12-1903

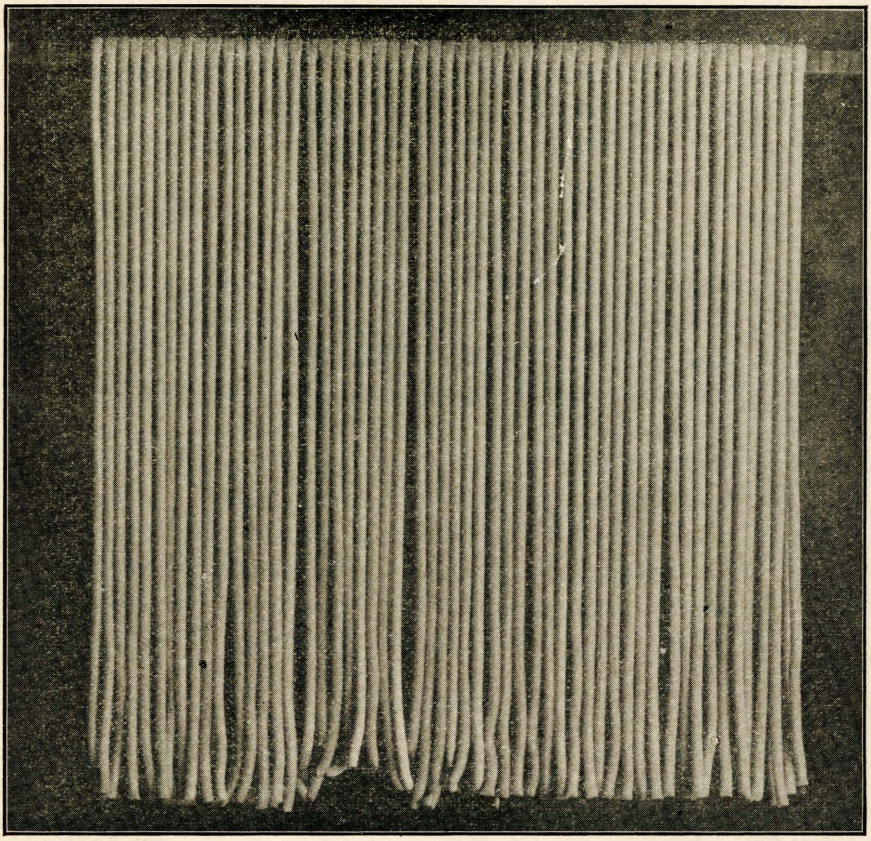
Macaroni Wheat: Its Milling and Chemical Characteristics

J.H. Shepard
South Dakota Agricultural College

Bulletin 82 December 1903

South Dakota Agricultural College

EXPERIMENT STATION



MACARONI DRYING.

MACARONI WHEAT. ITS MILLING AND CHEMICAL CHARACTERISTICS.

Department of Chemistry, Brookings, S. D.

TIMES POWER PRESS, Springfield, S. D.

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Macaroni Wheat.

Its Milling and Chemical Characteristics.

Department of Chemistry, Jas. H. Shepard, Chemist.

In the year 1900 this Station commenced a co-operative investigation of the different varieties of macaroni wheat with the Bureau of Plant Industry, United States Department of Agriculture. At that time it was decided that the Department of Chemistry of this Station should undertake the work of determining the chemical and milling characteristics of the different wheats grown. It is evident that in introducing a new crop care should be taken that only varieties adapted to our soil and climatic conditions should be recommended and distributed for general cultivation. Especially is this true of a cereal crop, such as wheat, where so many different industrial factors are concerned. It is not only necessary that the farmer should have the best kinds to grow, but it is also necessary that from the best yielding kinds, those should be farther selected which will best meet the requirements of the miller, the baker and the consumer. Moreover, since macaroni wheat has different uses and adaptations from those of the ordinary bread wheats, something more than the usual routine work was required.

In order to meet these special requirements it became necessary to enlarge the Station equipment along lines not usually followed by our Station workers. It may not come amiss in this connection to state some of the problems connected with the work now in progress. In the first place, macaroni wheat owes its superior adaptation to its own peculiar uses, to the large amount and quality of the gluten or crude protein which it contains. It is evident that no one could foretell what would occur to a wheat having its natural habitat on the plains of the Azov region in Russia after it had been carried half way round the world and planted on the great plains of the United States. Would its protein content remain constant in its new home? Or would it deteriorate? Or would the change of soil and climate

increase the gluten? Then again, would the quality of gluten suffer any changes, and if so, what would be the nature of the change?

Then again, how would these wheats behave in the hands of the miller? Would they yield a fair percentage of marketable flour, or would they give mostly mill refuse in the form of bran and shorts?

The reader will notice that a great many varieties of macaroni wheat have been used in these experiments, and that they have come from widely separated localities. Secretary Wilson has sent his explorers to the different homes of these wheats, and we have, at the very beginning, most of the different varieties known to the civilized world. Some might be inclined to think that we have too many sorts, but a little consideration will show that in this very completeness we are exceedingly fortunate. We have both the best and the poorest at our disposal, and if the proper selection is made at the beginning much has been gained. Moreover, it would be exceedingly embarrassing to distribute and recommend a variety which should eventually prove worthless or inferior in its essential characteristics. Yet this very thing might occur had we not such a complete collection to select from.

It is not necessary for the writer to dwell upon the work of testing these different wheats in regard to their yielding capacity or their adaptability to our soil and climatic conditions. This work has already been recorded by the Department of Agriculture in Bulletin No. 77 of this Station. That work will be continued and it is necessary here to state that the investigations recorded in this bulletin are more in the nature of a report of progress than a final conclusion dismissing the whole subject. It is the intention to carry these wheats through a number of years, rejecting the poorer sorts, and thus determining once for all the best varieties when all their characteristics are taken into consideration.

In selecting these wheats, especial attention was given to find varieties growing under soil and climatic conditions similar to our own. These conditions obtain most nearly on the

great Russian inland plains north of the Sea of Azov, on the highlands which finally rise to the Ural Mountains. Here the rainfall and the short, hot summers are most favorable to the proper development of the macaroni wheats, and it is here that the best varieties used for manufacturing macaroni are grown. The factories of southern Europe draw their supplies largely from these regions. But macaroni wheats are also grown largely around the Mediterranean Sea. India and South America also grow these wheats, and seed from these countries has been obtained and their characteristics are discussed in the following pages of this report.

DESCRIPTION OF SAMPLES.

A—RUSSIAN MACARONI WHEATS.

No. 5639—Kubanka. This sample was personally selected in Russia by Mr. M. A. Carleton for the purpose of propagation and distribution to farmers in the macaroni wheat belt. He describes it as: "From the Uralsk Territory. One of the best macaroni wheats known. Sown in the spring. Admirably adapted for growing in the semi-arid regions between the 100th meridian and the Rock Mountains, from North Dakota to Texas, and also in New Mexico, Arizona, eastern Oregon and the Palouse country." With us it has proven the best variety grown when all its properties have been taken into consideration. This seed was from the crop of 1900.

No. 1490—Kubanka. This seed came from C. I. Mrozinskii Proskurov, in the government of Podolia, Russia. Crop of 1900.

No. 8212—Kubanka. Came from Uralsk, crop of 1900. This wheat was bought on the market and distributed directly to the farmers of the northwest through the State Experiment Stations. No. 8213 has the same history, but was of a later inportation, crop of 1901.

No. 5644—Velvet Don. This wheat was selected by Mr. Carleton for propagation and distribution. He describes it as: "From Ambrocievka, twenty miles north of Tagenrog, in the Don Territory. An excellent macaroni wheat, with black beards, sown in the spring. Adapted for trial in the most arid portions of the great plains region of Arizona, New Mexico, Utah and the dryest portions of the Pacific coast states."

No. 8231. Velvet Don. Also from Ambrocievka, but of a second importation.

Lab. No. 52—Arnautka. Seed from Lisbon, N. D. Origin unknown.

No. 5351.—Berdiansk. Crop of 1901. This variety came direct from Marseilles, France, but was received at that port originally from Berdiansk, Russia. It may be any one of the half

dozen different macaroni wheats exported from the Azov ports.

No. 5352—Novo-Rossisk. Crop of 1901. This variety has the same history as the preceding, except that it came originally from Novo-Rossisk, Russia. The variety is still to be identified.

No. 5355—Tagenrog. Crop of 1901. Same history as the preceding, but came originally from Tagenrog, Russia. Variety to be identified.

No. 5642—Yellow Gharnovka. Selected by Mr. Carleton in 1900. From Ambrocievka, twenty miles north of Tagenrog, in the Don Territory. "A macaroni wheat similar to 5643, but having quite yellowish grains. Sown in the spring and adapted for trial in the most arid portions of all the great plains region, in Arizona, New Mexico, Utah, and the dryest portions of the Pacific coast states."

No. 5643—Gharnovka. Same history as the preceding. The best macaroni wheat from the vicinity of Tagenrog. Adapted same as preceding.

No. 5645—Black Don. Same history as preceding and adapted the same. Black chaff and black beards and sown in the spring.

No. 5646—Gharnovka. From Tagenrog, Don Territory. A spring variety which may be sown in late autumn south of the 35th parallel. This and No. 5643 are the best of the Tagenrog macaroni wheats. Adapted same as three preceding.

No. 5800—Beloturka. Crop of 1901. Received through Vilmorin Andrieux et Cie, Paris, but probably came originally from Russia. It is one of the best known Russian macaroni wheats, and is commonly grown in the north Caucasus and the southern Volga region.

No. 1431—Arnautka. Grown in the region north of the Azov Sea, and obtained at Berdiansk, Russia, in 1900.

No. 1515—Pererodka. From Simbirsk, Russia. Obtained in exchange at the Paris exposition.

No. 1537—Arnautka. From Berdiansk, Russia. The important variety from that region.

No. 8230. Yellow Gharnovka. Same as 5642, but a later

importation.

No. 8232. Black Don. Same as No. 5645, but of a later importation.

B—SOUTHERN OR MEDITERRANEAN MACARONI WHEATS.

No. 5353—Algerian. Received direct from Marseilles, France. Crop of 1901. No varietal name given.

No. 5380—Pellissier. One of the best wheats grown in Algeria. Crop of 1901. A select variety.

No. 5492—Medeah. Crop of 1901. A standard variety from Algeria. Probably one of the best wheats grown there, and one which has proven to be a good sort in several other countries.

No. 7579—Medeah. Same as preceding, but from crop of 1902.

No. 1428—Egyptian. From Samara government, crop of 1900.

No. 1481—Ble dur. From Algeria. Obtained in exchange at the Paris exposition. Crop of 1900.

No. 7578—Marouni. From Algeria, crop of 1902.

No. 7580—Adjini. From Algeria, crop of 1902.

No. 7581—Kahla. From Algeria, crop of 1902.

No. 7785—Pellissier. From Algeria, crop of 1901.

No. 7792—Mahmoudi. From Algeria, crop of 1902.

No. 7793—Mohamed ben Bachis. From Algeria, crop of 1902.

No. 7794—Kahla. From Algeria, crop of 1902.

No. 7795—Richi. From Algeria, crop of 1902.

No. 9130—Saragolle. From Italy. One of the most highly prized varieties used in making macaroni, owing to the superior flavor it imparts to the manufactured product. It is said that no macaroni made from this wheat is exported.

C—MISCELLANEOUS MACARONI WHEATS.

No. 5354—Argentine. This wheat came from Argentina through Marseilles. No name was assigned, but it is probably Candeal, a good variety grown in Argentina. Crop of 1901.

