and produced a soft, velvety flour. The milling characteristics were good, but the yield of flour was slightly less than expected in relation to test weight. Baart averaged 2.1 pounds higher in test

TABLE 5—Quality characteristics of varieties of soft-textured white wheat (spring-seeded)<sup>1</sup> grown in the Northwestern States, 1936-45

Variety and years grown	C. I. No. <sup>2</sup>	Samples analyzed	Yield per acre	Test weight <sup>3</sup>	Flour yield <sup>4</sup>	Ash content of flour <sup>5</sup>	Protein content of <sup>6</sup> —		Carotenoid content of wheat <sup>7</sup>	Particle-size index	Dough-ball time	Yellow-loaf cake		Cooky factor	Water absorption of flour	Bread		
							Wheat	Flour				Loaf volume	Grain and texture			Loaf volume	Grain and texture	Crumb color
1936-45:		No.	Rt.	Lb.	Pct.	Pct.	Pct.	Pct.	P. p. m.	Pct.	Min.	Cc.	Score	W. T. <sup>7</sup>	Pct.	Cc.	Score	Score
Baart	1697	15	52.4	61.9	69.1	0.47	11.9	10.4	2.21	27.6	52	953	102	4.94	55	593	70	72
Idaol	11706	15	52.5	61.3	69.9	.41	11.3	10.0	2.48	28.0	76	947	101	5.25	54	599	70	71
Pacific Bluestem	4067	15	47.3	61.0	69.9	.46	11.2	9.7	2.48	20.9	53	961	104	5.32	54	533	58	62
Lemhi	11415	14	58.1	59.5	70.0	.49	10.2	8.9	2.20	27.3	42	918	100	5.47	54	551	70	72
Onas	6221	15	55.5	59.5	69.7	.52	10.0	8.7	2.95	29.6	106	932	97	5.30	54	533	65	63
Federation	4734	15	52.0	59.8	70.5	.48	10.0	8.7	3.24	27.2	80	935	101	5.40	54	570	65	60
1936-39:																		
Jenkin	5177	8	49.1	60.7	69.6	.50	10.9	9.5	4.02	27.2	34	925	96	5.56	55	527	48	49
Federation	4734	8	51.9	60.3	69.5	.49	10.3	9.0	3.27	27.4	91	911	97	5.20	55	595	66	63
1936-41:																		
Pileraw	10036	6	61.8	59.0	70.5	.48	10.1	8.8	2.83	25.8	45	909	98	4.99	55	559	60	63
Federation	4734	6	61.4	59.9	69.9	.48	10.1	8.7	3.21	26.5	56	916	102	5.22	54	572	62	60
1936-40:																		
Union	11704	9	51.1	60.9	69.0	.48	10.9	9.3	3.40	33.4	32	925	101	5.49	55	524	48	51
Federation	4734	9	53.7	60.4	69.9	.49	10.3	9.0	3.29	27.4	85	908	99	5.20	55	594	66	62
1941 and 1945:																		
Marfed	11919	4	51.6	59.6	71.4	.48	10.1	8.9	3.01	29.0	57	967	91	5.65	54	537	60	59
Federation	4734	4	47.6	58.2	71.6	.51	9.5	8.3	3.17	27.2	66	971	104	5.33	54	525	61	54
1936-41; 1943-45:																		
Irwin Dicklow	8555	9	58.9	57.8	68.8	.44	10.2	8.9	1.95	27.3	33	911	101	5.57	55	547	64	68
Federation	4734	9	60.5	59.8	70.8	.46	10.1	8.7	3.13	26.8	65	943	102	5.41	54	575	65	62
1936-42, 1944, and 1945:																		
Fedawa	11975	15	55.6	60.8	71.7	.50	10.4	9.2	2.71	23.1	152	913	93	5.22	54	502	74	68
Federation	4734	15	52.7	59.8	70.5	.48	10.0	8.7	3.24	27.2	80	935	101	5.40	54	570	65	60
1938-45:																		
Baart 38	11997	10	50.3	62.4	70.3	.51	12.0	10.6	2.16	26.2	57	984	105	5.02	54	577	70	72
Baart	1697	10	51.1	61.9	70.2	.50	11.7	10.3	2.18	26.6	52	958	102	5.00	54	590	75	75
Federation	4734	10	52.0	59.2	71.4	.49	9.9	8.7	3.22	26.7	79	950	102	5.51	54	575	69	64
1942-44:																		
Federation 41	12230	3	56.0	60.4	72.0	.42	9.8	8.4	3.14	26.8	72	993	102	5.58	54	568	72	70
Federation	4734	3	56.6	60.1	71.3	.44	9.6	8.3	3.10	26.3	70	975	103	5.88	54	552	68	63
Onas 41	12229	3	58.3	60.4	71.2	.47	9.5	8.3	2.84	26.1	123	945	107	5.65	54	585	75	70
Onas	6221	3	58.0	60.6	70.6	.46	9.4	8.1	2.84	28.5	107	980	102	5.90	54	595	75	77

<sup>1</sup>The grain used in these studies was grown at several locations and composited by variety as noted for table 1. It was grown at the following places: 1936, Aberdeen and Moscow, Idaho, Logan, Utah, Pullman, Walla Walla, and Pomeroy, Wash., and Pendleton, Oreg.; 1937, Aberdeen, Idaho, Bozeman, Mont., Pullman, Walla Walla, and Pomeroy, Wash., Pendleton and Union, Oreg.; 1938, Davis, Calif., Pullman, Pomeroy, Walla Walla, Lind, and Prosser, Wash., Pendleton and Union, Oreg., Aberdeen, Idaho, Logan, Utah, Bozeman, Mont., and Hesperus, Colo.; 1939, Aberdeen and Sandpoint, Idaho, Logan, Utah, Bozeman, Mont., Hesperus, Colo., Pullman, Lind, Pomeroy, and Walla Walla, Wash., Pendleton, Moro, and Union, Oreg., and Davis, Calif.; 1940, Bozeman, Mont., Hesperus, Colo., Logan, Utah, and Aberdeen, Idaho; 1941, Logan, Utah, Bozeman, Mont., Aberdeen and Moscow, Idaho, Pullman, and Walla Walla, Wash., and Pendleton, Union, and Moro, Oreg.; 1942, Pullman, Pomeroy, and Walla Walla, Wash., Moscow and Aberdeen, Idaho, Bozeman, Mont.,

