Wheat, Flour, and Bread in Central Asia[1]

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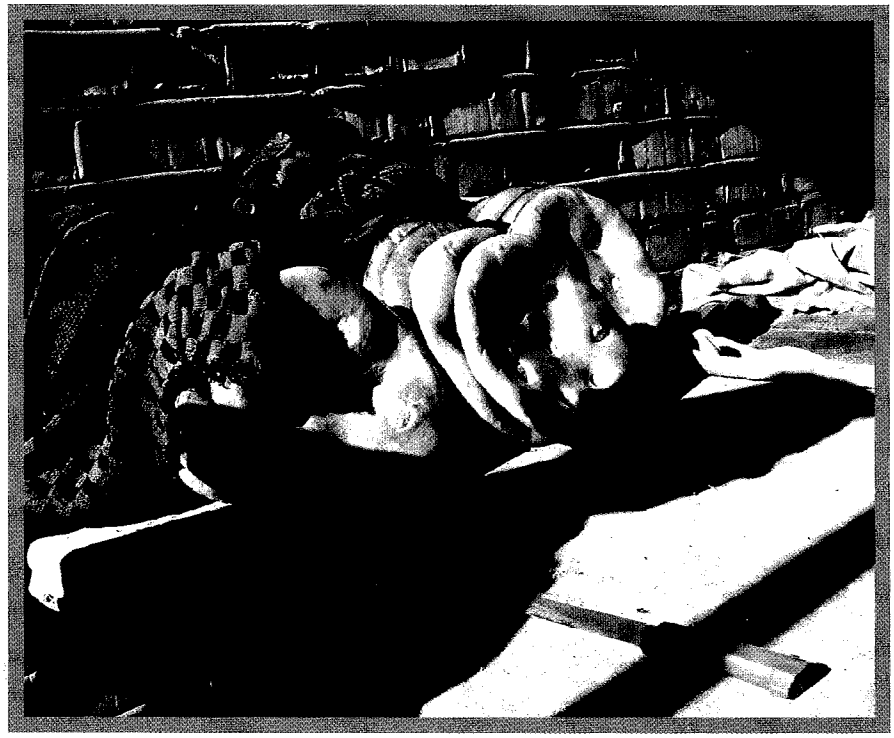

Bread is a critical food staple in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) (Fig. 1). The consumption of flour and bread in Central Asia is remarkably high (Table I). In some rural regions, per capita consumption of bread is as high as 500 g/day. Other countries in the region that share much in common with Central Asia regarding wheat and bread include Azerbaijan, Afghanistan, and Mongolia.

There is some evidence that suggests cultivation of wheat as a food crop may have originated in an area of Central Asia that today is part of Turkmenistan, rather than in the fertile crescent of Iraq as is generally believed. The president of Turkmenistan, Saparmurat Niyazov, has even built a museum to celebrate this idea (Fig. 2).

This article discusses traditional breads produced in Central Asia, as well as the properties of the wheat and flour used to make them. Efforts to improve the iron and zinc content of flours and breads through plant breeding and fortification are also described.

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Role of Wheat in Central Asia

After the disintegration of the Soviet Union, people in Central Asian countries returned to more native social and cultural traditions, which included increasing their participation in agriculture, a very important economic and strategic activity in the region. Restructuring their agricultural infrastructure toward food security and profitability has become one of the main priorities of Central Asian countries.

Special attention has been given to wheat, which is the main cereal crop grown in the region and the main raw material for making bread (a staple food consumed as part of every meal). As such, wheat is an important and in some areas the main source of nutrients. Given the major role wheat production plays in the region, efforts are underway to improve wheat productivity under sustainable agricultural systems.

