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C. T. Hirst

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EXPERIMENT STATION

Utah Agricultural College

Bulletin No. 125

GOLD COIN TURKEY

The Chemical Milling and Baking Value of Utah Wheats

BY

ROBERT STEWART and C. T. HIRST

Logan, Utah, August, 1913

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The Chemical Milling and Baking Value of Utah Wheats

By Robert Stewart and C. T. Hirst.

The Chemical Department of the Utah Experiment Station, since 1903, has been conducting investigations regarding the value of different wheats grown in the State. The results obtained during the years 1903 to 1906 were published as Bulletin No. 103 of this station. A special investigation in 1910 regarding the influence of the combined harvester on the value of the wheat was conducted and the results obtained issued as Bulletin No. 113. The results reported in the following pages were obtained during the progress of these investigations during the years 1907, 1908, and 1909. The method of milling the samples of wheat are essentially the same as previously reported.* The samples of wheat were all cleaned by the scrubber as indicated in the previous report. The methods of analysis are similar to the ones described in the former bulletins. The determinations for gliadin and glutenin are not reported because considerable energy has been expended on perfecting a better method of determining the gliadin content of the flour. Th results of this special investication have been published by Dr. Greaves.† The determination of the acidity of the flour has also been omitted. Before any valuable information can be obtained from this factor, it is necessary to make a complete study of the methods of determination. Such a study will be taken up at this laboratory. The volumetric method as reported in the former bulletin has no value.

*Utah Exp. Sta. Bull. 113.
†Univ. of Cal. Publications in Physiology, Vol. 4 No. 6, Berkeley, Cal.

1. Brief Review of Work Already Done at the Utah Experiment Station.

Some interesting and important results have been obtained, as indicated in the former publications. A low moisture content is characteristic of arid farm grains. This is an item of considerable practical importance to the grain buyer, since it gives to arid farm grain a higher intrinsic value. The difference of one per cent in moisture content is one which the buyer cannot ignore in the purchase of large quantities of grain. A high protein content of the arid farm grains is characteristic. The protein content of the winter grains was found to be nearly as high as the protein content of the spring grains, notwithstanding the fact that the spring varieties were nearly all Durum varieties, which are usually regarded as containing a much higher percentage of protein than the ordinary so-called common bread varieties. A marked difference was found in the protein content of some of the varieties grown; some of the more common favorites were found to be very deficient in this important constituent and therefore of less value for bread-making purposes.

2. Necessity of Standardization of Western Grains.

The western grain grower is beginning to realize that it is not only necessary to grow his grain, but that he must receive full market value for his product. In the past, he has ignored the importance of having his product receive fair treatment in the grain markets of the world. The grain buyers at the great central wheat markets attempt to standardize the grain brought by classifying them as No. 1, 2, 3, etc., and base their classification almost wholly upon certain physical characteristics, such as hardness, plumpness, color of berry, etc., characteristics which may not be the controlling ones in determining the value of the wheat for flour production. In fact, they may often mislead the

buyer. It would seem that reliable information regarding the actual moisture content of the wheat and the protein content and actual baking value of the flour would be more reliable guides in the purchase of wheat. The wheat of the arid West is not receiving the consideration due it at the great grain markets of the country. It is regarded as having poor quality from the millers' and bakers' point of view and is merely classed as "Western Red" or "Western White." This is a condition which must be corrected and the farmer must see that this is done. But the farmers of a given district must first unite in growing a few varieties of wheat having the combined properties of high yield, good milling and good chemical characteristics. The farmer of the intermountain region must overcome the stigma of growing a heterogenous mixture of grains before he can receive the kind of treatment which should be accorded him because of the high quality of his product. The significance and importance of a study of the milling qualities of dry farm wheats and the chemical and baking value of the flour produced from them is thus readily apparent.

B. EXPERIMENTAL PART.

A discussion of the work reported in this bulletin naturally falls into three divisions: a discussion of the spring grains, the winter grains and the irrigated grains. Under each subject, there is logically taken up a discussion of the yield of milling products; chemical composition of wheat, bran and shorts; the chemical composition of the flour and the baking value of the flour produced.

1. The Spring Grains.

Only the spring grains grown in 1907 and 1908 were milled. In all cases, the grain was stored for at least nine months after harvesting before it was milled. Thus, the milling was done under as uniform conditions as possible.

The spring grains studied consisted almost entirely of Durum varieties. In 1908, a few of the common bread varities were grown. The spring grains are classified as hard, semi-hard, and Durum varieties.

a. Yield of Milling Products.

The yield of milling products obtained from milling of the spring grains is recorded in Table 1.

TABLE 1.—YIELD OF MILLING PRODUCTS. RESULTS EXPRESSED AS PER CENT OF DRY WEIGHT.

Variety.	No. of tests	Weight of 100 kernels	Per cent flour	Per cent bran	Per cent shorts	Per cent error
Hard Spring Varieties.						
Wellman's Fife .	1	2.211	69.85	18.69	10.13	–1.33
Whitington	1	2.407	69.41	19.89	10.02	–0.59
Average	2	2.309	69.63	19.34	10.08	–0.96
Semi-hard Spring Varieties.						
Egyptian Spring.	1	2.123	54.31	33.97	10.54	–1.18
Ghirka Spring...	1	2.696	61.86	27.82	11.49	1.17
New Zeland	1	2.677	61.84	19.60	17.77	0.41
Galgalos	1	3.282	67.31	25.38	8.36	1.05
Mexican No. 1 ..	1	3.288	65.83	24.28	9.01	–0.88
Mexican No. 2 ..	1	2.336	63.46	28.46	6.12	–1.96
Average	6	2.726	62.35	25.59	11.58	–0.59
Durum Varieties.						
Romanow	1	2.216	72.38	13.24	13.31	–1.07
Kubanka	1	3.411	66.57	22.52	10.95	–0.04
Medeah	1	2.773	66.24	21.19	12.24	–0.33
Kahla	1	4.326	71.33	13.42	14.60	0.66
Richi	1	3.277	67.18	17.29	12.73	–2.80
Nicaragua	1	2.699	72.04	16.01	10.08	–1.87
Mohamed Ben Bachir	1	3.326	64.29	21.60	.....	.....
Average	7	3.419	69.80	16.31	12.89	–1.01

With the spring grains, the maximum yield of flour, 72.38 per cent, was obtained from Romanow, which has nearly the lowest weight per 100 Kernels. The next highest yield of Flour, 72.04 per cent, is given by Nicaragua. The minimum yield of flour was obtained from Egyptian Spring, which has the smallest weight per 100 kernels.

The average yield of milling products for the spring grains is recorded in Table 2.

TABLE 2.—AVERAGE YIELD OF MILLING PRODUCTS FOR SPRING GRAINS.

	No. of tests	Weight of 100 kernels	Per cent flour	Per cent bran	Per cent shorts	Per cent error
Av. for Hard Spring..	2	2.309	69.63	19.34	10.08	–0.96
Av. for Semi-Hard Spring	6	2.726	62.35	25.59	11.58	–0.59
Av. for Durum	7	3.419	69.80	16.31	12.89	–1.01

These average results show that the Durum wheat has the greatest weight per hundred kernels, while the hard spring wheat is lowest in this respect; yet, the yield of flour is practically the same. This table also shows that the class giving the highest yield of flour has a tendency to give also the highest yield of shorts and the lowest yield of bran and those giving the lowest yield of flour give the lowest yield of shorts and the highest yield of bran.

b. Chemical Composition of Wheat, Bran and Shorts.

The results obtained from the determination of the moisture and protein in the wheat, bran and shorts are recorded in Table 3.

TABLE 3.—MOISTURE AND PROTEIN IN WHEAT, BRAN AND SHORTS. RESULTS EXPRESSED AS PER CENT OF DRY WEIGHT.

Variety	No. of tests	Where grown	WHEAT Moisture	WHEAT Protein	BRAN Moisture	BRAN Protein	SHORTS Moisture	SHORTS Protein

Hard Spring Varieties.

Wellman's Fife.	1	32 To'le	7.25	18.43	10.16	23.08	9.04	21.97
Whitington ...	1	34 To'le	6.96	17.98	6.30	21.62	8.76	23.46
Average	2		7.11	18.21	8.23	22.35	8.90	22.72

Semi-Hard Spring Varieties.

Egyptian Spring	1	Juab	8.08	19.41	10.38	21.96	9.22	20.43
Ghirka Spring.	1	Juab	8.58	17.67	9.53	21.75	8.68	20.55
New Zealand ..	1	Juab	8.36	17.64	9.27	21.71	8.83	20.38
Galgalos	1	Juab	8.45	17.63	9.36	22.95	9.03	20.56
Mexican No. 1..	1	Juab	8.13	16.29	8.97	20.93	8.01	18.88
Mexican No. 2..	1	Juab	7.83	15.95	8.39	18.88	7.53	18.48
Average	6		8.26	17.46	9.31	21.41	8.59	19.95

Durum Varieties.

Romanow	1	Tooele	6.99	19.88	8.74	22.54	8.75	22.50
Kubanka	1	Juab	6.35	17.49	9.79	18.48	8.75	.....
Medeah	1	Juab	8.63	16.94	9.32	21.05	8.47	19.26
Kahla	1	Juab	8.17	16.28	9.62	18.95	8.97	17.59
Richi	1	Tooele	5.96	15.94	10.33	19.40	8.39	18.06
Adjini	1	Juab	8.35	15.91	4.88	21.22	8.78	18.43
Nicaragua	1	Wash'n	7.47	15.85	10.24	19.82	9.02	18.82
Mohamed Ben Bachir	1	Juab	8.47	15.83	9.01	17.95	8.14	18.37
Average	7		7.67	16.67	9.12	19.73	8.72	18.69

The grains in this table in each group are arranged in the descending order of their protein content and this arrangement is maintained in the tables showing the milling products and the chemical composition of flour.