Logan, Utah, and Pendleton, Oreg.; 1943, Pullman, Walla Walla, and Prosser, Wash., Moro and Pendleton, Oreg., and Moscow, Idaho; 1944, Pullman and Prosser, Wash., Pendleton, Oreg., Logan, Utah, Aberdeen, Idaho; 1945, Logan, Utah, Bozeman, Mont., and Pullman, Wash.

<sup>2</sup> See footnote 2, table 1.

<sup>3</sup> Dockage-free.

<sup>4</sup> Moisture-free basis.

<sup>5</sup> 14.0-percent-moisture basis.

<sup>6</sup> Carotenoid content expressed as carotene parts per million; naphtha-alcohol extract.

<sup>7</sup> W/T=ratio of width to thickness.

<sup>8</sup> Only 14 samples of Lemhi were tested, but the average of the 14 comparable Federation samples did not differ significantly from the 15-sample average for the characteristics.

TABLE 6.- Quality characteristics of soft-leaved white (spring-seeded) varieties, expressed as a percentage of Federation, in the same tests as those shown in table 5, 1936-45

Variety	C. I. No.	Sam- ples ana- lyzed	Sta- tion years rep- re- sented	Yield per acre	Test weight	Flour yield	Ash con- tent of flour	Protein con- tent of		Car- otenoid con- tent of wheat	Par- ticu- lar size index	Dough- ball time	Yellow-leaf cake		Cooky factor	Water absorp- tion of flour	Bread						
								Wheat	Flour				Leaf vol- ume	Grain and tex- ture			Leaf vol- ume	Grain and tex- ture	Crumb color				
Federation	4734			100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Bart 38	11907	10	51	96.7	105.4	98.5	104.1	121.2	121.8	87.1	98.1	72.2	103.6	102.9	91.1	100.0	100.3	101.4	120.0				
Bart	1697	15	72	99.1	103.5	98.0	97.9	119.0	119.5	68.2	101.5	65.0	101.9	101.0	91.5	101.9	104.0	107.7	120.0				
Idaho	11706	15	72	99.2	102.5	99.1	85.4	113.0	114.9	76.5	102.9	95.0	101.3	100.0	97.2	103.0	105.1	107.7	118.3				
Pacific Bluestem	4067	15	72	89.4	102.0	99.1	95.8	112.0	111.5	76.5	109.9	66.3	103.1	103.0	98.5	100.0	93.5	89.2	103.3				
Marfed	1919	4	20	108.4	102.4	99.7	94.1	106.3	107.2	95.0	106.6	86.4	99.6	87.5	102.2	106.0	102.3	98.4	109.3				
Union	11704	2	41	95.2	100.8	98.7	98.0	105.5	103.3	103.3	121.9	37.6	101.7	102.0	105.6	100.0	88.2	72.7	82.3				
Junkin	5177	8	37	94.6	100.7	100.1	102.0	105.8	105.6	122.0	99.3	37.4	101.5	98.9	106.9	100.0	88.4	72.7	77.8				
Fedawa	11975	15	46	105.5	101.7	101.7	104.2	104.0	105.7	83.6	84.9	190.0	97.6	92.1	96.7	100.0	105.6	113.8	113.3				
Federation 41	12230	3	19	98.9	100.5	101.0	95.5	102.1	101.2	101.3	101.9	102.9	101.7	99.0	94.9	100.0	102.9	105.9	111.1				
Lemhi	11415	14	68	109.5	99.5	99.2	102.2	102.0	102.3	67.9	100.4	52.5	98.2	96.0	101.3	100.0	97.0	107.7	120.0				
Irwin Dicklow	8855	9	34	97.4	96.7	97.2	95.7	101.0	102.3	62.3	101.9	50.8	96.6	96.0	103.0	101.9	95.1	98.5	109.7				
Omas	6221	15	72	104.9	98.9	98.9	108.3	100.0	100.0	91.4	108.8	132.5	99.7	96.0	98.1	100.0	93.5	100.0	105.0				
Pillar	10036	6	20	105.5	98.5	100.9	100.0	100.0	101.1	88.2	97.4	85.7	99.2	96.1	95.5	101.9	97.7	96.8	105.0				
Omas 41	12229	3	19	103.0	100.5	99.9	106.8	99.0	100.0	91.6	110.6	175.7	96.8	103.9	96.1	100.0	106.0	110.3	111.1				



weight per bushel but yielded 1.4 percent less flour than the comparably grown samples of Federation. The protein content of the grain averaged slightly higher than Federation. It averaged about the same in flour ash, had a shorter dough-ball time, and was considerably less in carotenoid content than Federation. The flour from Baart was generally creamy white with much less yellow color than flour from Federation or Onas.

It made excellent cake, averaging slightly better than Federation. It was uniformly good in the different years tested, providing the protein content was not too high for cake flour. The cookies made from Baart flour averaged only fair and materially poorer than those from Federation. Bread from Baart was good, considering the protein content of the samples. Water absorption of the flour was low compared with that of hard red winter and hard red spring wheats, but similar to other white wheats. Baart had the same dough-mixing time as Federation, but required a smaller quantity of oxidizing agent for the best bread.