The majority of wheat grown in most Central Asian countries is winter wheat, which generally has quality attributes (protein quantity and quality) that are inferior to those of spring wheat grown in northern Kazakhstan. This inferior quality is one of the main reasons (the other is lack of or inconsistent local wheat supply) why the milling and breadmaking industries of southern Kazakhstan, Kyrgyzstan, and Tajikistan prefer the high-quality spring wheat from northern Kazakhstan over local winter wheat varieties. Large quantities of wheat from northern Kazakhstan, referred to here as Kazakh wheat, are imported by Kyrgyzstan and Tajikistan despite its higher price. Uzbekistan and Turkmenistan, where wheat imports are not allowed, do not impart Kazakh wheat, but do import Kazakh wheat flour. Because other Central Asian countries import large quantities of wheat flour produced in Kazakhstan to supplement their weaker, poorer quality flour, Kazakhstan has become the third largest exporter of wheat flour in the world after Turkey and the European Union.

In Kyrgyzstan, Tajikistan, and southern Kazakhstan the main problems with local wheat are low test weight, low protein and gluten content (below 20–22% wet gluten in grain), and weak gluten. The gluten deformation index (GDI) for the local wheat is about 120, which is indicative of low gluten quality. In addition, insects and molds may damage grain lots during storage if they are not stored properly, and insect damage during grain maturation may occur.

Grain texture generally ranges from soft to medium hard. Soft, starchy grain is difficult to mill because soft wheat flour tends to clog the sieves. As a result, the milling industry prefers medium hard wheat.

In Uzbekistan the local wheat has low gluten content (<20%) and low gluten quality (GDI = 115). In small village mills problems with local wheat include sprouting, mold due to high moisture, and a high proportion of starchy kernels (up to 50–60%). High incidence of starchy kernels indicates low protein content, which could result from low nitrogen fertilization of the crop or nitrogen washed from the soil by irrigation. Grain texture in general ranges from semisoft to semihard.

In southern Kazakhstan, Kyrgyzstan, and Tajikistan, wheat varieties commonly used for the production of good-quality *tandyr* bread include Saratovskaya 29, Omskaya, Tselinaya, Kazakhstan 10, Belozyorka, Intensivnaya, Kras-ya 10, and Jagger (winter wheat introduced from the United States). In Uzbekistan wheat varieties commonly used for the production of good-quality *tandyr* bread include Kazakh varieties Tespizhor and Sanzar-8; local varieties PolovchaKazakha, Kupava, Kroshka, Uma-Kazakha, Chillaki, and Starshina (a new good-quality local variety).

Wheat Milling

The milling industry in Central Asian countries includes old, very large but only partially operating mills (once operated at full capacity when the region was part of the Soviet Union) and newly equipped large flour mills (>50 t/day), as well as medium (10–50 t/day) and small (<10 t/day) mills. The milling industry has been privatized in Kazakhstan, Kyrgyzstan, and Tajikistan, but most of the mills in Turkmenistan and Uzbekistan remain under government control.

There are five types of flour available in Central Asia: premium or supreme grade (0.5–0.7% ash), first grade (0.7–0.8% ash), second grade (1.25% ash), whole wheat, and rye. The most common is first-grade flour, which accounts for up to 70% of mill output. Wet gluten content in flour obtained from Kazakh wheat ranges, depending on flour type, between 26 and 32%. Flours from Central Asian winter wheat are reported to contain 3–4% less wet gluten than flour from Kazakh wheat. According to the milling industry, first-grade flour with 27–30% wet gluten, from Kazakh wheat or blends between Kazakh and local wheats, yields medium strong gluten, which is adequate for making dough by hand in *tandyr* breadmaking. Excessively strong gluten requires too much handwork to develop the dough properly.