The most striking thing brought out by a study of Table 3 is the high protein and low moisture content of all varieties of wheat. The highest protein content, 19.88 per cent, is found in Romanow, but reference to Table 1 shows that this grain is much shrunken, the weight of 100 kernels being only 2.216 grams, thus accounting partially for the high protein content. The lowest protein content, 15.83 per cent, is found in Mohamed ben Bachir, which has about

an average weight per 100 kernels. The weight of 100 kernels of Kahla is very high, indicating a well developed grain, while the protein content is medium, 16.28 per cent, indicating a normal protein content. The average result for the two years are given in Table 4.

TABLE 4.—AVERAGE COMPOSITION OF WHEAT, BRAN AND SHORTS.

		WHEAT		BRAN		SHORTS	
	No. of tests	Moisture	Protein	Moisture	Protein	Moisture	Protein
Av. for Hard Spring...	2	7.11	18.21	8.23	22.35	8.90	22.72
Av. for Semi-Hard Spring	2	8.26	17.46	9.31	21.41	8.59	19.95
Av. for Durum	7	7.65	16.67	9.12	19.73	8.72	18.69

This table emphasizes the statement that the moisture content is low and the protein content high in the spring dry farm grains. The moisture and protein content is higher in the bran and shorts than the moisture and protein content in the wheat. It is also interesting to note that the protein content of he hard spring and semi-hard spring varieties is higher than that of the Durum varieties. This is also true of the bran and shorts.

c. The Chemical Composition of Flour.

The results obtained from a chemical analysis of the flour are recorded in Table 5.

TABLE 5.—CHEMICAL COMPOSITION OF FLOUR.

Variety	No. of tests	Where grown	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
Hard Spring Varieties.								
Wellman's Fife	1	32 To'le	10.83	19.00	51.83	20.19	2.56:1	0.378
Whitington ...	1	34 To'le	9.91	18.06	61.95	21.09	2.93:1	0.639
Average	2		10.37	18.53	56.89	20.64	2.75:1	0.509

Semi-Hard Spring Varieties.

Egyptian Spr'g	1	Juab	10.74	15.54	50.77	16.93	2.99:1	0.779
Ghirka Spring.	1	Juab	9.91	14.47	43.23	15.39	2.80:1	0.593
New Zealand..	1	Wash.	10.64	15.05	43.75	14.94	2.94:1	0.512
Galgalos	1	Juab	10.41	16.27	39.12	13.54	2.88:1	0.565
Mexican No. 1	1	Juab	10.39	13.92	38.51	14.44	2.66:1	0.498
Mexican No. 2	1	Juab	9.38	13.92	40.76	13.93	2.92:1	0.557
Average	6		10.30	14.89	42.84	14.87	2.87:1	0.574

Durum Varieties.

Romanow	1	Tooele	9.75	20.63	62.38	21.54	2.89:1	0.862
Kubanka	1	Juab	10.44	16.03	49.45	16.57	2.98:1	0.823
Medeah	1	Juab	10.29	16.80	48.52	16.91	2.86:1	0.628
Kahla	1	Juab	10.21	16.59	45.52	15.84	2.86:1	0.793
Richi	1	Tooele	10.49	15.87	44.06	14.57	3.02:1	0.600
Adjini	1	Juab	11.11	15.61	37.38	14.03	2.66:1	0.853
Nicaragua	1	Wash.	10.60	12.79	36.17	12.63	2.86:1	0.541
Mohamed ben Bachir	1	Juab	9.72	15.44	38.20	13.66	2.79:1	1.045
Average	8		10.31	16.23	45.06	15.69	2.86:1	0.787

These results for the chemical composition of the flour show that the variety Romanow, which has the highest protein content in the wheat, has also the highest protein content in the flour. Nicaragua, another Durum variety, however, has the lowest protein content in the flour. It is noteworthy that the protein content of all the spring varieties of wheat is exceptionally high. The moist gluten content is remarkably high throughout, the lowest result being above the average usually reported. The protein content obtained by multiplying the nitrogen by 5.7 agrees remarkably well with the dry glutten content obtained by washing out the starch in the usual manner.

In Table 6, the average composition of the flour is reported.

TABLE 6.—AVERAGE COMPOSITION OF FLOUR PRODUCED FROM SPRING GRAINS.

	No. of tests	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
Av. for Hard Spring	2	10.37	18.53	56.89	20.64	2.75:1	0.509
Av. for Semi-Hard Spring	6	10.30	14.89	42.84	14.87	2.87:1	0.574
Av. for Durum ...	8	10.31	16.23	45.06	15.69	2.86:1	0.787

This table indicates that the flour produced from all classes of spring wheat has a low moisture and a high gluten content, and that the protein content of the hard spring wheat is fully as high as that of the Durum wheat. This shows quite clearly that the Durum wheat has no place in the agriculture of Utah.

d. Bread-Making Value of Flour.

The bread-making value of the flour produced is recorded in Table 7. The method of obtaining the several numbers and their value has already been reported.*

TABLE 7.—BREAD-MAKING VALUE OF FLOUR PRODUCED FROM SPRING GRAINS.

Variety	No. of tests	Volume of water added	Volume of water retained	Ratio of protein to volume of water added	Weight of loaf	Volume of loaf	Ratio of protein to volume of loaf
Semi-Hard Spring Varieties.							
Galgalos	1	208	110	1:12.8	480	2328	1:143.1
Mexican No. 1....	1	190	106	1:13.6	476	1902	1.136.6
Egyptian Spring..	1	246	142	1.15.8	512	1329	1: 85.5
Average	3	215	119	1:14.1	489	1853	1:121.7

*Stewart and Hirst, Utah Exp. Sta. Bul. 113.

Durum Varieties.

Medeah	1	226	114	1:13.4	484	2180	1:129.8
Richi	1	234	118	1:14.7	488	1889	1:119
Nicaragua	1	230	144	1:17.9	514	1798	1.140.6
Mohamed Ben Bachir	1	228	125	1:14.7	475	1700	1.110.1
Kubanka	1	220	104	1:13.7	474	1583	1: 98.8
Kahla	2	246	147	1:13.6	517	1453	1. 74.9
Average	7	231	125	1:14.7	492	1767	1:112.2

Galgalos gave the loaf having the greatest volume, although it absorbed considerably less than the average amount of water.

The flour produced from Egyptian Spring gave the loaf of smallest volume, although it was one of the two which absorbed the greatest volume of water, the other being Kahla, which has next to the lowest volume of loaf. These two varieties having the smallest volume have also the greatest amount of water retained, and give loaves having the greatest weight.

In Table 8 are recorded the average results obtained for bread-making value from all the spring grains.

TABLE 8.—AVERAGE BREAD-MAKING VALUE OF FLOUR PRODUCED FROM SPRING GRAINS.

	No. of tests	Vol. of water added	Wt. of loaf	Vol. of of loaf	Ratio of protein to volume of loaf
Av. for Semi Hard Spring.	3	215	489	1853	1:121.7
Av. for Durum	7	231	492	1767	1:112.2

From Table 8 it is observed that the semi-hard spring varieties give a loaf having the greatest volume but having the lowest weight and absorbing the smallest volume of water.

e. Conclusions With Respect to Spring Grains.

While the spring grains on dry farms in Utah are not destined to become a crop worthy of much consideration, owing to the better yielding qualities of the winter grains, yet it is interesting to note some of the more important points brought out in a study of the results already obtained. The spring grains grown on the dry farms of Utah have a low moisture and a high protein content. In one or two cases the extremely high protein content is due to the shrunken state of the grain, but in the other cases there is no such shrunken condition, indicating quite clearly that the high protein content is a normal characteristic. The results obtained by a study of the spring wheat is summarized in Table 9.

TABLE 9.—SUMMARIZING THE RESULTS OBTAINED FROM SPRING WHEATS.

Variety	Protein in wheat	Gluten in flour	Vol. of water absorbed	Wt. of loaf	Vol. of loaf	Ratio of protein to vol. of loaf
Egyptian Spring	19.41	15.54	246	512	1329	1: 85
Galgalos	17.63	16.27	208	480	2328	1:143.1
Kubanka	17.49	16.03	220	474	1583	1. 98.7
Medeah	16.94	16.80	226	484	2180	1:129.8
Mexican No. 1	16.29	13.92	190	476	1902	1:136.6
Richi	15.94	15.87	234	488	1889	1:119.0
Nicaragua	15.85	12.79	230	514	1798	1.140.6
Mohamed ben Bachir.	15.83	15.44	228	475	1700	1.110.1
Kahla	15.73	16.27	246	517	1447	1: 86.1

From a study of this table, it is seen that the flour absorbing the greatest amount of water does not necessarily give the loaf of greatest weight. There does not seem to be a definite relationship between the amount of water absorbed by the flour and the amount of water retained by the bread.

2. Winter Dry Farm Grains.

The work with the winter dry farm grains in 1907 consists of a study of a number of varieties grown on the Tooele, Juab and Washington County farms. In 1908, all the experimental dry farm work was concentrated on the Juab County farm and many new varieties of dry farm winter wheat were introduced and therefore only the results for the two years are reported.

a. Yield of Milling Products.

The yield of milling products are recorded in Table 10.

TABLE 10.—YIELD OF MILLING PRODUCTS. RESULTS EXPRESSED AS PER CENT OF DRY WEIGHT. WINTER GRAINS, 1907.