No. 1377—Realli Forte. This variety was received through Jos. Torre & Bro., New Orleans, La. 1900.

No. 1492—Nicaragua. From J. B. Simpson, Dallas, Tex-

as. 1899.

No. 1493—Wild Goose. From Hougen Milling Co., Northwood, N. D.

No. 8550—No name. From the Experiment Station at Lahore, India. Crop of 1902. A round, red wheat, grown in slightly salty land irrigated by canal water.

No. 8551—No name. From the Experiment Station at Lahore, India, crop of 1902. A round, white wheat, grown on strong black soil irrigated by canal water.

No. 8552—Walnak. From the Experiment Station at Lahore, India, crop of 1902. Grown on light, slightly sandy soil, irrigated with well water.

These wheats have been grown not only at the home Station, but also at Mellette, in the James River valley. The reports cover the crops of 1901 and 1902.

During the present year trials of all these varieties have been made at the Sub-station at Highmore, located in the great range region, where these wheats should give the highest quality of grain. Reports from the Highmore wheats will be given in the next Bulletin issued on this subject.

MILLING CHARACTERISTICS.

At the very outset it became evident that a milling machine would be a necessary adjunct in order to handle the large number of varieties of wheats under trial. Many of these wheats could be had in quantity from our Station plats, but many more could be obtained in small quantities only for milling purposes. In a great many cases the Department of Agriculture had less than half an ounce of wheat to start with. Thus it may be readily seen that any commercial milling test was entirely out of the question.

Accordingly a miniature roller mill was ordered of the Allis-Chalmers Company. This mill is shown in Plate 1. It consists of two sets of seven-inch rolls, one with medium corrugations, the other smooth. A sifter, with removable frames covered with all the different screens, gauzes and bolting silks needed, is placed on the frame between the two sets of rolls. The feed arrangement consists of a corrugated roll placed above the reduction rolls, and this is fitted with a slide actuated by a cam so that the rate of feeding can be nicely adjusted. The product from the reduction rolls is caught in a drawer seen just underneath. From this drawer the reduced wheat is transferred to the bolting apparatus in order to separate the different mill products. As will be readily understood, this transfer must be made by hand. In order that the transfer might entail no loss a tin scoop was made and a set of graniteware dishes was procured to retain the different products during the reduction. A counter brush was found useful in effecting the transfers, and a couple of small paint brushes served to clean the rolls. These accessories are shown in Plate II.

The motive power for this reduction plant is furnished by a s ationary gasoline engine of three and one-half horse power, shown in Plate III.

By using care it was found possible to make a quantitative reduction on the different samples with an error amounting to less than 2 per cent. In fact the general average, plus and minus is practically zero.

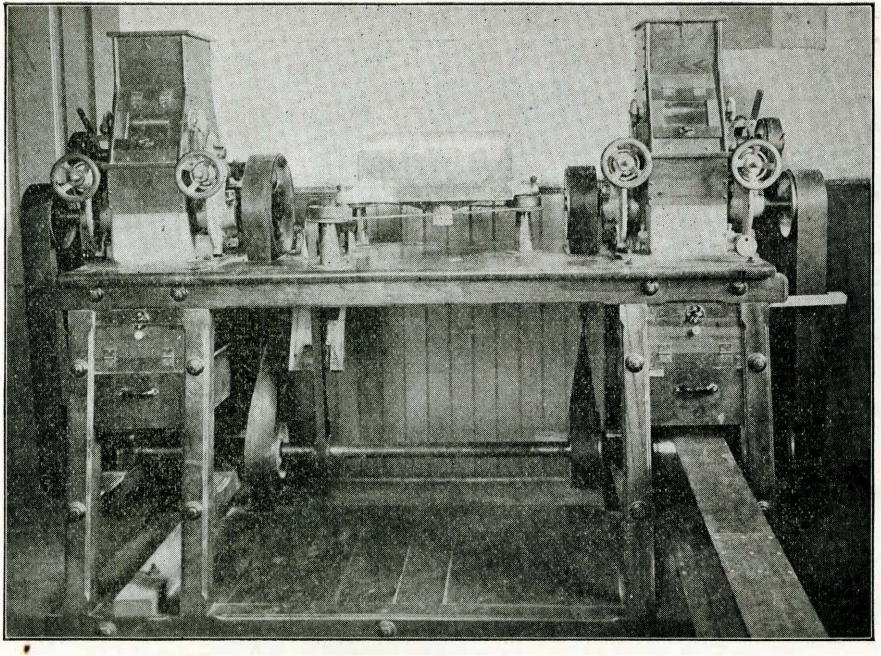

PLATE I.

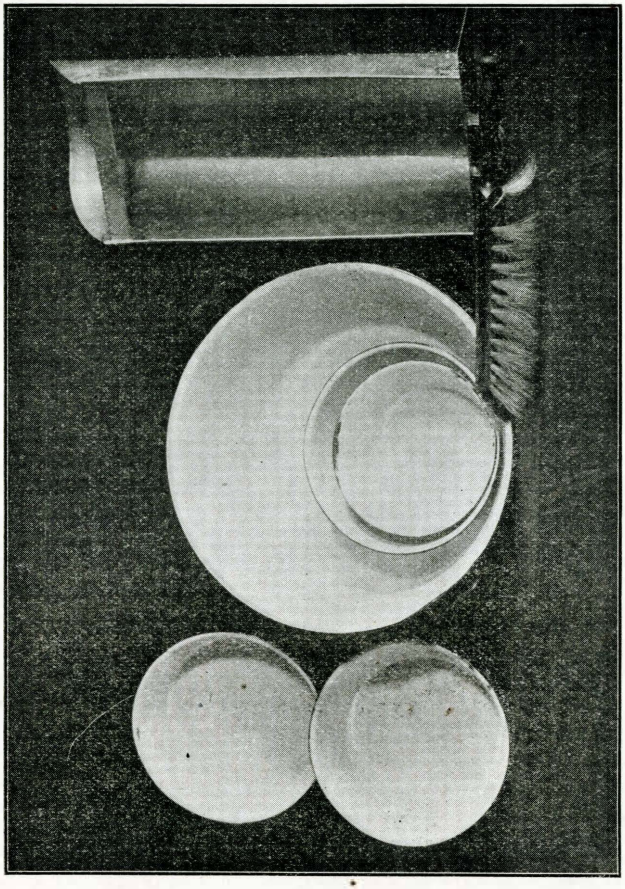

PLATE II.

For weighing a Springer Torsion Counter Balance, sensitive to ten milligrams, with highly polished nickel-plated eight-inch pans, was employed.

Before a sample of wheat is ready for reduction some preliminary treatment is necessary. Exactly one-half kilogram (1.1 pounds) was carefully weighed and then slightly moistened so that the outer covering of the grain was toughened, in order to insure a more perfect separation. The sample was then allowed to stand five hours in order that the moisture might penetrate the outer coverings, while any surplus was dissipated in the air.

The wheat is first reduced on the corrugated rolls and then transferred to the sifter, where a partial separation is effected. In grinding these wheats three different sieves are used at the same time. The coarsest one is at the top and the finest at the bottom. The flour passes through the last while the unreduced wheat and mill refuse are retained by the other sieves. The contents remaining on each sieve are returned separately to the corrugated rolls until sufficiently reduced, being returned to the sifter each time for further separation. The flour in the samples milled was sufficiently fine to pass a No. 90XX Shindler bolting silk. The bran was removed from a No. 20 wire screen and a No. 30 gauze. When the middlings were partially separated they were finished on the smooth rolls in order to complete the reduction. In short the wheat is handled about the same as a modern roller mill would do it with its trains of rolls and elevators. The shorts were retained by a No. 70XX Shindler silk; and finally the low grade flour stock retained by the No. 90XX silk, after sufficient reduction, was added to the shorts and returned as such.

In all these milling tests the wheat was reduced to "straight" flour, since this would give the total yield. It is not necessary to emphasize strongly the difference between the bran and shorts as shown in the table which follows. It is evident that with the absence of the middlings purifier used by a modern roller mill, a sharp separation as between these two products would not obtain. But by careful manipulation it was found

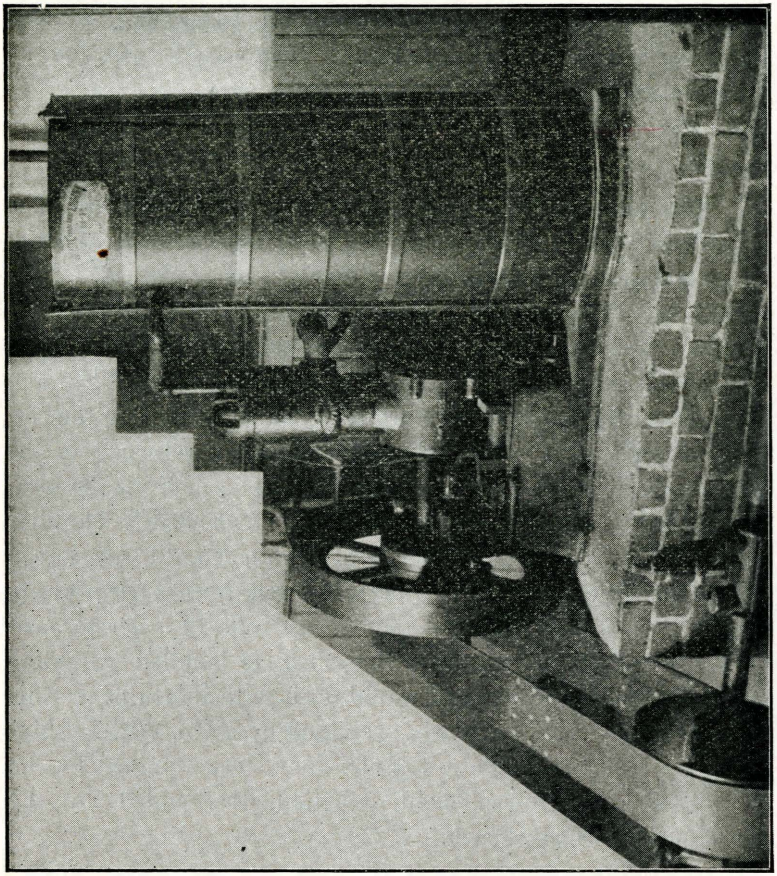

PLATE III.

that a sharp separation as between the flour and refuse was readily obtainable. This would make the sum of the bran and shorts a constant and reliable factor for any sample of wheat.

A study of the milling table which follows will reveal some interesting facts. It will be seen that the northern, or Russian, varieties have given the best results as grown with us. The Mediterranean wheats have proven thick skinned, yielding a large percentage of refuse products, with a corresponding reduction in the flour output. This will militate strongly against these wheats as a general culture crop for the great plains region. The miscellaneous wheats also seem to offer little or no inducement for general culture. These wheats, however, may be found valuable for feeding purposes in regions where there is a fairly abundant rainfall.

Of the Russian varieties, the Kubanka, Arnautka and the Gharnovkas are to be placed among the more desirable sorts. The Velvet Don, on account of its great drought resisting qualities, is also worthy of special consideration.

An inspection of the table will show that the yield of flour from the better varieties of macaroni wheat is fully equal to that obtained in milling ordinary bread wheat. This is an important factor since it will go far toward fixing the price paid to the grower. It is evident that a wheat yielding a low percentage of flour is not so valuable to the miller as one affording a larger yield. Another fact is plainly shown in the case of samples with shrunken berries. The flour yield is strongly reduced. This is true as between different samples of the same variety. These afford as much variation as do the samples from different varieties. Here we have another important fact. It shows that macaroni wheat will find its greatest usefulness restricted to those regions where the rainfall is habitually scant. It shows that in seasons of excessive moisture the quality of macaroni wheat is sure to deteriorate.

