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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF BOTANY.

RUSSIAN CEREALS

ADAPTED FOR CULTIVATION IN THE
UNITED STATES.

BY

MARK ALFRED CARLETON.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1900.

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NOTE.

In securing the importations referred to in the text, Mr. Carleton's itinerary was as follows: He set out from Washington July 4, 1898, his route lying through New York and London. On the European Continent he first visited a number of points in Sweden, Germany, Austria-Hungary, and Roumania. From Constanta, in Roumania, he crossed the Black Sea by steamer to Odessa, first entering Russia at that point August 22. Ten days were spent at this important grain port. After this his visits were as follows: Mordarovka (Kherson Government), September 3; Kief, September 5 to 8; Moscow, September 12; Samara, September 18 to 23; Orenburg, September 24 to 26; Samara, September 27 to October 1; Ufa, October 2 to 4; Moscow, October 8 to 18; St. Petersburg, October 19 to November 2; Moscow, November 3 to 20; St. Petersburg, November 21 to December 1; Moscow, December 2 to 8; Marie Experimental Farm, December 9; Saratof, December 10 to 15; Rostof-on-Don, December 17; Petrovsk, December 20; Tiflis, December 23 to 26; Batum, December 27; Sukhum-Kale, December 28 to January 1, 1899; Novorossisk, January 2; Ekaterinodar, January 3 and 4; Odessa, January 7 to 15; Warsaw, January 17 to 20. Returning by way of Berlin, Bremen, Paris, London, and Liverpool, he arrived at Washington February 18, 1899.

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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., November 1, 1899.

SIR: In connection with the recent discussion of a prospective shortage in the wheat supply of the world within the next generation, some statistics of immediate concern to this country have been brought out, showing the probable relation of the grain supply of the United States to our domestic consumption at the end of that period. An estimate has been made by Mr. John Hyde, statistician of the Department of Agriculture, that by the year 1931, on the basis of the present per capita consumption of cereals and the present product per acre, with a normal increase in population, the United States will require for home consumption all the cereals and hay we now consume and export, besides all that can be raised on about 150,000,000 acres additional to the present area devoted to these crops. There can be no question that the product per acre in the area now devoted to grain will be increased by the development of superior strains and superior methods of culture; but this method of adding to our grain crop will probably be offset by a demand for a larger area for fruit and vegetables.

It is clear that our domestic needs and the call for export grain will demand an enormous increase in cereal acreage. Where are we to find this land? A small portion of it only is to be found east of the Mississippi River. The remainder must come from the 600,000,000 acres of unimproved land in the arid-land States. The most liberal of reliable estimates places the irrigable lands in this area at about 70,000,000 acres. From the remaining 530,000,000 acres must be drawn most of the land that we require, and this land is too dry or too cold for the cultivation of the ordinary cereal crops.

During the past decade great advance has been made in introducing into the arid region drought-resistant varieties of grain and grass which would mature a crop where ordinary varieties failed. From 1888 to 1893 the Division of Botany maintained an experiment in western Kansas, one of the results of which was to demonstrate the success of Kafir corn as a grain and forage crop in an immense subarid area where Indian corn was either a total failure or a precarious crop. In 1893 the value of the Kansas crop of the different varieties of Kafir

corn was \$653,120; in 1894, \$813,156; in 1895, \$2,079,286; in 1896, \$3,599,646; in 1897, \$4,275,774; in 1898, \$5,842,682. The experiments showed also that Turkey wheat was one of the most drought-resistant varieties known in the West, and in the past few years it has become widely cultivated in the Great Plains. It is clear that one of the greatest possibilities of expansion in our cereal industry lies in the direction of securing new drought-resistant varieties with which to extend the cereal-producing area farther and farther into the arid region.

Mr. Mark Alfred Carleton, who has been engaged for several years, under the direction of the Chief of the Division of Vegetable Physiology and Pathology, in an investigation of wheat varieties with reference to their improvement, was detailed in July, 1898, as an agricultural explorer of the Section of Seed and Plant Introduction. From that time until his return to Washington, in February, 1899, Mr. Carleton was engaged in an investigation of the cereals of Russia suitable for introduction into the United States, especially those adapted to the rigorous conditions of the arid West. It has seemed desirable to publish a detailed account of the cereals thus secured, both as a matter of record and for reference by experimenters. The accompanying report has been prepared with this in view, and its publication as a bulletin of this division is recommended. It is believed that before the end of a decade some of the cereals enumerated in this report will have become established and important factors in the extension of the American grain-producing industry.

Respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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RUSSIAN CEREALS ADAPTED FOR CULTIVATION IN THE UNITED STATES.

INTRODUCTION.

For some time there has been a growing inclination among American agriculturists toward the more general use of Russian economic plants, especially of cereals, forage crops, and fruits. In some instances the cultivation of Russian cereals has gone on many years without any knowledge, apparently, on the part of the growers that they originally came from Russia; as an excellent example, the red winter wheat, commonly called Turkey wheat, may be mentioned. This very hardy sort has been grown in certain portions of the Great Plains for more than twenty-five years. More recently the use of this variety has become very extensive, and fresh importations of seed have been made at different times. At present it is probably the most highly prized variety in the hard winter wheat belt, its value being most apparent in years of extreme drought or cold. It is then often the means of saving certain districts from total failure of crop. The name, however, is misleading, and few people know that it is a native of the Crimean region of Russia. Similarly the evidence is rather strong that the entire group of Fife wheats, upon which is founded the immense wheat and flour production of the Northwest, came originally from Russia, and are not of Scottish origin, as many suppose. Therefore, the Fifes of the Red River region simply compete annually in the English market with their own race, the Ghirkas of the Volga region. So also Ames, Meekins, Grass, Black Sea, Mennonite, Ladoga, etc., are all simply special names of varieties of Russian origin, though usually not known to be such. The same thing is true in regard to some excellent sorts of oats. If a grower finds a variety well suited to his needs, he usually cares little to know its pedigree.

The experimenter, after giving years of study to the subject, learns that the great majority at least of introduced sorts that do best in his own region have uniformly originated in regions having similar soil and climate. In the case of Russian cereals introduced into this country, such parallelism is found to be especially striking. A series of field experiments, beginning with nearly 1,000 varieties of wheat,

and 300 of oats, barley, rye, and spelt, have been carried on by this Department for four years. The results show conclusively that Russian cereals, especially the wheats, are the sorts best adapted for culture in the prairie and northern portions of this country. In connection with these experiments, an investigation has also been made of the soil and climatic features of the two regions in question—the Steppe or Chernozem region of Russia and the Great Plains—in so far as these features bear any relation to wheat culture. A detailed discussion of the entire work is being prepared for publication in another bulletin. But it is thought well to present here briefly some of the important facts noted in that discussion, as a fitting introduction to the description of the particular varieties mentioned in this report.

RUSSIAN AND AMERICAN GRAIN SOILS.

The soil of the greater portion of the grain region of Russia and Siberia is well known in that country as the “Chernozem” or “black earth.” It is a broad belt of prairie, 600 to 700 miles in average width, beginning in Hungary and extending northeastward to the Ural Mountains, and then eastward into Siberia to unknown boundaries. On the north and west are “the gray forest lands” and on the south and east are salt and alkaline districts and sandy wastes, and finally the Caucasus and Ural mountains. By both chemical and mechanical analyses the soil is shown to be remarkably similar to that of our own prairies, also commonly known by the similar term of “black loam.” The depth is, on an average, probably a little greater than that of our prairie soil.

From a chemical standpoint, the soils of the two regions are similarly characterized (1) by an exceptionally large amount of thoroughly humified organic matter, (2) by the presence of an unusual proportion of phosphoric acid, and (3) by a great amount, comparatively, of lime, potash, and other alkalies. These soils are therefore alkaline, while many others, especially of forest regions, are acid. It is well known that the substances thus more abundant in these soils than in others are just those usually needed by the wheat plant. But the indirect influence of the great proportion of lime and humus in so changing the condition of other substances as to cause them to be more easily made use of by the plant is of equal importance. Of course, the amount of alkali present may become so great as to be really injurious to plant growth, forming actual alkaline wastes. But these are found only in certain restricted areas near the border of the black-soil region, and even in the vicinity of these wastes the very best quality of wheat is sometimes grown.

The mechanical structure of the soils, moreover, is of the very nature best adapted for giving the plant the benefit of the substances contained, even under adverse conditions of climate. Humus is a great

absorbent of water, and the extreme fineness of the particles renders it very retentive of moisture. This quality is still further increased by the presence of so much alkali. Such soils, therefore, may hold for the growing plants a large proportion of the water that reaches them, and thus is explained, partially at least, the fact that they will produce a crop with half the rainfall required in forest regions.

CLIMATIC PARALLEL.

The similarity between the Russian steppes and the Great Plains is fully as great in climate as in soil, both regions being emphatically continental and subject to great extremes of temperature and moisture. In the greater portions of the two regions the winters are long and very severe, while the summers, though short, are intensely hot. Other noteworthy features of the climate are (1) the great number of clear days in the year, (2) the extreme amount of precipitation during two or three months of the summer as compared with that of the remainder of the year, (3) the character of this precipitation, falling in quick thunderstorms, as a rule, with very few days of mists or fogs, (4) the excessive heat of midsummer, following intensely cold winters, as already mentioned, and (5) the comparatively light snowfall. These features, while common to the two regions, are considerably more pronounced for corresponding portions of the grain belt in Russia than in the United States. For this reason varieties brought from Russia are all the better adapted for cultivation in this country, as they are already used to even more rigorous conditions of climate than they will have to endure here. The snowfall, as a rule, is less on the Russian steppes than on the Great Plains. The rainfall is generally considerably less, and the extremes of temperature a little greater. At Samara, near the heart of the Volga wheat region, the mean annual rainfall is 15.6 inches (396.4 mm.), while at Bismarck, N. Dak., where it is considered to be already extremely dry for wheat growing, the average rainfall for the year is 19 inches (482.6 mm.). As to temperature, though the normal mean for the year is 39.3° F. (4.1° C.) at Samara, nearly 0.4 of a degree less than at Bismarck, where it is 39.7° F. (4.3° C.), yet the July normal is 1.1 degrees higher at Samara than at Bismarck, being 70.3° F. (21.3° C.) at the former place and 68.3° F. (20.2° C.) at the latter. The following table will show clearly these features of the two regions in comparison with each other. The normal mean temperature for the year and for the months of January and July, the mean annual rainfall, and the mean total rainfall for the three wettest months of the year are given for four localities in each region as nearly corresponding with each other as can well be selected. At the same time, for comparison with other regions, similar data are added for three points farther eastward in the United States—Oswego, N. Y., Eastport, Me., and Lynchburg, Va.

Comparison of climate in Russia with United States.