Variety	No. of tests	Where grown	Weight of 100 kernels	Per cent flour	Per cent bran	Per cent shorts	Per cent error
Hard Winter Varieties.							
Beloglina	1		2.819	70.83	19.42	10.70	–0.95
Turkey	1	14 Wash.	3.010	72.41	20.70	6.96	0.07
Average	2		2.915	71.62	20.06	8.83	–0.44
Semi-Hard Winter Varieties.							
Winter La Salle.	1	Wash.	3.476	73.75	13.70	12.96	0.41
Lofthouse	1	Juab	3.669	71.79	15.82	10.05	2.38
Sonora	1	60 To'le	3.420	68.15	16.93	12.25	2.67
Red Chaff	1	57 To'le	2.895	69.33	15.98	10.98	3.71
Blue Stem	1	55 To'le	3.008	70.10	18.36	10.34	–1.20
Odessa	1	51 To'le	3.074	74.37	15.57	8.67	–1.39
Lofthouse	1	52 To'le	3.683	74.87	19.08	4.14	–0.89
Sonora	1	Wash.	2.821	72.42	19.01	7.22	–0.98
Odessa	1	Wash.	3.089	73.14	16.01	10.57	0.17
Average	9		3.196	72.03	16.95	9.44	0.78
Soft Winter Varieties.							
Gold Coin	1	53 To'le	3.390	72.54	16.63	10.03	–0.79

TABLE 10 (Con.)

YIELD OF MILLING PRODUCTS. WINTER GRAINS, 1908-09.

Hard Winter Varieties.

G. I. No.	Variety	No. of tests	Wt. of 100 kernels	Per cent flour	Per cent bran	Per cent shorts	Per cent error
Tooele Co.	Turkey	1	2.327	67.13	24.47	9.48	1.03
1539	Torgova	1	2.801	71.47	22.77	6.60	0.84
1436	Crimean	2	2.716	70.23	23.28	6.98	0.49
1432	Crimean	2	2.974	70.15	23.66	6.64	0.45
1543	Beloglina	2	3.012	68.04	23.29	8.71	0.04
1544	Beloglina	2	2.888	71.04	22.81	7.66	1.51
1435	Crimean	2	3.093	71.94	22.08	6.15	0.17
1560	Banat	2	3.039	69.09	26.08	5.45	0.62
2998	Turkey	5	2.944	69.36	23.03	8.84	1.23
1437	Crimean	2	2.935	69.69	22.70	7.69	0.08
2086	Pellissier	2	2.914	68.81	22.87	9.18	0.86
1824	Zim'erman T'k'y	1	2.812	70.02	22.07	9.95	2.04
1676	Servian	2	3.073	70.19	23.16	7.28	0.63
2337	Blk. Win. Emmer	1	3.278	67.76	16.05	16.49	0.30
1558	Turkey	2	2.905	69.23	24.46	7.85	0.54
1433	Crimean	2	3.192	68.66	24.85	6.89	0.40
1564	Pesterboden	2	2.791	68.78	23.45	7.56	–0.21
2042	Hungarian	1	3.158	70.13	22.82	7.43	0.38
1439	Ulta	2	2.756	67.69	23.93	9.13	0.75
1571	Turkey	2	2.786	68.50	24.71	8.03	1.24
2034	Hungarian	2	3.230	70.37	21.23	7.83	–0.57
1739	Budapest	2	3.385	70.71	24.22	6.07	1.00
2100	Black Don	2	3.549	63.69	22.80	15.11	2.26
1442	Kharkov 2		2.894	67.88	25.48	8.05	1.40
1559	Crimean	2	2.878	69.72	25.83	5.36	0.91
1658	Roumanian	2	3.565	70.80	23.70	6.92	1.42
1583	Kharkov	2	2.910	67.84	25.20	8.44	1.48
1563	Weissenberg ...	2	3.017	70.22	21.97	8.18	0.37
1756	Missouri	2	3.047	71.55	23.11	7.32	1.98
1561	Theiss	2	2.671	68.56	24.39	7.45	0.40
1596	Fretes	2	2.688	64.36	25.36	5.86	–2.91
2979	Alberta Red ...	2	2.901	69.94	25.16	6.24	1.35
2048	Bulgarian	2	3.202	67.33	24.32	8.54	0.19
1656	Roumanian	2	2.896	71.10	22.86	7.84	1.80
1691	Bosnian	2	3.131	69.79	26.72	3.29	–0.20
1355	Armivar	2	2.905	68.05	25.84	6.29	0.18
2908	Malakof	2	2.857	69.00	24.09	6.99	0.08

1662	Roumanian	2	2.855	71.30	24.09	6.53	1.92
1667	Beloglina	2	2.970	68.06	24.98	7.40	0.44
1783	Oklahoma	2	2.697	70.97	24.05	5.84	0.86
3055	Turkey	1	2.997	68.72	22.10	8.30	–0.88
Wash. Co.	Turkey	1	2.606	55.92	21.84	20.81	–1.43
Average	.....	80	2.944	69.27	23.64	7.89	0.56

TABLE 10 (Con.)

YIELD OF MILLING PRODUCTS. WINTER GRAINS, 1908-09.

G. I. No.	Variety	No. of tests	Wt. of 100 kernels	Per cent flour	Per cent bran	Per cent shorts	Per cent error
	Semi-Hard Winter Wheat.						
Tooele	Lofthouse	2	2.791	66.20	28.60	4.31	–0.89
Wash.	Lofthouse	1	2.624	56.84	25.34	18.47	0.65
1532	Red Russian ...	2	2.875	67.89	25.16	7.36	0.41
1781	Jap. Sq. Head..	2	3.458	66.89	26.39	6.72	.....
Wash. Co.	Odessa	1	3.080	65.92	27.97	5.81	–0.30
1438	Ghirka Winter..	2	2.878	73.64	21.55	5.89	1.08
Average	.....	10	2.95	66.23	25.84	8.09	0.16
	Soft Winter Wheat.						
29	Currell	2	2.796	66.93	26.46	7.98	1.77
Tooele	Kofod	1	3.213	66.32	22.75	9.48	–1.45
1784	Oklahoma	1	3.208	66.23	24.27	8.81	–0.69
2907	Zimmerman ...	2	2.502	68.20	26.39	6.38	0.77
3000	Blue Stem	1	3.094	69.04	24.14	5.42	–1.40
1787	Japanese	2	2.994	68.91	23.88	7.52	0.31
3018	Salt Lake Club..	2	3.042	67.46	26.65	6.70	0.81
2996	Gold Coin	1	3.042	70.08	22.87	6.74	–0.31
2986	California Gem .	2	2.617	66.66	27.17	6.37	0.20
2985	Blue Stem	2	3.528	69.19	25.50	6.16	0.85
2999	White Club	2	2.711	69.12	24.27	5.01	–1.60
2997	Kofod	2	3.430	67.38	26.48	5.84	–0.30
1395-2	Diehl's Med. ...	2	3.068	67.94	26.32	5.85	0.11
1757	Jap. Velv. Chaff	2	3.387	66.11	25.74	6.34	–1.81
3019	Australian	2	3.455	68.90	25.75	5.61	0.27
Average	.....	26	3.073	67.90	25.24	6.68	–0.16

In 1907, the semi-hard variety Lofthouse with the highest weight per 100 kernels gave the highest yield, 74.87 per cent, of flour. Sonora gave the lowest yield, with 68.15 per cent. The Lofthouse gave a high yield of bran and a low yield of shorts, while Sonora gave about two-thirds as much shorts as bran.

The average yield of milling products for winter grains can readily be seen in Table 11.

TABLE 11.—AVERAGE YIELD OF MILLING PRODUCTS FOR WINTER GRAINS.

	No. of tests	Wt. of 100 kernels	Per cent flour	Per cent bran	Per cent shorts	Per cent error
1907						
Hard winter varieties.....	2	2.915	71.62	20.06	8.83	–0.44
Semi-hard winter varieties.	9	3.196	72.03	16.95	9.44	0.78
Soft winter varieties	1	3.390	72.54	16.63	10.03	–0.79
1908-9						
Hard winter varieties	80	2.944	69.27	23.64	7.89	–0.56
Semi-hard winter varieties.	10	2.950	66.23	25.84	8.09	0.16
Soft winter varieties	26	3.073	67.90	25.24	6.68	–0.16

The uniformly high yield of flour will be noted. The soft winter variety leads with 72.54 per cent, and also the greatest weight per 100 kernels, but this average includes only one determination of one variety. Of the winter grains of 1908-09, Ghirka Winter, 1438, a semi-hard variety, in an average of two determinations, gave the highest yield of flour, it being 73.64 per cent. The lowest yield, 55.92 per cent, was given by a Turkey from Washington County. It may, however, be noted that an average of five samples of Turkey, 2998 from Juab County, gave 69.36 per cent of flour.

From Table 11, averages for 1908-09, it will be seen that the semi-hard varieties, although having a slightly lower weight per 100 kernels, gives about a one-per cent higher yield of flour. The soft winter varieties with the highest weight per 100 kernels come next.

b. Chemical Composition of Wheat, Bran and Shorts.

The wheat is characterized by a low moisture and high protein content. The bran and shorts have a uniformly high protein content. In 1907, the two wheats having the lowest protein content are Gold Coin and Odessa.

TABLE 12.—MOISTURE AND PROTEIN IN WHEAT, BRAN AND SHORTS. RESULTS EXPRESSED AS PER CENT OF DRY WEIGHT. WINTER GRAINS.