In order to show with what exactitude each reduction was made one column of the milling table is devoted to the actual errors which occurred. It will be noticed that some samples showed a loss when the sum of the mill products is compared

with the wheat taken. Again, a gain is obtained in the mill products. It will be seen by inspection that the losses occurred with the plumper and better samples, while the gains are usually from the shrunken and poorer varieties. This variation depends entirely upon the amount of water absorbed and retained by the different samples when moistened in the tempering process. The shrunken ones absorbed the most moisture.

All samples lost moisture during the milling process. This is due to the heat generated in the rolls during the reduction, and to the exposure of the products to the air during the separation and classification of the different mill products.

In order to exhibit the relation between the air dry wheat's moisture content and that of the mill products obtained these data are given in the last four columns of the table, which follows:

Milling and Moisture Table.

SAMPLE.				MILL PRODUCTS				MOISTURE—PER CENT			
Lab. No.	Name	Year Grown	Condition.	Pct. Bran	Pct. Shorts	Pct. Flour	Pct. Error	Wheat	Bran	Shorts	Flour
A	Northern or Russian Macaroni Wheats										
48	5639 Kubanka, grown by J. H. S.	1901	Slightly Shrunken	6.38	20.83	71.54	—1.25	11.31	7.56	8.48	9.86
"	" " " " " J. H. S.	1902	" "	14.44	12.30	73.20	—0.06	15.06	9.81	8.99	12.22
"	" " " at station	1902	Shrunken	12.64	12.26	74.00	—1.10	11.05	10.10	8.87	11.26
"	" " " at Mellette	1902	Plump	20.00	7.70	72.20	—0.10	11.68	10.68	9.14	11 25
49	5644 Velvet Don, grown by J. H. S.	1901	"	10.10	16.56	73.66	+0.32	10.38	9.64	9.55	11.17
"	" " " " at station	1902	"	9.44	16.57	73.30	—0.69	10.68	10.22	10.15	11.32
"	" " " " at Mellette	1902	"	24.84	14.28	59.06	—1.82	11.59	11.08	9.98	11.23
52	Arnautka	1901	"	14.00	15.22	71.38	+0.60	9.44	9.11	8.94	10.18
53	5351 Berdiansk	1901	Shrunken	14.20	21.96	63.18	—0.66	9.57	9.47	9.27	10.39
"	" "	1902	"	17.84	18.78	63.20	—0.18	9.37	10.13	9.38	11.33
"	" " grown at Mellette	1902	Plump	35.96	12.58	50.80	—0.66	11.40	11.81	11.16	11.88
54	5352 Novo Rossisk	1901	Shrunken	18.11	18.45	64.86	+1.42	8.55	11.36	10.89	12.99
"	" " "	1902	"	22.70	21.00	59.46	+3.10	9.43	11.50	9.92	10.84
"	" " " grown at Mellette	1902	Plump	22.02	11.74	66.14	—0.10	11.05	9.62	9.45	10.84
57	5355 Taganrog	1901	Slightly Shrunken	23.76	16.02	60.06	—0.22	8.78	9.63	9.11	9.88
"	" "	1902	Shrunken	42.00	15.82	41.90	—0.28	7.98	10.99	10.23	11.46
"	" " grown at Mellette	1902	Plump	29.54	11.70	57.54	—1.22	10.97	10.40	9.72	11.03
60	5642 Yellow Gharnovka	1901	Slightly Shrunken	36.18	14.16	50.16	+0.50	8.68	10.24	9.39	10.59
"	" " "	1902	" "	32.62	19.82	48.52	+0.96	8.73	11.10	10.27	11.54
"	" " " grown at Mellette	1902	Plump	25.74	12.34	61.00	—0.92	10.33	9.48	8.63	9.94
61	5643 Gharnovka	1901	Slightly Shrunken	33 84	12.18	55.46	+1.48	9.44	11.66	10.44	12.01
"	" "	1902	Shrunken	24.94	13.70	60.44	—0.92	7.96	9.07	8.52	9 41
"	" " grown at Mellette	1902	Plump	26.78	11.20	61.82	—0.20	9.67	9.21	8.39	9.94
62	5645 Black Don	1901	Shrunken	45.14	12.90	43.40	+1.44	8.94	11.13	8.52	11 80
"	" " "	1902	Plump	23.68	13.20	62.00	—1.12	8.52	8.80	8.17	9.40
"	" " " grown at Mellette	1902	"	24.84	13.16	61.30	—0.70	9 58	10.29	9.20	10.75
63	5646 Gharnovka	1901	Shrunken	29.02	12.78	58.00	—0.20	8.18	9.56	8.61	9.77
"	" "	1902	Plump	26.08	18.20	57.12	+1.40	7.77	10.28	9.99	10.46
"	" " grown at Mellette	1902	Shrunken	35.04	11.46	53.14	—0.36	10.11	10.92	9.88	10.88
64	5800 Beloturka	1901	"	19.84	10.26	70.18	+0.28	8.43	9.57	9.27	10.43
"	" "	1902	Badly Shrunken	28.54	19.50	52.44	+0.48	8.78	9.77	9.20	10.22
"	" " grown at Mellette	1902	Plump	22.64	14.14	62.62	—0.60	10.08	10.52	9.83	10 07
78	1431 Arnautka	1902	"	15.36	13.88	70.18	—0.58	8.60	8.46	8 29	9.15
129	1490 Kubanka	1902	Slightly Shrunken	16.60	7.44	75.40	—0.56	8.80	9.43	8.49	10 16
134	1515 Pererodka	1902	" "	18.34	11.08	70.30	—0.28	8.56	8.68	7.53	9.29

SAMPLE				MILL PRODUCTS				MOISTURE—PER CENT.			
Lab. No.	Name	Year Grown	Condition	Pct. Bran	Pct. Shorts	Pct. Flour	Pct. Error	Wheat	Bran	Shorts	Flour
	Northern or Russian Macaroni Wheats										
134	1515 Pererodka, grown at Mellette	1902	Slightly Shrunken	35.90	11.80	52.44	+0.14	11.53	12.52	11.76	12.48
139	1537 Arnautka	1902	Plump	20.10	10.50	69.60	+0.20	8.22	9.70	9.19	9.38
154	8212 Kubanka	Im.	"	15.48	10.20	73.04	—1.28	8.51	8.13	7.52	9.10
"	" "	1902	Badly Shrunken	23.84	26.30	50.70	+0.84	8.05	9.74	9.61	10.54
"	" " grown at Mellette	1902	Slightly Shrunken	21.40	10.88	66.82	—0.90	11.51	10.86	10.37	11.12
155	8213 Kubanka	Im.	Plump	19.90	13.88	67.62	+1.40	8.12	10.12	9.41	10.59
"	" "	1902	Badly Shrunken	38.84	11.20	52.30	+2.34	8.20	11.02	9.01	11.53
"	" " grown at Mellette	1902	Slightly Shrunken	21.50	10.50	68.20	+0.20	11.15	10.20	9.91	10.96
156	8230 Yellow Gharnovka	Im.	Plump	24.40	14.98	60.68	+0.06	7.92	9.07	8.52	9.59
"	" " "	1902	Slightly Shrunken	23.28	16.00	60.50	—0.22	8.26	9.54	8.99	9.85
"	" " " grown at Mellette	1902	Plump	19.58	12.20	67.74	—0.48	10.99	11.33	11.06	11.34
157	8231 Velvet Don	1902	Slightly Shrunken	23.36	12.14	65.00	+0.50	8.44	10.50	9.61	7.84
158	8232 Black Don	Im.	Plump	25.68	10.00	64.92	+0.60	8.02	8.87	7.74	9.39
"	" " "	1902	"	24.38	12.20	63.60	+0.18	8.14	9.93	8.95	9.96
"	" " " grown at Mellett	1902	"	20.54	15.04	63.60	—0.82	11.06	10.70	10.14	11.60
	AVERAGE			23.63	14.06	62.31	0.00	9.56	10.08	9.35	10.64
	Southern or Mediterranean Mac. Wh'ts										
B 55	5353 Algerian	1901	Shrunken	29.24	13.80	56.30	—0.66	9.74	10.34	9.3	10.77
"	" "	1902	Badly Shrunken	33.10	18.82	51.60	+3.52	9.42	12.18	10.81	12.97
"	" " grown at Mellette	1902	Slightly Shrunken	33.24	12.02	54.44	+0.30	10.59	11.53	10.56	11.67
58	5380 Pellissier	1901	" "	34.38	15.80	50.22	+0.40	9.02	10.16	9.06	10.66
"	" "	1902	Plump	45.02	14.60	40.00	—0.38	8.63	10.48	9.48	10.68
"	" " grown at Mellette	1902	"	32.10	13.00	54.34	—0.56	10.59	11.03	10.35	10.99
59	5492 Medeah	1901	"	28.98	13.04	58.56	+0.58	8.63	9.48	8.75	9.87
"	" "	1902	Slightly Shrunken	30.54	15.14	54.84	+0.52	8.80	9.60	9.01	9.97
"	" " grown at Mellette	1902	Plump	29.64	12.20	57.22	—0.94	10.51	10.73	9.46	11.26
77	1428 Egyptian, grown at Mellette	1902	"	29.24	13.84	57.00	+0.08	10.33	10.69	9.24	11.15
112	1481 Bledur, grown at Mellette	1902	"	38.30	17.06	45.40	+0.70	10.00	11.06	11.78	12.12
145	7578 Marouni	1902	Shrunken	28.00	17.52	54.70	+0.22	8.87	10.10	9.83	10.42
"	" " grown at Mellette	1902	Slightly Shrunken	24.78	16.24	58.32	—0.66	11.35	10.63	9.87	11.71
146	7579 Medeah	1902	Plump	34.24	17.94	49.22	+1.40	8.74	10.72	10.15	11.02
"	" " grown at Mellette	1902	"	31.10	17.70	49.80	+0.60	11.59	11.94	11.66	12.16
147	7580 Adjini	1902	Slightly Shrunken	36.38	18.22	44.60	—0.80	8.00	10.44	9.82	10.55
"	" " grown at Mellette	1902	" "	30.12	16.90	51.64	—1.34	11.62	11.85	11.43	11.76
148	7581 Kahla	1902	Plump	35.64	16.54	49.02	+1.20	9.06	11.69	10.62	11.87
"	" " grown at Mellette	1902	Slightly Shrunken	36.38	13.96	48.92	—0.74	11.34	11.20	10.36	11.65
149	7785 Pellissier	1902	" "	28.90	15.78	54.60	—0.72	8.77	9.30	8.20	9.28
"	" " grown at Mellette	1902	" "	31.06	20.04	48.90	—0.00	11.72	12.41	12.55	12.76
150	7792 Mahmoudi	1902	Plump	40.04	18.16	42.90	+1.10	7.80	10.66	9.64	10.67

