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RESEARCH ARTICLE

Grain production trends in Russia, Ukraine and Kazakhstan: New opportunities in an increasingly unstable world?

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Abstract Grain production in the countries of the former USSR sharply declined during the past two decades and has only recently started to recover. In the context of the current economic and food-price crisis, Russia, Ukraine, and Kazakhstan might be presented with a window of opportunity to reemerge on the global agricultural market, if they succeed in increasing their productivity. The future of their agriculture, however, is highly sensitive to a combination of internal and external factors, such as institutional changes, land-use changes, climate variability and change, and global economic trends. The future of this region's grain production is likely to have a significant impact on the global and regional food security over the next decades.

Keywords Russia, Ukraine, Kazakhstan, food security, global change, grain production

1 Introduction

Global grain stocks of the past ten years have been particularly volatile. In 2008, they fell to two-decade lows as a complex result of political, economic, and environmental factors, including shifting allocation of grain production toward biofuel feedstocks in the United States and the European Union (EU), increasing global oil prices, changes in food consumption patterns in South and East Asia, and the disruption of food production due to droughts in Australia and poor harvests in Europe (OECD-FAO, 2008; Lioubimtseva, 2010). This dynamic global food situation clearly indicates that the world's food security is highly vulnerable to the existing economic instability and climatic variability and change.

In the context of the current food crisis and fundamental demand increases, if the grain-growing countries of the former USSR, such as Russia, Ukraine, and Kazakhstan, where grain production sharply fell in the 1990s, succeed in increasing their agricultural productivity, they will have an opportunity to reemerge on the global market and alleviate the global crisis. With abundant highly fertile, but under-utilized lands, Russia, Ukraine, and Kazakhstan could become top beneficiaries of the rapidly changing food-production landscape.

Since 1991, the agricultural systems of Russia, Ukraine, and Kazakhstan have undergone enormous institutional changes that have resulted in exclusion of approximately 23 million hectares of arable lands from production, 90% of which had been used for grain (FAOSTAT, 2009). This land use transition was the largest withdrawal from arable lands in recent history. The major changing trends in the 1990s were the disintegration of the centrally planned institutions in the agricultural sector and uncertainties in the legal status of land, which resulted in declines in agricultural subsidies, use of technology, and access to markets (Lerman et al., 2004). In turn, these factors precipitated significant declines of both cereal areas and grain productivity that bottomed out across the region at the end of the 1990s (Zhang, 1997; Meng et al., 2000; de Beurs and Henebry, 2004; Bokusheva and Hockmann, 2005; Muratova and Terekhov, 2005; Uzun, 2005). The grain productivity in these countries is currently low: 2.6 t/ha of wheat in Ukraine, 1.8 t/ha in Russia, and < 1 t/ha in Kazakhstan (compared to 5.5 t/ha in the EU, 4.7 t/ha in China, and 2.9 t/ha in the United States) (FAOSTAT, 2009; USDA, 2009), but it could potentially grow several-fold. The rate of recovery of food production in the post-Soviet economies and the ability to realize their full agricultural potential is likely to have a significant impact on the global food security in the near future. It will depend on several internal and external factors, such as success of agricultural reforms, subsequent land-use changes, climate variability and changes, and global economic trends.

The paper examines the potential impact of each group of these factors on the cereal production and food security

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in Russia, Ukraine, and Kazakhstan, and the future role that these grain producing countries could play in alleviating the unfolding global food crisis.

2 Factors of change in food production

Food security and the associated risks of disruption to production and distribution networks depend on multiple biogeophysical, socio-cultural, political, and economic factors. These can include the respective sensitivities of the agricultural sector to land changes, climate variability and change, global market variations, country-scale political and economic changes, local policies, and other factors. Thus, food security can be affected by the interplay of several groups of internal and external factors. Internal factors, such as institutional changes (agricultural reforms, management practices, policies, legislation, etc.), and the subsequent regional land-use changes can be intimately interconnected with external or global factors, such as climate variability and change, and the internationalization of markets or "globalization" (Fig. 1).