Variety	No. of tests	Where grown	WHEAT Moisture	WHEAT Protein	BRAN Moisture	BRAN Protein	SHORTS Moisture	SHORTS Protein
Hard Winter Varieties, 1907.								
Beloglina	1	Juab	9.72	14.74	9.87	17.62	9.95	15.84
Turkey	1	Wash.	9.23	13.04	10.53	16.69	9.74	15.54
Average	2		9.48	13.89	10.20	17.16	9.85	15.69
Semi-Hard Winter Varieties, 1907.								
Winter La Salle	1	Wash.	9.25	15.40	11.22	20.03	9.51	20.84
Lofthouse	1	Juab	6.97	15.38	9.56	21.29	8.97	20.37
Sonora	1	Tooele	6.64	14.78	10.63	18.02	9.48	17.21
Red Chaff	1	Wash.	8.34	14.75	10.15	18.80	9.62	17.84
Red Chaff	1	Tooele	5 03	14.09	10.74	17.19	10.32	17.63
Blue Stem	1	Tooele	6.99	13.48	10.12	16.18	9.47	15.89
Odessa	1	Tooele	7.14	13.43	7.82	15.91	8.66	16.46
Lofthouse	1	Tooele	6.79	13.30	7.59	16.02	6.10	18.64
Sonora	1	Wash.	8.44	13.03	10.04	17.58	9.50	17.30
Odessa	1	Wash.	8.35	12.31	9.80	13.75	8.92	16.92
Average	10		7.49	13.91	9.79	17.49	9.10	17.85
Soft Winter Varieties, 1907.								
Gold Coin	1	Tooele	8.40	12.40	10.31	16.33	9.60	16.67

TABLE 12 (Con.)—MOISTURE AND PROTEIN IN WHEAT, BRAN AND SHORTS. RESULTS EXPRESSED AS PER CENT OF DRY WEIGHT. WINTER GRAINS.

Hard Winter Varieties, 1908-09.

No. of	Variety	G. I. No.	WHEAT		BRAN		SHORTS	
			Mois-ture	Pro-tein	Mois-ture	Pro-tein	Mois-ture	Pro-tein
1	Turkey	Tooele Co.	8.06	17.87	9.25	20.61	9.41	18.71
1	Torgova	1539	8.52	17.53	8.97	21.01	8.97	19.05
2	Crimean	1436	8.45	17.46	8.86	22.09	8.00	19.56
2	Crimean	1432	8.35	17.41	9.10	21.63	7.45	18.20
2	Beloglina ...	1543	8.55	17.35	9.78	20.98	8.15	18.38
2	Beloglina ...	1544	8.41	17.08	9.17	20.43	9.23	18.78
2	Crimean ...	1435	8.20	17.03	7.99	20.94	8.18	19.14
2	Banat	1560	7.66	16.96	8.41	20.04	7.90	17.55
5	Turkey	2998	8.53	16.93	9.15	20.44	8.78	18.09
2	Crimean	1437	8.67	16.90	9.21	20.87	8.43	18.47
2	Pellissier ...	2086	8.42	16.88	9.08	20.10	9.47	17.93
1	Zimmerman-Turkey ..	1824	7.85	16.84	9.45	21.66	8.85	20.13
2	Servian	1676	8.36	16.68	9.44	20.81	9.20	18.22
1	Black Winter Emmer ...	2337	8.82	16.53	10.25	20.88	9.83	15.89
2	Turkey	1558	8.04	16.50	9.58	19.01	8.42	17.06
2	Crimean ...	1433	8.29	16.46	8.66	21.31	7.93	19.00
2	Pesterboden..	1564	8.19	16.35	9.43	19.84	8.59	17.20
2	Hungarian ..	2042	8.55	16.34	9.65	20.85	9.49	17.83
2	Ulta	1439	8.68	16.26	9.16	19.50	8.65	17.43
2	Turkey	1571	8.47	16.20	9.85	19.36	9.52	16.30
2	Hungarian ..	2034	8.52	16.47	9.73	20.71	9.34	18.31
2	Budapest ...	1739	8.65	16.12	9.45	20.23	9.32	16.58
2	Kharkov ...	1442	8.39	16.04	9.47	19.72	8.14	18.99
2	Crimean	1559	8.26	15.87	8.92	19.54	9.14	18.05
2	Roumanian .	1658	8.57	15.78	9.45	20.32	9.17	17.96
2	Kharkov	1583	8.21	15.72	8.82	19.13	8.95	17.60
2	Weissenberg.	1563	7.77	15.64	9.25	19.94	8.99	16.77
2	Missouri	1756	8.15	15.61	9.29	19.43	8.67	17.10
2	Theiss	1561	7.91	15.53	8.82	18.82	8.79	17.40
2	Fretes	1596	8.33	15.53	9.31	18.19	9.00	16.80
2	Alberta Red.	2979	8.61	15.51	8.72	18.84	7.92	17.58
2	Bulgarian ..	2048	8.20	15.46	9.39	18.96	9.41	17.24
2	Roumanian .	1656	8.47	15.40	9.29	20.04	9.05	17.31
2	Bosnian	1691	8.08	15.31	9.06	18.60	8.54	17.00
2	Armivar ...	1355	8.15	15.17	8.61	22.59	8.14	19.01

2	Malakof	2908	8.28	15.12	8.99	19.22	8.99	17.78
2	Roumanian .	1662	8.70	14.84	9.04	19.66	8.86	17.95
2	Beloglina ...	1667	8.60	14.62	9.89	20.12	9.46	17.54
2	Oklahoma ..	1783	8.18	14.60	8.37	18.28	9.01	17.28
1	Turkey	3055	8.69	14.50	8.31	18.63	7.70	16.47
1	Turkey	Wash. Co.	8.76	14.28	11.44	17.49	9.06	18.05
80	Average		8.35	16.11	9.22	20.02	8.79	17.85

TABLE 12 (Con.)

MOISTURE AND PHOTEIN IN WHEAT, BRAN AND SHORTS. RESULTS EXPRESSED AS PER CENT OF DRY WEIGHT.

			WHEAT		BRAN		SHORTS	
No. of tests	Variety	G. I. No.	Mois-ture	Pro-tein	Mois-ture	Pro-tein	Mois-ture	Pro-tein
			Semi-Hard Winter Wheat.					
1	Lofthouse ..	Tooele Co.	7.86	19.60	9.07	24.19	8.32	21.62
1	Lofthouse ..	Wash. Co.	9.46	16.97	10.46	19.95	10.23	19.74
2	Red Russian.	1532	8.41	16.78	10.27	20.38	8.91	18.42
2	Jap. Sq. Head	1788-1	8.68	16.57	9.29	22.37	8.46	19.93
1	Odessa	Wash. Co.	8.17	15.39	8.24	20.06	7.66	17.04
2	Ghirka Wint.	1438	8.72	15.15	9.39	19.17	8.92	16.81
9	Average		8.55	16.74	9.45	21.02	8.75	18.93
			Soft Winter Wheat.					
2	Currell	2906	8.16	17.14	9.55	21.74	9.39	18.76
1	Kofod	Tooele	7.77	16.78	8.66	20.70	8.36	19.64
1	Oklahoma ..	1784	7.08	16.77	8.47	21.27	8.63	19.05
2	Zimmerman .	2907	8.39	16.02	9.04	21.59	7.86	19.20
2	Blue Stem ..	3000	7.68	16.00	8.25	20.52	8.04	17.99
2	Japanese ...	1787	8.17	15.87	8.40	20.33	8.69	18.71
2	Salt L. Club	3018	8.32	15.66	8.42	20.61	8.01	17.29
1	Gold Coin ...	2996	8.33	15.42	8.33	20.43	8.08	19.40
2	CCal. Gem .	2986	8.03	15.39	7.65	20.20	7.58	18.35
2	Blue Stem ..	2985	8.86	15.31	8.31	20.69	7.24	18.51
2	White Club .	2999	7.77	15.20	8.27	19.29	7.38	18.53
2	Kofod	2997	8.13	15.04	8.48	19.56	8.65	17.03
2	Diehl's Medit	1395-2	7.85	14.86	9.02	20.34	8.59	18.12
2	Jap. Vel. Chaff	1757	7.33	14.62	8.78	22.38	8.10	19.62
2	White Aust..	3019	8.16	14.16	8.46	20.27	7.80	17.77
27	Average		8.00	15.62	8.54	20.66	8.15	18.53

The grain of both years has a high protein and low moisture content. The bran and shorts are uniformly high in protein. In 1907, Winter La Salle from Washington County has the highest and Odessa, also from Washington County, the lowest protein content, they being 15.40 and 12.31 per cent, respectively. From Table 10, it may be observed that Winter La Salle has next to highest weight per 100 kernels of the 1907 winter wheats and Odessa is only a little below the average. Gold Coin, which has the next lowest protein content, has a weight per 100 kernels of 3.390 grams, almost as great as Winter La Salle.

In 1908-09, Lofthouse from Tooele County leads in protein content in wheat, with 19.60 per cent, with a weight per 100 kernels of 2.791, which is a little below the average. Turkey comes next with 17.87 per cent, and a weight of 2.327 grams per 100 kernels. The lowest is White Australian, with 14.16 per cent protein and a weight per 100 kernels of 3.455 grams.

TABLE 13.—AVERAGE COMPOSITION OF WHEAT, BRAN AND SHORTS. WINTER GRAINS.

	No. of tests	WHEAT Moisture	WHEAT Protein	BRAN Moisture	BRAN Protein	SHORTS Moisture	SHORTS Protein
1907 grains							
Av. of hard winter	1	9.48	13.89	10.20	17.16	9.85	15.69
Av. of semi-hard winter	10	7.49	13.91	9.79	17.49	9.10	17.85
Av. of soft winter	1	8.40	12.40	10.31	16.33	9.60	16.67
1908-09 grains							
Av. of hard winter ...	80	8.35	16.11	9.22	20.02	8.79	17.85
Av. of semi-hard winter.	9	8.55	16.74	9.45	21.02	8.75	18.93
Av. of soft winter	27	8.00	15.62	8.54	20.66	8.16	18.53

Table 13 shows that in 1907 the semi-hard winter grains are slightly higher in protein and lower in moisture in wheat, bran and shorts than the hard or soft varieties. In 1908-09, the same conditions hold true with respect to the protein, but not the moisture.

C. CHEMICAL COMPOSITION OF FLOUR.

TABLE 14.—CHEMICAL COMPOSITION OF FLOUR FROM WINTER GRAINS. 1907.

Hard Winter Varieties.