SAMPLE				MILL PRODUCTS				MOISTURE—PER CENT.			
Lab. No.	Name	Year Grown	Condition	Pct. Bran	Pct. Shorts	Pct. Flour	Pct. Error	Wheat	Bran	Shorts	Flour
	Southern or Mediterranean Mac. Wh'ts										
150	7792 Mahmondi, grown at Mellette	1902	Slightly Shrunken	32.28	14.08	53.54	—0.10	11.51	12.03	11.51	12.20
151	7793 Mohamed ben Bachis	1902	Plump	34.04	18.30	47.58	—0.08	8.66	9.88	9.24	10.28
"	" " " " " grown at Mel.	1902	"	26.66	12.10	60.90	—0.34	11.87	12.55	11.77	13.13
152	7794 Kahla	1902	Slightly Shrunken	29.36	18.40	53.28	+1.04	9.09	10.97	10.23	11.69
"	" " " grown at Mellette	1902	" "	22.04	14.30	63.10	—0.56	12.30	12.21	12.58	12.82
153	7795 Richi	1902	" "	27.46	15.20	58.04	+0.70	8.37	10.08	9.51	10.99
"	" " " grown at Mellette	1902	" "	26.60	15.20	56.94	—1.26	12.15	11.82	11.48	11.94
162	9130 Saragolle	Im.	" "	21.98	14.10	63.82	—0.60	9.55	9.67	8.90	10.15
	AVERAGE			31.36	15.75	52.98	+0.09	9.97	10.58	10.24	11.30
C	Miscellaneous Macaroni Wheats										
56	5354 Argentine	1901	Slightly Shrunken	23.44	15.94	59.98	—0.64	9.02	9.76	8.60	10.02
"	" "	1902	" "	24.10	11.20	63.74	—0.96	8.55	9.55	8.69	10.08
"	" " grown at Mellette	1902	" "	28.88	11.94	58.24	—1.44	10.78	10.70	9.60	11.26
75	1377 Realli Forte	1902	Plump	29.62	15.10	54.42	—0.86	9.00	9.27	8.58	9.74
"	" " " grown at Mellette	1902	Badly Shrunken	36.90	15.36	46.94	—0.80	10.12	9.84	9.58	10.67
122	1492 Nicaragua, grown at Mellette	1902	Slightly Shrunken	41.16	11.40	47.94	+0.50	10.50	10.96	10.87	11.11
123	1498 Wild Goose	1902	Plump	20.64	12.48	66.40	—0.48	9.09	9.58	8.65	9.18
"	" " " grown at Mellette	1902	"	34.66	14.54	50.40	—0.40	11.26	11.22	11.12	11.95
159	8550	1902	Badly Shrunken	27.56	11.94	61.58	+1.08	8.72	9.57	8.38	10.48
160	8551	1902	" "	26.56	10.54	62.50	—0.40	8.31	8.95	8.07	10.14
161	8552 Walnak	1902		30.38	14.04	56.34	+0.76	8.07	10.33	9.10	10.28
	AVERAGE			29.40	13.14	57.13	—0.33	9.40	9.97	9.20	9.54
D	Ordinary Bread Wheats										
50	Jone's Pedigreed Bluc Stem	1902	Badly Shrunken	30.20	16.44	54.32	+0.96	10.25	9.52	8.11	10.59
	GENERAL AVERAGE			26.91	14.53	58.56	0.00	9.67	10.22	9.61	10.73

CHEMICAL CHARACTERISTICS OF MACARONI WHEAT.

One of the most important characteristics of macaroni wheat is the amount of protein or gluten it contains. Closely allied to this is the nature or quality of the gluten itself. These points may best be illustrated by considering the requirements in a first class article of macaroni. In the first place the per cent of gluten must be high; anything less than about 45 to 50 per cent of wet gluten makes a macaroni of poor texture and one that does not hold up well in cooking. Again not only must the per cent of gluten be high, but it must also have a certain tenacity in order to insure the stability of the finished product. If the tenacity be low the macaroni is liable to suffer in many of its physical properties. And last, but not least, the flavor of the gluten must be of high quality since it imparts its own peculiar flavor to the finished product.

The protein factor, therefore, is one of the first to receive consideration. It is the foundation upon which the success of macaroni wheat must rest. If American grown macaroni wheats suffer a gradual diminution of protein when grown in this country it is useless to try to compete with foreign grown wheats of high gluten content. Especial care, therefore, has been taken to determine how these foreign wheats are affected by growing upon American soils. We are now removed two crops from the imported seed. Trials have been made both at the home Station and at Mellette, in the James River valley. While the series has not been extended as many years as will be desirable, the results already obtained point toward an increase rather than toward a diminution of the protein content of the whole wheat. In the case of the Kubanka variety, the original seed imported gave a protein content of 14.1 per cent. In the year of 1901, a favorable year, when grown on South Dakota soil the protein increased to 18.8 per cent. When the 1901 crop was grown again in 1902, a wet, unfavorable year, the protein content was 13.9 per cent, or practically the same as that of the imported seed. This series

will be continued further.

The chemical data for all the varieties obtained up to this writing are given in the protein and Gluten Table which follows. These results are given for the air dry wheat, with its varying quantity of moisture just as the wheat would reach the miller. In the first column the protein in the whole air-dry wheat is given. The moisture in the different samples was given in the milling and moisture table. The protein and gluten table also gives the protein content of the mill products obtained from the different varieties of wheat. In these determinations the protein factor used was 5.7. The value of the bran and shorts for feeding purposes depends largely on their protein content. The value of the flour to the baker and manufacturer of macaroni products also depends upon the protein.

By comparing the two tables mentioned it will appear that the per cent of protein varies not only with the variety of wheat, but also with the physical condition of different samples of the same variety. A plump, well developed berry carries more protein than a shrunken one. Also a comparison between the crops of 1901 and of 1902 is interesting. The former year was dry and favorable while the latter was wet and unfavorable to macaroni wheat. The wheats grown at Mellette in 1902 are richer in protein than those grown at the home Station. It was dryer at Mellette. Again, the difference between high land and low land in a wet year is shown in Nos. 5639 and 5644. The samples grown by the writer were on high land and those grown by the Station were on rather low land. In the case of the Kubanka grown by the writer it will be seen by referring to the moisture table that this sample carried about one-half more moisture than the average. This was due to the fact that it was milled and analyzed as soon as threshed, while the other samples had time to dry properly. By making the proper computations it will appear that the protein content of this sample is much greater when reduced to a fair air-dry basis.

Two columns of this table show the gluten in the flour. This is of special value to the baker and macaroni manufacturer. The last column gives the water holding power of the gluten. In a

crude way the water-holding capacity of a gluten is closely related to its tenacity and elasticity. For instance, a short gluten of little tenacity has a low water-holding capacity. A gluten with high water capacity is more valuable for the manufacture of both bread and macaroni.

In regard to flavor it is more difficult to give a fixed factor. The very nature of a flavor is in itself so elusive that it is difficult to describe it. But in general we may say that flavor is neutral, agreeable, or disagreeable. In the manufactured article, such as bread or macaroni, the flavor plays an important part. In bread the best wheats give a flavor slightly resembling some of the edible nuts, and this nutty flavor is accompanied by a slightly sweetish taste. But after all is said and done it is easier to test a flavor than it is to describe it. Flavor is best determined in the manufactured product after it is cooked ready for consumption.

Protein and Gluten.

Computations on Air Dry Samples—N x 5.7 equals Crude Protein.

SAMPLE.		Per Cent Protein.					Gluten in Flour.		
Laboratory Number.	NAME.	Year Grown	Wheat	Bran	Shorts	Flour	Per Cent Wet Gluten.	Per Cent Dry Gluten.	Water Capacity—Gr'ms Water Held by One Gram Dry Gluten.
A	Northern or Russian Macaroni Wheats—								
48	5639—Kubanka—grown by J. H. S.	1901	16.63	16.25	17.39	16.94	54.83	18.03	2.04
48	5639—Kubanka—grown by J. H. S.	1902	11.83	12.67	12.82	12.03	39.63	13.54	1.93
48	5639—Kubanka—grown at station	1902	10.67	10.48	10.78	10.80	27.47	10.22	1.68
48	5639—Kubanka—grown at Mellette	1902	12.72	13.12	12.48	12.53	42.73	15.11	1.83
49	5644—Velvet Don—grown by J. H. S.	1901	14.88	14.74	14.13	14.96	45.33	16.08	1.82
49	5644—Velvet Don—grown at station	1902	12.30	12.07	11.92	12.46	41.38	14.31	1.89
49	5644—Velvet Don—grown at Mellette	1902	13.02	13.41	11.99	12.97	44.09	15.60	1.83
52	Arnautka	1901	17.92	17.92	17.16	17.62	58.64	19.95	1.94
53	5351—Berdiansk	1901	17.24	16.86	16.86	17.54	63.13	20.71	2.05
53	5351—Berdiansk	1902	11.54	11.83	11.54	11.47	37.54	13.27	1.83
53	5351—Berdiansk—grown at Mellette	1902	15.09	15.92	14.40	14.79	50.66	16.74	2.03
54	5352—Novo Rossisk	1901	17.98	17.37	17.00	17.68	57.60	19.84	1.90
54	5352—Novo Rossisk	1902	14.64	14.03	14.42	14.03	48.04	15.97	2.01
54	5352—Novo Rossisk—grown at Mellette	1902	15.48	16.80	15.09	15.28	54.94	17.81	2.08
57	5355—Taganrog	1901	15.60	15.97	14.69	14.84	51.96	18.10	1.87
57	5355—Taganrog	1902	13.78	13.54	12.88	12.65	44.99	15.04	1.99
57	5355—Taganrog—grown at Mellette	1902	13.13	14.25	13.03	13.28	47.40	16.08	1.95
60	5642—Yellow Gharnovka	1901	17.78	17.41	16.50	17.18	64.03	21.18	2.02
60	5642—Yellow Gharnovka	1902	11.37	11.59	11.51	10.91	35.48	12.47	1.84
60	5642—Yellow Gharnovka—grown at Mellette	1902	16.27	16.27	15.28	16.46	60.98	21.16	1.88
61	5643—Gharnovka	1901	16.65	16.20	15.66	16.50	53.61	20.24	1.65
61	5643—Gharnovka	1902	11.17	10.45	11.17	10.91	30.37	11.99	1.53
61	5643—Gharnovka—grown at Mellette	1902	15.58	15.52	14.94	15.04	58.13	19.36	2.00
62	5645—Black Don	1901	18.31	18.27	17.71	17.78	61.29	20.76	1.95

Computations on Air Dry Samples—N x 5.7 equals Crude Protein.