Locality.	Normal January temperature.		Normal July tem- perature.		Normal yearly tem- perature.		Normal total rainfall three wettest months.		Normal yearly rainfall.	
	°C.	°F.	°C.	°F.	°C.	°F.	Mm.	In.	Mm.	In.
Samara, Russia	-12.7	9.0	21.3	70.3	4.1	39.3	176.6	6.9	396.4	15.6
Orenburg, Russia	-15.2	4.5	21.6	70.9	3.2	37.8	137.4	5.4	395.3	15.5
Ekaterinoslaf, Russia	-7.3	18.7	23.4	74.1	8.1	46.7	202.2	7.9	542.2	21.3
Odessa, Russia	-3.1	26.4	23.0	73.4	10.1	50.1	142.6	5.6	431.3	16.9
Bismarck, N. Dak.	-14.8	5.3	20.2	68.3	4.3	39.7	220.9	8.7	482.6	19.0
Huron, S. Dak.	-14.1	6.6	21.8	71.2	5.8	42.4	274.3	10.8	548.6	21.6
North Platte, Nebr.	-6.7	19.9	23.4	74.1	9.1	48.3	236.2	9.3	485.1	19.1
Dodge City, Kans.	-3.4	25.8	25.6	78.0	12.0	53.6	259.0	10.2	533.4	21.0
Oswego, N. Y.	-4.2	24.4	21.0	69.8	8.0	46.4	233.6	9.2	889.0	35.0
Eastport, Me.	-6.5	20.3	15.7	60.2	5.2	41.3	307.3	12.1	1,229.3	48.4
Lynchburg, Va.	3.0	37.4	25.4	77.7	14.0	57.2	284.4	11.2	1,130.3	44.5

The three wettest months for the different localities of the two regions compared in the table are May, June, and July, except in cases of Ekaterinoslaf and Odessa. At Ekaterinoslaf they are June, July, and August. For Odessa the months May, June, and July are used in the table, although the rainfall in November or December is greater than in May; therefore the amount for these three months, in this case, is not so great in proportion to the yearly rainfall as in the cases of the other localities. Nevertheless, even at Odessa the amount falling in these three months is very nearly one-third of the amount for the entire year; while at Oswego, Eastport, and Lynchburg, in the forest region of the United States, about one-fourth of the yearly total falls during that time, precipitation being pretty equally distributed throughout the year. At all other points in the Great Plains and Chernozem above mentioned over one-third the yearly precipitation falls in these months, and at Huron exactly half, while at three points—Huron, North Platte and Dodge City—the absolute amount falling in May, June, and July is greater than at Oswego. As regards temperature, it will be similarly observed that, while the yearly mean at all points in the prairie region is generally lower than in the forest region, yet the extremes for January and July are always proportionally greater at the former points. But these extremes are also a little greater proportionally in the Russian steppes than in the Great Plains. The extremes at Samara and Orenburg are especially remarkable.¹

Phytogeographical investigations have already shown that plants growing naturally in regions having the above-described characteristics of climate, particularly the very light yearly rainfall and excessive summer heat, are constituted differently from those growing naturally in wet or forest regions. To a less marked degree, perhaps, the same

¹ The figures upon which the above table is based are averages of many years' observations, and are given by the following authorities: Wild.—“Die Temperaturverhältnisse des Russischen Reiches,” Tabellen, S. LXXII–CCXL, and “Die Regenverhältnisse des Russischen Reiches,” S. 12–28; Kaiserl. Akad. der Wissenschaft., St. Petersburg, 1881 and 1887. Klossovski.—“Klimat Odessui” (Russian), Meteorological Observatory of the Imperial New Russian University, Odessa, 1893. Harrington, “Report of the Chief of the Weather Bureau,” U. S. Department of Agriculture for 1891–92, Washington, 1893.

is also true of cultivated plants that grow best in such regions. Besides other adaptations the plants that thrive best in the Russian steppes and the Great Plains are so constructed as to resist more or less the intense evaporating power of the hot, dry atmosphere. The cereals that are most successful in these regions, especially the wheats, are usually characterized by the possession of a short, slender, but firm stem; very narrow leaves, often glaucous or pubescent, and of a grayish color; very narrow, compressed heads, often bearded, with very hard, heavy, small, red grains. In the cases of some exceptions to this description, for example, the varieties of *Triticum durum* grown in south and east Russia, the leaves, though quite broad, nevertheless possess a very harsh, glaucous surface, quite resistant to transpiration, as well as to the attacks of orange leaf rust; and the grains, while large and yellowish white, are still harder than the red grains of other varieties. The proportion of proteid matter in the grain is usually very great.

For these reasons, one would naturally seek in a region like Russia and Siberia for cereals adapted for cultivation in our States of the plains. The fact that these cereals have to undergo more severe climatic rigors in Russia than in this country might be variously illustrated. As examples, the governments of Perm and Vyatka, with a rainfall as low as or less than our Great Plains for two degrees west of the one hundredth meridian, have stood for years at the head of the Russian governments in growing oats; while Samara, with wide extremes of temperature and a rainfall of only 15 to 16 inches, stands fourth as a spring-wheat government, producing an average of over 24,000,000 bushels a year for the years 1892 to 1896. In the more northern portions of Russia, where the winters are especially severe, certain winter sorts have become, by long acclimation, very resistant to cold, and are particularly valuable for trial in corresponding districts of this country, where at present only spring varieties are grown.

RUSSIAN CEREALS RECENTLY SECURED FOR TRIAL.

In consideration of such facts as the above, and also of the fact that certain Russian cereals have already been tried in this country and found to be very successful, it was arranged that the writer should during the season of 1898-99 obtain, so far as possible, the best sorts of Russian cereals for trial in this country. Accordingly a visit was made to Russia and Siberia, and twenty-three varieties of cereals, one of buckwheat, and two of forage plants have been secured, besides numerous smaller packages of oil plants, melon, and garden seeds, and sample packets of seeds of other cereals and grasses for breeding purposes. In addition to the cereals thus already obtained, arrangements were made for the importation of others fully as valuable.

Of the twenty-three varieties of cereals proper, seven are of wheat, three of oats, two of barley, two of rye, two of emmer, five of broom-corn millet, one of German millet, and one of sugar corn.

The different varieties were obtained from localities representative of large agricultural regions—the wheats, emmers, and millets mainly from the steppe or Chernozem region, and the other sorts from northern Russia and Siberia.

VARIETIES OF WHEAT.

The greatest objection that can be made against Russian wheats for this country is that so large a proportion of them are more especially

adapted for spring planting.¹ (Fig. 1.) Therefore a special effort was made to obtain winter varieties; but to get such from the proper localities is sometimes difficult, and was particularly so the season of the writer's visit, when there happened to be an actual wheat famine in the upper Volga region. Of one variety in particular, Winter Ghirka, which it was very desirable to secure from a latitude as far north and east as possible, not a grain could be found in any part of the governments of Saratof, Samara, or Orenburg, although it had previously been grown in those governments, an importation from Samara being even now under experiment by this Department in Kansas and Nebraska. However, after long searching, several of the very best winter sorts yet known in Russia were found.

FIG. 1.—Russian varieties of spring wheat. 1, Imperial; 2, Polish; 3, Gharnovka; 4, Belokoloska.

But we have a very large spring-wheat belt in our own country, and it will be a long time hence, if ever, when winter sorts will be

¹ It may be briefly stated here that there are two chief reasons for the usual superiority of winter over spring varieties in the same locality: (1) The large amount of reserve force acquired by the winter-wheat plant in its root growth during the autumn gives it greater hardiness and productive power, so that winter wheats usually yield more than spring wheats; (2) winter wheats, by getting a better start in the spring, mature earlier, and therefore more often escape the effects of drought and damage by rust and chinch bugs.

found that are sufficiently hardy to entirely supplant spring varieties. Besides, in the introduction of Russian spring sorts two other favorable circumstances are to be kept in mind: (1) Many of them are varieties of *Triticum durum*, at present little known in this country except in very limited districts. These, besides being considerably resistant to certain diseases, are the main varieties used for macaroni, and possess a very nutritious grain. To furnish entirely our own durum wheat for the manufacture of macaroni would be an important point gained. In one case, at least, the spring Fife wheats of the Northwest are employed in making macaroni in this country. But no doubt a better product could be made with true macaroni wheats, though in the meantime, it is claimed that even with American wheats the American product is better than the Italian made from durum wheats. Nevertheless, the writer was told by the manager of a well-known cereal-food company that they would have engaged in macaroni manufacture years ago if there had been a home supply of these durum wheats. As it is, there were, during the years ending June 30, 1896, 1897, and 1898, from 15,000,000 to 20,000,000 pounds of "macaroni, vermicelli, and similar preparations" annually imported into this country. Altogether, there is considerable evidence that there will be at least a good home market for these wheats once they are successfully grown in the United States. On the other hand, there seems to be no good reason yet why such varieties should not succeed in this country.¹ A con-

¹ Since the above was written, an article has appeared in the advance sheets of Consular Reports, No. 438, May 29, 1899, entitled "Wheat for alimentary pastes in France," in which the writer, John C. Covert, consul at Lyons, France, brings out still more strongly, and from the export standpoint, the facts already emphasized in this bulletin concerning these macaroni wheats. The entire article is important and interesting, but the following statements are especially worthy of quotation: "The continued growth of this (paste) industry will depend upon the supply of special kinds of wheat, for a decline in consumption would immediately follow any attempt to manufacture pastes of ordinary wheat. Paste makers are unanimous in the opinion that American wheats will not answer their purposes; but, when one considers the almost endless variety of our soil and climate, it seems that some locality must be found where a suitable wheat can be grown. What is wanted is a hard wheat, containing a large percentage of gluten and a relatively small percentage of starch. Our wheat is lacking in both these desiderata. * * * Millers and bakers in France have found that bread is improved by putting into it a larger amount of gluten than is found in French or American wheats, and as a consequence very hard wheats—the Taganrog, generally—are mixed with the others. * * * If our farmers could produce such a wheat it would find more uses than in the *pâtes alimentaires* above referred to. There would be an excellent market in years of drought in Russia. * * * These wheats can not be raised in France and must be imported, and they are the only kinds which are always sure to find a market in this country, as the French farming community will always demand, and are politically strong enough to secure, a high protective tariff on wheat and other grain. * * * Moreover, as the experience of the French has proven that an admixture of hard wheat in small quantities improves the quality of the bread, it is reasonable to infer that the practice will extend to other countries, further enlarging the market for hard wheats."

siderable quantity of the sort called Nicaragua has already been produced in southern Texas. The chief trouble in most of the few instances where these wheats have already been tried is that there was not sufficient perseverance in keeping up the experiments. (2) A second point in favor of Russian spring wheats is that many of them may be readily transformed into winter varieties when it becomes desirable to grow them so, if they are sown in the proper latitude. Indeed, the durum sorts, when grown below the thirty-fifth parallel, will probably succeed if sown at any time from October to March. On the other hand, red-grained spring varieties of *Triticum vulgare* of Russian origin may be sown in autumn farther north than our ordinary spring sorts.