Variety	No. of tests	Where grown	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
Beloglina	1	Juab	10.17	15 54	38.89	14.18	2.74:1	0.592
Turkey	1	14 Wa'sh.	11.03	13.05	30.79	11.69	2.63:1	0.561
Average	1		10.60	14.30	34.84	12.94	2.69:1	0.577

Semi-Hard Winter Wheat.

Wint. La Salle	1	Wash.	10.39	14.60	41.13	14.46	2.84:1	0.548
Lofthouse ...	1	Juab	10.48	14.93	37.62	14.57	2.60:1	0.471
Sonora	1	Tooele	11.40	14.01	39.83	14.40	3.12:1	0.531
Red Chaff	1	Tooele	11.02	13.66	42.31	14.54	2.91:1	0.512
Blue Stem ...	1	Tooele	10.99	13.62	37.26	13.66	2.72:1	0.514
Odessa	1	Tooele	9.87	13.57	36.52	13.44	2.71:1	0.501
Lofthouse ...	1	Tooele	10.38	12.48	34.73	12.32	2.81:1	0.522
Sonora	1	Wash	10.59	12.07	31.37	11.26	2.78:1	0.528
Odessa	1	Wash.	10.64	12.49	27.22	9.76	2.79:1	0.516
Average	9		10.63	13.44	36.90	13.32	2.81:1	0.518

Soft Winter Varities.

Gold Coin ..	1		10.69	11.99	30.20	10.69	2.81:1	0.542

TABLE 14 (Con.)—CHEMICAL COMPOSITION OF FLOUR OF WINTER GRAINS. 1908-09.

Hard Winter Varieties.

Variety	No. G. I. No.	No. of tests	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
Turkey	Tooele	1	10.23	16.86	52.64	16.99	3.091:1	.491
Torgova	1539	2	10.05	16.93	46.60	16.71	2.81:1	.553

Crimean	1436	2	8.24	16.19	40.95	16.34	2.51:1	.588
Crimean	1432	2	7.98	15.73	47.45	16.77	2.79:1	.557
Beloglina	1543	2	9.84	16.71	27.64	16.14	2.91:1	.526
Beloglina	1544	2	9.61	15.61	42.37	15.30	2.75:1	.581
Crimean	1435	2	8.51	16.83	42.07	15.76	2.66:1	.538
Banat	1560	2	9.44	15.26	42.05	14.41	2.87:1	.507
Turkey	2998	5	8.56	14.82	40.06	13.41	2.98:1	.452
Crimean	1437	2	9.73	15.73	37.01	14.50	2.56:1	.524
Pellissier	2086	2	10.60	15.57	46.85	15.27	3.05:1	.540
Zimmerman-Turk.	1824	1	10.76	15.37	49.79	15.44	3.23:1	.523
Servian	1676	2	9.61	14.62	44.09	14.19	2.93:1	.496
Blk. Wint. Emmer	2337	1	8.61	14.60	34.63	13.27	2.61:1	.600
Turkey	1558	2	9.56	14.29	37.22	13.39	2.74:1	.502
Crimean	1433	2	9.13	15.82	41.57	15.41	2.69:1	.772
Pesterbodem ...	1564	2	9.80	14.73	46.58	15.67	2.94:1	.506
Hungarian	2042	2	10.24	14.91	45.59	15.75	2.87:1	0.496
Ultra	1439	2	9.55	14.50	39.63	14.32	2.75:1	.729
Turkey	1571	2	10.88	13.45	39.85	14.02	2.08:1	.464
Hungarian	2034	2	10.43	15.12	39.64	13.80	2.84:1	.549
Budapest	1739	2	9.54	16.07	40.36	13.49	3.00:1	.512
Kharkov	1442	2	10.10	14.67	41.51	14.34	2.87:1	.520
Crimean	1559	2	10.80	13.28	42.39	14.60	2.85:1	.526
Roumania	1658	2	10.08	14.64	44.52	15.13	2.90:1	.483
Kharkov	1583	2	10.09	15.26	41.85	13.81	2.99:1	.473
Weissenberg	1563	2	10.22	13.91	41.71	14.09	2.96:1	.486
Missouri	1756	2	9.37	14.85	41.84	14.05	2.97:1	.506
Theis	1561	2	9.81	13.95	40.15	14.62	2.88:1	.547
Alberta Red	2979	2	8.64	14.39	37.93	12.68	2.96:1	.448
Bulgarian	2048	2	10.31	13.51	39.34	13.39	2.91:1	.460
Roumanian	1656	2	9.89	14.53	42.26	14.68	2.82:1	.401
Bosnian	1691	2	8.96	13.95	37.55	12.59	2.96:1	.490
Armivar	1355	2	8.43	15.71	40.23	15.37	2.61:1	.454
Malakof	2908	2	10.55	14.07	25.89	13.26	3.51:1	.470
Roumanian	1662	2	9.71	13.55	42.17	13.89	3.00:1	.450
Beloglina	1667	2	9.80	13.83	40.38	13.51	2.95:1	.622
Oklahoma	1783	2	10.07	13.45	37.27	14.52	2.57:1	.508
Turkey	3055	1	8.54	12.61	29.99	10.89	2.75:1	.600
Turkey	Wash.	1	10.10	15.12	37.85	13.19	2.86:1	.527
Average		78	9.64	14.85	40.62	14.44	2.86:1	0.525

CHEMICAL COMPOSITION OF FLOUR OF WINTER GRAINS.
TABLE 14—(Continued).

Variety	G. I. No.	No. of tests	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
Semi-Hard Winter Grains.								
Lofthouse	Tooele	1	10.93	18.01	61.81	19.04	3.21:1	.503
Lofthouse	Wash.		10.50	14.65	38.80	13.04	2.97:1	.454
Red Russian	1532	2	10.43	15.96	41.42	15.52	2.67:1	.468
Jap. Sq. Head....	1781	2	9.80	13.83	39.67	13.63	2.87:1	.543
Odessa	Wash.	1	9.17	13.36	32.70	12.39	2.64:1	.440
Ghirka Winter ..	1438	2	9.65	14.68	37.86	13.89	2.72:1	.547
Average		9	10.08	15.08	42.04	14.59	2.85:1	.491
Soft Winter Varieties.								
Currell	2906	2	9.29	14.52	42.87	14.79	2.89:1	.502
Kofod	Tooele	1	10.05	15.34	47.66	15.73	3.02:1	.596
Oklahoma	1784	1	9.91	14.62	47.04	15.02	3.13:1	.513
Zimmerman	2907	2	10.00	13.61	39.08	12.60	3.08:1	.490
Blue Stem	3000	2	10.18	14.60	35.25	12.70	2.74:1	.446
Japanese	1787	2	9.65	13.79	39.41	12.72	3.08:1	.586
Salt Lake Club .	3018	2	9.98	12.57	36.88	13.02	2.81:1	.508
Gold Coin	2996	1	10.03	15.61	33.50	10.77	3.11:1	.428
Calif. Gem	2986	2	8.89	13.02	39.33	13.57	2.88:1	.613
Blue Stem	2985	2	8.86	12.50	32.99	11.21	2.94:1	.482
White Club	2999	2	9.25	12.93	33.22	11.48	2.89:1	.495
Kofod	2997	2	9.35	14.46	37.04	11.80	3.18:1	.486
Diehl's Med.	1395-2	2	9.13	13.96	36.79	13.92	2.60:1	.474
Jap. Vel. Chaff .	1757	2	9.43	14.36	41.78	13.58	3.03:1	.524
White Australian	3019	2	9.36	11.94	29.68	11.40	2.58:1	.469
Average		27	9.56	13.86	38.17	12.95	2.93:1	.507

In the 1907 crop Beloglina leads in the protein content in the flour with 15.54 per cent. Winter La Salle, which had the highest protein content in the wheat, comes third with 14.60 per cent. Sonora is lowest with 11.97 per cent and Gold Coin next with 11.99 per cent.

With respect to the 1908-09 crop Lofthouse grown in Tooele county gave the highest percentage of protein,, 18.01

per cent. This sample also gave the highest protein content in the wheat.

White Australian containing 11.94 per cent protein was the lowest and likewise contained the lowest percentage of protein in the wheat.

The sample of Turkey which came second among the wheat samples in nitrogen comes third among the flours Torgova being .07 per cent higher.

The sample of flour from Lofthouse having the highest protein content has also the highest moist and dry gluten content and Turkey comes second in moist and dry gluten content.

In 1908-09 the variation is not so great. The flour containing the higest protein content is that produced from Lofthouse, which contains 18.01 per cent. White Australian produces a flour having the lowest protein content, 11.94 per cent, with the flour produced from S. L. Club a close second. The average results are recorded in Table 15.

TABLE 15—SUMMARY OF CHEMICAL COMPOSITION.

	No. of tests	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
1907							
Hard Winter Varieties.	2	10.60	14.30	38.84	12.94	2.69:1	0.577
Semi-Hard Wint. Var.	9	10.63	13.44	36.90	13.32	2.81:1	0.518
Soft Winter Varieties .	1	10.69	11.99	30.20	10.69	2.81:1	0.543
1908-9							
Hard Winter Varieties .	78	9.64	14.85	40.62	14.44	2.86:1	0.525
Semi-Hard Wint. Var. .	9	10.08	15.08	42.04	14.59	2.85:1	0.491
Soft Winter Varieties ..	27	9.56	13.86	38.17	12.95	2.93:1	0.507

It will be noted that the protein and dry gluten content of the winter grains is high and that the variation is not great. In 1908-09 the semi-hard winter varieties have the highest protein and dry gluten content.

Bread-Making Value of Flour Produced.

The results obtained from the baking tests of the flour produced from the winter grains is recorded in Table 16. The results in this table are arranged in the order of the decreasing volume of loaf. In every case 340 grams of flour were made into dough and baked under standard conditions. The amount of water added to make a dough of uniform consistency varies from 181 cc. to 242, or a variation of 61 cc. of water. The volume of water retained varies from 72 cc. to 130 cc., a variation of 58 cc.