Laboratory Number	SAMPLE. NAME.	Year Grown	Per Cent Protein. Wheat	Bran	Shorts	Flour	Gluten in Flour. Per Cent Wet Gluten	Per Cent Dry Gluten	Water Capacity—Grams Water Held by One Gram Dry Gluten.
62	5645—Black Don	1902	12.19	12.72	12.27	11.74	36.96	13.42	1.75
62	5645—Black Don—grown at Mellette	1902	15.88	15.82	14.25	15.78	55.99	18.99	1.95
63	5646—Gharnovka	1901	16.88	16.20	15.44	16.58	52.87	18.38	1.88
63	5646—Gharnovka	1902	12.33	12.27	12.19	12.42	36.66	13.31	1.75
63	5646—Gharnovka—grown at Mellette	1902	15.47	15.92	14.45	14.89	56.96	18.55	2.07
65	5800—Beloturka	1901	15.22	15.22	14.39	14.62	46.33	17.03	1.72
65	5800—Beloturka	1902	12.12	11.89	11.89	11.82	30.35	11.85	1.56
65	5800—Beloturka—grown at Mellette	1902	13.17	13.57	12.44	12.83	45.35	15.61	1.91
78	1431—Arnautka	1902	13.74	14.20	13.63	13.78	40.68	15.03	1.71
120	1490—Kubanka	1902	13.48	13.70	13.40	13.33	39.38	14.85	1.65
134	1515—Pererodka	1902	13.03	13.56	12.57	12.80	39.07	14.57	1.68
134	1515—Pererodka—grown at Mellette	1902	13.22	13.45	13.13	12.39	42.05	14.05	1.99
139	1537—Arnautka	1902	12.72	13.03	12.57	12.72	[illegible]	14.00	1.62
154	8212—Kubanka	Imp	14.02	14.32	13.65	14.02	46.94	16.28	1.88
154	8212—Kubanka	1902	11.62	11.47	11.55	11.02	34.65	12.25	1.83
154	8212—Kubanka—grown at Mellette	1902	15.82	16.17	15.58	15.38	56.64	18.28	2.10
155	8213—Kubanka	Imp	17.36	16.90	16.23	16.54	62.20	20.88	1.98
155	8213—Kubanka	1902	11.33	11.56	11.33	10.51	32.26	11.76	1.74
155	8213—Kubanka—grown at Mellette	1902	15.53	16.13	15.38	15.73	56.50	17.66	2.20
156	8230—Yellow Gharnovka	Imp	17.17	17.17	15.83	16.59	60.72	19.61	2.10
156	8230—Yellow Gharnovka	1902	11.86	11.86	11.56	11.63	31.85	11.50	1.77
156	8230—Yellow Gharnovka—grown at Mellette	1902	12.49	13.07	12.34	12.34	46.25	15.70	1.95
157	8231—Velvet Don	1902	11.26	12.01	11.11	10.44	33.06	11.86	1.79
158	8232—Black Don	Imp	16.59	17.03	14.71	16.05	56.12	19.00	1.95
158	8232—Black Don	1902	11.33	11.26	10.44	11.04	31.34	11.69	1.68
158	8232—Black Don—grown at Mellette	1902	12.73	12.64	12.39	12.53	44.97	15.43	1.91
	Average	....	14.20	14.32	13.72	13.92	46.54	16.10	1.89

Computations on Air Dry Samples—N x 5.7 equals Crude Protein.

Laboratory Number	SAMPLE NAME	Year Grown	Per Cent Protein. Wheat	Bran	Shorts	Flour	Gluten in Flour. Per Cent Wet Gluten	Per Cent Dry Gluten	Water Capacity—Grams Water Held by One Gram Dry Gluten.
B	Southern or Mediterranean Macaroni Wheats—								
55	5353—Algerian	1901	16.77	16.77	15.70	16.77	54.58	18.47	1.95
55	5353—Algerian	1902	12.59	12.44	12.37	12.75	37.78	13.60	1.78
55	5353—Algerian—grown at Mellette	1902	15.88	15.97	14.79	15.68	50.48	17.34	1.91
58	5380—Pellissier	1901	16.95	16.95	16.13	16.88	58.85	19.44	1.89
58	5380—Pellissier	1902	13.02	12.95	12.72	12.12	35.84	13.21	1.71
58	5380—Pellissier—grown at Mellette	1902	14.15	14.25	13.03	13.81	45.42	16.28	1.79
59	5492—Medeah	1901	15.44	15.29	14.76	15.37	53.63	17.75	2.02
59	5492—Medeah	1902	14.46	14.33	13.63	14.20	51.80	17.51	1.96
59	5492—Medeah—grown at Mellette	1902	13.96	15.04	13.02	13.86	51.70	17.03	2.04
77	1428—Egyptian—grown at Mellette	1902	12.88	14.30	13.13	12.64	44.80	15.11	1.96
112	1481—Ble dur—grown at Mellette	1902	14.45	15.19	13.17	13.62	47.76	15.98	1.99
145	7578—Marouni	1902	14.46	14.54	13.93	14.46	51.49	16.64	2.09
145	7578—Marouni—grown at Mellette	1902	15.24	15.92	14.79	14.55	50.70	17.21	1.95
146	7579—Medeah	1902	14.46	14.99	13.93	14.46	54.61	17.47	2.13
146	7579—Medeah—grown at Mellette	1902	13.45	14.60	12.98	13.03	51.50	16.75	2.07
147	7580—Adjini	1902	15.22	14.76	14.23	14.54	46.52	15.59	1.98
147	7580—Adjini—grown at Mellette	1902	13.57	14.70	12.83	12.72	41.94	14.44	1.90
148	7581—Kahla	1902	15.14	15.67	14.31	14.23	49.15	15.86	2.10
148	7581—Kahla—grown at Mellette	1902	15.67	16.02	14.35	16.47	48.35	16.08	2.01
149	7785—Pellissier	1902	14.99	15.14	14.54	14.76	48.32	16.34	1.96
149	7785—Pellissier—grown at Mellette	1902	14.79	15.78	14.01	14.11	46.71	15.24	2.06
150	7792—Mahmoudi	1902	15.22	15.69	14.39	14.99	48.13	16.36	1.94
150	7792—Mahmoudi—grown at Mellette	1902	13.22	14.06	12.98	12.72	41.86	14.12	1.96
151	7793—Mohamed ben Bachis	1902	14.92	16.20	13.93	14.22	46.99	15.67	2.00
151	7793—Mohamed ben Bachis—grown at Mellette	1902	12.59	14.01	12.64	12.15	42.01	13.83	2.03
152	7794—Kahla	1902	16.20	16.05	15.00	15.29	52.25	17.27	2.03
152	7794—Kahla—grown at Mellette	1902	13.66	14.89	13.45	13.28	48.75	15.75	2.09

Computations on Air Dry Samples—N x 5.7 equals Crude Protein.

Laboratory Number	NAME.	Year Grown	Per Cent Protein. Wheat	Bran	Shorts	Flour	Gluten in Flour. Per Cent Wet Gluten	Per Cent Dry Gluten	Water Capacity—Grams Water Held by One Gram Dry Gluten.
153	7795—Richi	1902	15.60	16.58	14.39	14.92	52.03	16.53	2.15
153	7795—Richi—grown at Mellette	1902	14.30	15.38	13.91	14.01	48.07	15.74	2.05
162	9130—Saragolle	Imp	12.01	12.91	12.23	11.63	39.22	12.94	2.03
	Average	....	14.51	15.04	13.84	14.12	48.03	16.05	1.98
C	Miscellaneous Macaroni Wheats—								
56	5354—Argentine	1901	16.01	17.37	15.55	15.48	57.44	18.83	2.05
56	5354—Argentine	1902	11.82	12.61	11.82	11.06	37.81	13.09	1.89
56	5354—Argentine—grown at Mellette	1902	15.68	16.27	15.48	15.33	58.54	19.39	2.02
75	1377—Realli Forte	1902	14.84	15.37	14.01	14.23	37.98	13.48	1.82
75	1377—Realli Forte—grown at Mellette	1902	16.22	16.02	14.75	15.53	51.37	17.07	2.01
122	1492—Nicaragua—grown at Mellette	1902	13.37	13.77	13.45	13.07	45.26	15.25	1.97
123	1493—Wild Goose	1902	12.72	13.18	12.85	12.12	39.03	14.50	1.69
123	1493—Wild Goose—grown at Mellette	1902	14.11	14.99	14.01	13.77	46.53	16.10	1.89
159	8550	1902	12.61	13.21	12.23	12.76	38.70	13.25	1.92
160	8551	1902	12.91	13.21	12.23	12.83	37.23	12.80	1.91
161	8552—Walnak	1902	13.43	13.96	12.61	12.76	42.97	14.72	1.92
	Average	....	13.97	14.54	13.54	13.54	44.81	15.32	1.92
D	Bread Wheats—								
50	Jones' Pedigreed Blue Stem	1902	13.44	13.29	13.63	13.17	40.56	13.33	2.04
	General average	....	14.27	14.57	13.74	13.94	46.76	15.96	1.93

DISTRIBUTION OF CRUDE PROTEIN.

The value of a wheat depends not alone upon the total crude protein which it carries. The location of the protein also is an important consideration. It would avail the miller and the baker little if the protein should be chiefly concentrated in the outer coverings of the wheat kernel. In such a case the mill refuse would carry away the protein, leaving the flour poor and starchy.

In the Distribution Table which follows some useful and interesting data are given. The fourth column gives the total pounds protein in 100 pounds of the whole wheat. The next three columns give the number of pounds of this total protein which appears, respectively, in the bran, shorts and flour. In three other columns which follow appears the per cent of the total protein in the wheat which goes into the bran, shorts and flour.

The difference between the various samples of wheat when considered from a milling and manufacturing standpoint, is strikingly shown by inspecting the percentages under the flour column. It is interesting to note the variations between the different varieties. It also appears that the Russian varieties are more economical than those of Mediterranean origin or those listed as Miscellaneous on account of the larger percentage of protein which passes into the flour. These differences will be a potent factor in determining which of these wheats shall go into general cultivation. It is evident that those wheats which carry an extremely large per cent of their protein in their outer coverings will not be profitable sorts to grow for milling purposes. That these wheats may be found most useful for stock feeding, however, is most probable. The Mediterranean wheats will thrive with a more abundant rainfall, and as a rule their yields per acre are large.

On the other hand, the Russian wheats require a restricted rainfall in order to develop to their highest degree of usefulness. The Distribution Table follows:

Distribution of Crude Protein in Wheat.

(Calculated to air dry samples.)

N x 5.7 equals Crude Protein.

SAMPLE.			Pounds Protein in 100 Pounds Wheat and in Mill Products Therefrom.						Per Cent Distribution Between Mill Products of Total Protein in Wheat.			
Laboratory Number	NAME.	Year Grown	Whole Wheat	Bran	Shorts	Flour	Error		Bran	Shorts	Flour	Error
A	Northern or Russian Macaroni Wheats—											
48	5639—Kubanka—grown by J. H. S.	1901	16.63	1.04	3.62	12.12	+0.15		6.25	21.77	72.88	+0.90
48	5639—Kubanka—grown by J. H. S.	1902	11.83	1.83	1.58	8.83	+0.41		15.47	13.35	74.64	+3.46
48	5639—Kubanka	1902	10.67	1.32	1.32	7.99	−0.04		12.37	12.37	74.88	−0.38
48	5639—Kubanka—grown at Mellette	1902	12.72	2.62	0.96	9.05	−0.09		20.60	7.55	71.15	−0.70
49	5644—Velvet Don—grown by J. H. S.	1901	14.88	1.49	2.34	11.01	−0.04		10.01	15.73	73.99	−0.27
49	5644—Velvet Don	1902	12.30	1.14	1.98	9.13	−0.05		9.27	16.09	74.23	−0.41
49	5644 Velvet Don—grown at Mellette	1902	13.02	3.33	1.71	7.66	−0.32		25.58	13.13	58.83	−2.46
52	Arnautka	1901	17.92	2.51	2.61	12.58	−0.22		14.01	14.57	70.19	−1.23
53	5351—Berdiansk	1901	17.24	2.39	3.70	11.08	−0.07		13.86	21.46	64.27	−0.41
53	5351—Berdiansk	1902	11.54	2.11	2.17	7.25	−0.01		18.28	18.80	62.82	−0.10
53	5351—Berdiansk—grown at Mellette	1902	15.08	5.72	1.81	7.51	−0.04		37.93	12.00	49.80	−0.27
54	5352—Novo Rossisk	1901	17.98	3.15	3.14	11.47	−0.22		17.52	17.47	63.79	−1.22
54	5352—Novo Rossisk	1902	14.64	3.19	3.03	8.33	−0.09		21.79	20.69	56.89	−0.63
54	5352—Novo Rossisk—grown at Mellette	1902	15.48	3.70	1.77	10.11	+0.10		23.90	11.43	65.31	+0.64
57	5355—Taganrog	1901	15.60	3.80	2.35	8.90	−0.55		24.36	15.06	57.05	−3.53
57	5355—Taganrog	1902	13.78	5.69	2.04	5.30	−0.75		41.29	14.80	38.46	−5.45
57	5355—Taganrog—grown at Mellette	1902	13.13	4.21	1.52	7.64	+0.24		32.06	11.57	58.19	+1.82
60	5642—Yellow Gharnovka	1901	17.78	6.30	2.34	8 62	−0.52		35.43	13.16	48.48	−2.93
60	5642—Yellow Gharnovka	1902	11.37	3.78	2.28	5.29	−0.02		33.25	20.05	46.53	−0.17
60	5642—Yellow Gharnovka—grown at Mellette	1902	16.27	4.19	1.89	10.04	−0.15		25.75	11.62	61.71	−0.92
61	5643—Gharnovka	1901	16.65	5.48	1.91	9.15	−0.11		32.91	11.47	54.95	−0.67
61	5643—Gharnovka	1902	11.17	2.61	1.53	6.59	−0.44		23.37	13.70	58.99	−3.94
61	5643—Gharnovka—grown at Mellette	1902	15.58	4.21	1.68	9.30	−0.39		27.02	10.78	59.69	−2.51
62	5645—Black Don	1901	18.31	8.48	2.28	7.72	+0.17		46.31	12.45	42.16	+0.92

N x 5.7 equals Crude Protein.