KUBANKA SPRING WHEAT.¹

The seed of this variety was obtained in the Turghai territory, in the Kirghiz Steppes, at a point about 40 miles southeast of Orenburg. The grain was grown by Mr. Gnyezdilov. The average annual rainfall of the locality is probably 15 inches (381 mm.) or less, as it is a little drier than at Orenburg, where the rainfall is 15.6 inches (395.3 mm.). For the growing season² it is about 8 inches (203.2 mm.) or less. The last season was unusually dry. The summers are short but intensely hot. In spite of the severe drought, there is very little shriveling of the grain. The soil of the locality is much grayer than the usual black earth of the Chernozem region, with a greater mixture of clay and sand. It is a significant fact that the soil is always thus of a grayer color where this wheat is most successfully grown. As the soil becomes blacker, when seed is transferred to different localities, there is an invariable change in the appearance and character of the grain. It becomes darker colored and a little softer, and is then called by the name "Pererodka." It also requires an exceedingly hot, dry, midsummer climate for the most perfect development of the grain.

In this country just about the soil and climate to which this variety is adapted exist in the following districts: West Kansas, east Colorado, west Oklahoma, Texas Panhandle, southwest Texas, and certain dry hot portions of New Mexico, Arizona, and southern California. For spring wheat it is a common custom in east Russia to plow the ground in midsummer or autumn for the next spring planting. Then the surface is again slightly stirred just before sowing. This allows the soil to obtain and hold the greatest possible amount of moisture from the little rainfall that occurs. During the very severe winter, too, the alternate freezing and thawing mellows the soil, leaving it finally in excellent condition at sowing time after harrowing. This

¹ Inventory number, 2953.

² In all instances in this report of the use of the term "growing season" the period of May to September, inclusive, is to be understood.

custom of summer fallowing probably in a large degree accounts for the great production of spring wheat in east Russia, where agricultural methods are otherwise very crude and drought so frequent and severe. In localities so far north as the one from which this seed came it is impossible for fall-sown Kubanka wheat to survive the winter, but farther south, in the Kuban territory, it is successfully grown as a winter sort. In this country, from Texas to California, it may well be sown at any time from October to March, but may produce unsatisfactory harvests until thoroughly adapted to a particular treatment.

The name Kubanka is derived from the name of a large and important wheat-growing territory in North Caucasus and bordering on the Azof Sea, called Kuban territory. It is without much doubt synonymous with Beloturka, as the two names are commonly applied interchangeably to the same variety. The name Arnautka is also occasionally applied to this variety, but the true Arnautka is certainly a distinct sort. Kubanka is a variety of *Triticum durum*, the species to which nearly all the macaroni wheats belong. However, it is not so good for making macaroni as is Arnautka. Kubanka wheat is one of the most highly prized varieties in Russia and has been popular for many years. At present it is grown throughout the Volga region from the latitude of Samara to the Caspian Sea, thence to the Caucasus Mountains and westward to the sea of Azof, and in portions of the Kirghiz Steppes and Turkestan.

There are many different strains or forms of the variety, caused by changes of soil and climate, including some that are fall-sown and able to withstand the winter. It is the popular bread wheat of the south Volga region, but in grinding it is always mixed with 10 to 25 per cent of a softer red wheat. This is an interesting and significant fact. The varieties of *Triticum durum*, called commonly "durum" wheats, are not supposed to be bread wheats at all, yet the excellent quality of Russian bread is frequently remarked upon by travelers. The grains of the best strains are large, extremely hard, whitish, and slightly transparent. The proteid content of the grain is rather large, but apparently of a different quality from that contained in the hard red wheats, being better adapted for making pastries and macaroni than for producing extreme lightness in bread. The millers in this country will probably experience some difficulty in grinding the durum wheats, and will be obliged, at the beginning at least, to use with them a considerable proportion of a softer variety. But if it shall be found that they can be widely and successfully grown in this country, and especially in districts where wheat was not previously extensively cultivated, it will be well worth the effort of millers to become familiar with some successful method of grinding. Also, the grain is so highly nutritious that mere habit should not be allowed to prejudice one against the use of the flour in bread making.

PERERODKA SPRING WHEAT.¹

This variety was obtained in the Orsk district of Orenburg government. The average annual rainfall at the city of Orsk is 10.6 inches, (270.1 mm.) and the rainfall for the growing season is normally 5.7 inches, (146.6mm.). The mean annual temperature can not be given accurately, but it is probably not far different from that at Orenburg, which is normally 37.8° F. (3.2° C.), and for January 4.5° F. (-15.2° C.), and for July 70.9° F. (21.6° C.) The soil of the Orsk district is the usual "black earth" of east Russia, though perhaps not so dark as the soil of the Samara region. The methods of culture and time and manner of seeding are much the same as for Kubanka wheat. In the Orenburg government the period of growth of spring wheat is about one hundred days. The mean harvest time is August 10 to 12, but both seedtime and harvest in the Orsk district are about or nearly one month later than in those parts of the United States where this wheat would most likely prove successful. This wheat—also a variety of *Triticum durum*—is very closely allied to Kubanka. The word "pererodka" means something regenerated or degenerated. In the case of its application to this sort of wheat it is apparently understood to have the latter meaning. As already stated, when Kubanka wheat, by transference to darker soil, becomes softer and darker grained, it is called Pererodka. In this country Pererodka wheat is adapted for growing in a climate rather similar to that required for Kubanka, but may be grown in a darker prairie soil and a little farther north, in such regions as east Colorado and the western portions of Kansas, Nebraska, and South Dakota. It might well be tried as a winter sort in Kansas, Colorado, California, and the Columbia Plains.

RUSSIAN SPRING WHEAT.²

The seed of this variety was obtained from the Kirghiz Steppes, in the vicinity of Orenburg. The normal rainfall and temperature at Orenburg have already been stated. The summers are always very hot and short. The soil is a rich black earth, darker than in the Orsk district or Turghai territory. It is rather similar to west Dakota soils. The methods of culture, seeding, etc., are similar to those in use for the two varieties just described. The ground is nearly always plowed the previous autumn.

The wheat is sown as early as possible. This sort, a rather small-grained, hard or semihard red wheat, is a variety of *Triticum vulgare*. It is very similar to the Spring Ghirka wheat, and also to the Fifes of our Northwestern plains. It makes a very good bread flour, similar to that made by our Fife wheats, but is also mixed with Kubanka by millers of the Volga region. This is the common export wheat of all the north Volga region, and intergrades into other rather

¹ Inventory number, 2954.² Inventory number, 2955.

similar strains, grown quite extensively as far north as the Perm and Vyatka governments, and in the region about Cheliabinsk, in Siberia. In the north, however, the grains are often still smaller, as well as a little darker and harder. This variety, the Ghirkas, and the Ulka of south Russia make up the great bulk of the Russian wheat export. It is a variety admirably adapted for growing in North and South Dakota and Minnesota. In Nebraska, Iowa, and Kansas it might be successfully transformed into a winter variety.

BANATKA WINTER WHEAT.¹

The seed of Banatka wheat was obtained at Kublich, in the eastern part of Podolia. The normal annual rainfall of the district can not be given with accuracy, but it is probably near 19.6 inches (500 mm.), and for the growing season about 11 inches (280 mm.) The locality, though a part of the Chernozem region, is near the border of a large tract of "gray forest land," and the soil therefore is somewhat mixed in its nature, partaking of the character of soils in both forest and prairie regions. In this part of Russia a great deal of winter grain is grown. The usual method of culture for winter wheat or rye is as follows: After harvesting a season's crop, in late July and August, the land is left fallow until the next summer. In the meantime, during the early part of the following spring, the herbage springing up on the fallow is sufficient to afford considerable pasturage. Two plowings are given the land. It is plowed first between June 1 and 15. About four weeks afterwards—just after a rain, if possible—the plowed soil is harrowed. After three weeks longer, or during the latter part of July, it is cross-plowed, and a little deeper than the first plowing. This time it is not usually harrowed, unless there has been a very hard rain. The wheat is sown after the rains, that are expected sometime in August; but often the seeding is not completed until the middle of September. There is no harrowing just before seeding. The grain is usually sown broadcast and cross-plowed into the soil, running the plow very shallow, or it is sometimes drilled, especially on the larger estates.

At the Uman Agricultural School in southern Kief, not far distant from Kublich, Mr. V. A. Poggenpol made between 1891 and 1895 a large number of phenological observations with regard to the time of occurrence of different stages in the development of agricultural plants.²

For winter wheat it was found that the average date of sowing is September 9, the date when it begins heading May 31 to June 1, the date of completion of heading June 9, the beginning date of flowering

¹Inventory number, 2956.

²V. A. Poggenpol: Results of Phytophenological Observations on the Stages of Development of Wild and Cultivated Plants at the Czarina Garden, and in the Fields of the Agricultural School at Uman, pp. 74; included in the Meteorological Review, by A. Klossovski, Odessa, 1896 (in Russian).

June 5, the final date of flowering June 13, and the date of harvest July 15.

This variety came originally from the Banat district in Hungary, where it is considered to be an excellent wheat. But it has been grown many years in southwest Russia, and through acclimation in that region is made probably all the better for cultivation in this country. It is a variety of *Triticum vulgare*, a semihard red-bearded wheat, able to endure considerable drought and cold. The grain is of medium size and a little softer than that of the spring Ghirkas and the Russian of the Volga region and south Russia. It makes a good quality of bread. This variety and the sort called "Podolia" make up the bulk of the red winter wheat exported from southwestern Russia, by way of Odessa, though the winter Ghirka perhaps figures to some extent. In this country the wheat will probably be found adapted for cultivation in Illinois, Missouri, Kansas, Indiana, Ohio, Michigan, Iowa, and Nebraska.

POLISH SPRING WHEAT.¹

This variety was obtained at Glinyanaya, in the district of Elisavetgrad, in the northern portion of Kherson government. The normal rainfall and temperature of the locality is not known. At Elisavetgrad, in the same district, not far distant from Glinyanaya, the normal annual rainfall is 16.7 inches (425.1 mm.), and the normal rainfall for the growing season 9.8 inches (248.9 mm.). The normal mean temperature for the year at the same point is 44.6° F. (7° C.); for January it is 40.2° F. (4.6° C.), and for July, 70.8° F. (21.6° C.). The soil is the ordinary rich black earth of south Russia. As is generally the case in south and east Russia, the ground for spring sowing is plowed the previous summer or autumn. The average date of sowing spring wheat is April 12 to 15, and the harvest occurs during the first two weeks of August. The soil of the locality from which this variety was obtained is a little too heavy and the climate perhaps not quite hot and dry enough in midsummer to be best adapted for such wheat. Nevertheless, it seems to have done exceedingly well in that district.

The seed from which this strain of the variety was developed was obtained originally from a member of a colony in the Kherson district, in the southern part of the government—where the conditions are probably a little better for the growth of this variety—at the suggestion of Agronom V. A. Bertenson,² of Odessa, and grown on the grounds of one of the lower agricultural schools in Elisavetgrad district, under direction of the head master of the school, Baron E. E. Shvakhgheim. In 1896 Mr. Shvakhgheim grew on his own estate about 60 acres of this wheat, from which there was a harvest of 1,440 bushels, or a yield of

¹ Inventory number, 2957.