#### BAART 38

Baart 38 (C. I. 11907) was developed in a backcross program at the California Agricultural Experiment Station, Davis, and has been reported by that station to have replaced practically all Baart in that State. Tests were made on 10 composite samples of Baart 38, representing 51 station-years, grown in the crop years 1938-45 with comparable samples of Federation. Similar samples of Baart were also included. Since the primary interest here relates to Baart and Baart 38 the discussion will be mostly limited to this comparison.

Although the individual data were not clear-cut in every case, the average results suggested that Baart 38 was slightly higher than the comparably grown Baart in test weight per bushel and protein content of wheat and flour. The grain was slightly harder and more vitreous than Baart as determined by the particle-size index, but the differences were small. Both varieties were equal and satisfactory in milling characteristics. Baart 38 made slightly poorer bread than Baart. The differences in loaf volume and crumb characteristics were small, but nevertheless appear to be significant, especially when considered in relation to the protein content, which averaged higher for Baart 38. Baart 38 made slightly better cake than Baart. Both varieties made poor cookies. The other quality characteristics were generally the same or, where different, were so small that they were considered unimportant.

Since Baart 38 was very similar to Baart in all important characteristics, the comparison of Baart 38 and Federation was substantially the same as for Baart and Federation discussed above.

#### FEDAWA

Fedawa (C. I. 11975) was developed in Australia from a cross between Federation  $\times$  Currawa. It was introduced into the United States and grown at a number of the agricultural experiment stations in the western region. Tests were made on 15 composite samples of Fedawa grown from the crop years 1936-42 and 1944-45. These composites represent 46 station-years.

Fedawa averaged slightly higher than Federation in test weight per bushel, flour yield, protein content of wheat and flour, and ash content of flour. It also had a lower carotenoid content and was creamy yellow in color. Although whiter than the flour from Federation, it was not so white as the flour from either Baart or Lemhi. The dough-ball time averaged long. The flour from Fedawa had a lower particle-size index and was generally semigranular in nature and not so soft and fluffy as that from Federation. The grain generally handled satisfactorily in the experimental mill and required no special handling or tempering treatment.

Fedawa made slightly poorer cookies and much poorer cake than Federation. Some very good cakes and cookies were made from Fedawa, indicating that the quality characteristics of this variety depended upon the location and the crop year in which the grain was grown. The bread-baking characteristics of Fedawa were better than those of Federation, due in part to a higher protein content. The bread was nearly equal to that from the hard-textured wheat varieties. Fedawa had the same water absorption and dough-mixing time, but required substantially less oxidizing agent for optimum bread than Federation.

#### FEDERATION 41

Federation 11 (C. L. 12230) was developed by backcrossing at the California Agricultural Experiment Station, Davis. Three composite samples representing 19 station-years grown from 1942 to 1944 were included in this experiment.

Federation 41 was much like Federation in quality. The greatest difference between the two varieties was in the cooky test, where Federation 11 was slightly poorer than Federation. Differences between the other characteristics of the two varieties were small and were considered unimportant.

#### IDAED

Idaed (C. L. 11706) resulted from a cross between Sunset and Boadicea (two Australian varieties) made at Davis, Calif., in 1920. A head selected from this cross at the Idaho Agricultural Experiment Station, Moscow, was increased and distributed from that station in 1938. Tests were made on 15 composite samples of Idaed, representing 72 station-years, grown in the crop years 1936-45.

Idaed, grown under conditions of relatively high rainfall where most of it was produced, usually grades soft white, but under limited rainfall it frequently grades hard white. The yield of flour was good but somewhat lower than expected in relation to test weight. The milling characteristics were generally satisfactory. It was lowest in flour ash, and averaged about the same in dough-ball time and particle-size index value as Federation. It was among those highest in protein content of the comparably grown varieties, being 1.3 percent higher than Federation. The carotenoid content was much lower than Federation, and the flour was creamy yellow in color, being much whiter than that from Federation.

Idaed made satisfactory cakes, equal in quality to those from Federation, and cookies that were good but slightly inferior to those from Federation. Cakes were consistently good from season to season, but

the cookies varied in quality, being much poorer in some years than in others. On the average, *Idaed* ranked ninth in cooky quality and sixth in cake grain and texture of the 15 white spring-seeded varieties. The bread was fair, being equal only to *Baart* and somewhat better than *Federation*. It had the same dough-mixing time but required substantially less oxidizing agent for optimum bread than *Federation*. It ranked third in bread grain and texture and third in loaf volume of the 15 white spring-seeded varieties.

On the whole, *Idaed* excels in test weight per bushel, protein content of grain, and low flour ash. It may be somewhat deficient in flour yield when considered in relation to test weight. It makes particularly good cake and good cookies and is among the best of the white spring wheats for bread.

#### IRWIN DICKLOW

*Irwin Dicklow* (C. I. 8855), selected from a field of *Dicklow* by a farmer at Twin Falls, Idaho, is considered one of the better wheats by the Idaho millers for the soft wheat flour trade. Its largest acreage is in Idaho and Utah, where it is grown under irrigation. Tests were made on nine composite samples of *Irwin Dicklow* grown in each of the crop years 1936-41 and 1945-45, with comparable composite samples of *Federation* and other varieties.

*Irwin Dicklow* usually grades soft white on the market. The grain was soft in texture and milled satisfactorily, making a soft, white flour. It averaged about the same in protein content, flour ash, and particle-size index as the comparably grown samples of *Federation*. It was lowest of the 15 white spring-seeded varieties in carotenoid content, indicating that the flour was much whiter. It was also lowest in test weight per bushel and yield of flour. Excellent cakes and cookies were made from *Irwin Dicklow*, the cakes being similar but the cookies somewhat better than those from *Federation*. It was one of the better varieties for cookies. Like most of the soft-textured wheats, it made unsatisfactory bread.