Laboratory Number	NAME.	Year Grown	Pounds Protein in 100 Pounds Wheat and in Mill Products Therefrom. Whole Wheat	Bran	Shorts	Flour	Error	Per Cent Distribution Between Mill Products of Total Protein in Wheat. Bran	Shorts	Flour	Error
62	5645—Black Don	1902	12.19	3.02	1.62	7.28	—0.27	24.77	13.29	59.72	—2.22
62	5645—Black Don—grown at Mellette	1902	15.88	3.93	1.85	9.67	—0.43	24.75	11.65	60.89	—2.71
63	5646—Gharnovka	1901	16.88	4.70	1.97	9.62	—0.59	27.84	11.67	56.99	—3.50
63	5646—Gharnovka	1902	12.33	3.19	2 22	7.0[illegible]	+0.17	25.87	18.00	57.50	+1.37
63	5646—Gharnovka—grown at Mellette	1902	15.47	5.58	1.66	7.92	—0.31	36.07	10.73	51.20	—2.00
65	5800—Beloturka	1901	15.22	3.02	1.48	10.25	—0.47	19.84	9.72	67.34	—3.10
65	5800—Beloturka	19[illegible]2	12.12	3.39	2.32	6.20	—0.21	27.97	19.14	51.15	—1.74
65	5800—Beloturka—grown at Mellette	1902	13.17	3.07	1.76	8 04	—0.30	23.32	13.36	61.05	—2.27
78	1431—Arnautka	1902	13.74	2.15	1.89	9.67	—0.03	15.65	13.76	70.38	—0.21
120	1490—Kubanka	1902	13.48	2.27	1.01	10.05	—0.15	16.84	7.49	74.57	—1.10
134	1515—Pererodka	1902	13.03	2.49	1.39	8 99	—0.16	19.11	10.67	68.99	—1.23
134	1515—Pererodka—grown at Mellette	19[illegible]2	13.22	5.38	1.55	6.5[illegible]	+0.21	40.70	11.72	49.16	+1.58
139	1537—Arnautka	1902	12.72	2.62	1.32	8.85	+0.07	20.59	10.38	69.58	+0.55
154	8212—Kubanka	Imp	14.02	2.22	1.39	10.24	—0.17	15.83	9.91	73.04	—1.22
154	8212—Kubanka	1902	11.62	2.74	3.04	5.59	—0.25	23.58	26.16	48.11	—2.15
154	8212—Kubanka grown at Mellette	1902	15.82	3.46	1.6[illegible]	10.28	—0.39	21.87	10.68	64.98	—2.47
155	8213—Kubanka	Imp	17.36	3.38	2.25	11.18	—0.55	19.47	12.96	64.40	—3.17
155	8213—Kubanka	1902	11.33	4.49	1.27	5.50	—0.07	39.63	11.21	48.54	—0.62
155	8213—Kubanka—grown at Mellette	19[illegible]2	15.53	3.47	1.61	10.73	+0.28	22.36	10.38	69.09	+1.83
156	8230—Yellow Gharnovka	Imp	17.17	4.19	2.57	10.07	—0.54	24.40	13.80	58.65	—3.15
156	8230—Yellow Gharnovka	1902	11.86	2.76	1.85	7.04	—0.21	23.27	15.59	59.36	—1.78
156	8230—Yellow Gharnovka—grown at Mellette	1902	12.49	2.56	1.51	8.36	—0.06	20.49	12.09	66.93	—0.49
157	8231—Velvet Don	1902	11.26	2.81	1.35	6.78	—0.32	24.96	12.00	60.12	—2.92
158	8232—Black Don	Imp	16.59	4.71	1.47	10.40	—0.01	28.39	8.86	62.69	—0.06
158	8232—Black Don	1902	11.33	2.74	1.27	7.02	—0.30	24.18	11.21	61.96	—2.65
158	8232—Black Don—grown at Mellette	1902	12.73	2.69	1.86	7.97	—0.30	20.42	14.61	62.61	—2.36
	Average		14.20	3.42	1.93	8.68	—0.17	24.01	13.64	61.18	—1.17
B	Southern or Mediterranean Macaroni Wheats—										
55	5353—Algerian	1901	16.77	4.90	2.17	9.44	—0.26	29.22	12.94	56.29	—1.55
55	5353—Algerian	1902	12.59	4.12	2.33	6.57	+0.43	32.72	18.51	52.18	+3.41

(Calculated to air dry samples.)

N x 5.7 equals Crude Protein.

Laboratory Number	SAMPLE. NAME.	Year Grown	Pounds Protein in 100 Pounds Wheat and in Mill Products Therefrom. Whole Wheat	Bran	Shorts	Flour	Error	Per Cent Distribution Between Mill Products of Total Protein in Wheat. Bran	Shorts	Flour	Error
55	5353—Algerian—grown at Mellette	19 2	15.88	5.31	1.87	8.53	—0.17	33.44	11.78	53.71	—1.07
58	5380—Pellissier	1901	16.95	5.83	2.55	8.48	—0.09	34.40	15.04	50.03	—0.53
58	5380—Pellissier	1902	13.02	5.81	1.86	4.85	—0.50	44.62	14.29	37.25	—3.84
58	5380—Pellissier—grown at Mellette	1902	14.15	4.54	1.69	7.51	—0.41	32.08	11.94	53.07	—2.91
59	5492—Medeah	1901	15.44	4.43	1.93	9.00	—0.08	28.70	12.50	58.29	—0.51
59	5492—Medeah	1902	14.46	4.35	2.06	7.79	—0.26	30.08	14.25	53.87	—1.80
59	5492—Medeah—grown at Mellette	1902	13.96	4.46	1.61	7.93	+0.04	31.95	11.53	56.81	+0.29
77	1428—Egyptian—grown at Mellette	1902	12.88	4.18	1.81	7.20	+0.31	32.45	14.05	55.90	+2.40
112	1481—Ble dur—grown at Mellette	1902	14.45	5.81	2.24	6.19	—0.21	40.21	15.50	42.84	—1.45
145	7578—Marouni	1902	14.46	4.07	2.44	7.91	—0.04	28.15	16.87	54.70	—0.28
145	7578—Marouni—grown at Mellette	1902	15.24	3.95	2.40	8.48	—0.41	25.92	15.75	55.64	—2.69
146	7579. .Medeah	1902	14.46	5.13	2.50	7.11	+0.28	35.48	17.29	49.17	+1.94
146	7579—Medeah—grown at Mellette	1902	13.45	4.54	2.56	6.48	+0.13	33.75	19.03	48.18	+0.96
147	7580—Adjini	1902	15.22	5.37	2.57	6.54	—0.74	35.28	16.89	42.97	—4.86
147	7580—Adjini—grown at Mellette	1902	13.57	4.42	2.17	6.52	—0.46	32.57	15.99	48.05	—3.39
148	7581—Kahla	1902	15.14	5.19	2.36	6.98	—0.61	34.28	15.59	46.10	—4.03
148	7581—Kahla—grown at Mellette	1902	15.67	5.83	2.01	7.11	—0.72	37.20	12.83	45.37	—4.60
149	7785—Pellissier	1902	14.99	4.38	2.29	8.06	—0.26	29.22	15.28	53.77	—1.73
149	7785—Pellissier—grown at Mellette	1902	14.79	4.90	2.81	6.90	—0.18	33.13	19.00	46.65	—1.22
150	7792—Mahmoudi	1902	15.22	6.24	2.61	6.43	+0.06	41.00	17.15	42.25	+0.40
150	7792—Mahmoudi—grown at Mellette	1902	13.22	4.54	1.83	6.81	—0.04	34.36	13.84	51.51	—0.29
151	7793—Mohamed ben Bachis	1902	14.92	5.40	2.55	6.77	—0.20	36.19	17.09	45.38	—1.34
151	7793—Mohamed ben Bachis—grown at Mellette	1902	12.59	3.73	1.53	7.40	+0.07	29.63	12.15	58.78	+0.56
152	7794—Kahla	1902	16.20	4.71	2.76	8.15	—0.58	29.07	17.04	50.31	—3.58
152	7794—Kahla—grown at Mellette	1902	13.66	3.28	1.92	8.38	—0.08	24.01	14.06	61.35	—0.58
153	7795—Richi	1902	15.60	4.56	2.19	8.66	—0.19	29.23	14.04	55.51	—1.22
153	7795—Richi—grown at Mellette	1902	14.30	4.09	2.11	7.95	—0.15	28.60	14.75	55.60	—1.05
162	9130—Saragolle	Imp	12.01	2.84	1.73	7.36	—0.08	23.65	14.40	61.28	—0.67
	Average	....	14.51	4.70	2.18	7.45	—0.18	32.35	15.05	51.43	**—1.17**

N x 5.7 equals Crude Protein.

Laboratory Number	NAME.	Year Grown	Pounds Protein in 100 Pounds Wheat and in Mill Products Therefrom. Whole Wheat	Bran	Shorts	Flour	Error	Per Cent Distribution Between Mill Products of Total Protein in Wheat. Bran	Shorts	Flour	Error
C	Miscellaneous Macaroni Wheats—										
56	5354—Argentine	1901	16.01	4.07	2.48	9.28	—0.18	25.42	15.49	57.96	—1.13
56	5354—Argentine	1902	11.82	3.04	1.32	7.05	—0.41	25.72	11.17	59.64	—3.47
56	5354—Argentine—grown at Mellette	1902	15.68	4.62	1.85	8.93	—0.28	29.46	11.80	56.95	—1.79
75	1377—Realli Forte	1902	14.84	4.55	2.12	7.74	—0.43	30.66	14.29	52.16	—2.89
75	1377—Realli Forte—grown at Mellette	1902	16.22	5.91	2.26	7.29	—0.76	36.44	13.93	44.94	—4.69
122	1492—Nicaragua—grown at Mellette	1902	13.37	5.67	1.53	6.26	+0.09	42.41	11.44	46.82	+0.67
123	1493—Wild Goose	1902	12.72	2.72	1.61	8.05	—0.34	21.38	12.66	63.29	—2.67
123	1493—Wild Goose—grown at Mellette	1902	14.11	5.20	2.03	6.94	+0.06	36.85	14.39	49.18	+0.42
159	8550	1902	12.61	3.64	1.46	7.85	+0.34	28.87	11.58	62.25	+2.70
160	8551	1902	12.91	3.51	1.29	8.02	—0.09	27.19	9.99	62.12	—0.70
161	8552—Walnak	1902	13.43	4.24	1.77	7.19	—0.23	31.57	13.18	53.54	—1.71
	Average		13.97	4.29	1.79	7.69	—0.20	30.54	12.72	55.35	—1.39
D	Bread Wheats—										
50	Jones' Pedigreed Blue Stem	1902	13.44	4.01	2.24	7.01	—0.18	29.84	16.67	52.16	—1.53
	General average		14.27	3.95	2.00	8.14	—0.18	27.58	14.02	57.20	—1.20

SUMMATION.