TABLE 16.

BREAD-MAKING VALUE OF FLOUR. WINTER GRAINS, 1907-08-09. WEIGHT OF FLOUR USED, 340 GRAMS.

	1907.							
Variety	No. of Tests	G. I. No. or where grown	Vol. of water added	Vol. of water retained	Ratio Protein to vol. of wat. added	Wt. of loaf	Vol. of loaf	Ratio of protein to vol. of loaf
Hard Winter Varieties.								
Beloglina	1		204	127	1:14.4	497	2631	1:169.3
Zimmerman ..	1	1824	206	100	1:13.4	470	2107	1: 13.7
Beloglina	2	1543	201	102	1:12.0	472	2050	1:102.7
Budapest	2	1739	203	103	1:12.6	473	2018	1:126
Beloglina	2	1667	207	102	1:15.0	472	1998	1:144.5
Bosnian	2	1691	196	92	1:14.1	462	1971	1.141
Kharkov	2	1583	200	114	1:13.1	484	1970	1:129
Pellissier	2	2086	205	93	1:13.0	463	1964	1: 26.1
Crimean	2	1435	200	116	1:11.9	486	1912	1:113.6
Roumanian ...	2	1658	202	108	1:13.8	478	1905	1:130
Oklahoma	2	1783	209	114	1:15.3	482	1878	1:140
Banat	2	1560	205	97	1:13.4	467	1863	1:122.1
Bulgarian	2	2048	201	88	1:14.9	468	1841	1:136
Missouri	2	1756	194	100	1:13.1	470	1834	1:124
Servian	2	1676	201	80	1:13.8	450	1830	1:125
Theiss	2	1561	200	98	1:13.7	468	1824	1:124.8
S. Dak. Red ..	1		186	120	1:10.7	490	1788	1:102.4

Fretes.	2	1596	194	119	1:14.6	489	1773	1:113.5
Turkey	2	1571	200	96	1:14.9	466	1769	1:131.5
Hungarian ...	1	2034	185	86	1:12.3	446	1751	1.116
Ulta	2	1439	196	111	1:13.5	481	1744	1:120.3
Kharkov	2	1442	189	115	1:12.9	475	1720	1:117.2
Turkey	2	3055	200	115	1:75.9	485	1714	1:135.9
Beloglina	2	1544	208	118	1:13.3	488	1710	1:109.5
Hungarian ...	1	2042	200	93	1:13.4	463	1689	1:113
Pesterboden ..	2	1564	207	88	1:14.1	458	1668	1:113.2
Crimean	2	1433	197	101	1:12.5	471	1666	1:105.3
Turkey	4	2998	200	102	1:13.5	472	1663	1:112.3
Alberta Red ..	1	2979	190	79	1:13.2	449	1655	1:115
Roumanian ...	1	1662	190	90	1:14.0	460	1630	1:120
Crimean	4	1559	206	96	1:15.5	466	1627	1:122.5
Torgova	1	1539	195	103	1:11.5	473	1626	1: 96.0
Turkey	1	1558	200	103	1:14.0	473	1615	1:113
Armivar	2	1355	187	116	1:11.9	486	1583	1:100.8
Weissenberg .	1	1563	200	72	1:14.4	442	1538	1:110.6
Malakof	1	2908	190	95	1:13.5	465	1503	1:107
Crimean	2	1436	195	124	1:12.0	494	1493	1: 92.2
Crimean	2	1432	186	120	1:11.8	490	1409	1: 89.3
Crimean	2	1437	194	90	1:12.3	460	1348	1: 85.7
Average	71		199	102	1:14.9	474	1771	1:118.9

TABLE 16 (Con.)

BREAD-MAKING VALUE OF FLOUR. WEIGHT OF FLOUR USED 340 GRAMS. WINTER GRAINS 1907-08-09.

Variety	No. of Tests	G. I. No. or where grown	Vol. of water added	Vol. of water retained	Ratio Protein to vol. of wat. added	Wt. of loaf	Vol. of loaf	Ratio of protein to vol. of loaf
Semi-Hard Winter Varieties.								
Lofthouse	4		206	100	1:13.8	470	1879	1:126
Odessa	2		208	105	1:16.8	475	1847	1:154
Red Russian ..	3	1532	205	106	1:12.8	476	1820	1:114
Ghirka	2	1438	193	113	1:13.1	483	1357	1: 92.4
Jap. Sq. Head.	1	1788-1	200	106	1:14.5	476	1096	1: 79.2
Average	12		202	106	1:14.2	475	1600	1:113

Soft Winter Varieties.

Club	1	2999	186	103	1:14.4	473	1836	1:142.0
Diehl's Med. ..	2	1352	188	104	1:13.5	474	1819	1:130.3
Zimmerman ..	2	2907	196	125	1:14.4	495	1631	1:119.3
Jap. Vel. Chaff	2	1757	198	110	1:13.8	480	1629	1:113.4
Blue Stem	2	3000	200	108	1:13.7	478	1619	1:110.9
Blue Stem ...	1	2985	190	133	1:15.2	500	1614	1:129.1
Calif. Gem ..	2	2986	188	103	1:14.4	473	1538	1:118.1
Gold Coin	2		207	103	1:17.3	473	1510	1:121.0
Currell	1	2906	200	92	1:13.8	462	1501	1:103.0
White Austral.	2	3019	181	115	1:15.2	485	1485	1:124.4
Salt L. Club .	2	3018	185	110	1:14.7	480	1388	1.110.4
Kofod	1	2997	186	90	1:12.9	460	1329	1: 91.9
Japanese	1	1787	200	80	1:14.5	450	1329	1: 96.0
Average	21		193	106	1:14.4	476	1556	1:116.1

Thus, it will be readily seen that Beloglina gave the loaf having the greatest volume, 2631 cc., while Japanese 1787 gave a loaf having the smallest volume, 1329 cc. The summarized results for bread-making value are recorded in Table 17.

TABLE 17.—SUMMARY OF BREAD-MAKING VALUE OF FLOUR.

	No. of tests	Vol. of water added	Vol. of water retained	Ratio Protein to vol. of wat. added	Wt. of loaf	Vol. of loaf	Ratio of protein of vol. of loaf
Hard winter varieties	71	199	102	1:14.9	474	1771	1:118.9
Semi-hard wint. var.	12	202	106	1:14.2	476	1600	1:113
Soft winter varieties	21	193	106	1:14.4	476	1556	1:116.1

3. The Irrigated Grains.

The irrigated grains were grown on the Greenville Farm in Cache Valley, where the equipment is such that the amount of irrigation water applied can be measured. There were three plots of each of ten varieties: New Zealand, Minn. 163, 169, 188, Kofod, Whitington, Egyptian Spring,

Kubanka, White Club, and Pellissier. One plot of each variety received 25 inches of irrigation water, another 15 inches, while the third was unirrigated.

a. Yield of Milling Products.

The results obtained for the milling products are recorded in Table 18.

TABLE 18.—THE INFLUENCE OF IRRIGATION UPON THE YIELD OF MILLING PRODUCTS.

Variety	Treatment	No. of tests	Wt. of 100 ker.	Per cent of flour	Per cent of bran	Per cent of shorts	Error
New Zealand	25 in.	2	4.735	72.00	22.93	5.13	0.06
" "	15 "	2	4.624	72.37	22.14	4.67	0.82
" "	0 "	2	3.673	72.07	22.27	4.87	0.79
Minn. 163	25 "	2	3.518	71.13	22.71	6.68	0.52
" "	15 "	2	3.509	71.41	23.21	7.49	2.11
" "	0 "	2	3.067	70.43	21.71	7.24	0.51
Minn. 169	25 "	2	3.537	71.56	21.71	7.24	0.51
" "	15 "	2	3.589	70.15	21.09	8.79	0.03
" "	0 "	2	3.202	67.70	24.07	7.69	0.54
Minn. 188	25 "	2	3.276	67.59	23.72	8.77	0.08
" "	15 "	2	3.563	69.55	25.95	5.79	1.29
" "	0 "	2	3.037	66.84	26.45	6.61	0.10
Kofod	25 "	2	4.728	70.03	22.37	7.04	0.56
"	15 "	2	4.277	72.18	21.40	7.44	1.02
"	0 "	2	4.298	70.92	21.49	7.68	0.09
Whittington	25 "	2	4.732	66.67	20.58	12.18	0.57
" "	15 "	2	5.113	66.01	21.18	11.36	1.45
" "	0 "	1	4.274	66.79	28.47	4.59	0.15
Egypt. Spring ...	25 "	2	4.863	63.17	25.15	11.04	0.64
" "	15 "	2	4.359	68.18	24.51	6.71	0.60
" "	0 "	2	4.350	66.58	28.02	5.16	0.24
Kubanka	25 "	2	4.191	62.68	25.95	11.47	0.10
"	25 "	2	4.647	65.58	23.03	11.60	0.21
"	0 "	2	3.816	64.73	22.86	11.92	0.49
White Club	25 "	2	3.220	68.17	25.27	5.87	0.69
" "	15 "	2	3.428	69.00	23.17	7.62	0.21
" "	0 "	2	2.829	67.81	26.17	5.75	0.27
Pellissier	25 "	2	3.275	67.80	23.53	9.82	1.15
" "	15 "	2	3.541	68.01	23.72	9.56	1.29
" "	0 "	2	3.140	64.93	25.96	9.62	0.45

The application of irrigation water gives a plump grain of heavy weight per 100 kernels. As the water applied decreases the weight of 100 kernels also decreases. The application of irrigation water has had no apparent effect on the yield of milling products, or if any it is not greater than the experimental error. The results obtained from the different plots of the same variety of wheat are practically as close as the duplicate millings of the sample. There is quite a difference in the yield of milling products obtained from the different varieties of wheat, however. New Zealand gives the best yield of flour, approximately 72 per cent, while Kubanka gives the poorest yield, approximately 64 per cent—a difference of 8 per cent. The results obtained are summarized in Table 19.