² See Bertenson, "Polskaya Pshenitsa" (Polish wheat), pp. 16, Odessa, 1897. Reprint from the Report of the Imperial Society of Agriculturists of South Russia for 1897 (in Russian),

24 bushels per acre. The seed was sown on mellow, fall-plowed land. The early part of the spring was rainy, and in spite of the drought that came later on, the result was an excellent harvest. The wheat was cut with a self-binder, and although the work was much delayed, there was very little loss of grain from shattering.

True Polish wheat is a variety of *Triticum polonicum*, and must not be confused with the sort commonly called by that name in southwest Russia, which latter is a variety of *Triticum vulgare*. Why this wheat is called Polish is not known. It is certainly not a native of Poland, and, indeed, is very little known in that region. It is, besides, adapted to a very different sort of soil and climate. Polish wheat has been called by various other names, as follows: Algerian, Astrakhan, Lorraine, Egyptian, Diamond, Macaroni, Lebanon, Himalayan rye, Jerusalem rye, Giant rye, etc. Its appearance in the field is strikingly different from that of all other sorts of wheat. The heads are of enormous size, especially in thickness, the glumes of the spikelets are particularly broad and thin, and the grains, when perfect, are very long, and also hard and vitreous, as are those of durum varieties. There is a large per cent comparatively of gluten in the grain.

Bread is occasionally made from the flour of Polish wheat. In taste it somewhat resembles that made from a mixture of ordinary wheat and rye flour. But so far this wheat has been used mainly for macaroni.

Polish wheat, like some of the varieties of *Triticum durum*, is rather exacting as to the kind of soil and climate required for its most successful cultivation. In general it does best on a rather light soil. It should have considerable moisture at first, but ripens more perfectly in dry, hot weather. It is grown in several localities in south and east Russia and Turkestan. In this country it is probably best adapted to such districts as southwest Texas, Arizona, New Mexico, and portions of southern California, eastern Colorado, western Kansas and Utah. If used as a spring wheat, it should always be sown very early. But in most of the districts just mentioned it might be successfully grown as a winter sort, and could be planted at any time from October to March, depending upon the time of rainfall. It should always be thinly sown.

SANDOMIR WINTER WHEAT.¹

Sandomir wheat was obtained from the government of Radom, in Poland. The mean annual rainfall at the city of Radom is 27 inches (685.8 mm.), and the mean total for the growing season 15.5 inches (393.7 mm.). The soil is of the kind characteristic of forest regions, being poorer than the soils of the Chernozem region. Manure is required, but is not so much used for winter crops as for spring, and sometimes not at all. For winter grains the ground is first plowed

¹Inventory number, 2958.

during the first half of May, and then plowed and harrowed at least twice afterwards before sowing. This keeps down weeds and leaves the soil in mellow condition. Winter wheat is harvested during the first week of August.

This is the only one of the cereals obtained which is not intended primarily for dry cold regions. It is a rather soft, plump, yellowish-white wheat, a variety of *Triticum vulgare*. The best seed is always to be obtained near the town of Sandomir, in the Radom government. It seems to degenerate easily when grown in a different soil or climate. It is a much-prized variety in Poland. This wheat has already been tried in the United States, even many years ago, but probably not so thoroughly as it should be. It would probably prove a valuable sort for making crackers and certain kinds of breakfast foods. In this country it is, perhaps, best adapted for growth in the Middle States, Virginia, Michigan, and from northern California to Washington.

YAROSLAF WINTER WHEAT.¹

This wheat was obtained in two localities, in the governments of Yaroslaf and St. Petersburg. At Yaroslaf the mean annual rainfall is 18.5 inches (469.9 mm.), and the rainfall for the growing season 9 inches (230.1 mm.). The soil where this seed was grown is a strong clay, and was well manured and well drained. The wheat was sown September 9 and harvested July 24, with a yield of 18 bushels per acre.

At St. Petersburg the mean annual rainfall is 18.5 inches (470.5 mm.), and for the growing season it is 10.6 inches (271.3 mm.) The normal mean temperature is 38.5° F. (3.6° C.) for the year, 15° F. (—9.4° C.) for January, and 63.8° F. (17.7° C.) for July. The soil where the seed was grown is a clay loam, rich in humus. The wheat was sown September 4 and harvested July 24, producing 20 bushels per acre.

This variety of *Triticum vulgare* is a semihard, red wheat, which will probably be able to withstand very severe winters. But it should always be sown very early, and on soil that has been plowed immediately after harvest, and kept free of weeds and thoroughly pulverized at the surface. On ground thus prepared the wheat should probably be sown at the proper time, whether rain has fallen or not. Persistent efforts should be made to replace spring wheat with this variety in Iowa, northern Nebraska, and South Dakota, and even in the southern portions of Wisconsin, Minnesota, North Dakota, and Alaska.

VARIETIES OF OATS.

It has long been known that varieties of oats originating in cold, dry regions are as a rule superior in quality and vigor to those native in warmer countries. The same thing is more or less true with many other economic plants. It is quite a natural result, therefore, that

¹ Inventory numbers, 2791 and 2972.

wherever Russian oats have been already introduced into this country they have become very popular sorts, as the best oat districts in Russia and Siberia generally possess a climate a little drier and colder than corresponding oat districts in this country. In the selection of the following described varieties the aim was to secure good sorts from points as far north as possible.

SWEDISH SELECT OATS.¹

Seed of this variety of oats was obtained from the government of St. Petersburg. The rainfall and temperature of the locality is probably very nearly the same as already given for the city of St. Petersburg, under the description of Yaroslaf wheat (p. 20). The soil is a dark humus clay with considerable sand intermixed. For the cultivation of oats, the ground is either plowed very early in the spring or in the preceding autumn, and left in furrow without harrowing until seeding time or until after a rain. Sowing is usually done by hand after the ground is harrowed, and the seed is then plowed in lightly with the small, one-horse peasant plow ("sokha"), followed again by the harrow. In some cases the drill is used. The crop from which this seed was obtained was sown April 27, the period of growth being one hundred and three to one hundred and eight days. Oat harvest occurs between August 8 and August 20. Swedish Select is a very large-grained white oat, much improved from the original seed, which was introduced from Sweden into Finland and the St. Petersburg government. The variety has been tested at the Petrovsk Agricultural and Forestry Academy, near Moscow, by Professor Williams, who considers it to be an excellent northern sort. In this country it will be suitable for cultivation in all the extreme Northern States, from New York to Washington, and in southern Alaska.

TOBOLSK OATS.²

This variety comes from the government of Tobolsk, in northern Siberia. The rainfall and temperature of the particular locality in which the grain was grown can not be given. At the city of Tobolsk, however, where the climate is probably not far different, the normal rainfall for the year is 18.6 inches (473.4 mm.), and for the growing season 12.1 inches (309.2 mm.). The normal mean temperature for the year is 31.7° F. (—0.1° C.); for January it is —2.1° F. (—18.9° C.), and for July 66.6° F. (19.2° C.). Tobolsk oats is a vigorous variety, with large white grains. It is admirably adapted to cold, dry regions, such as the extreme Northern States of this country and Alaska.

ZHELANNI OATS.³

A small amount of seed of this variety was obtained at Ust-Sisolsk, in the government of Vologda. The locality is north of the sixty-first

¹ Inventory number, 2788. ² Inventory number, 2800. ³ Inventory number, 2963.

parallel. The climate is extremely cold and rather dry. The normal rainfall can not be given, but during one year it was about 18 inches, and during the growing season 12.2 inches (310 mm.). The normal mean temperature for the year is 32.5° F. (0.2° C.), and for the growing season it is 52.8° F. (11.6° C.). The soil of the locality is of the class usually to be found in forest regions. A sort of rotation of crops is practiced, as follows: (1) Fallow without manure; (2) winter rye; (3) spring barley and oats with manure. For growing spring crops the ground is plowed first either early in the spring or in the preceding autumn. Seeding of oats is accomplished from May 17 to 22. It is considered to be very advantageous to soak the seed in water for two days before sowing, in order to hasten germination. The oat harvest occurs from August 25 to September 4. The crop is always cut by hand, often with the sickle. Thrashing is done with the flail, and the grain cleaned by the shovel-and-wind method in the open air.

The variety was originally introduced into this locality from Moscow, but has been grown at Ust-Sisolsk for twelve years, and is therefore thoroughly acclimated to the region. It is possibly the same as the sort known as "Welcome," as the name Zhelanni is simply the Russian translation of that word. The seed was obtained through the agricultural board of the Ust-Sisolsk district from the grower, Mr. M. I. Tur, who kindly supplied it free of charge. The variety is well adapted for trial in the coolest portions of the United States and Alaska.

VARIETIES OF BARLEY.

The distribution of barley cultivation in Russia is peculiar. By far the greater area, in proportion to that of other crops, is grown in the northern part and extends entirely to the Arctic Ocean. In fact, the proportional cultivated area given to barley constantly increases northward from about the fifty-fifth parallel. In central Russia little or no barley is grown; then southward its production increases again, especially toward the southwest. Spring sorts are grown generally, but a considerable quantity of winter barley is produced in the Caucasus.

KOSTROMA SPRING BARLEY.¹

This variety of barley was obtained in the government of Kostroma. The normal rainfall for the year at the city of Kostroma, in the same government, is 20.1 inches (511.6 mm.), and for the growing season is 12.1 inches (307.4 mm.). The normal mean temperature for the year is 37.5° F. (3° C.), for January it is 10.8° F. (—11.7 C.), and for July 66.2° F. (19° C.). The soil of the locality is a sandy, clay loam, and was well manured. For barley the best land is supposed to be necessary, and beginning early in the spring the soil is plowed several times. Barley is sown much later than oats. In the Kostroma gov-

¹ Inventory number, 2793.

ernment it is sown from June 1 to June 13. The harvest takes place from August 22 to August 27. The period of growth of this variety is about eighty-eight days. The crop which furnished this seed yielded 26 bushels per acre. In Russia this barley is considered to be especially valuable for beer brewing. It is adapted to a cold and rather dry climate, and is suitable for cultivation in the northwestern States from Michigan to the Dakotas.

SISOLSK SPRING BARLEY.¹

Sisolsk barley was obtained from the vicinity of Ust-Sisolsk, in Vologda government. The seed was donated by Mr. M. I. Tur and delivered by the agricultural board of the Ust-Sisolsk district. The latitude and climatic conditions of the locality and crop rotation practiced there have already been mentioned under the description of Zhelanni oats. Barley is sown in this government from May 22 to June 4, and harvested from August 22 to August 27. This variety of barley is a vigorous, well-selected sort, and, coming from a locality so far north, it should be admirably adapted for cultivation in the very coldest portions of the United States, including the tillable portion of Alaska.

VARIETIES OF RYE.