In order to exhibit the principal data obtained from the different varieties of wheat a table has been compiled giving the averages where more than one sample of any variety has been investigated. The Saragolle and Walnak varieties are included in this table for comparison.

When every factor is taken into consideration, the Kubanka variety stands at the head. Of the eleven samples reported two were extremely low in value; in fact, it is doubtful if these samples would have sold on the market. If proper allowance be made for these two low grade samples, the Kubanka average will be largely increased. The other varieties had no such poor samples in the test. It was thought best, however, to include these since the results reported can probably be realized from year to year, taking the seasons as they come, the good together with the bad.

Of the other Russian varieties the Arnautka, the Gharnovka, and the Velvet Don are among the best. The Velvet Don is an extremely hardy sort that has great drouth resisting capacity.

Further comment on the Summation Table is not necessary:

SUMMATION OF THE PRINCIPAL MILLING AND CHEMICAL DATA FOR THE MACARONI WHEATS.

Results Calculated to the Air Dry Sample.

SAMPLE.		Per Cent Mill Products.				Per Cent Crude Protein.				Distribution of Crude Protein in Wheat.									Per Cent Gluten in Flour.		
										Pounds Protein in 100 Pounds Wheat and in Mill Products Therefrom.					Per Cent Distribution Between Mill Products of Total Protein in Wheat.							
Number of Analyses Made	VARIETY.	Bran	Shorts	Flour	Error	Whole Wheat	Bran	Shorts	Flour	Whole Wheat	Bran	Shorts	Flour	Error	Bran	Shorts	Flour	Error	Wet Gluten	Dry Gluten	Water Capacity, Gms. Water Held by One gm. Gluten
11	Kubanka	19.17	13.84	67.73	−0.06	13.71	13.90	13.69	13.53	13.71	2.62	1.79	9.23	−0.07	19.48	13.26	66.93	−0.33	44.66	15.35	1.95
12	Gharnovka	28.12	14.08	57.88	+0.08	14.33	14.49	13.99	14.29	14.33	4.13	1.68	8.26	−0.20	27.97	13.55	56.76	−1.72	48.99	16.95	1.89
3	Arnautka	16.49	13.20	70.39	+0.08	14.79	15.05	14.45	14.71	14.79	2.43	1.94	10.33	−0.39	16.75	12.90	70.05	−0.30	45.35	16.33	1.76
6	Black Don	27.38	12.75	59.80	−0.07	14.51	14.62	13.63	14.15	14.51	4.25	1.72	8.35	−0.1[illegible]	28.14	12.61	58.34	−1.51	47.78	16.55	1.85
4	Velvet Don	16.93	14.89	67.76	−0.42	12.87	13.06	12.29	12.71	12.87	2.19	1.85	8.65	−0.18	17.45	14.24	66.72	−1.52	40.97	14.46	1.83
5	Pelissier	23.29	15.84	49.61	−0.26	14.78	15.01	14.09	14.34	14.78	5.09	2.24	7.16	−0.29	34.69	15.11	48.15	−2.05	47.03	16.31	1.91
5	Medeah	30.9[illegible]	15.60	53.93	+0.43	14.35	14.85	13.66	14.[illegible]8	14.3[illegible]	4.58	2.1[illegible]	7.66	+0.02	31.99	14.92	53.26	+0.18	52.65	17.30	2.04
4	Kahla	30.86	15.80	53.58	+0.24	15.17	15.66	14.28	14.82	15.1[illegible]	4.75	2.26	7.66	−0.50	31.14	14.88	50.78	−3.20	49.62	16.24	2.06
3	Algerian	31.86	15.08	54.11	+1.05	15.08	15.06	14.29	15.07	15.08	4.78	2.12	8.18	0.0[illegible]	31.79	14.41	54.06	+0.26	47.61	16.37	1.88
1	Saragolle	21.98	14.10	63.32	−0.60	12.01	12.91	12.23	11.63	12.01	2.84	1.73	7.36	−0.08	23.65	14.40	61.28	−0.67	39.22	12.94	2.03
3	Argentine	25.31	13.08	60.65	−1.01	14.50	15.42	14.28	13.96	14.50	3.91	1.88	8.42	−0.29	26.86	12.82	58.18	−2.14	51.26	17.10	1.97
1	Walnak	30.38	14.04	56.34	+0.76	13.43	13.96	12.61	12.76	13.43	4.24	1.77	7.19	−0.23	31.57	13.18	53.54	−1.71	42.97	14.72	1.92

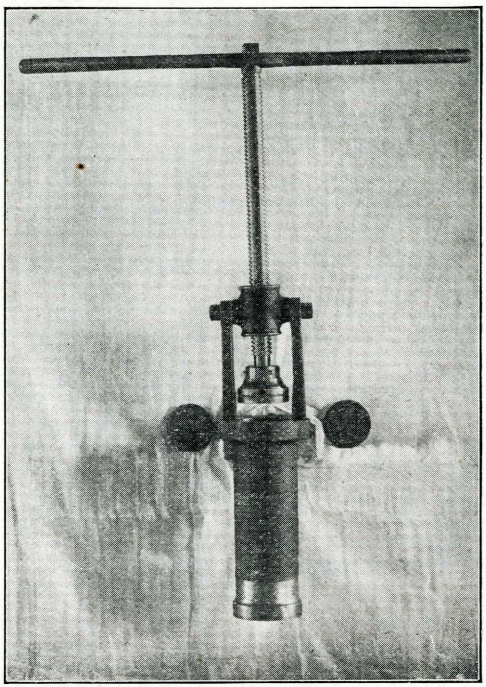

PLATE IV.

THE MANUFACTURE OF MACARONI.

Theoretically the manufacture of macaroni is a very simple matter. Practically, however, the case is far different. Perhaps no other manufacturing process connected with cereal products requires more care and closer attention to details. In all stages of the manufacture great care must be exercised in order to produce a first class article. Commencing with the wheat itself only the best varieties should be used. The grain should be plump and clean, with a high gluten content of excellent flavor. The best grades of macaroni are not made from even macaroni wheat flour. A coarse product known as "semolina" is employed. This product corresponds to the granular middlings produced in one stage of milling bread wheats.

This semolina should carry from 45 to 55 per cent of gluten of high water-holding capacity and of great tenacity. Moreover, it should be carefully freed from fine flour, dust and bran particles. When thus prepared the semolina has lost a large proportion of the starchy break products that are usually consigned to the baker's grade of flour in milling ordinary bread wheats. The reason why ordinary hard wheats make an inferior quality of macaroni lies in the employment of flours low in gluten, and the gluten itself is of an inferior flavor. This latter objection can not be overcome. Hence growers should be careful not to mix bread wheats with macaroni wheat intended for manufacturing edible pastes.

The semolina is mixed with about 30 per cent of water and kneaded to a stiff, elastic dough. It is sometimes advantageous to use a little sodium carbonate in the water, using about one part of the dry salt to five hundred parts of water. This tends to cause the grains of semolina to coalesce, thus insuring a homogeneous dough which will work up smoothly in succeeding operations. While the amount of water will vary with the kind of semolina employed, it may be stated as an unvarying rule that the dough should be worked by powerful pressure and kneading for a period of at least half an hour. In our experiments we were unable to secure proper kneading by hand owing to the stiffness of the

dough. So we employed a common lever butter worker, prolonging the time somewhat to compensate for the slowness of the operation.

When the dough reaches the proper stage it is then introduced into a press, see plate IV., which shows a simple hand press used in our experiments. In large factories powerful presses of large capacity and actuated by machinery are employed. In the bottom of the press a perforated plate is inserted. In each opening a wire is suspended which does not completely close the orifice. When pressure is applied to the dough it issues in long hollow tubes. These tubes can be made of any length desired. It is best to have the press slightly warmed, and we have also found it advantageous in our work to moisten the inside of the press slightly with olive oil. These precautions tend to make the tubes smoother.

The next step is the drying and curing. There are two systems in use, the Italian and the French. In the Italian method the green macaroni is cut into suitable lengths and hung over rods. One such is shown in the cut on the title page of this Bulletin. These rods are first placed in a dry room where the outside of the macaroni dries rapidly. This rapid drying is accompanied by warping. When this occurs the rods are removed to a tempering room in which the air is kept warm and damp. Here the outside absorbs enough moisture so that the macaroni hangs straight again. It is now removed again to the drying room until it has warped again, when it is once more taken back to the tempering room, and so on till curing is completed. As we had no tempering room we had a galvanized cubical box made three feet square with an opening at the top for a thermometer, and with an opening and plate below so that the temperature of the tempering box could be controlled by means of a Bunsen burner. A temperature between 70 and 80 degrees F. in the tempering box gave the best results. This tempering box is shown in Plate V. The greatest caution must be used in the drying and curing. If the macaroni is dried too rapidly it becomes brittle. If it is dried too slowly and at too low a temperature it is liable to sour. In either case the product is spoiled.

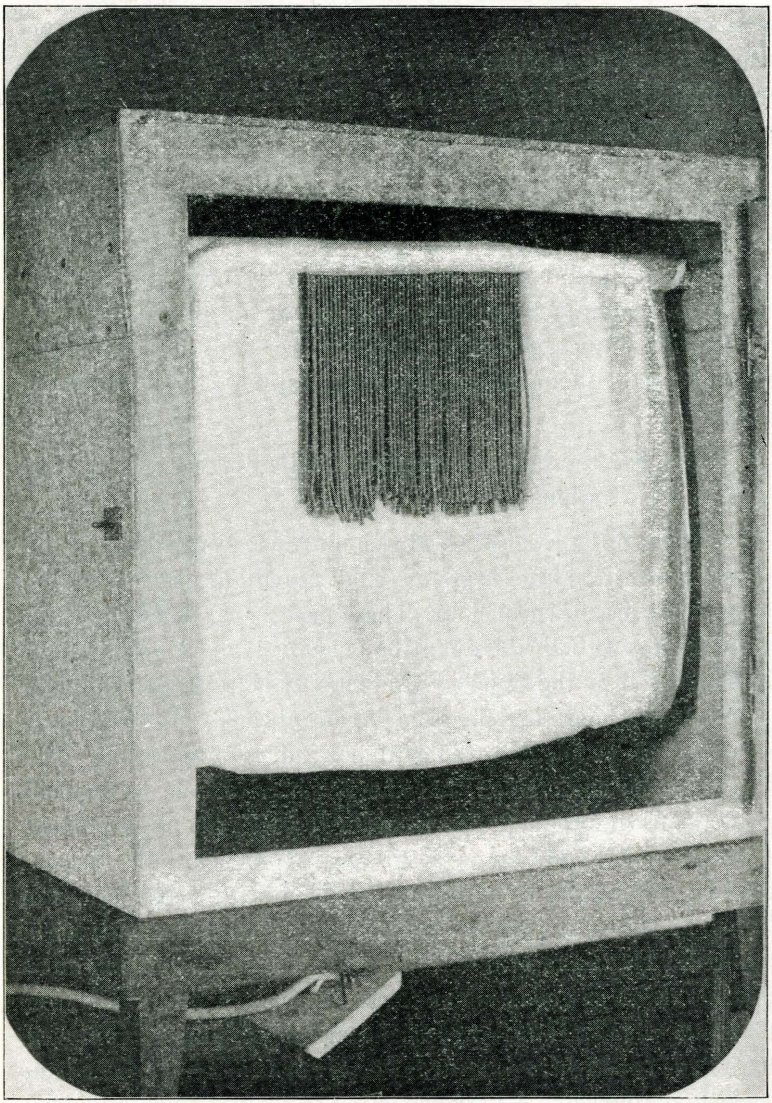

PLATE V.