Most of the small mills with a 0.25–1 Mt/day capacity are Chinese mills that contain only one set of rolls with an adjustable roll gap and a sieve for separating the flour from the bran. These produce first-grade flour with an ash content of 0.7–0.9%. There are also a number of stone mills that produce whole-wheat flour. These mills typically provide their milling service for a charge of 7–10% of the total wheat lot processed. Small-scale farmers living in small villages far from cities take their wheat crop to these service mills to obtain flour for their own consumption. Hundreds of small Chinese service mills can be found throughout the rural areas of Central Asia. As a result, they process large amounts of locally produced

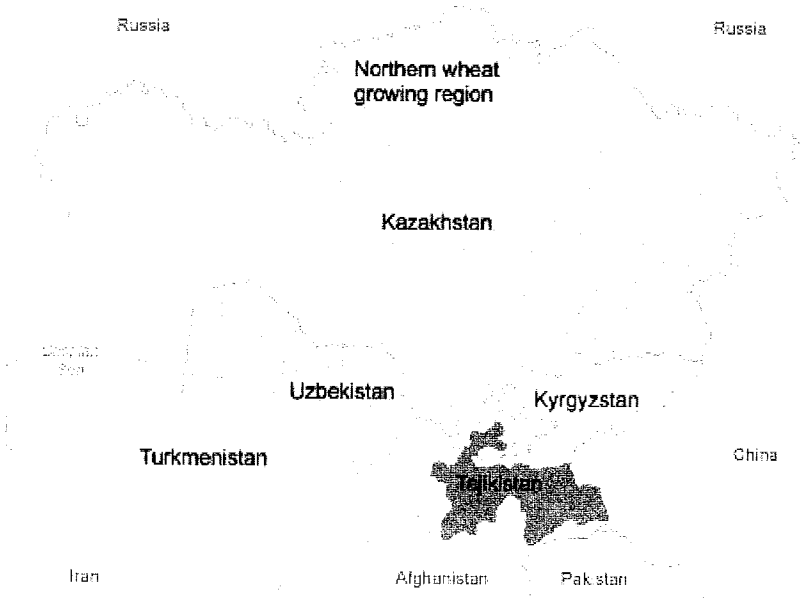

Fig. 1. Map of Central Asia.

Table I. Wheat production and consumption in Central Asian countries

Country	Population (millions)	% of Population That Is Rural	Wheat Production[a] (million Mt/year)	Wheat Flour Consumption[a] (g/person/day)
Kazakhstan	15.1	43	12.8	284
Kyrgyzstan	5.6	66	1.0	499
Tajikistan	6.7	76	0.6	302
Turkmenistan	5.4	53	NA[b]	472
Uzbekistan	28.8	64	5.4	342

[a] Derived from FAO data.
[b] Production figures for Turkmenistan are disputed.

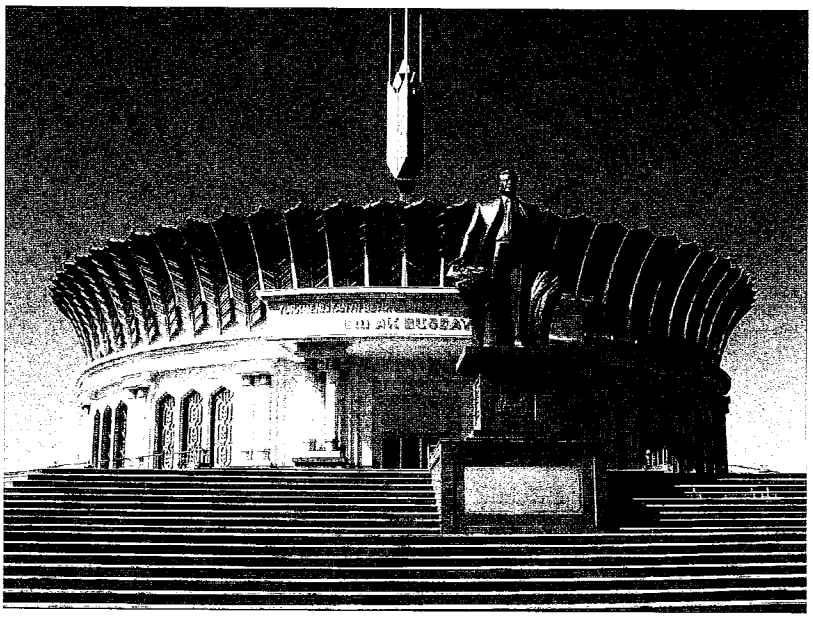

Fig. 2. The wheat museum in Ashgabat, Turkmenistan.

wheat throughout the region even though the output from a single mill is very small. In some cases, because bakers recognize Kazakh wheat as having better breadmaking qualities, Kazakh wheat flour is purchased to blend with local wheat flour and taken to a service mill to obtain higher quality flour. People living far from cities cannot afford to buy either Kazakh wheat or Kazakh flour, however, so they make do with flour from local wheat.