The yearly production of rye in Russia is far greater than in any other country. In 1897 the total production of rye was over 654,000,000 bushels, of oats above 663,000,000 bushels, and of wheat over 340,000,000 bushels. The distribution of proportional area given to rye cultivation is just the reverse of that of the area devoted to barley, being greatest in central Russia and diminishing northward and southward. However, the greatest absolute yield of rye is rather far northward. The government of Vyatka takes first rank in rye production. The average yield of winter rye in Vyatka for the years 1892 to 1896, inclusive, was over 45,000,000 bushels, and in 1897 it was over 41,000,000 bushels. In northern and eastern governments this cereal seems to find exactly the soil and climate best suited for its cultivation. Almost all of Russian rye is fall sown. Of the spring-sown rye by far the greatest bulk is grown in Siberian governments, especially in Tomsk and Tobolsk.

TESHITIN WINTER RYE.²

Teshitin rye was obtained in the government of Tver. The normal rainfall for the year at the city of Tver is 20.1 inches (510.8 mm.), and for the growing season 12.5 inches (317.6 mm.). The normal mean temperature for the year is 37.1° F. (3.2° C.); for January it is 14.6° F. (—9.6° C.), and for July 63.8° F. (17.7° C.). The soil of the locality is a sandy clay and rather poor.

Rye is the chief winter crop in this portion of Russia. The first

¹Inventory number, 2962.

²Inventory number, 2790.

plowing of the rye field is from April 30 to May 15. Between that time and seeding time the ground is harrowed two or three times and perhaps manured. The seed is usually sown by hand and covered with the harrow. Harvesting is generally accomplished with sickles. Rye is sown in the Tver government from August 20 to August 27, and is harvested from August 1 to August 13. Often the grain is not gathered in time to furnish seed for the following crop, but old seed has to be used. But this variety was harvested very much earlier and is a particularly early sort, the average length of time between seeding and harvest being 320 days. It is an excellent Russian rye and well adapted for growing in all our Northern States from New York to the Dakotas and southward to Kentucky and Kansas; also perhaps in Alaska.

SISOLSK WINTER RYE.¹

This variety comes from Ust-Sisolsk, in the Vologda government. The latitude and climatic conditions of the locality and the kind of crop rotation practiced have already been mentioned (pp. 21, 22). The seed was contributed free of charge by Mr. A. E. Sukhanov, and delivered through the medium of the agricultural board of Sisolsk district. The variety has been grown in that region for many years, and is, therefore, thoroughly adapted to an extremely cold climate, and is also rather drought-resistant. The methods of culture are probably much the same as for Teshitin rye in the Tver government. The time of seeding is from August 12 to 15. Rye is harvested in this government from about August 20 to August 25. This rye being a winter sort from so cold a latitude, will probably prove an excellent variety for the coldest districts of the United States and for Alaska.

VARIETIES OF EMMER.

Emmer is a cereal not well known in this country, but is grown to a considerable extent in the middle Volga region of Russia. It is usually known as "Russian spelt," and is called by the Russians "polba." True spelt, however, is a different cereal, belonging to the subspecies *Triticum spelta* L., and is very little grown in Russia, if at all. Emmer is a German name, and seems to have no equivalent in English. The botanical name of the cereal is *Triticum dicoccum* Schrank. (*T. amyleum* Ser.). It is the "Amidonnier" of the French in contradistinction from "épeautre," meaning spelt.

Emmer is very much restricted in its cultivation in Russia, apparently by climatic conditions. It is similar to rye in being adapted to a rigorous climate, being very resistant to cold, and withstands drought quite well, at least in some instances. It is quite natural, therefore, to find that this cereal is grown in Russia almost wholly in the region east of the fortieth meridian, between the fiftieth and

¹ Inventory number, 2961.

1, 2, 3, 4, 5, 6
A GROUP OF SPELTS, EMMERS, AND EINKORN, SHOWING THEIR DIFFERENCES IN APPEARANCE: 1, BLACK VELVET COMPOUND EMMER;
2, WHITE SUMMER CLUB SPELT; 3, BLACK VELVET EMMER; 4, BLACK BEARDED SPELT; 5, EN GRAIN DOUBLE EINKORN;
6, SPRING EMMER.

GRAINS OF RUSSIAN WHEATS AND EMMER (NATURAL SIZE).

1, Beloturka; 2, Polish; 3, Banatka; 4, Turkey; 5, Black Velvet Emmer; 6, Winter Ghirka.

sixtieth parallels. Although the production is least of all the cereals in Russia, nevertheless there is a considerable quantity grown each year. In 1897 nearly 17,000,000 bushels were produced. The Government of Ufa ranks first in the production of emmer, followed next, in the order of their importance, by the governments of Kazan, Samara, Simbirsk, Vyatka, etc. In these governments not only is there extreme drought occasionally, but sometimes the summer is so short that the cereal crops suffer greatly from severe weather, both in late spring and early autumn. Emmer has, therefore, by virtue of its hardness, taken the place of other cereals to a considerable degree. It also probably possesses an advantage over true spelt, as its period of growth seems to be shorter. Notwithstanding, it is always necessary to sow very early. An appreciable amount of emmer is grown also in the Don and Kuban territories, and in Tobolsk government.

The grains of emmer remain in the chaff in thrashing, as is well known to be true in cases of most varieties of oats and barley. On the other hand, the rachis of the head is extremely brittle, so that the head easily breaks in pieces when very ripe and dry. Usually each spikelet of the head contains two grains, though sometimes there are three. The grains are somewhat boat-shaped or almost triangular in cross section. In all these respects emmer is very similar to spelt, but differs from the latter in several characters. In the spelt head the spikelets are situated far apart, and stand out from the rachis, while in the emmer the internodes are shorter and the spikelets stand close together in a compressed head. The leaves of emmer are often pubescent, and sometimes the heads as well. The grains are rather large, reddish, and usually quite hard, appearing vitreous in fracture.

There are both spring and fall sown varieties of emmer, though in Russia almost all seeding is done in the spring. In the north nearly all the varieties have white heads, but in the Caucasus red-headed sorts are grown. Emmer is less exacting than wheat in all its requirements for growth. It demands less care, will succeed on poorer soil, and withstands more severe weather. It will probably be found most profitable in cold, dry regions, and should be given a thorough trial in this country. It is rather resistant to the orange leaf rust. Though not possessing so good feeding qualities, perhaps, as oats, it may often, on account of its hardness, take the place of that cereal where the latter can not be successfully grown. In Russia the grain is also much used for human food. The flour is occasionally used in bread making, though the bread is said to become dry and stale sooner than that made from wheat. A little rye flour mixed with that of the emmer improves the bread. The most prevalent use of emmer as a table food, however, is in the form of a gruel or porridge. It is prepared for this purpose in large quantities and sold chiefly in the market places of Samara, Ufa, and other cities along the Volga.

UFA SPRING EMMER.¹

This variety was obtained in the government of Ufa, about 8 miles from the city of the same name. The normal rainfall for the year at the city of Ufa is 16.6 inches (421.8 mm.) and for the growing season 10.9 inches (278 mm.). The normal temperature is 37.5° F. (3° C.) for the year, 7.6° F. (-13.5° C.) for January, and 69.4° F. (20.8° C.) for July. The soil is the usual deep, black loam characteristic of the Chernozem region. The ground is usually plowed in the autumn previous to the time of seeding, at least on the best farms. On account of the less exacting soil requirements of emmer, if there is any sort of crop rotation, it is usually preceded by two or more other crops. The seed is preferably drilled at the rate of $1\frac{1}{2}$ to 3 bushels per acre. When it is sown broadcast, as is often the case in east Russia, as much as 4 to 12 bushels per acre are used. Sowing should be accomplished very early, as this cereal will bear considerable late spring frost and snow, and it is very desirable for it to ripen early. In order to produce the most palatable grain for human food, emmer should be harvested only during dry, hot weather.

Ufa emmer is a white-headed sort, with very hard red grains, which appear vitreous in fracture. The present seed was bought at the warehouse of the agricultural board of the Ufa district. The spikelets are awned. This sort should prove particularly resistant to drought and cold, and probably to leaf rust. It is adapted for growing in all the extreme Northern States of this country from Minnesota to Washington, in Alaska, and in arid districts farther south.

YAROSLAF SPRING EMMER.²

This variety comes from the government of Yaroslaf. The normal rainfall and normal mean temperature for the city of Yaroslaf have been stated in the description of Yaroslaf wheat. The soil of the locality where this emmer was obtained is sandy, with considerable clay, but very little humus. The seed was sown about May 1. The period of vegetation of this sort in that locality is one hundred and eight to one hundred and twelve days. Yaroslaf emmer has white heads, with no awns or beards, and medium-sized reddish hard grains, though the grains seem not so hard as those of Ufa emmer. It will probably be successfully grown in all the Northern States from New York to Washington, and southward to the fortieth parallel. Both varieties of emmer here described should be tried as winter sorts also.

INDIAN CORN.

One is not likely to find in Russia many kinds of corn particularly superior to those of this country, where so many varieties and such an enormous quantity of this cereal are produced. Nevertheless, at least two sorts were found that were thought to be well worthy of introduc-

¹ Inventory number, 2959.² Inventory number, 2789.

tion. One of these, a field corn, has yet to arrive. The other, a sugar corn, is already at hand.

MALAKOF SUGAR CORN.¹

This comes from Tula government, where the mean annual rainfall at Blagodatnoe is 19.1 inches (486 mm.), and for the growing season the average is 11.3 inches (286.9 mm.). The normal mean temperature for the locality can not be given, but the summers are very short. In Tula this sugar corn is considered to be of excellent flavor, but is especially valued as a sort that ripens very early. It is suitable for such regions as Iowa, Nebraska, Kansas, South Dakota, Michigan, Illinois, and perhaps North Dakota and Minnesota.

VARIETIES OF MILLET.

One of the most important cereal crops in eastern and southern Russia and in the Kirghiz Steppes and Turkestan is millet. By far the greater bulk of it is made up of varieties of *Panicum miliaceum*, known always among the Russians by the name "proso." It is the "Rispenhirse" of Austria-Hungary, and in Trans-Caucasia is called "phetvi" by the Georgians. In this country it has been distributed by seedsmen under the name of "broom-corn millet." The writer succeeded in obtaining a very fair representation of these broom-corn millets in the five varieties described below.

The average annual production of millet (seed) in Russia (including Siberia) for the years 1892 to 1896 was over 60,000,000 bushels, and in 1896 there was an enormous yield of nearly 95,000,000 bushels. In 1897 the production fell again to about 54,000,000 bushels. The greatest millet-producing governments are as follows, named in order of rank: Tambof, Voronezh, Kief, Saratof, and the Don territory. But Samara, Kursk, Ryazan, and the Ter and Kuban territories in North Caucasus all produce large quantities. In portions of these governments millet has become almost the "staff of life," in place of wheat bread. The broom-corn millets, like emmer, have the advantage over other cereals of being able to produce a good crop often when the latter entirely fail from adverse weather conditions. They are extremely resistant to drought, and probably produce even a better quality of grain during dry, hot weather, but of course must have some rain at certain periods in their growth. On the other hand, they differ widely from such grains as emmer in being very sensitive to cold. Nevertheless, they have ample time to ripen during the hot summers in regions as far north as the Samara and Simbirsk governments, which correspond somewhat in climate to North Dakota.