In the French system the green sticks of macaroni are placed between strawboards and piled in racks in the curing room. The moisture and temperature are carefully watched and controlled by means of ventilators. The strawboards prevent the macaroni from drying too rapidly, so there is little tendency to warp as compared with the Italian system. But there is danger of slightly souring, to the detriment of the flavor. The French system requires less labor, but it is probable that the Italian method in the hands of a skilled workman will give, on an average, rather better results.

Vermicelli and other edible pastes are made in the same way from semolina and water, but different dies are used and the drying is done on frames. There are many different dies, often of fantastic form, employed in making these different pastes.

Plate VI. shows some vermicelli coils drying. They were made at this Station.

Owing to the recent introduction of macaroni wheat in this country, most manufacturers are making edible pastes from ordinary hard bread wheat flour. These pastes are of inferior quality in respect to both the quantity (usually) and quality of the gluten carried by the finished product. It is impossible to make a strictly first class article from bread wheats. Unfortunately the American people as a whole are not judges of macaroni. But it is generally understood that the imported article is superior to our domestic product. So in order to catch the unwary trade as it now exists, our manufacturers are putting their inferior goods on the market in cartons labeled with imported names of French and Italian origin. This state of affairs is greatly to be deplored. But some of our leading firms are now putting out a genuine brand of goods under their own names, and made from macaroni wheat. In a few cases macaroni semolina is employed. Others are substituting macaroni flour for the bread wheat flour formerly employed. A very few cling to the use of bread wheat flour, but a majority of our manufacturers are ready and willing to employ the very best grade of semolina when our mills are ready to furnish it. There is no reason why as good an article

of macaroni can not be produced in this country as can be imported. Just as soon as American consumers become aware of this fact they will turn towards our genuine American products made from macaroni semolina and the low grade of goods under imported names will become a drug in the market.

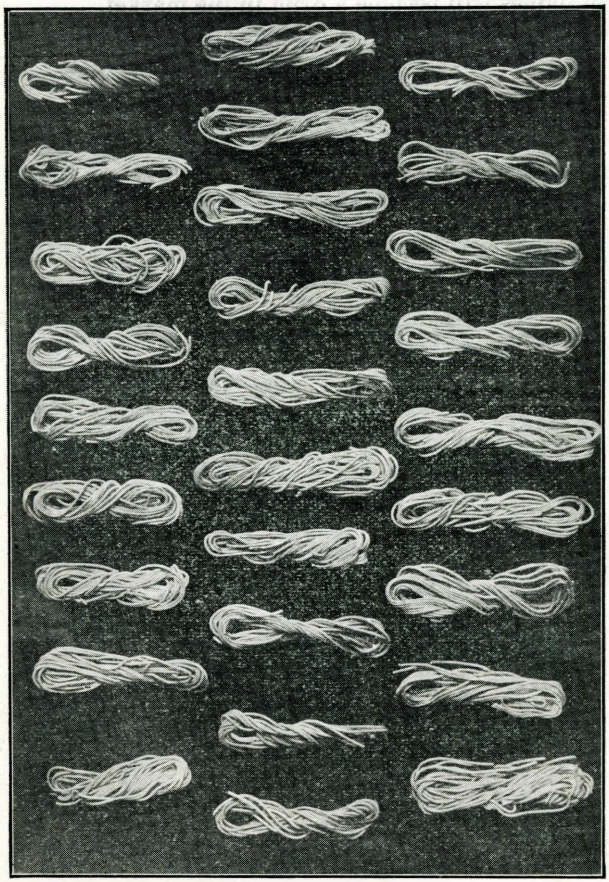

PLATE VI.

THE POINTS OF GOOD MACARONI.

It may be well in this connection to give some of the ways in which a good macaroni may be distinguished. It is possible by giving attention to some of the physical characteristics, together with some simple tests to determine the grade and quality of a macaroni.

1. The color of a high grade macaroni is a light amber. When the color is white and the macaroni is opaque, it is made from a flour or adulterated with starch. Such macaroni is low in protein and not so nutritious.

2. The fracture when broken is smooth and glassy. Moreover, first class macaroni is semi-translucent and has a horny appearance when broken. When a stick is taken by the ends and bent, a high class macaroni is quite elastic, springing back into its original shape.

3. The cooking quality and flavor may be tested thus: Add a little salt to some water, using about a teaspoonful of salt to a quart of water. Bring the water to a brisk boil and then drop in a few pieces of the macaroni to be tested. Boil briskly for fifteen minutes. A good macaroni will be white in color and retain its shape. When eaten it will be tender and have a slightly sweetish taste, together with a peculiar nutty flavor, which is characteristic. A poor macaroni will have a starchy, unpleasant taste, and the flavor will be disagreeable. It may also be tough and leathery. If it has soured in curing the disagreeable flavor will betray the fact. An expert will form a very fair opinion of a macaroni by chewing the dry stick, noting the taste and flavor, but these are more readily observed in the sample boiled as directed. A first class macaroni will respond favorably to all these tests.

COOKING MACARONI.

Owing to the high nutritive value of first class macaroni it is worthy of more extended use in our American dietaries. When our manufacturers provide a first class article made from high grade macaroni wheat semolina, and when this macaroni may be had fresh from the factory, its superiority and fine flavor will cause a greater demand for this nutritious food. In our work at this Station with macaroni, cooking tests have been made in comparison with the best imported kinds. These tests were kindly made by Miss Ruth A. Wardall, Professor of Domestic Science in this College. She prepared the fresh home-made product, from macaroni semolina, and other kinds of macaroni as found on the market. These were submitted to a committee who had no knowledge of the variety being tested. The home-made product was unanimously preferred. Also small samples of home-made macaroni have been sent to a large number of house wives in this city, and it has been found by them to be superior to the kinds to be had on the market. The reasons for this superiority lie in the high grade wheat used and the high gluten content of most excellent flavor which the semolina contained. Moreover, the home-made product was fresh, while from the very nature of the case, the imported macaroni was stale.

Miss Wardall has kindly furnished several ways of preparing most palatable dishes in which macaroni is employed. These have all been tried and found to be most excellent. A few recipes are given here.

MACARONI AND PEANUTS.

One cup macaroni broken into about one and one-half inch pieces, one-half pound peanuts, one pint milk, three tablespoons flour, three tablespoons butter. The macaroni is put into two quarts of rapidly boiling water in which one tablespoon of salt has been dissolved and cooked till tender. It is then drained dry.

The butter is melted in a pan, the flour added and thoroughly cooked. Then the milk is added and the mixture cooked until

of a creamy consistency. This makes a sauce which is also used in some of the following recipes. Salt, pepper and the ground peanuts are next added to the cream sauce. Now a layer of the macaroni is put in a baking dish and a layer of the sauce and peanuts is poured on. Then another layer of macaroni and then more cream sauce and peanuts are used until the materials are consumed. Buttered crumbs are now placed on top, and the dish is placed in the oven until browned on top.

MACARONI AND CHEESE.

Prepare the macaroni and cream sauce as just described and use one-half pound grated cheese in place of the peanuts. Use one-half teaspoon of salt and a dash of cayenne pepper. Cover with buttered bread crumbs and bake as before.

MACARONI AND TOMATOES.

Prepare the macaroni as before. In preparing the sauce use two cups tomato juice instead of the milk. Use a slice of onion as flavoring for the sauce. Arrange the macaroni and sauce in layers in the baking dish, using buttered bread crumbs, and proceed as before.

MACARONI AND OYSTERS.

Prepare the macaroni and cream sauce as before. The liquor drained from the oysters may be used in place of part of the milk. Use one pint oysters, which, together with the sauce, are arranged in layers with the macaroni as before. Salt and pepper according to taste. Use buttered bread crumbs and bake as before.

MACARONI AND SALMON.

Prepare the macaroni as before. In making the cream sauce use the oil from the salmon in place of part of the butter. Ar-

range the macaroni and salmon, of which one pound can is used, in layers, pouring a part of the sauce each time over the salmon. Season with salt and a dash of cayenne pepper. Sprinkle buttered bread crumbs over the top and bake as before.

Any good cook book will give other recipes for preparing macaroni. Again many other ways will suggest themselves in which different meats, such as clams, shredded chicken, veal, etc., etc., may be used instead of the meats mentioned in the preceding recipes.

MACARONI BREAD.

Much interest has been aroused of late in regard to the use of macaroni flour for making bread. In southern Europe a blend of soft and macaroni wheat flours is largely employed in bread making. In Bulletin 77 of this Station recipes for making bread and other pastry from macaroni flour are given. Miss Wardall furnishes the following, and competent judges pronounce the bread made from it excellent. It has the characteristic macaroni taste and flavor while the physical characteristics leave little to be desired. The recipe follows:

One-half cup milk, one-half cup water, one tablespoon butter, one tablespoon sugar, three-fourths tablespoon salt, two and seven-eighths cups macaroni flour, one compressed yeast cake dissolved in two tablespoons tepid water.

The water should be boiled and the milk scalded. To these the butter, sugar and salt are added. When the mixture has become tepid, the dissolved yeast cake is added. The flour is added gradually and very thoroughly beaten into the mixture. When a stiff dough is formed, turn it on the kneading board and knead for about thirty minutes, or until the dough shows little bubbles over the surface and it can be handled without flour on the hands or board. Let the dough stand in a warm place until its bulk is doubled. Then form into loaves leaving them stand until their volume is doubled. Bake like ordinary bread, using a greater heat for the first part of the process than for the last part. About forty-five minutes are required for baking.

One compressed yeast cake would serve for double this

amount of dough, but the time required would be correspondingly longer.

The Brookings Roller Mill has recently ground a quantity of macaroni flour. By careful inquiry among the ladies of Brookings who have been trying this flour for bread making, it appears that a very good quality of bread can be made by setting sponge, etc., with common yeast, just as ordinary spring wheat bread is made. Care must be taken to mix the dough stiffer than with spring wheat flour, otherwise the process is just the same.

This flour has also been used in making pancakes and good results have followed. While the use of macaroni flour in domestic operations is somewhat new, it may be said that in all probability, a better acquaintance with its properties will lead to a more extended use.

Another field in which macaroni flour should find a most favorable reception is in the manufacture of breakfast foods. Owing to its high protein content it is peculiarly fitted for that use.

In conclusion the writer wishes to acknowledge the efficient assistance rendered in obtaining the data for this Bulletin to Messrs. Hepner and Norton. While there has been no exact division of the work, nevertheless, in a general way Mr. Hepner has made most of the nitrogen determinations while Mr. Norton has made most of the gluten determinations. Mr. Norton has also taken special interest in the manufacture of the macaroni which we have made from semolina milled at this Station.