#### JENKIN

The origin of *Jenkin* (C. I. 5177) is undetermined. It is known to have been grown as early as 1895 in the vicinity of Wilbur, Wash. Tests were made on eight composite samples of *Jenkin* grown from spring seed in the crop years 1936-39 with comparable samples of *Federation*. These composites represent 37 station-years.

*Jenkin* is a white club wheat. The grain is soft in texture and produces a very soft and velvety flour. It had about the same test weight per bushel, yield of flour, flour ash, and particle-size index as the comparably grown samples of *Federation*. It exceeded all other varieties considerably in carotenoid content and produced a yellow flour. *Jenkin* had a much shorter dough-ball time than *Federation*.

The cakes from *Jenkin* were about like those from *Federation*, but the cookies were much better. The cookies averaged the best of the white spring-seeded wheat varieties. It made unsatisfactory bread, as would generally be expected from club wheat.

## LEMHI

Lemhi (C. I. 11415) was developed from a cross between Federation and Dicklow in cooperative investigations at the Aberdeen Substation of the Idaho Agricultural Experiment Station. It was released for commercial growing in the irrigated districts of southern Idaho in 1930. Tests were made on 14 composite samples of Lemhi grown in the crop years 1936-45. These composites represent 68 station-years.

Lemhi usually grades soft white. It averaged about the same as Federation in test weight per bushel, flour yield, flour ash, protein content of wheat and flour, and particle-size index; shorter in dough-ball time; and much lower in carotenoid content. The flour was creamy white and not nearly so yellow as the flour from Federation. The cake and cookies from Lemhi were good and similar to those from Federation. Cake quality was more variable than from Federation, being much better in certain years than in others and from grain grown under certain cultural conditions. It made poor bread that was similar to that from Federation.

## MARFED

Marfed (C. I. 11919) was developed from a cross between (Marquis × Florence) × Federation in cooperative experiments at the Washington Agricultural Experiment Station, Pullman. It was released for commercial growing in 1916 in areas where Federation is commonly grown. Tests were made on four composite samples of Marfed grown in 1941 and 1945. These composites represent 20 station-years.

Flour from Marfed has been somewhat softer in texture, as indicated by the particle-size index, and was slightly more fluffy and softer than that from Federation. The very limited data for Marfed suggested that the milling properties might be somewhat variable. Some samples showed a tendency to produce a slow-bolting flour, while others appeared to be satisfactory. The hardness of the grain, as indicated by the particle-size-index test, was somewhat variable; apparently this variability depended on the crop year and the cultural conditions under which it was grown. Flour yields have been satisfactory, considering the test weight of the grain.

Marfed averaged slightly higher in test weight and protein content, but about the same in dough-ball time and carotenoid content as Federation. The flour was creamy yellow in color and similar to that from Federation. It was only slightly lower in flour ash.

The baking characteristics of Marfed were variable. The quality of cakes varied from fair to very good, but averaged lowest in grain and texture of the white spring varieties compared in table 6. Marfed made very good cookies, which were better than those from comparably grown samples of Federation. The quality of the bread varied from poor to good, averaging similar to Federation. The higher protein samples generally made the most satisfactory bread, and those samples lowest in protein the best cakes.

## ONAS

Onas (C. I. 6221) was developed in Australia from a cross between Federation and Tarragon, the latter a variety related to Federation through one of its parents. Onas was introduced by the United States Department of Agriculture, and after tests were made in cooperative experiments it was distributed in 1923 by the California Agricultural Experiment Station, Davis. Fifteen composite samples of Onas grown in the crop years 1936-45 were included in the present experiments. These composites represent 72 station-years.

Onas usually grades soft white on the market, but when grown under certain cultural and soil conditions it may be harder in texture and may be placed in the subclass hard white. It averaged about the same in test weight per bushel, yield of flour, protein and carotenoid content, but higher in ash content of flour than Federation. The milling characteristics were generally satisfactory. The color of the flour was creamy yellow and similar to Federation. It bleached satisfactorily, making a white flour. The particle-size index was somewhat higher than that for Federation, indicating a softer flour. The dough-ball time was long for a soft-type variety, exceeding that of Federation.

Onas made good but slightly poorer cake than Federation, and the cookies were good. Like several other varieties, it made consistently good cake and cookies from season to season. On the average, it ranked thirteenth in cake grain and texture and eighth in cooky quality of 15 white spring-seeded varieties. Bread from Onas was poor.

## ONAS 41

Onas 41 (C. I. 12220) was developed by backcrossing at the California Agricultural Experiment Station, Davis. These tests include three composite samples of Onas 41 grown in each of the crop years 1942-44. These composites represent 19 station years. Onas, as well as Federation, was included for comparison. Since the principal question here relates to the quality characteristics of Onas and Onas 41, this discussion will be mostly limited to these two varieties.

Both Onas and Onas 41 were satisfactory in milling and averaged about the same in yield of flour. Onas 41 averaged about the same as Onas in test weight per bushel, protein content, carotenoid content, particle-size index, and flour ash. The greatest difference between the two varieties was in the cake test, where Onas 41 was not only better than Onas but the best of all the white spring-seeded varieties in grain and texture. Onas 41 was slightly poorer than either Onas or Federation for cookies. Both made fair bread, which was better than expected in relation to the low protein content of the flour.

## PACIFIC BLUESTEM

Pacific Bluestem (C. I. 4067) was introduced from Australia, where it was one of the leading wheat varieties during the earlier years of wheat production in that country. It has been grown in the western United States for more than 90 years. Tests were made on 15 composite samples of Pacific Bluestem grown in the crop years 1936-45. These composites represent 72 station-years.