Broom-corn millet is always valued chiefly for its seed, whether used as human food or in feeding stock. It is not so good for forage as the Hungarian and common millets. On the other hand, the seed

¹ Inventory number, 2799.

is not only much larger, but it is very nutritious, and seems to have none of the drastic action on the alimentary system that is noticed in the seed of common millets. On account of the large size of the panicles the seed production is sometimes very great, the yield per acre in Russia varying from 20 to 50 bushels.

The Russian sorts of broom-corn millet differ from each other chiefly in the form of the panicle and in the color of the seed. The panicle may be erect and spreading, long and drooping, or very much compacted or club-shaped. The colors of the seed generally recognized are white, yellow, gray, red, and black; the most common being red and white, with the former more common than the latter, especially in the driest regions. Both the colors and forms of panicle intergrade very much, and are sometimes mixed in the same crop.

Occasionally other millets are also grown in Russia, especially the one called there "Moghar," and often called in this country German millet, but probably more correctly Hungarian millet, being the same as the "Mohar" of Austria-Hungary (*Chaetochloa italica germanica*). False millet ("Rosichka" in Russian) (*Syntherisma sanguinalis*) is also grown to some extent. But these millets are of minor importance.

Plowing for millet is usually done during the autumn, as in cases of other spring crops. In east Russia, where most of the millet is grown, a great deal of new land is still being broken up, and in such cases red broom-corn millet is usually made the second crop, the first being either melons, or more often, perhaps, durum wheat. After millet the softer wheats are grown for several years. Sometimes after old land has had a rest from cultivation a similar rather crude crop rotation is practiced. Millet is sown during the month of May, or even during the first week of June, depending upon the latitude and the condition of the weather. It is best to drill the seed in rows at the rate of 10 to 15 pounds per acre. A warm, black, sandy loam seems to be the best soil. The millet, generally cut by hand, is bound in sheaves and placed in shocks, just as in harvesting wheat. Methods of thrashing and cleaning are usually very crude and primitive, but on large estates thrashing machines are sometimes used.

TAMBOF BROOM-CORN MILLET.¹

This millet was obtained near Morzhansk, in the northern part of Tambof government. The normal mean temperature for the year at Morzhansk is 40.2° F. (4.5° C.); for January it is 9.2° F. (-12.6° C.), and for July 68° F. (20° C.). The normal yearly rainfall for the locality can not be given, but at the nearest point, Tambov, not far distant, it is 22.1 inches (563.5 mm.), and the normal for the growing season 10.8 inches (274.3 mm.). The soil of the locality is a black sandy loam, rather rich in humus. The usual time of seeding millet in this region is from May 10 to 25. The crop which furnished this

¹Inventory number, 2794.

seed was sown during the last week of May, and the vegetation period was about one hundred and twelve days. Millet is usually harvested there from August 25 to September 10.

This variety is a yellow-seeded millet, and is considered to be a new sort, not yet well known even in that region, but said to have given excellent results. It is adapted for growing in Minnesota, the Dakotas, Iowa, Nebraska, and perhaps in Wyoming, Montana, Utah and east Colorado.

BLACK VORONEZH BROOM-CORN MILLET.¹

This is a black-seeded variety from the government of Voronezh, where three different sorts of broom-corn millets were obtained. The rainfall at the city of Voronezh is normally 22 inches (560 mm.) for the year, and 10.3 inches (263.9 mm.) for the growing season. The soil is the ordinary black sandy loam, containing much humus. The periods of seeding and harvesting are much the same as for Tambor millet. It is adapted for cultivation in almost all the prairie States, but especially in regions where there are hot summers.

RED VORONEZH BROOM-CORN MILLET.²

This millet was also obtained in the Voronezh government. The rainfall, temperature, soil, time of seeding, etc., of the locality are the same or similar to those mentioned above under No. 2795. This variety is a red-seeded millet, with a very compacted club-shaped panicle, belonging to the group *Panicum miliaceum compactum* of Körnicke. It is at least closely allied to the "Mein Roca" of Roumania, and may be the same. It is adapted for growing in most of the prairie region, but particularly in the drier portions.

RED RUSSIAN BROOM-CORN MILLET.³

From the Voronezh government, also, comes the Red Russian broom-corn millet. The climatic and other conditions of the region have been given above. This variety is another red-seeded millet, but varies considerably in the form of the panicle. It is also suitable for the drier and hotter portions of the prairie region.

RED ORENBURG BROOM-CORN MILLET.⁴

This variety was obtained in the Turghai territory of the Kirghiz steppes, 40 miles southeast of Orenburg. The crop which furnished the present seed was grown by the Kirghiz people. The approximate climatic and soil conditions of the locality have already been stated in the description of Kubanka wheat. It is in such regions as this one near Orenburg that these red millets find conditions exactly suited for their best development, which conditions are also ideal for the production of the best durum wheats. The summers are intensely

¹ Inventory number, 2795.

² Inventory number, 2796.

³ Inventory number, 2797.

⁴ Inventory number, 2960.

hot and dry, and the soil is a grayish sandy loam. Of course there is much new land for cultivation in this region, and, as before stated, the first crop grown is usually durum wheat, which is followed by millet. Red millet seems to be far more commonly grown, but other sorts occur also, particularly yellow-seeded millet. Millet is sown in this region from May 13 to 27, or later, and harvested August 17 to September 6. The period of vegetation is considerably shorter than west of the Volga, because of the drought and heat.

Though only the seed of this millet was seen, it is most likely a variety of *Panicum miliaceum contractum* AL., the group having pendent panicles, to which sort also the Red Japanese belongs. These red drooping millets seem particularly adapted to the driest regions. Varieties of probably the same group are grown on the dry steppes of eastern Roumania, between Bukharest and Constanta, as observed by the writer. The Red Orenburg is admirably adapted for cultivation in the very driest and hottest portions of our Northwestern plains and in the arid portions of the mountain and basin States.

KURSK MILLET.¹

The seed of this millet was obtained in the government of Kursk. The normal rainfall at the city of Kursk is 16.9 inches (430.8 mm.) during the year, and 11.2 inches (284.7 mm.) for the growing season. The normal mean temperature is 41.3° F. (5.1° C.) for the year, 14.1° F. (-9.9° C.) for January, and 66.7° F. (19.3° C.) for July. The soil is a black, sandy, clay loam, rather rich in humus. This variety is called "Moghar" in Russia, and is one of the Hungarian millets. In Russia, as in this country, it is used chiefly as a forage crop, being better for that purpose than the broom-corn millets. This particular sort is well adapted for growing in any part of the Northwestern plains.

OTHER INTRODUCTIONS.

Three other plants, not cereals, one buckwheat and two forage plants, were also obtained. They are introduced solely because highly recommended in the country from which they came, and may or may not prove to be of value in the United States.

ORENBURG BUCKWHEAT.²

This seed comes from the Orenburg government, the climatic conditions of which have already been described under Kubanka spring wheat (p. 14). The soil where the crop was grown is a black, sandy loam. For the cultivation of buckwheat the ground is first plowed in the fall, and again plowed and harrowed several times before sowing in the spring. The crop is sown quite late, even later than millet, to avoid danger of frost. In the Orenburg government it is sown from June 1 to 13, and harvested August 17 to September 6. It is usually

¹ Inventory number, 2798.

² Inventory number, 2801.

cut by hand, often with the cradle. After drying awhile in the sunshine, it is bound into sheaves.

This buckwheat is grown considerably in east Russia and west Siberia. The seed is rather large, deep brown in color, and wingless. A sort of gruel is made of the hulled seed, or it is baked into cakes and served with soups. This variety is adapted for trial in the Great Plains north of Oklahoma, and perhaps in portions of the mountain States and in Iowa and Minnesota.

TAMBOF FLAT PEA.¹

The seed of this forage plant (*Lathyrus sylvestris wagneri*) was obtained from the Tambof government. The climatic conditions of the region have been mentioned (p. 28). This is claimed to be a very good forage plant in the drier portions of the middle Volga region, but is slow in making a start. It is adapted for the States of the plains from Oklahoma northward.

POLYGONUM WEYRICHIL.²

This perennial plant came originally from the island of Sachalin, but was recently grown in the government of Kief. It was discovered by a Russian physician, Dr. Weyrich, and first introduced into Russia from Sachalin by Prof. A. T. Batalin, and grown at the imperial botanic gardens at St. Petersburg. It is an entirely new plant for forage purposes, and no guaranty can be given as to its value for this country. It seems to have all the good qualities of sachalin (*Polygonum sachalinense*) and at the same time the leaves are tender, and the branches are not woody as in the case of the latter, which was its chief objection. It is claimed by some that Russian cattle eat this plant readily, while others say they do not. It may be tried in all regions where sachalin has been grown successfully.

OTHER RUSSIAN CEREALS, NOW BEING OBTAINED.

VARIETIES OF WHEAT.

The fact that so large a proportion of the annual wheat production of Russia is of spring varieties has already been remarked upon. In 1897 the production of spring wheat was two and two-thirds times as great as that of winter wheat. Remembering the very severe climatic conditions prevailing in the greater part of the grain region, as already discussed, such a fact is not difficult to understand. In addition to the long, severe winters, the greater part of the little rain that falls during the year, as before stated, occurs in three to five months of the spring and summer. Such are ideal conditions for spring wheat, but for winter wheat there is so little moisture in autumn that it is very difficult and sometimes impossible for the plant to develop reserve strength enough, in the form of good roots, to withstand the winter.

¹Inventory number, 2802.

²Inventory number, 2804.

The severity of the winter, too, is always increased by strong winds and the lack of snowfall. In the part of Russia east of the fortieth meridian the extremes of climate are so great that very little winter wheat is grown north of the Stavropol government, though it is a very important export region for spring wheat. But in occasional instances where winter sorts are successfully grown in this region, they are invariably found to be very hardy varieties, as one would naturally suppose. Therefore a special effort was made to secure winter wheats from the Volga region. In the northern portion of this region no winter wheat at all could be obtained, but two varieties were found to be grown sufficiently far north to make them of interest for trial in the northwestern portion of the Great Plains, where they may supplant spring wheats. Wherever such a change from spring to winter sorts can be effected, it ought to give great impetus to the wheat industry, judging from the good effects that have followed the increased use of winter in preference to spring varieties in northern Kansas and Nebraska, which began many years ago, and from the further fact that the yield per acre of wheat in Iowa (where spring wheat is almost entirely grown) is far below what it should be with such a soil and climate.

Farther south, in north Caucasus and the Crimea, where the climate is very similar to that of Kansas, other winter varieties were found which are very resistant to drought and will probably also resist the leaf rust to a considerable degree. Besides, they possess a grain of very high quality. The red winter wheats of these two regions are without doubt the very best varieties of *Triticum vulgare* in the world. Two or three of these varieties are so far wholly unknown in this country. But those of the Crimea are very similar to the so-called Turkey variety now grown in the States of the plains.

GHIRKA WINTER WHEAT.