2.1 Institutional changes

At the beginning of the 1990s, there was a general expectation that trade liberalization would lead to removal of price subsidies and expose the Commonwealth of Independent States (CIS) agriculture to global competition; as a consequence, some contraction of agricultural production during the first years of reforms. However, it was also expected that this initial contraction of the agricultural sector would be offset by an increase in productivity as soon as the management system adjusted to the new, market-oriented price signals. In the long run, agriculture was expected to recover in a few years, leading to an increase in productivity and exports (Osborne and Trueblood, 2002).

The actual result of the reforms was a much larger than expected drop in production once agricultural subsidies were eliminated at the early stages of economic transformation, but no corresponding rise in productivity. The implementation of reforms and adjustment to market economy took much longer than was expected by the CIS and western experts (Lerman et al., 2004; Macey et al., 2004). Until the end of the 1990s, land reforms in Russia, Ukraine and Kazakhstan had no or little impact on the size and internal structure of large farms. In the Soviet era, agriculture had been supported by budget subsidies and favorable relative prices, and benefitted from fuel and transportation subsidies that were not specific to agriculture but helped farmers more than most other producers. Very abrupt price liberalization of the early 1990s led to an increase in the cost of key inputs that was much larger than the increase in the market value of farm outputs. OECD producer support estimates for Russia, Ukraine, and Kazakhstan indicate substantial positive support for farmers up to 1991, which then almost fell to zero in the following few years (OECD-FAO, 2008). Among the three countries, Ukraine most drastically reduced its agricultural subsidies during the years of transition. Although agricultural subsidies have increased in the CIS countries in past few years and are now comparable with the US level, they are significantly lower than those in Europe or Japan. According to the Food and Agriculture Organization (FAO), the level of overall support given to agricultural producers as a share of their total farm receipts amounted to 15% and 12%, respectively, in Russia and Ukraine, compared to 33% in the EU, 55% in Japan, and 16% in the USA (FAOSTAT, 2009). Russia declared agriculture a

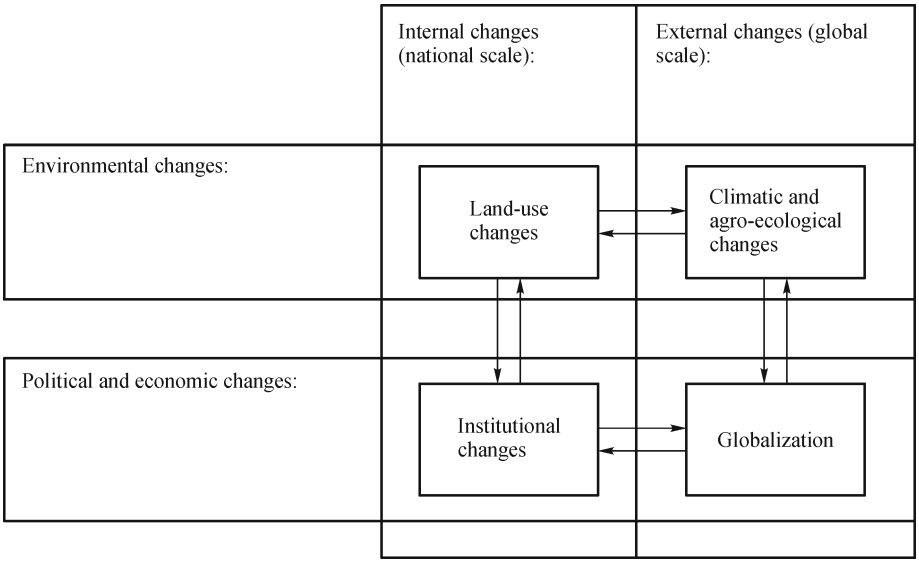

Fig. 1 Groups of factors affecting food production

national priority area in 2005 and increased federal support for agricultural development from US$ 2.6 billion in 2006 to US$ 5.2 billion in 2008 (EBRD-FAO, 2008); the same tendency is observed in Kazakhstan, and to a lesser extent in Ukraine (EBRD-FAO, 2008).