Milling practices for Chinese mills differ greatly from mill to mill. Gap distance between the rolls, number of times the intermediate milling products are passed through the rolls before the final refined flour is obtained, and time the grain is conditioned with water before it is milled are all variables that are determined arbitrarily. This causes the quality of the flour produced to vary widely, particularly in regard to ash content and water absorption. Gluten quality may also be diminished by heat during milling, particularly in stone mills.

Fig. 3. A *tandyr* oven in a small commercial bakery in Turkmenistan.

The wheat milling industry in Uzbekistan differs in some ways from the milling industries in other Central Asian countries. First, large portions of the milling and baking industries belong to the state, except for village service mills and bakeries. The government stores locally produced wheat in large silos according to gluten content and distributes the wheat to large mills, providing certificates for quality attributes, including test weight and gluten and moisture contents. The flour extraction rate to be obtained at the mills is also regulated (78–82%, depending on the region) by the government. There are four flour grades: extra or premium, first, second, and Uzbek. Extra-grade flour is used mainly for cookies and French-type breads, first grade is used for *tandyr* bread, and second and Uzbek (0.8–0.9% ash) grade flours are used to produce an inexpensive, dense, dark pan bread called diabetic bread.

In Uzbekistan and Turkmenistan there are still large breadmaking plants that use the old sponge-and-dough liquid ferment pro-

cess to produce this inexpensive, dark, dense pan bread. In these countries the governments do not allow import of wheat, although flour can be imported. The milling and baking industries in Uzbekistan recognize that the winter wheat varieties cultivated locally possess low gluten content and weak gluten characteristics that are unsuitable for producing high-quality *tandyr* bread. Considering that consumption of *tandyr* bread has been increasing significantly, particularly in city suburbs and villages in rural areas, there is a real need to improve winter wheat quality for the production of *tandyr* bread, not only in Uzbekistan, but throughout Central Asia.

Traditional Central Asian Breads

While part of the Soviet Union, people in Central Asia mainly consumed the dense, dark pan-type (Russian) bread produced in large quantities by large baking plants. However, after Central Asian countries achieved their independence, traditional flat breads rapidly regained popularity throughout the region and are now the main bread type consumed in small cities and the only type of bread consumed in small villages in rural areas. One traditional flat bread is *tandyr* (clay oven) bread made from lean dough baked while stuck on the concave walls of aboveground clay ovens (Fig. 3). In larger cities, this type of bread may be baked from similar dough in gas or electric hearth ovens, but in more rural areas and at home, clay *tandyr* ovens predominate.

Basic *tandyr* bread is made with slightly salty water-flour (water 50–60% of flour weight) dough fermented with a small amount of yeast or with sour dough in small villages. Milk and oil occasionally are included in the bread dough. The dough is made by hand, with all the ingredients mixed in while kneading to the point at which the dough is cohesive and slightly rough to smooth. Dough roughness and consistency depend on the quality (gluten strength) of the flour, as well as on the preference of the baker. The dough is allowed to ferment for 60–180 min. After fermentation the dough should be elastic and slightly extensible so it can be flattened and shaped into a thick to thin disk. The disk is stamped in the center before it is baked while stuck on the concave wall of a preheated clay (or clay-brick) *tandyr* (or *tandoor*) oven. The bread dough may be moistened with milk before baking to yield a shiny surface. A variety of center stamps made from wood and steel pins are used to produce distinctive patterns that remain in the crust of the baked bread.