This variety is to be obtained in the government of Kursk. The climatic conditions and nature of the soil have been mentioned in the description of Kursk millet (p. 30.) As already stated, this wheat could not be found in 1898 in any of the governments of Samara, Saratof, or Orenburg, although it has in other years been grown in these governments in small quantities. However, in Kursk it is sufficiently dry and cold to make it quite probable that a winter wheat successfully grown there will prove to be very hardy for this country. Ghirka winter is a medium-sized or small, hard or semihard red wheat. The heads are beardless. Samples of the wheat from Kharkof and Samara have already been grown experimentally by the Department in this country, and it was found to be very hardy. Two objections to the variety are the small size of the heads and its lateness in ripening, but it varies so much in these respects that it can doubtless be greatly improved by selecting for seed the largest and earliest-maturing heads. It

yields well, and the grain furnishes an excellent bread flour. It is admirably adapted for trial in Iowa, northern Nebraska, northern Illinois, Michigan, South Dakota, and the southern portions of Wisconsin, Minnesota, and North Dakota.

RED SANDOMIR WINTER WHEAT.

This variety comes from the vicinity of Rtishchevo, in the north-western part of the Saratov government. The climatic conditions of the locality can not be given exactly. It is probably not so dry as at the Marie Experimental Farm, in the same government, where the normal rainfall is 15.2 inches (387 mm.) for the year and 8.5 inches (215.3 mm.) for the growing season. The normal mean temperature for the year at Saratov, in the same government, is 41.7° F. (5.4° C.), for January it is 13.7° F. (-10.1° C.), and for July 71° F. (21.7° C.). The soil is the usual rich black loam of the Chernozem region. A winter wheat grown successfully in this locality ought to be a very hardy sort for our northern great plains.

Red Sandomir is a variety apparently not extensively cultivated yet. It is a hard or semihard red wheat, and is possibly a strain of the true Sandomir of Poland developed under different conditions of soil and climate, though this is somewhat doubtful. It is well suited for trial in the northern and western prairie States, even where spring wheat is grown.

BUIVOLA RED WINTER WHEAT.

This wheat is grown in the valley of the Buivola River, a branch of the river Kuma, about 100 miles nearly due east of Stavropol, in the Stavropol government, north Caucasus. The climatic features of the locality can not be given exactly, but it is very dry and hot in summer. The drought is much greater than at Pyatigorsk (about 72 miles distant), which seems to be the nearest point where meteorological records are kept. At that place the normal rainfall for the year is 21.7 inches (551.9 mm.) and for the growing season 14.7 inches (373.9 mm.). The mean temperature is normally 48.3° F. (9° C.) during the year, 26.9° F. (-2.8° C.) for January, and 68.9° F. (20.5° C.) for July. The soil is a deep black loam, though the locality is near the border of the Chernozem. There is much alkali in the same region.

Buivola wheat is a medium-sized, hard, red-grained variety, very resistant to drought, and is considered to be the most rust-resistant and early-maturing sort in all the Caucasus. It is entirely unknown in this country and very little known in the greater part of Russia. The writer first saw a sample of the wheat in the possession of Mr. A. E. Filipchenko, wheat expert of the ministry of agriculture at St. Petersburg, who called it the best wheat in Russia. Afterwards it was learned at Rostof-on-Don that a considerable quantity of the wheat

is exported by way of that port. This variety will be an exceedingly valuable sort for our western States of the plains.

RED KUBANKA WINTER WHEAT.

This variety is to be obtained from the Kuban territory in the vicinity of Ekaterinodar. The mean yearly temperature at Ekaterinodar is normally 53.7° F. (12° C.); the normal for January is 28.2° F. (—2.1° C.) and for July 77.2° F. (25.1° C.). The rainfall can not be given exactly, but it is probably not far from 27.5 inches (700.0 mm.) for the year and 14.7 inches (375 mm.) for the growing season. The soil of the Kuban territory is the usual black loam of the Chernozem, with varying proportions of sand and clay.

The Kuban territory ranks first among Russian governments in the production of winter wheats. In fact, its average production for the years 1892 to 1897 is very nearly twice that of Podolia, which ranks as the second winter wheat government. The climate and soil are rather similar to those of Kansas, Missouri, and Illinois. A number of different varieties of good, hard, red or yellow grained wheats are grown in the territory.

The fact that Kubanka spring wheat changes under different conditions of soil and climate has been mentioned. In this territory not only has the variety become red-grained instead of yellowish white, but it is now also able to withstand the winter. Thus, it is explained, has originated what is now called Red Winter Kubanka. It is a variety apparently not yet extensively cultivated, but it is claimed by Agronom N. I. Morëv, of Ekaterinodar, to be one of the very best sorts in the territory, being rather hardy and considerably rust-resistant. It is adapted for trial in this country in the region north of the thirty-fifth parallel, from Ohio to the Rocky Mountains, and as far north as winter wheat can be grown.

CRIMEAN RED WINTER WHEAT.

This wheat is grown in the central portion of the Crimea, not far from Simferopol, in the government of Taurida. The annual rainfall at Simferopol is normally 16.5 inches (419.3 mm.), and for the growing season 8.1 inches (206.4 mm.). The normal mean temperature is 50.1° F. (10° C.) during the year, 30.9° F. (—0.6° C.) for January, and 69.2° F. (20.6° C.) for July. The summer climate is very dry and rather hot. Dry winds are quite prevalent during the period of growth of the wheat crop. Also in central and southern Crimea the greater part of the summer rainfall occurs in late summer, instead of during May, June, and July, as in other portions of south Russia. Hence the climate is on the whole rather severe, but nevertheless, so long as there is moisture at all sufficient to permit a harvest, the nature of the climate and soil together is such as to produce an extremely hard red grain of the very best quality. The soil is a deep black loam and contains a great proportion of alkalies.

The Crimean wheat is bearded and has very hard medium-sized red grains. It is closely allied to various sorts already introduced into this country from south Russia, and called by such names as Turkey, Red Russian, Russian Hard, Crimean, Russian Red Bearded, etc. It is admirably adapted for growing in Kansas, Oklahoma, Nebraska, Iowa, and South Dakota, and perhaps in Texas, North Dakota, Minnesota, Illinois, and Missouri.

ARNAUTKA SPRING WHEAT.

This variety is to be obtained in the little peninsula forming the eastern portion of Crimea, in the government of Taurida. The climatic conditions of the region will be approximately shown by the records kept at Kerch. At that place the annual rainfall is normally 15.1 inches (383.8 mm.) and for the growing season 8.1 inches (206 mm.). The normal mean temperature is 52.7° F. (11.5° C.) for the year, 33.4° F. (0.8° C.) for January, and 75.1° F. (23.9° C.) for July. The soil is the usual black loam of the Chernozem, but with a considerable amount of sand. But aside from that there seems to be certain special features of the soil that can not yet be accurately described. At any rate it is pretty generally supposed among grain growers and agriculturists that only in very limited districts, similar to the one here described, are the soil and climate of the nature required for the best development of this variety of wheat. The rainfall, as in southern Crimea, is usually greater in late summer than in early summer, an exception to the general rule for dry regions.

Arnautka wheat is a variety of *Triticum durum*, and is considered by many to be the best of all varieties for the manufacture of macaroni. The grains are yellowish white, extremely hard, partially transparent, and vitreous in fracture, and are nearly, or sometimes fully, as large as those of Polish wheat. Field tests of the variety will be required to determine definitely the particular localities in this country in which it will be most successful, but in general it may be recommended for trial in dry alkaline districts from western Kansas to southwest Texas and in portions of New Mexico, Arizona, and southern California. It should be sown thinly and extremely early in the spring or late in the fall. The hotter and drier the weather the better for its best development, within limits, of course. It should be harvested only during the hot part of the day, so far as possible. If this wheat can by persistent effort be made successful in this country, it will no doubt prove to be one of the most valuable varieties, because of its suitability for macaroni production.

OTHER CEREALS.

BLACK RUSSIAN OATS.

This variety is to be obtained from the government of Ufa. The soil and climatic conditions have already been stated in the descrip-

tion of Ufa emmer (p. 26). Coming from a region so far north and east, this oat will be admirably fitted for cultivation in all the extreme northern and western States of the plains, and perhaps Alaska. A variety called by the same name, and which is indeed probably identical with this one, has already been grown many years in this country and has always proved to be hardy and productive, and in many instances, at least, rather rust-resistant.

MOTO MAIZE.

Moto maize is grown in the southern portion of Samara government. The climatic conditions of the locality can not be stated accurately. It is probably much drier and colder than at the city of Saratof, which seems to be the nearest point where meteorological records are kept. The normal annual rainfall at Saratof is 16.6 inches (423.1 mm.), and the normal for the growing season is 7.5 inches (191.9 mm.). The normal mean temperature is 41.7° F. (5.4° C.) for the year, 13.7° F. (-10.1° C.) during January, and 71.0° F. (21.7° C.) during July. It is so dry at any rate, and the summer season so short that any variety that is successful in that locality should be well adapted for our Great Plains climate at least as far north as the northern boundary of South Dakota and as far west as the 100th meridian.

This variety of corn bears rather thin ears, tightly filled with very hard, small, reddish-yellow grains. It is claimed to be a hardy variety, resistant to drought, and, above all, very early in maturing. The grain probably contains a rather large proportion of proteid substances. The variety ought to be valuable for the feeding of dairy cattle, for which purpose varieties furnishing a large proportion of nitrogenous matter are now considerably in demand. It is adapted for trial in all northwestern States of the plains.

RUSSIAN CEREALS ALREADY GROWN IN THIS COUNTRY.

Although a comparative study of the soil and climatic features of the grain regions of Russia and this country indicate decidedly that Russian cereal varieties are those best adapted, as a rule, for growth in our prairie regions, fortunately, as already stated, we have more than mere theory in support of such a proposition. Certain Russian sorts have already been well tested, and after thorough acclimation, are now considered to be of the highest grade. Reference has already been made to the variety known as Turkey wheat, and the Fifes of the northwest, which most likely were originally native in Russia. Such varieties as these make up a large bulk of the wheat export of this country; but in addition to these a number of other Russian wheat varieties have been grown for a considerable time. Some of the most important are Crimean, Red Russian, Russian Hard, Odessa, and Moscow. Still others, though promising to become excellent

sorts, have been tried only for a short time, and are not yet sufficiently acclimated. Of these there should be mentioned especially a number tested by the Department in different portions of the country. Some of them are very resistant to cold and drought. Of the winter varieties the most promising are Ghirka Winter, Red Winter, Bearded Winter, Vyssoko-Litovsk, Red Bearded, Don, and Yx, and the best spring sorts are probably Imperial, Krasnokoloska, Spring Ghirka, and Alsace. The last two named, in the early stages of growth, are peculiar in appearance, being usually soft-pubescent and grayish green in color. All the following Russian varieties of wheat, and no doubt several others that might be named, have been tried at various times in this country:

Alsace.	Crimean.	Podolia.	Sandomir.
Arnautka.	Don.	Polish.	Saxonka.
Beloturka.	Krasnokoloska.	Red Bearded.	Spring Ghirka.
Belokoloska.	Kubanka.	Red Ghirka.	Taganrog.
Bearded Winter.	Ladoga.	Red Russian.	Turkey.
Chernokoloska.	Moscow.	Red Winter.	Winter Ghirka.
Chernuska.	Odessa.	Russian Hard.	Yx.