Pacific Bluestem usually grades hard white on the market. The grain from the samples was somewhat softer than that of Federation, according to the particle-size index. It milled satisfactorily and produced a soft-textured white flour. The test weight per bushel and dough-ball time averaged higher and the flour yield and ash content of flour slightly lower than Federation. The carotenoid content was lower and flour made from it whiter than the flour from Federation. It averaged 1.2 percent higher than Federation in protein content. This was the result in part at least of a lower acre yield.

Pacific Bluestem made excellent cakes, which were, on the average, better than those from Federation, and consistently made good cakes from season to season. The cookies were good and equal to those from Federation. The bread from Pacific Bluestem averaged 37 cc. lower in loaf volume than Federation, even though the flour was 1.0 percent higher in protein. Pacific Bluestem had about the same dough-mixing time as Federation, but required a smaller quantity of oxidizing agent for optimum bread than Federation.

#### PILCRAW

Pilcrow (C. I. 10036) was discovered by a farmer near Napa, Calif. It has been grown to a limited extent in Oregon, Washington, and California. Six composite samples of Pilcrow grown in the crop years 1936-41, representing 20 station-years, were tested.

The grain of Pilcrow was substantially like that of Federation in softness and was generally satisfactory in milling quality. Flour yields were slightly higher than Federation and the flour texture soft and similar to it. Pilcrow was about the same as Federation in ash content, wheat protein, particle-size index, and dough-ball time. The test weight per bushel and the carotenoid content of Pilcrow were slightly lower. The flour was slightly whiter. Pilcrow made slightly poorer cakes and poorer cookies than comparably grown Federation. The bread was similar to that from Federation of the same protein content. Water absorption of the flour was low, and the grain and texture of the bread were poor.

#### UNION

Union (C. I. 11704) is the best of many head selections made in 1923 from a field of Redchaff club. It was distributed for commercial growing in 1936 by the Eastern Oregon Livestock Branch Experiment Station, Union. These tests include 9 composite samples of Union grown in the crop years 1936-40, representing 37 station-years.

Union grades white club on the market. It averaged about the same in test weight per bushel, yield, and ash content of flour, and was slightly higher in protein and carotenoid content than Federation. It had the highest particle-size index of the 17 white spring-seeded varieties. The dough-ball time was much shorter than that of the comparably grown Federation.

Union made excellent cookies and cakes that were better than those from Federation. It consistently made good cookies, being exceeded only by Jenkin. It ranked fourth in cake grain and texture of the 15 white spring-seeded varieties, but made much poorer bread than Federation of the same protein content.

## HARD RED SPRING AND SPRING-SEEDED WHITE VARIETIES OF HARD TEXTURE

Three hard red spring varieties (Ceres, Marquis, and Thatcher) and three white spring-seeded varieties of hard texture (White Federation, White Federation 38, and Hard Federation 31) were studied and are compared in this group. The results are presented in tables 7 and 8 and figure 4. These varieties all produce flour that is granular and not adapted to making cakes, cookies, or other pastries.

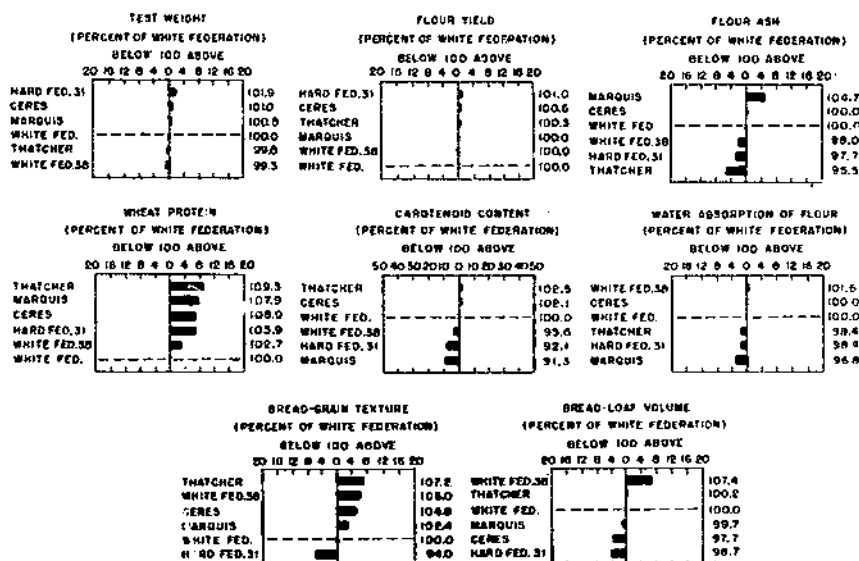


FIGURE 4.—A comparison of some quality characteristics of hard red spring and spring-seeded white varieties of hard texture in percentage of White Federation grown under comparable conditions.

## WHITE FEDERATION

The White Federation variety (C. I. 4981) was selected from Federation in Australia, introduced into the United States by the United States Department of Agriculture, and distributed in 1920 for commercial growing. It was chosen as a standard of comparison with five other varieties of hard-textured white wheats (spring-seeded) and hard red spring wheat that have hard, vitreous grain. Quality characteristics discussed here are based on 12 composite samples, representing 58 station-years, of White Federation grown in the crop years 1936-42.

The flour of White Federation is granular and similar in this respect to the flour milled from the hard red spring wheats. It is one of the hardest textured white wheats grown in the western region. For this reason some millers have found it extremely difficult to reduce it to flour. The ash content of the flour is similar and the protein content lower than that of the good hard red spring varieties. Generally it is fairly high in test weight per bushel and produces a satisfactory yield of flour. The carotenoid content of the grain is low and the flour white in color.