The lack of a fully developed land market is continuing to have a negative impact on the agriculture of the CIS countries. The question of sales of agricultural land has been the subject of heated debate in all three countries, and it took much longer than reforms in any other sector of the economy to create a land market. In Russia, the land code passed in 2002 after several unsuccessful attempts to legalize land transactions and the use of land as collateral, but the sale of agricultural land was not allowed until 2006. The current land code of Russia allows private land ownership and treats foreign individuals and legal entities as equal with Russians, which is expected to create favorable conditions for the land market in future years. The low farmland values favor the rise of large corporate farms: the land prices in Russia are much lower than in most western countries (e.g., a hectare of land in the Black Sea region with the best chernozem soils (mollisols), is ten times cheaper than a similar plot in Iowa or Kansas) (USDA, 2009).

The direction of institutional changes during the first decade of reforms was occasionally inconsistent with regard to land ownership and land market development. For example, in Kazakhstan the Presidential Decree "On further improvement of land relations" (Decree #1639, April 5, 1994) allowed citizens and legal entities to sell, rent, or pledge their land rights as collateral. However, several years later, this legislation was cancelled by the Constitutional Court of Kazakhstan as anti-constitutional. In 2001, the permanent land-use right of citizens and legal entities was cancelled, and the duration of long-term land-use rights was reduced from 99 to 49 years (Almaganbetov, 2005). The current land code of Kazakhstan (adopted in June 2003) allows for the long-term leases of agricultural lands to individuals and corporate farms, but reserves the governmental ownership of the land, and prohibits land market and the use of land as collateral (The Land Code of Republic Kazakhstan 2007). Among the three CIS states, Ukraine has been the most successful in transferring the land into private ownership. The decree of 1999 (Presidential Decree #1599/99 "On immediate measures to accelerate the reforms in the agricultural sector") transferred almost 70% of agricultural land to the private ownership of nearly seven million rural residents (Lerman et al., 2007). However, the moratorium on sales of agricultural land has been recently extended until the end of 2012, blocking the process of formal farm acquisition. The control of agroholdings in Ukraine is less prominent than in Russia or Kazakhstan, and is mainly associated with the food processing industry rather than farming. The ownership of corporate farms represented less than 60% in 2006 and their share of gross agricultural output was less than 30% (Lerman et al., 2007).

One of the more serious problems associated with implementation of agricultural reforms in all three countries has been the lack of long-term support of agricultural reforms by the key stakeholders — the rural population — resulting in weak public and private governance in the agricultural sector. Several studies conducted in the CIS countries reveal the lack of public support for land reform and rather negative public perception of land ownership and the land market (Koester and Striewe, 1998; Uzun, 2005; Koester and Brümmer, 2006). In a study conducted in the Russian countryside, about 90% of the respondents disagreed with a concept of cropland privatization, and were against the idea of private land ownership and market. Interviews in several CIS countries indicate that food security is generally perceived in this region as one of the key responsibilities of the state and people generally tend to blame poor economic situation and increasing food prices on the failure of the central government (Serova, 2000). There is a generally negative attitude of the population to the removal of agricultural subsidies and institution of the land market. These attitudes of stakeholders might be the key factor explaining why the three countries have been quite slow and inconsistent in implementation of their new land codes, and came back to some agricultural policies that are not in line with market orientation (Lissitsa and Odening, 2005; Uzun 2005; Koester and Brümmer, 2006).