Tandyr breads, commonly known as "*nan*" or in Russian as "*lepyoshka*," are round-to-oval shaped with diameters of approximately 15–20 cm (small), 20–30 cm (medium), and 30–40 cm (large). Bread thickness may range from 5 to 10 cm. The crust may be dark to light brown and range from thin to thick. The bread may be light with an open crumb (180–360 g); medium dense with a slightly open crumb (180–750 g, depending on size); or dense to very dense (400–850 g).

Lightweight breads are usually consumed as part of a full meal (mainly in urban areas), while dense breads are consumed as the main component of a meal, as is frequently the case among people living in rural areas of Central Asia. Taste, crumb texture (nonsticky while masticating), and satiation capacity are among the bread characteristics most important to consumers.

Commercial Bread Bakeries

Large breadmaking plants manufacture mainly pan-type bread, with only a small output of *tandyr* bread, for which they generally use the bottoms of horizontal ovens rather than the walls of concave clay ovens. The resulting bread has the appearance of *tandyr* bread, but its crumb texture and crust characteristics do not correspond to the traditional product.

Numerous small-to-medium *tandyr* bread bakeries are widely spread throughout Central Asia in large cities, towns, and large villages. The number of bakeries is limited by the size of the local population and by the number of households producing bread for their own consumption. *Tandyr* bread is sold directly from the bakery or by venders in the large bazaars, local markets, and streets. The larger commercial bakeries located in cities and large towns may produce from 200 to more than 1,500 bread units/day, while small commercial bakeries produce from 50 to 100 bread units/day.

Most commercial bakeries in the region use first-grade flour from Kazakh wheat, either alone or blended with flour from local wheat. In Uzbekistan some commercial bakeries use only flour from local wheat. Interviews with small bakers showed they understood that flour from local wheat has lower gluten content and lower dough water absorption than flour from Kazakh wheat. In many cases the bakers indicated that flour from local wheat had poor dough-handling properties (dough stickiness) and poor baking quality (dough overly extensible, causing it to hang undesirably while stuck on the oven walls), as well as yielding fewer pieces of bread per kilogram of flour. On the other hand, flour from Kazakh wheat sometimes is excessively strong (due to high gluten content), making it difficult to mix the dough by hand. Hence, a blend of flour from Kazakh and local wheat (usually 50:50) was thought to produce the best flour properties (medium strong) to facilitate dough mixing, achieve good fermentation, and obtain the most loaves of good-quality bread from one bag of flour.

The basic dough formula used in commercial bakeries includes flour, water, dry yeast (in some cases fresh yeast), and salt. Milk is frequently added to the dough formula in Kyrgyzstan bakeries. Water is added to an absorption level that varies from 48 to 64%, causing dough consistency to vary from stiff to soft. The fermented dough is generally smooth to slightly rough and possesses the elasticity and extensibility necessary to flatten and extend the dough without further dough contraction. Dough with little extensibility tends to contract, losing the original dimensions produced by the baker.

Commercial *tandyr* bread may be small, medium, or large in diameter, thickness, and weight. Bread size and weight depends on consumer preferences. Bread crust is generally light brown, but the crumb structure may vary from open in lightweight breads to dense in heavy breads. Bread produced in Uzbekistan in general is more dense than in other countries of the region.

A survey revealed that in the opinion of the bakers, taste, color, and bread satiation capacity, in this order, are the bread qualities most important to consumers. Bread storage life (retention of freshness/softness) is not very important to consumers, because they buy commercial bread in amounts small enough to avoid consuming staled bread. Commercial *tandyr* bread may remain fresh from one day up to one week depending on bread storage conditions. Per capita consumption of *Tandyr* bread varies from as little as 181 g/day, for those consuming bread as a complement to a full meal, to more than 500 g/day, for those eating bread as a main component of a meal.