TABLE 7.—Quality characteristics of varieties of hard red spring and hard-textured white wheat (spring-seeded)<sup>1</sup> in the Northwestern States, 1936-42

Variety and years grown	C. I. No. <sup>2</sup>	Samples analyzed	Yield per acre	Test weight <sup>3</sup>	Flour yield <sup>4</sup>	Ash content of flour <sup>5</sup>	Protein content of <sup>5</sup> —		Carotenoid content of wheat <sup>6</sup>	Particle-size index	Dough-ball time	Yellow-loaf cake		Cooky factor	Water absorption of flour	Bread		
							Wheat	Flour				Loaf volume	Grain and texture			Loaf volume	Grain and texture	Crumb color
1936-39:		No.	Bu.	Lb.	Pct.	Pct.	Pct.	Pct.	P.p.m.	Pct.	Min.	Cc.	Score	W/T <sup>7</sup>	Pct.	Cc.	Score	Score
Thatcher.....	10003	8	47.1	61.6	69.0	0.42	12.9	12.1	2.48	13.4	234	892	79	4.56	62	658	89	82
Ceres.....	6900	8	46.9	62.3	69.2	.44	12.5	11.5	2.47	12.0	204	888	78	4.93	63	642	87	81
Hard Federation 31.....	8255	8	46.2	62.9	69.5	.43	12.5	11.6	2.23	18.6	242	969	76	4.46	62	635	78	79
White Federation.....	4981	8	47.6	61.7	68.8	.44	11.8	10.6	2.42	16.4	201	886	79	4.46	63	657	83	83
1936-42:																		
Marquis.....	4158	12	48.1	62.0	69.8	.49	12.3	11.4	2.20	14.4	217	927	84	4.92	60	649	84	84
White Federation.....	4981	12	48.6	61.5	69.8	.47	11.4	10.4	2.41	15.9	170	895	81	4.52	62	651	82	81
1938-42:																		
White Federation 38.....	11906	7	49.8	60.8	71.3	.50	11.3	10.4	2.37	13.7	159	893	81	4.48	62	679	88	83
White Federation.....	4981	7	49.2	61.2	71.3	.51	11.0	10.1	2.48	13.4	150	905	86	4.51	61	632	83	78

<sup>1</sup> The grain of each variety used in these studies was grown at several locations each year, as shown in footnote 1 of table 5, and thoroughly mixed or composited by variety.

<sup>2</sup> See footnote 2, table 1.

<sup>3</sup> Dockage-free.

<sup>4</sup> Moisture-free basis.

<sup>5</sup> 14.0-percent-moisture basis.

<sup>6</sup> Carotenoid content expressed as carotene parts per million; naphtha-alcohol extract.

<sup>7</sup> W/T=ratio of width to thickness.



TABLE 8.—Quality characteristics of hard red spring and hard-textured white wheats (spring-seeded), expressed as a percentage of White Federation, in the same tests as those shown in table 7, 1936-42

Variety	C. I. No.	Sam- ples analyzed	Sta- tion years repre- sented	Yield per acre	Test weight	Flour yield	Ash con- tent of flour	Protein con- tent of—		Caro- tenoid con- tent of wheat	Par- ticle- size index	Dough- ball time	Yellow-leaf cake		Cooky factor	Water absorp- tion of flour	Bread			
								Wheat	Flour				Leaf vol- ume	Grain and tex- ture			Leaf vol- ume	Grain and tex- ture	Crumb color	
White Federation.....	4981			100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Thatcher.....	10003	8	37	98.9	99.8	100.3	95.5	109.3	114.2	102.5	81.7	116.4	100.7	100.0	102.2	98.4	100.2	107.2	98.8	
Marquis.....	4158	12	58	99.0	100.8	100.0	104.7	107.9	109.6	91.3	90.6	127.6	103.6	103.7	108.8	96.8	99.7	102.4	103.7	
Ceres.....	6900	6	37	98.5	101.0	100.6	100.0	105.9	108.5	102.1	73.2	101.5	100.2	98.7	110.5	100.0	97.7	104.8	97.6	
Hard Federation 31.....	8255	8	37	97.1	101.9	101.0	97.7	105.9	109.4	92.1	113.4	120.4	98.1	96.2	100.0	98.4	96.7	94.0	95.2	
White Federation 38.....	11906	7	35	101.2	99.3	100.0	98.0	102.7	103.0	95.6	102.2	106.0	98.7	94.2	99.3	101.6	107.4	106.0	106.4	

White Federation is high in water absorption of flour and makes bread equal to that from Marquis. It has a medium-long dough-mixing time compared with the soft white varieties grown in the western region and needs only a small quantity of oxidizing agent or yeast food for optimum bread. White Federation makes unsatisfactory cake and cookies.

#### CERES

Ceres (C. I. 6900) was developed at the North Dakota Agricultural Experiment Station from a cross between Marquis and Kota made in 1918. It was distributed for commercial production in North Dakota in 1926. Eight composite samples, representing 37 station-years from 1936 to 1939, were tested in these experiments. Ceres averaged slightly lower in particle-size index, slightly higher in flour yield and test weight, 0.7 percent higher in protein, and about the same as White Federation in carotenoid content, dough-ball time, and flour ash. The flour was hard and granular. The milling characteristics of Ceres were generally satisfactory, although the grain appeared to be somewhat harder than that of White Federation. It ranked among the hardest textured wheats grown in the western region, as measured by the particle-size index. Ceres made as good bread as comparably grown samples of the other red spring varieties except Thatcher. The loaf volume, however, was not equal to samples of Ceres of similar protein content grown in Montana.

Ceres averaged about the same as White Federation in water absorption of flour, grain and texture of crumb, and loaf volume of bread. It had a slightly longer dough-mixing time than White Federation and made poor cakes and cookies.

#### HARD FEDERATION 31

Hard Federation 31 (C. I. 8255) was the best of many head selections made from a field of Hard Federation at the Sherman Branch Experiment Station, Moro, Oreg., in 1921. It was distributed for growing in eastern Oregon in 1928. These tests include 8 composite samples representing 37 station-years from 1936 to 1939.