2.2 Land-use changes

Cereal production of the USSR grew from 119 million tons in 1961 to 155 million tons in 1991, with a maximum production of more than 170 million tons in 1980 (FAOSTAT, 2009). In contrast to the land expansion of the 1950s, the growth of production during the later years was entirely driven by increasing yields, while the area of cereal cultivation slightly contracted during the same period of time. During the last decade of its existence, the USSR launched its "agricultural intensification program" with a strong focus on cereals, particularly winter wheat, as well as meat production. The intensification program emphasized the use of improved varieties of crops and the increased application of fertilizer and plant-protection chemicals. Yields had significantly increased during that period in response to the enhanced management practices. However, when the collapse of the Soviet institutions ended massive subsidies for agriculture, the intensification program was abandoned during the early 1990s.

The transitional period of the 1990s and early 2000s was marked almost everywhere in the CIS by several distinctive trends: 1) deintensification of agriculture followed by reduction of yields, 2) abandonment of arable lands, 3) conversion of arable lands into pastures, 4)

decrease of grazing intensity, followed by further abandonment of pastures, and 5) deforestation due to increasing local demand for fuel (de Beurs and Henebry, 2004; Lioubimtseva and Henebry, 2009a,b; Lioubimtseva, 2010).

The yields and the sown area declined during the 1990s in all three countries as the high price of imported herbicides, fungicides, and insecticides caused farmers to cut back on their use. Fertilizer use fell by 85% in Russia and Ukraine and by almost 90% in Kazakhstan between 1990 and 2000; the grain production fell by more than 50% during the same period of time (FAOSTAT, 2009). The loss of state subsidies following the collapse of the Soviet Union in 1991 also increased feed and production costs and reduced profitability for livestock enterprises. As prices for meat products increased, consumer demand declined, thus establishing a downward spiral that continued throughout the decade. Livestock inventories and demand for forage continued to shrink. Russia lost almost half of its meat production between 1992 and 2006: 1) the number of cattle dropped from almost 20 million to 10.3 million head, 2) the number of pigs fell from more than 36.3 million to 18.7 million, and 3) the number of sheep dropped from 20 million to 7 million (FAOSTAT, 2009). Similar trends occurred in Kazakhstan and to a lesser extent in Ukraine. The increasing inability of large agricultural enterprises to maintain livestock operations, largely due to inefficient management and farms' inability to secure adequate supplies of feed, resulted in increased dependence on private producers and household farms to satisfy demand for meat. Furthermore, the involvement of investor groups in agricultural production has had an impact on livestock numbers. Many farmers, who entered agreements with investment firms, killed off their herds because livestock was not quickly profitable and not as attractive to investors. For example, in Kazakhstan, due to the loss of incentives to keep the herds, two-thirds of the sheep population of the country was lost in only five years of reforms between 1995 and 1999 (Lioubimtseva and Henebry, 2009a). The drop in livestock inventories led in turn to a drop in demand for feed grain and pastures across the region. Although the freefall in livestock inventories has slowed since 2000, large industrial farms are shifting away from livestock and toward crop production and total livestock inventories continue to decrease, particularly in areas with extensive herding, such as Central Asia and semi-arid and arid zones of Russia (Lioubimtseva and Henebry, 2009b; Lioubimtseva, 2010).

The recovery trend since 2002 has been too brief to have a significant and unequivocal impact on land cover dynamics. Due to recovery of some agricultural subsidies and at least a partial success of reforms, fertilizer and machinery use has increased during the past few years. The use of mineral fertilizer has tripled since 1999 in Kazakhstan and doubled in Russia and Ukraine, but current application rates represent only a fraction of the amounts applied in the late 1980s (FAOSTAT, 2009). A return to the 1980s application rates is unlikely and unnecessary, as they were frequently above recommended levels. Another important technological factor contributing to the apparent improvement in Kazakhstan grain yield is the increase in the use of certified planting seed. By 2004, the use of certified seed had increased to 94%, including an increase in the use of top-quality certified seed from 37% to 57% (USDA FAS, 2010).

Detailed discussions of the magnitude, direction, and prevalence of land-cover and land-use changes as observed in this region by remote sensing can be found in de Beurs and Henebry (2004), de Beurs et al. (2009), Kovalskyy and Henebry (2009), Lioubimtseva and Henebry (2009a), and Wright et al. (2012).