Home Breadmaking

Household breadmaking is widespread in small villages located far from towns and cities. In Turkmenistan, it is the standard practice. For household breadmaking, flour is acquired from the market or from wheat grown personally and taken to the local, small Chinese-type service mill. Household bakers generally use flour from local wheat, mainly because it is cheaper than flour from imported wheat. However, in some cases, when the household baker can afford to buy imported flour (or grain), a blend of flours from Kazakh wheat and local wheat is used. This is done because even at the village level it is recognized that Kazakh wheat produces flour of better quality than the those obtained from local winter wheat. Household bakers prefer to use first-grade flour because it produces whiter bread. Less prosperous populations use cheaper second-grade or whole-wheat flour to produce dark brown, dense breads that have a high satiation capacity.

When making *tandyr* bread, the household baker uses less yeast than in commercial bakeries or no yeast at all, relying on old (sour) dough for leavening. A stiff to slightly stiff dough is produced, mainly due to high fiber content in the flour grade commonly used, that generally is rough and less cohesive than the dough prepared in commercial bakeries. This type of dough has limited elasticity and extensibility and tends to separate from the oven wall and fall during bread baking, due largely to its heavy weight and rough dough surface, which does

not stick to the wall as readily as a smooth dough does. The resulting bread generally has a dense crumb that tends to be sticky during mastication. Its also has low water absorption, making it difficult to masticate and swallow.

Household bakers believe bread satiation capacity and crumb texture (the two are interrelated) to be the most important bread quality factors, followed by taste and color (they prefer it to be whiter).

Mineral Content

Tables II and III show mineral contents in Central Asian wheat flour as determined in two separate studies: one by GAIN and Unicef that investigated the feasibility of fortifying flour at small mills (Table II) and one by Harvest Plus that assessed wheat varieties for those with naturally high levels of iron and zinc (Table III). Iron is the mineral of primary interest because of the widespread prevalence of iron deficiency anemia in the region.

The average level of iron found in the most common first-grade flour was 30 ppm (76 samples), twice that found in the more refined premium grade, which had a 15 ppm average (27 samples). The average iron content in the second-grade flour (28 samples) was 36 ppm.

Although these are high levels for unfortified flours, there is a huge range in values, from 5 to 95 ppm. Some of the higher values were due to soil contamination, which is indicated by the aluminum level. Kazakhstan and Kyrgyzstan had the lowest aluminum levels, probably a result of using cleaner wheat or better cleaning practices at the mill. They also had lower iron levels compared with the other countries. Most of the contamination iron would be in the form of iron oxides, which are not very bioavailable.

Along with the amount and form of iron in the food, the level of phytic acid (PA) also determines the food's value in providing nutritional iron to the diet. PA binds iron, making it unavailable to the body. It is the main storage form of phosphorus in grains, so the phosphorus content is directly related to its content, as is the ash content. The higher the ash content, the higher the PA level. A useful index in predicting iron absorption is the PA/Fe molar ratio in the food as consumed. The lower the ratio, the better the iron will be absorbed. The iron in foods with a PA/Fe ratio <1 should be well absorbed, while ratios >6 would be very poor sources of absorbable iron. Unfortunately, most of the ratios are >6 (Table II). The ratio can be reduced by fermentation of the dough during the breadmaking process, which is very limited with *tandyr* breadmaking, and by adding iron.

Zinc content varies with the ash content and grade of flour, with the highest levels found in second-grade flour and the lowest levels in premium-grade flour. Calcium levels change very little, and although the amount of iron and zinc supplied by flour is nutritionally important, the amount of calcium is quite small compared with its requirement.

Fortification Programs To Improve the Quality of Wheat and Flour

In 2001 the Asian Development Bank started a project under the Japanese Fund for Poverty Reduction to initiate voluntary fortification of flour produced at the larger mills in four countries (Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan) in Central Asia and in Azerbaijan and Mongolia. This program was expanded in 2005 to include medium size mills in Kyrgyzstan, Tajikistan, and Mongolia.