TABLE 19.—THE INFLUENCE OF IRRIGATION ON YIELD OF MILLING PRODUCTS.

Water Applied	No. of tests	Wt. of 100 ker.	Flour	Bran	Shorts	Error
25 in. of water applied	10	4.008	68.08	23.39	8.52	0.01
15 in. of water applied	10	4.065	69.24	22.94	8.10	0.18
No Irrigation	10	3.569	67.88	24.75	7.11	0.26

b. The Chemical Composition of Wheat, Bran and Shorts.

The results obtained from a chemical analysis of the wheat, bran and shorts are recorded in Table 20. The application of irrigation water has had no apparent effect on the moisture content of the wheat, bran or shorts.

TABLE 20.—THE INFLUENCE OF IRRIGATION ON THE CHEMICAL COMPOSITION OF WHEAT, BRAN AND SHORTS.

Variety	Treatment	No. of tests	WHEAT Moisture	WHEAT Protein	BRAN Moisture	BRAN Protein	SHORTS Moisture	SHORTS Protein
Minn. 163 ...	25 in.	2	8.41	13.59	9.25	18.23	8.62	15.61
" "	15 "	2	8.76	13.57	9.51	18.66	7.91	16.08

" "	0 "	2	8.69	16.48	9.24	20.31	9.24	18.59
Minn. 169	25 "	2	8.61	14.82	9.26	19.18	9.30	17.58
" "	15 "	2	8.71	14.63	9.52	18.92	9.18	16.86
" "	0 "	2	8.38	15.88	10.38	20.50	8.62	17.09
Minn. 188	25 "	2	8.20	13.58	9.62	20.21	8.42	16.66
" "	15 "	2	8.35	15.84	8.66	19.45	7.91	18.41
" "	0 "	2	8.43	15.15	8.95	19.64	8.47	17.35
New Zealand .	25 "	2	8.00	12.68	9.77	18.81	8.88	15.92
" "	15 "	2	8.46	12.71	9.29	17.30	8.11	16.51
" "	0 "	2	8.39	16.20	7.93	18.64	7.69	16.56
Kofod	25 "	2	8.32	13.62	9.69	17.62	8.09	14.88
"	15 "	2	8.45	13.44	9.19	18.15	7.86	18.15
"	0 "	2	8.77	13.41	9.10	17.68	8.59	16.53
Pellissier	25 "	2	8.31	16.54	9.70	20.89	8.89	17.98
"	15 "	2	8.64	16.20	9.22	19.57	9.51	17.64
"	0 "	2	8.32	18.11	10.20	21.15	8.98	18.53
Kubanka	25 "	2	8.83	14.17	9.19	18.67	8.53	16.67
"	15 "	2	8.43	14.88	9.96	18.68	8.48	17.14
"	0 "	2	8.22	15.26	9.56	18.30	8.46	17.66
Whitington ...	25 "	2	8.85	14.70	9.28	18.35	8.28	16.74
"	15 "	2	8.44	15.42	9.68	19.05	8.96	16.07
"	0 "	1	8.40	15.41	10.06	20.38	9.14	21.10
Egypt. Spring.	25 "	2	8.84	13.02	9.18	18.64	8.80	15.81
" "	15 "	2	8.84	13.62	8.91	19.07	7.38	15.81
" "	0 "	2	8.51	14.26	8.74	17.04	7.60	15.42
White Club ...	25 "	2	8.23	13.25	9.19	18.10	7.63	16.15
" "	15 "	2	7.89	12.79	9.41	17.79	8.28	16.26
" "	0 "	2	8.11	14.34	9.04	19.51	7.60	17.89

TABLE 21.—INFLUENCE OF IRRIGATION ON CHEMICAL COMPOSITION OF WHEAT, BRAN AND SHORTS.

Water applied	No. of tests	WHEAT Mois-ture	WHEAT Pro-tein	BRAN Mois-ture	BRAN Pro-tein	SHORTS Mois-ture	SHORTS Pro-tein
25 inches	10	8.46	14.00	9.41	18.87	8.54	16.40
15 inches	10	8.50	14.35	9.34	18.66	8.36	16.89
Unirrigated	10	8.44	15.45	9.32	18.32	7.68	17.67

As the amount of irrigation water applied increases, it causes a decrease in the protein content of the wheat, bran and shorts. In case of the wheat, the difference in protein content of the wheat grown with an application of 25 inches of irrigation water and that which receives no irrigation wa-

ter is a little less than 1.5 per cent. In the case of the bran, the difference is not nearly so marked. In the case of the shorts, the difference is more marked than in the case of the bran, but not so marked as in the wheat. The results obtained are summarized in Table 21.

c. Chemical Composition of the Flour.

The results obtained from a chemical analysis of the flour are recorded in Table 22.

TABLE 22.—EFFECT OF IRRIGATION ON CHEMICAL COMPOSITION OF FLOUR.

Variety	Treatment	No. of tests	Moisture	Protein	Moist gluten	Dry gluten	Ratio of moist to dry gluten	Ash
New Zealand.	25 in.	2	10.01	10.50	29.48	10.11	2.91:1	0.451
" "	15 "	2	10.53	10.92	30.80	10.19	2.01:1	0.446
" "	0 "	2	10.11	13.65	32.24	11.98	2.92:1	0.443
Minn. 163 ...	25 "	2	10.78	12.00	51.45	11.35	2.77:1	0.457
" "	15 "	2	10.24	11.75	35.95	11.69	2.90:1	0.394
" "	0 "	2	10.42	14.73	36.95	14.66	2.69:1	0.391
Minn. 169 ...	25 "	2	10.75	13.57	34.76	12.89	1.69:1	0.440
" "	15 "	2	11.36	13.95	34.57	12.94	2.67:1	0.582
" "	0 "	2	11.27	14.35	37.31	13.28	2.80:1	0.517
Minn. 188 ...	25 "	2	11.01	13.35	28.66	12.03	2.42:1	0.573
" "	15 "	2	10.56	14.47	34.80	12.70	2.73:1	0.524
" "	0 "	2	10.37	13.44	33.90	12.67	2.68:1	0.480
Kofod	25 "	2	10.45	12.10	31.49	11.05	2.85:1	0.559
"	15 "	2	10.54	12.03	28.08	10.38	2.85:1	0.476
"	0 "	2	10.88	10.63	26.06	9.95	2.62:1	.....
Whitington ..	25 "	2	10.53	13.56	31.80	11.79	2.68:1	0.760
"	15 "	2	10.38	14.31	33.85	12.28	2.73:1	0.796
"	0 "	1	11.16	14.07	39.65	13.60	2.91:1	0.708
Egypt. Spring.	25 "	2	10.33	11.48	27.87	10.30	2.70:1	0.698
" "	15 "	2	10.30	11.23	25.02	9.71	2.57:1	0.564
" "	0 "	2	9.54	12.37	28.77	10.58	2.71:1	0.707
Kubanka	25 "	2	10.14	13.71	32.82	12.54	2.61:1	0.769
"	15 "	2	10.68	14.90	33.00	12.47	2.64:1	0.614
"	0 "	2	10.81	14.91	37.14	14.06	2.64:1	0.770

White Club ..	25 "	2	10.00	9.81	25.28	9.36	2.71:1	0.466
" "	15 "	2	9.47	10.10	26.42	9.32	2.83:1	0.462
" "	0 "	2	9.13	12.06	31.94	10.92	2.92:1	0.503
Pellissier ...	25 "	2	10.14	16.21	46.97	15.73	2.96:1	0.607
"	15 "	2	10.01	15.50	43.04	14.59	2.94:1	0.581
"	0 "	2	10.58	15.95	47.82	16.08	2.96:1	0.558

The moisture content of the flour is not affected by the application of irrigation water. It is practically constant in the three instances. The protein content increases as the water applied decreases. The same thing is true with respect to the moist and dry gluten content. The irrigation water has no apparent effect on the ash content of the flour. The summarized results obtained are recorded in Table 23.

TABLE 23.—EFFECT OF IRRIGATION ON CHEMICAL COMPOSITION OF FLOUR.

	Moisture	Protein	Moist gluten	Dry gluten	Ratio of moist to dry gluten	Ash
25 inches	10.41	12.63	34.05	11.71	2.73:1	0.578
15 inches	10.41	12.92	32.55	11.63	2.79:1	0.544
No irrigation	10.43	13.62	35.18	12.58	2.79:1	0.552

d. The Bread-Making Value of the Flour.

The results obtained from the bread-making test of the flour produced are recorded in Table 24.

The application of irrigation water has had no apparent effect on the water absorbed or retained by the flour. The ratio of the protein to the water added and the weight of the loaf produced are practically constant.

As the amount of water applied decreases, the volume of the loaf produced from the flour slightly increases. The results obtained are summarized in Table 25.

TABLE 24.—BREAD-MAKING VALUE OF FLOUR. IRRIGATED GRAINS. 1908-09.