2.3 Impacts of climate changes

Agricultural production and export opportunities are highly sensitive to interannual climate variability as expressed in growing season weather. Productivity of grain cultures in Central Eurasia (winter wheat in the European part of Russia and Ukraine, and spring wheat and barley in Kazakhstan and Russia east of the Volga River) strongly depends on summer precipitation, which is particularly important during the critical phases of wheat growth, such as bushing and earring (Muratova and Terekhov, 2005). The second major climatic constraint is the temperature: high summer temperatures above 33°C can damage crops and reduce production.

Climate change and increasing climate variability are likely to bring changes in land suitability and yields. Atmosphere-Ocean General Circulation Models (AOGCMs) predict that the temperature in the grain-producing areas of Central Eurasia will increase by 1.5°C – 3.5°C by 2030 –2050, with the greatest increase in winter (IPCC, 2007). Despite significant differences in the range of changes among the scenarios produced by different models, the majority of them tend to agree that summer precipitation is likely to decline all over the region and winter precipitation is projected to increase in parts of European Russia and Siberia (Dronin and Kirilenko, 2008; Lioubimtseva, 2010). We used MAGICC/SCENGEN 5.3 model (Wigley, 2008) to analyze regional climate change scenarios projected by 20 different AOGCMs used in the IPCC Fourth Report (IPCC, 2007). There is a strong agreement of AOGCM projections that under any policy scenario temperature maxima are likely to increase by 2050 both in summer and in winter; increase of the mean and maximum summer temperatures in combination with precipitation decrease potentially means more droughts (Fig. 2).

Climate change projections indicate both increasing risks and opportunities for the CIS region. Several food security modeling studies employed the AOGCM projections and the International Institute for Applied System

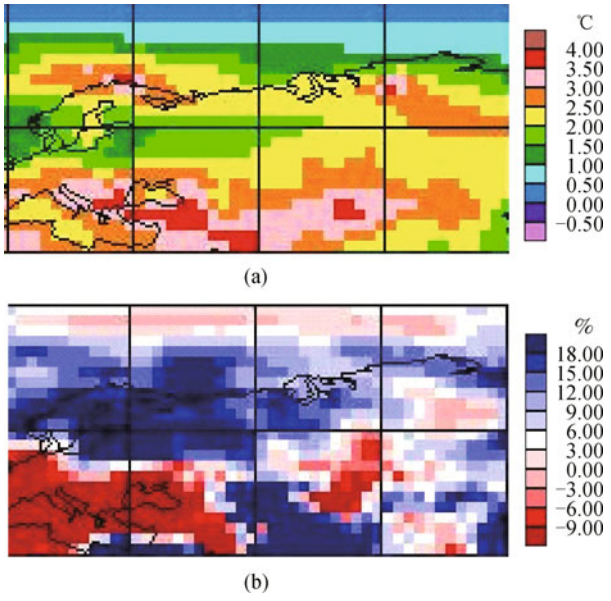

Fig. 2 A1FI scenario for the period around 2050 generated from an average of 20 AOGCMs used in the IPCC AR4 (a) summer temperature (°C) and (b) summer precipitation (%)