Hard Federation 31 averaged slightly higher in test weight per bushel, flour yield, and particle-size index; slightly longer in dough-ball time; and higher in protein than did White Federation. The flour was hard and granular and similar to that milled from the hard red spring varieties. It was also white in color and medium low in ash. It ranked first of the six varieties in test weight per bushel and flour yield.

Hard Federation 31, although 1.0 percent higher in protein, made bread that was somewhat inferior to that from White Federation. It was lower in water absorption, loaf volume, grain and texture, and crumb color than White Federation. It had about the same dough-mixing time and needed about the same quantity of oxidizing agent as White Federation for optimum bread results. It made poor cake and cookies.

## MARQUIS

Marquis (C. I. 4158) was selected from a cross between hard red Calcutta and Red Fife made at the Central Experimental Farm, Ottawa, Canada, prior to 1905. It was introduced into the spring wheat area of the United States in 1912. These studies include 12 composite samples representing 58 station-years grown from 1936 to 1942.

The milling characteristics of Marquis were good. It averaged about the same as White Federation in test weight per bushel, flour yield, carotenoid content, particle-size index, and ash content of flour; somewhat longer in dough-ball time; and 1.0 percent higher in flour protein. The particle-size index indicated that the flour was granular and similar in this respect to the flour from White Federation. Marquis made bread similar to most other hard red spring varieties of like protein grown in the Pacific Northwest. The bread-baking qualities were not equal to Marquis of similar protein content grown in Montana. The bread from Marquis was substantially like that from the comparably grown White Federation. It averaged slightly lower in water absorption of flour and had a slightly shorter dough-mixing time than White Federation. Marquis required about the same quantity of oxidizing agent as White Federation for the best bread. It was not suited for making cake, cookies, or other pastries.

## THATCHER

Thatcher (C. I. 10003) was selected from a cross of two unnamed selections, one from a cross between Marquis and Iumillo and the other from a cross between Marquis and Kaured. It was developed in cooperative experiments at the Minnesota Agricultural Experiment Station and was distributed for commercial production in 1934. Eight composite samples, representing 37 station-years from 1936 to 1939, were included in this study.

Thatcher averaged about the same in test weight per bushel, flour yield, carotenoid content, and flour ash, as White Federation. The grain had very good milling characteristics. It had a slightly lower particle-size index, and the flour was hard and granular. The grain was 1.1 percent higher in protein content than White Federation. Thatcher made good bread but not equal to that from Thatcher of similar protein content grown in Montana. The bread averaged better in grain and texture but was about the same in loaf volume and crumb color as that from White Federation. The dough characteristics of the Thatcher flour tended to be "bucky" and not so soft and pliable as the dough from Marquis. It required a medium-long dough-mixing time and a larger quantity of oxidizing agent than many other varieties grown in the Pacific Northwest. Cakes and cookies from Thatcher were not satisfactory.

## WHITE FEDERATION 38

White Federation 38 (C. I. 11906) was developed by backcrossing in cooperative investigations at the California Agricultural Experiment Station, Davis. Seven composite samples, representing 35 station-years grown from 1938 to 1942, were compared with samples of White Federation.

White Federation 38 had good milling characteristics and averaged about the same as White Federation in test weight per bushel, flour yield, carotenoid content, particle-size index, flour ash, and water absorption of flour but was slightly higher in protein content. It was much like the comparably grown White Federation in quality. White Federation 38 made better bread than White Federation. It was not only higher in loaf volume than White Federation but averaged somewhat better in grain and texture and crumb color of loaf. Cakes and cookies from White Federation 38 were poor.

### SUMMARY

Chemical, milling, and baking data relating to the quality characteristics of winter and spring wheats were reported for 44 varieties and strains grown at experiment stations in the western United States. All winter wheats were grown without irrigation, but part of the spring wheat tests were irrigated. The important commercial and the more promising new varieties and strains were included. The grain was grown during one or more of the crop years from 1936 to 1945, with a number of the varieties or strains grown in all 10 years.

Each variety or strain was compared with a variety of known quality characteristics grown under comparable conditions. The varieties used as standards were among the more important commercial wheats produced in the area. In these experiments only the samples of varieties and strains grown under comparable conditions were compared, whereas variety samples received by the trade are often grown in different areas. Some varieties like Baart and Turkey are nearly always grown in the drier areas (less than 15 inches of rainfall), while varieties such as Hymar, Elgin, and Federation are usually grown in the more humid areas of the intermountain region.

A comparison of the 13 soft-textured winter varieties and strains showed that Triplet and Orfed excelled the other wheats in test weight per bushel. With the exception of Athena, all the soft-textured winter varieties exceeded Golden (standard included with this group of wheats) in test weight per bushel. Elgin, Hymar, and Jenkin appeared to be best in yield of flour, while Rex and Triplet were lowest.

The high-yielding varieties, Elgin and Brevon, averaged consistently lower in protein than Golden. Rex and Orfed appeared to have somewhat stronger gluten properties than many of the other soft-textured winter varieties at similar protein levels. Jenkin materially exceeded all the varieties in carotenoid content, followed by Hymar, Albit, Rex, and Hybrid 128. The latter four varieties were about equal in pigmentation. Goldcoin and Requa were lowest in carotenoid content and produced relatively white flour. All varieties appear to bleach to what is generally regarded as a satisfactory level, regardless of the original carotenoid content.