A number of varieties of Russian oats have also been grown for many years in the United States, while still others have been tried and are supposed to be not successful. Black Russian, Black Tartarian, White Russian, Shatilovski, Zhelanni, Amur, and several Siberian sorts are among the best known of these varieties. Black Russian is a well known standard variety of the northwestern States, and is one of the best kinds of oats ever introduced into this country.

Other Russian cereals have not, so far, been introduced on so large a scale, but several barleys, including naked varieties, some Siberian sorts of rye, and a few varieties of emmer ("spelt,") and broom-corn millet have already been grown to some extent.

HARVESTING AND SUBSEQUENT OPERATIONS IN RUSSIA.

It is hardly necessary to state, in the first place, that Russian methods of gathering and cleaning cereals are yet quite primitive in the greater portion of the country. Some of these methods have already been mentioned in the descriptions of the different cereal varieties.

HARVESTING.

As already stated, a common method of cutting the grain among the peasants is with the sickle. It seems that this instrument is especially used in harvesting the durum wheats, where unusual care is used in handling the grain. The scythe and cradle are also often employed, particularly in harvesting the soft wheats and broom-corn millet. In a number of instances reaping machines which drop the grain without binding are used, and the writer was informed that

certain machines rather similar to the American header are occasionally employed in the same way as these reapers. Often after cutting with these machines the grain is simply raked up into cocks as in gathering hay. But in recent years, and particularly on the largest estates, a large number of self-binding harvesters have come into use. These are almost all of foreign manufacture and principally from this country. Methods of shocking and stacking grain seem to be much the same as with us.

THRASHING.

A common method of thrashing among the peasants is with the flail. Another method, however, which was often observed by the writer, is the driving of horses or cattle over circular winrows of straw, knocking out the grain by the tramping. This method is practiced even near Odessa in Kherson government. Sometimes sleds or drags, constructed in various ways and often weighted, are pulled over the piles of grain, adding to the effects of tramping. The large thrashing machines are now often seen on large farms, though they are by no means commonly used. Steam thrashers were occasionally observed in operation in the midst of many large ricks, reminding one of similar operations on a Dakota wheat farm, but such scenes were rare.

CLEANING.

The operations of cleaning grain are generally very primitive and very bad. For this reason it is impossible to obtain seed grain that is pure and free of weed seeds, unless it is all cleaned over again by some reliable seed firm. Even then it is often found that certain varieties require further cleaning on reaching this country. It is believed, however, that all the varieties mentioned in this report that have already been secured will be found to have been pretty thoroughly cleaned.

In the many instances where the grain has not been thrashed with the large machines the complete separation of the chaff from the grain is often effected by the "shovel-and-wind" method—that is, the grain is simply allowed to stream from the edge of a shovel in the open air while the wind carries away the chaff. For the separation of weed seeds and the grading of the grain, a circular sieve 3 or 4 feet in diameter is commonly used, as shown in the accompanying illustration (fig. 2). Such sieves are of different grades, depending upon the size of mesh which they possess. They are swung from the center of tripods made of rough poles, and are given various complex movements, which only a skilled performer can execute, in order to bring constantly a new layer of grain in contact with the sieve. This method of grain cleaning was often observed by the writer, and even in the rather advanced agricultural region of Kherson government, where the ordinary fanning mill is also sometimes used. Fanning mills are no

doubt used in other parts of the country also, but are certainly rather uncommon.

It should be remarked, however, that after all the existence of dirty grain, just as in all regions where grain growing is practiced on a large scale, is largely due simply to carelessness, however elaborate the cleaning machinery may be. On the other hand, the writer noted that in cases where great care was exercised excellent work was performed by the use of these simple circular sieves, though the operation is of course exceedingly slow.

MILLING.

In methods of milling great advancement has been made in Russia. The modern roller system has been in operation for almost thirty years.

FIG. 2.—Cleaning wheat in Kherson government.

Apparently most excellent work is being done in the larger mills along the Volga and in south Russia, work that will compare favorably with that done in this country and in Hungary. One of the mills visited by the writer, that of Schmidt Brothers, at Saratof, reminds one very much of the mills of our Northwestern States. It grinds wheat only, and possesses over ninety sets of rolls of recent pattern, new steaming machines, bolters, purifiers, etc. Dampening the wheat seems to be a very important operation, as most of the grain used is extremely dry. As mentioned in another place, the wheat generally used at the Volga mills is Kubanka or Pererodka, varieties much harder than any ever used in this country, though a considerable per

cent of the softer red wheats is mixed with these in grinding. But to gain a proper idea of the work these millers perform, it must be remembered that even the softer red wheats are fully as hard as the so-called hard spring wheats of the Dakotas and Minnesota. The flour thus produced is of a golden color and highly nutritious. After being accustomed to eating bread well made from such flour most persons prefer it to any other. Fortunately, in that country the color of the bread is considered to be of minor importance compared with its quality. A kind of bread which is especially common in Moscow, called "kalach," and always served warm, is very popular, and when well made is an agreeable novelty to the traveler. Yet this bread is said to be made from the fourth or fifth grade of the above-mentioned flour.

PREPARATION OF CEREAL FOODS.

In portions of Russia the bulk of the population depends almost wholly upon certain special cereal foods for their principal subsistence, and a greater number of grains are employed in making such foods than in this country. The chief plants represented in these foods are wheat, barley, rye, oats, emmer, rice, broom-corn millet, and the noncereal, buckwheat. But occasionally other grains are used, such as common millet, false millet (*Syntherisma sanguinalis*), etc. The generic Russian term applied to these different foods in the raw state is "krupa," corresponding to the word groats, and the gruel or porridge made from them is called "kasha." There are, however, many special names for the different kinds. Though these foods are much more important in Russia than in this country, the methods of their manufacture are less developed there, and apparently not so many kinds are produced from any one cereal. Because of lack of time and opportunity, the writer was not able to visit any of the mills devoted especially to manufacturing groats. The operations are known to be rather simple, and a large part of the production is really made at the ordinary flouring mills. The stones for grinding groats are hung either on vertical or horizontal shafts, and the grinding is done on the outer cylindrical surface by passing the grain between the stone and the casing. Several kinds or grades of groats are made sometimes from one cereal, but the product is always rather coarse, and in no instance was any sort of flaked product observed.

One of the most common cereal foods, especially in east Russia, is "psheno," made from broom-corn millet. The grains are so small that this form of groats is often little less than the hulled seed. When the hulled seed is very white it is sometimes artificially colored yellow. Millet groats make an excellent porridge, which is deservedly popular. A kind of pearl barley, much like our own food of the same name, is produced to a great extent. In the middle Volga region a kind of groats made from emmer is commonly seen in the market places. In

making this groats the grain is first hulled (which is never accomplished in thrashing) and polished, and then either left in such condition or cracked. Another very popular food wholly unknown in this country is made from buckwheat groats ("grechevnaya krupa"). Two general types of groats are made from the hulled buckwheat—one made up of angular pieces, which is more common, and another composed of rounded pieces, known usually as Smolensk groats. Buckwheat groats, as well as all others, are not only used for porridge, but very often in soups, in certain puddings, and in various other ways. A very common "kasha" on Russian bills of fare is the cooked buckwheat groats compacted into cake form and served along with soups. On the other hand, curiously enough, buckwheat cakes seem to be generally unknown.

REQUISITES OF A PROPER TEST OF NEW CEREALS.

In view of the fact that several of the cereal varieties described in this report have already been tried in this country, and that objection is occasionally made to the further trial of Russian sorts on the ground that some of these have proved to be failures either in cultivation or in the milling process, it seems well worth while to point out the reasons for persisting in introducing these sorts. Taking into consideration the general similarity of conditions between the grain regions of Russia and this country, these reasons seem to the writer to be sufficiently shown in the following propositions:

(1) Many or nearly all of our introductions of cereals heretofore, whether from Russia or any other country, have been made without sufficient information concerning the conditions under which the different varieties were grown in their native home and the particular localities, if any, of this country to which they are best adapted. Wheat varieties, such as Kubanka or Algerian, from dry, hot regions, should never be expected to succeed in Canada or our Eastern States, though admirably adapted to the region from west Texas to southern California. Much time has been expended in the trial of Australian and Indian varieties, which, in the greater portion of our grain region, naturally enough succumbed to adverse weather conditions, though some of these same sorts are counted among the best in California.

(2) In many cases, at least, it is of great importance to know also the conditions of cultivation to which different varieties have been subjected, and to practice as nearly as practicable such methods in this country in order to obtain the best results. This is especially true in the cases of varieties of emmer, broom-corn millet, and Polish and durum wheats. For example, complete success should not be expected from Polish and durum wheats without very early and thin sowing. In the descriptions of the different varieties in this report it is the aim to give all such information obtainable.

(3) In some instances new varieties, although promising to do well

in cultivation, are not accepted by millers because of the difficulties met with in grinding them and the new uses to be made of them. In such instances the miller's objection may not be well founded, especially when we consider the fact that a "good milling wheat" of thirty years ago is not considered to be a good milling wheat now. The wheat has not changed, but the mills changed in response to a demand for grinding very different sorts of wheat. If certain new varieties succeed in any region and also at the same time promise to form the foundation of a new industry, such as the production of a new kind of cereal food or even of a better quality of bread, one is certainly justified in expecting, not only any required change in method of milling for handling these sorts, but even the invention and construction of entirely new mills for the purpose, if necessary. The miller himself usually discovers later that changes of methods to conform to the demands of new crops are really after all an advantage to him financially.

(4) Perhaps the most important reason for continuing the trial of certain new varieties is the simple fact that heretofore in many cases such perseverance has not been sufficiently practiced. In some instances entirely new sorts have been tested for one or two seasons and reported to succeed fairly well, but, without any apparent reason, no mention is afterwards made of any further trial of them. Again, in some cases the experimenter seems to have become discouraged on finding that certain sorts have succeeded only in one season out of two or three and abandoned the experiment, when if the trial had been continued valuable and well-established varieties might have been added to that region. The results of experiments with new varieties carried on by this Department, as well as the experience of other experimenters in different States and in Canada and Australia, show decidedly that no reliable conclusions can be drawn from the results of such experiments if they have not been continued constantly in the same locality during five to eight years.

(5) Finally, there are certain varieties, such as macaroni wheats and broom-corn millets, which, if once proved by actual experiment to be well adapted to this country, would be of such manifest importance in forming the foundation of new industries that the utmost effort should be made to establish them even in the face of difficulties. All the best sorts should be tried in all soils and climates where they are at all likely to succeed, and before the impossibility of acclimatizing a valuable variety can be considered as demonstrated the experiment should be continued if necessary for five to ten years, using each year the best seed carefully selected from the preceding crop.

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