Analysis (IIASA) and FAO agro-ecological zoning (AEZ) combined with the IIASA Basic Link Combination (BSL) economic models (Fischer et al., 2002; 2005; Parry et al., 2004; Schmidhuber and Tubiello, 2007). The scenarios based on the IIASA AEZ-BSL approach indicate that Russia, Ukraine, and Kazakhstan might be among the greatest beneficiaries of expansion of suitable croplands due to increasing winter temperatures, a longer frost-free season, CO_2 fertilization effect, projected increases in water-use efficiency by agricultural crops, and possible, though uncertain, increases in winter precipitation projected by some AOGCMs. The IIASA BSL models driven by the HadCM3-A1FI scenario suggest that, due to regional climate changes by 2080, the total area with agro-ecological constraints could decrease, and the potential for rain-fed cultivation of major food crops could increase in Russia and Central Asia due to changing regional climate (primarily due to temperature increase and the CO_2 fertilization effect on C_3 plants). A crop suitability index (Fischer et al., 2005), which is expressed in suitability units ranging from 0 (not suitable) to 75 and higher (very suitable), is projected to increase in Russia and Central Asia, based on all 12 AOGCM scenarios used in the IIASA study. A study by Mendelsohn et al. (2000) based the Global Impact Model experiments that combined AOGCM scenarios, economic data, and climate-response functions by market sector, suggested that a 2°C temperature increase could bring Russia agricultural benefits of US$124 –351 billion, due to a combination of increased winter temperatures, extension of the growing season, and CO_2 fertilization. Pegov et al. (2000) estimated that grain production in Russia can increase 1.5–2.0 times due to a northward shift of agricultural zones.

However, not all climate modeling studies, share such an optimistic view of the climate change impacts on CIS agriculture. Modeling studies by Alcamo et al. (2007) and Dronin and Kirilenko (2008) indicate that although large portions of Russia might increase their agricultural potential under warming scenarios, agriculture of the Russian and Ukrainian "breadbasket" of the semi-arid chernozem zone between the Black and the Caspian Sea would suffer a dramatic increase in frequency of droughts. These regions are the main commercial producers of wheat and any declines in productivity would be detrimental to exports.

Global and regional food security assessments based on AOGCM scenarios are extremely uncertain. They primarily focus on the absolute changes and geographic shifts of mean temperature and precipitation, but do not take into account how changes in climate variability and extreme events might be detrimental to crop production. Numerous studies have documented that extreme events are disproportionately responsible for weather-related damages, furthermore, the sensitivity of extreme events to climate change may be greater than simple linear projections of climatological distributions (Tebaldi et al., 2006). The potential changes in variability and extreme events — frosts, heat waves, droughts, and heavy rains — are likely to have a stronger impact on food production than modest temporal shifts in temperature and minor precipitation changes. The global-scale study by Tebaldi et al. (2006) based on analysis of ten indicators of temperature and precipitation-related extremes computed by nine AOGCMs used in the IPCC-AR4 suggests that agricultural production in Eastern Europe and Central Asia is likely to benefit from the decrease of frosts and increase of the length of the growing season, but will also be adversely affected by the increasing variability of precipitation and series of dry days.

Another significant shortcoming of food production scenarios driven by global or regional climate change models is that they take into account only impacts of climate change without considering socio-economic and political dimensions of human vulnerability and adaptations to climate change. Human vulnerability to climate change is a multidimensional function of exposures to weather-related hazards, sensitivities to these hazards, and the adaptive capacities of the populace of the target location (Lioubimtseva and Henebry, 2009b; Lioubimtseva, 2010).

2.4 Impacts of globalization

Global economic changes associated with the internationalization of economic activity represent another group of factors that have profound impacts on food production and consumption. Many national-scale institutional changes in the post-Soviet economies discussed above have developed as direct or indirect responses to globalization after

the newly independent states emerged from the closed and highly regulated economic spaces of the USSR and COMECON into the more open and volatile spaces of regional and global markets. Economic globalization has led to liberalization of trade and investment, formation of the regional economic agreements, implementation of structural adjustment programs, and removal of subsidies, tariffs, and price supports (Castells, 1999; Leichenko and O'Brien, 2002). A select group of larger agricultural enterprises in Russia, Ukraine, and Kazakhstan may benefit from economic globalization by focusing on production of export commodities. However, many small to medium size farms in the post-Soviet states are threatened with failure due to removal of subsidies, volatile crop prices, competition with cheaper and/or better quality imports, inability to obtain credit, limited access to international markets, and shortage of inputs such as high-quality seeds, fertilizers, herbicides, machinery, and irrigation. As Leichenko and O'Brien (2002) demonstrated in a study on agriculture in southern Africa, farmers must adapt simultaneously to change in climate and in global markets; thus, the vulnerability/resilience of food production to the change must be considered from multiple perspectives.