There were marked differences among the soft-textured winter varieties in particle-size index values, suggesting that some produced soft, fluffy flour and others more granular flour. Rex was very soft in kernel texture. It was highest in particle-size index and produced soft and fluffy flour. Its milling properties were poor, largely because of the soft "cottony" nature of the flour, which bolted with difficulty. Brevon averaged low in particle-size index and produced a more granular-type flour. Hymar varied in texture from soft, chalky kernels to hard, vitreous kernels. In some years the flour was rather

granular, making it less desirable for pastry purposes. Most of the varieties and strains exceeded Golden in dough-ball time. Ash content of the flour was highest for Hybrid 128. Those varieties and strains that were lowest in flour ash were Albit, Requa, Orfed, and Triplet. The soft-textured winter varieties produced satisfactory cake, although they varied from fair to very good in quality. Goldeoin, Athena, Triplet, and Requa averaged best, and Brevon was lowest of the group in cake quality.

The white club varieties generally made better cookies than any of the wheats tested from the western region. Jenkin consistently made the best cookies, and it was uniformly good in the different years tested. The other varieties, including Golden, that made good cookies were Hybrid 128, Albit, Elgin, Hymar, Goldeoin, and Requa. Brevon and Athena made cookies that were poor and of questionable quality. None of the wheats produced flour that made satisfactory bread. Rex and Orfed, nevertheless, showed remarkably good bread-making properties, considering the low protein content of the samples tested.

Most of the 10 hard red winter varieties averaged higher in test weight per bushel than Turkey (C. I. 1442), which was the hard red winter standard of comparison. The two varieties, Cache and Wasatch, averaged slightly higher in test weight than Turkey. Turkey was outstanding in yield of flour. All but two of the varieties exceeded Turkey (the standard) in wheat protein content. Wasatch and Redit were two of the better varieties in comparison with Turkey. Some of the varieties with higher protein, however, were low in acre yield. There was some variation in carotenoid content among the varieties, but the differences were not so great as found in some of the other classes of wheats tested. Relief and Chiefkan were highest. Chiefkan and Turkey selection (C. I. 11530) averaged much higher in flour ash than the standard Turkey. Cache and Oro were also somewhat higher. None of the hard red winter wheats made acceptable cake or cookies.

Turkey (C. I. 6175) made exceptionally good bread, considering the protein content. Chiefkan made very poor bread, although it ranked high among the bread varieties in protein and water absorption of flour. Cache and Wasatch were also high, and Turkey (C. I. 11530) very low, in water absorption. Wasatch was equal to Turkey in bread quality, but Cache was somewhat lower in loaf volume. Chiefkan generally required a relatively large quantity of oxidizing agent for the best bread. It was short in dough-mixing time and exceedingly sensitive to overmixing. Wasatch and Cache required only a small quantity of oxidizing agent and had about the same dough-mixing time as standard Turkey.

A comparison of the 15 white spring-seeded varieties showed that Baart 38 and Baart considerably exceeded Federation (standard of comparison for this group of wheats) in test weight per bushel. Irwin Dicklow was lowest in test weight. Most of the varieties and strains averaged about the same or lower in yield of flour than Federation. Idaed, Baart 38, and Baart averaged 2.9, 2.1, and 1.9 percent, respectively, higher in protein content than Federation. Jenkin was uniformly higher in carotenoid content in all tests and considerably exceeded Federation. A number of varieties that were relatively low in carotenoid content in comparison with Federation were Baart, Lemhi, Baart 38, and Irwin Dicklow. The color of the flour from

these varieties was generally whiter than that from the varieties higher in carotenoid content.

The particle-size index values varied over a wide range, depending on whether they were soft- or semihard-textured varieties. Federation ranked intermediate in particle-size index among the varieties compared. Union, Pacific Bluestem, Marfed, Onas, and Onas 41 were relatively higher in particle-size index value than Federation. The flour from these varieties appeared to be somewhat softer than that from Federation. Some samples of Marfed had very high particle-size index values and were of questionable milling quality, showing a tendency to produce a slow-bolting flour, while other lots were satisfactory. A number of the varieties that generally grade as hard white on the market had low particle-size index values. Fedawa, Onas, and Onas 41 had the longest dough-ball time, and the white club wheats, Jenkin and Union, the shortest. In ash content of flour, Onas 41 and Onas averaged materially higher than Federation. Idaed averaged lowest in flour ash in comparison with the comparably grown Federation.

Most of the soft-textured white varieties made satisfactory cake, with some being slightly better and a number equal to or only slightly poorer than Federation in quality. Marfed and Fedawa made questionable or poor cakes. Onas 41, Pacific Bluestem, and Baart 38 were best, exceeding Federation in cake quality. Many of the varieties made cookies that were equal to or somewhat better than the cookies from Federation. Jenkin was outstanding in cooky quality, averaging better than any other variety grown in the western region. Union, Irwin Dicklow, and Marfed have also ranked among the better varieties for cooky purposes. Baart, Baart 38, and Pileraw made unsatisfactory cookies.

A number of the varieties exceeded Federation in bread-making quality. Among the best in loaf volume, compared with the comparably grown Federation, were Onas 41, Fedawa, Idaed, Baart, and Federation 41. Union and Jenkin averaged lowest in loaf volume in comparison with Federation. The varieties that averaged best in loaf volume of bread generally were best in grain and texture of crumb. Fedawa, Idaed, Baart, and Lemhi made bread that was better in grain and texture than the bread from Federation. There were no significant differences among the different varieties in water absorption of flour. All were low compared with the hard red spring varieties.

A comparison of the quality characteristics of the three hard red spring and three white varieties with hard-textured grain shows that all of the varieties were of good test weight and were similar in carotenoid content and flour yield. Some lots of Hard Federation 31, particularly those highest in particle-size index, bolted slow in milling and were less desirable in this respect than other lots of this variety. All varieties exceeded the comparably grown White Federation in wheat protein. Thatcher, Ceres, and Marquis, which averaged 1.0 to 1.5 percent higher in protein, made good bread, better in grain and texture but about the same in loaf volume as that from White Federation.

The hard red spring varieties produced in the Pacific Northwest apparently do not make bread equal to that from grain of the same protein content produced in Montana.

**END**