Premium- and first-grade flours are fortified with iron, zinc, and four B vitamins. The level of iron added is 50 ppm for premium grade and 40 ppm for first grade. The added iron combined with the natural iron provides a total iron content of 60 ppm. The type of iron added is electrolytic (elemental) iron powder. Zinc, in the form of zinc oxide, is added at a rate of 22 ppm to premium-grade and 17.6 ppm to first-grade flours, providing a total zinc content of more than 25 ppm.

Turkmenistan already had a separate flour fortification program initiated by Unicef. In Turkmenistan the level of iron added has been only 8 ppm, but the iron is in the form of the more bioavailable ferrous sulfate. The addition level was increased, by a presidential decree, to 20 ppm, along with the addition of 1.5 ppm folic acid, for all wheat flour in April 2006. Uzbekistan also expanded its flour fortification program to include all major mills.

Future Considerations

Improving *Tandyr* Baking Quality. A survey conducted by CIMMYT in mills, bakeries, and households across four Central Asian countries (Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) clearly indicated that the winter wheat cultivated in the region possesses inferior quality for the production of *tandyr* bread. Therefore, there is a real need to improve winter wheat quality to make local varieties more acceptable for the *tandyr* breadmaking industry and to gradually reduce wheat imports associated with wheat quality issues.

Winter wheat germplasm is already being tested for adaptation and agronomic performance throughout the region. This germplasm will be evaluated for relevant quality traits, such as gluten quality and quantity, to identify those varieties showing good agronomic characteristics, acceptable disease resistance, and desirable quality attributes. The winter wheat variety Jagger has been found to be satisfactory for *tandyr* breadmaking quality and could be used as a standard or quality reference. Systematic work that includes breeding and agronomic research, along with the establishment of a collaborative network for quality testing among the four countries (Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) should result in a substantial improvement in the *tandyr* breadmaking quality of winter wheat cultivated in Central Asia.

Biofortification. The Harvest Plus organization is working on identifying wheat varieties that are naturally high in iron and zinc and low in PA, so the resultant PA/Fe ratio is as low as possible. The first step is to determine the range of mineral content of the wheat grown in the region and the flour being produced (Table III). A future step will be to breed wheat for improved bioavailability. This will likely not replace the need for mineral fortification in the near future but will supplement it and make it more effective in combating the mineral deficiency diseases that cause major public health problems in this region of the world.

Table II. Micronutrient content of flour samples from two Central Asian countries

Country	Flour Grade	Mill	Ash (%)	Fe (ppm)	Zn (ppm)	Al (ppm)	Phytic Acid (%)	Phytic Acid/ Fe Ratio
Tajikistan	First	Small	0.84	32	15	15	0.37	9
Tajikistan	First	Small	0.89	28	16	18	0.50	13
Tajikistan	First	Small	0.91	46	18	34	0.47	7
Tajikistan	First	Small	0.62	20	11	10	0.24	8
Tajikistan	First	Small	0.67	31	11	28	0.27	6
Turkmenistan	First	Large	0.86	38	8	25	0.18	4
Turkmenistan	First	Large	0.81	26	9	7	0.22	7
Turkmenistan	Second	Large	1.99	54	36	26	0.92	14
Turkmenistan	Second	Large	1.41	29	25	10	0.60	17

Table III. Average mineral content of wheat flour samples from three Central Asian countries

Country	Flour Grade	No. of Samples	Fe (ppm)	Ca (ppm)	Al (ppm)	Zn (ppm)	P (ppm)
Kazakhstan	Premium	15	9.4	197	4.0	6.3	896
Kazakhstan	First	13	16.9	231	6.5	10.2	1,279
Kyrgyzstan	First	11	14.2	212	3.3	10.8	1,429
Tajikistan	First	19	38.7	287	20.4	17.5	1,793
Uzbekistan	First	33	36.3	262	19.0	13.3	1,602
Uzbekistan	Second	19	37.7	290	14.2	21.6	2,265