Variety	Water applied in inches	No. of tests	Vol. of water added	Vol. of water retained	Ratio protein to vol. of wat. added	Wt. of loaf	Vol. of loaf	Ratio of protein to vol. of loaf
New Zealand ..	25	1	190	100	1:18.0	470	1726	1:163.6
" "	15	2	195	108	1:17.9	478	1447	1:132.5
" "	0	1	184	100	1:13.5	470	1501	1:110.0
Minn. 163	25	2	199	97	1:16.6	467	1945	1:162.1
" "	15	2	203	112	1:17.3	482	1797	1:152.9
" "	0	2	194	101	1:13.2	471	1817	1:123.4
Minn. 169 25		2	212	94	1:15.6	464	1866	1:137.5
" "	15	2	215	113	1:15.4	483	1912	1:137.1
" "	0	2	201	97	1:14.0	467	1973	1:137.6
Minn. 188	25	2	198	102	1:14.8	472	1403	1:103.5
" "	15	2	200	112	1:13.8	482	1791	1:123.8
" "	0	2	200	110	1:14.9	480	1723	1:128.2
Kofod	25	3	204	104	1:16.9	474	1701	1:140.6
"	15	2	204	94	1:17.0	464	1586	1:179.0
"	0	2	197	101	1:18.5	471	1903	1:179.0
Whitington	25	3	221	129	1:16.3	499	1275	1: 94.0
"	15	4	232	108	1:16.2	478	1445	1:101.0
"	00	1	242	144	1:17.2	514	1446	1:102.8
Egypt. Spring .	25	2	202	100	1:17.6	470	1274	1:111.0
" "	15	2	215	102	1:19.1	472	1507	1:134.2
" "	0	2	207	118	1:16.7	488	1269	1:102.6
Kubanka	25	2	213	121	1:15.5	491	1611	1:117.5
"	15	2	204	129	1:13.7	499	1540	1:103.4
"	0	2	215	131	1:14.4	501	1636	1:109.7
White Club ...	25	1	186	93	:1 19.0	463	1362	1:138.8
" "	15	1	180	69	1:17.8	439	1525	1:151.0
" "	0	1	190	79	1:15.5	449	1581	1:131.1
Pellissier.	25	2	216	101	1:13.3	471	1886	1.116.3
"	15	2	198	199	1:12.8	469	1746	1:112.6
"	0	3	214	111	1:13.4	481	1697	1:106.4

TABLE 25.—EFFECTS OF IRRIGATION ON BREAD-MAKING VALUE OF FLOUR.

Water added	No. of tests	Vol. of water added	Vol. of water retained	Ratio protein to vol. of wat. added	Wt. of loaf	Vol. of loaf	Ratio of protein to vol. of loaf
25 inches	10	204	104	1:16.4	474	1605	1:128.5
15 inches	10	185	105	1:16.1	475	1630	1:128.0
No ririgation	10	204	109	1:15.1	479	1655	1:123.1

c. Conclusions.

The summarized results for the yield of milling products of spring and winter dry farming and irrigated wheat are recorded in Table 26.

TABLE 26.

SUMMARIZED RESULTS FOR YIELD OF MILLING PRODUCTS. RESULTS RECORDED AS PER CENT OF DRY WEIGHT.

	No. of tests	Year	Wt. of 100 kernels	Flour	Bran	Shorts	Error
Hd. Spr. varieties	2	1907-08	2.309	69.63	19.34	10.08	-0.96
Semi-hd. spr. varieties	6	1907-08	2.726	62.35	25.59	11.58	-0.59
Durham varieties ...	7	1907-08	3.419	69.80	16.31	12.80	-1.01
Hd. Winter varieties.	2	1907	2.915	71.62	20.06	8.83	-0.56
Semi-hd. win. varieties	9	1907	3.196	72.03	16.9.	9.44	0.78
Soft winter varieties	1	1907	3.390	72.54	16.63	10.03	-0.79
Hd. winter varieties.	80	1908-09	2.944	69.27	23.64	7.89	-0.56
Semi-hd. win. varieties	10	" "	2.950	66.90	25.84	8.09	-0.16
Soft winter varieties	26	" "	3.073	67.90	25.24	6.68	-0.16
Ir. wheat, 25-in. water	10	" "	4.008	68.08	23.39	8.52	-0.01
Ir. Wheat, 15-in. water	10	" "	4.065	69.24	22.94	8.10	0.18
No irrigation	10	" "	3.569	67.88	24.75	7.11	0.26

The weight per 100 kernels of the irrigated wheat is greater than that of either the spring or winter dry farming wheat. The yield of flour, bran and shorts shows nothing characteristic.

The summarized results for chemical composition of wheat, bran and shorts obtained from spring, winter and irrigated wheat are recorded in Table 27.

TABLE 27.

SUMMARIZED RESULTS FOR CHEMICAL COMPOSITION OF WHEAT, BRAN AND SHORTS. RESULTS EXPRESSED AS PER CENT OF DRY MATERIAL.

	No. of tests	Year	WHEAT Mois-ture	WHEAT Pro-tein	BRAN Mois-ture	BRAN Pro-tein	SHORTS Mois-ture	SHORTS Pro-tein
Hd. spr. varieties	2	1907-08	7.11	18.21	8.23	22.35	8.90	22.72
Semi-hd. spr. var.	6	" "	8.26	17.46	9.31	21.41	8.59	19.95
Durham varieties	7	" "	7.65	16.67	9.12	19.73	8.72	18.69
Hd. win. varieties	2	1907	9.48	13.89	10.20	17.16	9.85	15.69
Semi-hd. win. var.	10	"	7.49	13.91	9.79	17.49	9.10	17.85
Soft win. varieties	1	"	8.40	12.40	10.31	16.33	9.60	16.67
Hd. win. varieties	80	1908.09	8.35	16.11	9.22	20.02	8.79	17.85
Semi-hd. win. var.	9	" "	8.55	16.74	9.45	21.02	8.75	18.93
Soft win. var....	27	" "	8.00	15.62	8.54	20.66	8.16	18.53
Ir. wt., 25-in. wat.	10	" "	8.46	13.10	9.41	18.87	8.54	16.40
Ir. wt., 15-in. wat.	10	" "	8.50	14.35	9.34	18.66	8.36	16.89
No irrigation ...	10	" "	8.44	15.45	9.32	19.32	7.68	17.67

Nothing characteristic is shown with respect to the moisture content except that it is low in every case. The protein content of irrigated wheat is lower than that of either the spring or winter dry farm wheat. The spring wheat contains the highest protein content. The bran and shorts produced from the irrigated wheat has a lower protein content than that produced from dry farm wheat.

The summarized results obtained from the chemical composition of the flour produced from spring, winter and irrigated grain are recorded in Table 28.

TABLE 28.—SUMMARIZED RESULTS FOR CHEMICAL COMPOSITION OF FLOUR.

	No. of tests	Year	Moisture	Protein	Moist gluten	Dry gluten	Ratio of wet to dry gluten	Ash
Hd spr. var. .	2	1907-08	10.37	18.53	56.89	20.64	2.75:1	0.509
Semi-hd. spr..	6	" "	10.30	14.89	42.84	14.87	2.87:1	0.574
Durham var. .	7	" "	10.31	16.23	45.06	15.69	2.86:1	0.787
Hd. win. var. .	2	1907	10.60	14.30	34.84	12.94	2.69:1	0.577
Semi-hd. win..	9	"	10.63	13.44	36.90	13.32	2.81:1	0.518
Soft win. var..	1	"	10.69	11.99	30.20	10.69	2.81:1	0.543
Hd. win. var. .	78	1908-09	9.64	14.85	40.62	14.44	2.86:1	0.525
Semi-hd. win..	9	" "	10.08	15.08	42.04	14.59	2.85:1	0.491
Soft win. var..	27	" "	9.56	13.85	38.17	12.95	2.93:1	0.507
Ir. wt.25-in. w.	10	" "	10.41	12.63	34.05	11.72	2.73:1	0.578
Ir. wt.15-in. w.	10	" "	10.41	12.92	32.55	11.63	2.79:1	0.544
No irrigation.	10	" "	10.43	13.62	35.18	12.58	2.79:1	0.552

The flour produced from the winter dry-farm wheat has a slightly lower moisture content than the flour produced from the other kinds of wheat. The protein content of the flour produced from the wheat receiving the greatest amount of irrigation water is 3.11 per cent lower than that produced from spring dry-farm wheat and 2.01 per cent lower than that produced from dry-farm winter wheat. In case of the irrigated varieties of wheat, as the amount of water applied decreases, the protein content increases. The protein content of the flour produced from wheat which received no irrigation water is one per cent greater than that produced from wheat receiving an application of 25 inches, notwithstanding the fact that the seed wheat in both cases was the same and the non-irrigated wheat was grown on land which had been irrigated in previous years. The moist- and dry-gluten content of the flour produced from the irrigated wheat is considerably lower than that produced from either spring or winter dry-farm wheat.

The summarized results for the bread-making value of the flour produced from spring, winter dry-farm grains, and the irrigated grains are recorded in Table 29.

TABLE 29.—SUMMARIZED RESULTS FOR BREAD-MAKING VALUE.

	No. of tests	Vol. of water added	Vol. of water retained	Ratio of protein to vol. of wat. added	Wt. of loaf	Vol. of loaf	Ratio of protein to vol. of loaf
Semi-hd. spr. var....	3	215	119	1:14.1	489	1853	1.121.7
Durham varieties ...	7	231	125	1:14.7	492	1767	1.112.2
Hd. winter varieties.	71	199	102	1:14.9	474	1771	1:118.9
Semi-hd. win. var....	12	202	106	1:14.2	476	1600	1:113.0
Soft winter varieties.	21	193	106	1:14.4	476	1556	1:116.1
Ir. wheat, 25-in. water	10	204	104	1:16.4	474	1605	1:128.5
Ir. wheat, 15-in. water	10	185	105	1:16.1	475	1630	1:128.0
No irrigation	10	204	109	1:15.1	479	1655	1:123.1

Nothing characteristic of the several kinds of wheat is shown with respect to the volume of water added or retained. The ratio of protein to volume of water added is narrower in case of the dry farm grains. The volume of loaf made from dry farm flour is slightly greater than that produced from irrigated flour. The ratio of protein to volume of loaf is narrower in the dry farm flour than in the irrigated flour.

The investigations extending over a period of eight years clearly demonstrate the fact that the dry-farm grains in Utah are characterized by a low moisture content and a high protein content. They also clearly indicate that the protein content of the dry-farm wheats is higher than the protein content of the wheat on irrigated farms.

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