Globalization brought significant change to the food trade of the post-Soviet states, as per capita incomes in the 1990s fell sharply and the level of inequality increased dramatically. Accordingly, poverty grew more quickly in the transitional economies of the former USSR during the 1990s than in any other part of the world (Sedik et al., 1999). Only after 2000 have the standards of living begun to recover; however, as indicated by several assessments and data sets (FAOSTAT, 2009; WHO, 2009; World Bank, 2009), globalization has not yet led to deterioration of food security in Russia, Ukraine, and Kazakhstan, despite the deterioration of their agriculture sectors. While agricultural production, livestock inventories, and per capita incomes all have plunged and partially recovered during the past 16 years, anthropometric and dietary indicators show that food consumption in terms of calories remained steady, and indicators of food inadequacy were very moderate (Sedik et al., 1999; Dudwik and Fock, 2007). The predominant dietary problems are the same as before independence: namely, a high prevalence of overweightness and obesity, related to very high consumption levels of meat, dairy products and eggs, and low consumption of fruits and vegetables. This condition arose because average food consumption in these countries before 1991 was as high or higher than in developed countries, and far higher than in the developing world. From 1992 to 2000 agricultural production of Russia fell by 29% but per capita caloric consumption did not change (Sedik, 2004; WHO, 2009). Per capita food consumption fell moderately during the period of reforms — in Ukraine by 15% and by 11%–12% in Kazakhstan — but, as a study by Wehrheim and Wiesmann (2006), this reduction reflects a shift from overconsumption of meat rather than burgeoning malnutrition. Still the calorie reduction in the diet of post-Soviet republics is generally seen as a serious threat to the national food security by the local population, politicians, and occasionally by the national scientific community. For example, an article by Baydildina et al. (2000), based on the data from the Ministry of Agriculture of Kazakhstan, documents reductions in consumption of meat, dairy products, and sugar between 1990 and 1996, but the consumption of fruits, vegetables, potatoes, and grains during the same period remained almost unchanged. The authors interpret these data as an evidence of growing hunger and malnutrition in Kazakhstan. For example, milk and dairy product consumption at the end of 1980s was close to 1 kg per day per person in Kazakhstan and dropped by about 30% in 1997 (Baydildina et al., 2000). The authors fail to mention that protein and sugar consumption had been excessive during the Soviet period when food prices were kept extremely low.

While the rates of protein consumption in Russia, Kazakhstan, and Ukraine have been comparable to EU levels, the proportion of fruits and vegetables in the diet remains significantly lower than recommended. This problem, however, is cultural; it is a function of the traditional diets of these countries. During the Soviet years and in the 1990s consumption of fruits and vegetables was typically much lower in Kazakhstan than in Russia and Ukraine, but it was significantly below western standards in all three republics. Although there is little evidence that globalization has seriously threatened food security in Russia, Ukraine, or Kazakhstan, the popular opinion is that it is indeed threatened (Sedik et al., 1999; Sedik, 2004). This perceived threat maybe be one of the key reasons for the continuing strong opposition to agricultural reforms (Sect. 2.1).

Globalization impacts after independence have led to changes of import and export partners and geography of trade flows. While livestock inventories in the post-Soviet economies declined rapidly during the period of reforms, high levels of consumption of meat and dairy products have been maintained. Russia and Ukraine, previously importers of feed grains, have recently become the major importers of beef, poultry, and dairy products from the US and EU. Meat and dairy product imports have also grown in Kazakhstan, although meat is also a major export. Economic reforms and related land use changes in Russia, Ukraine, and Kazakhstan have also impacted food security worldwide due to the changes in their trade structure. USSR was an important exporter of grain in the 1960s but became a major importer of grain in the 1970s and 1980s due to increasing meat consumption and growing need for feed grains to support livestock. During the past few years, Russia, Ukraine, and Kazakhstan have been becoming, once again, important players in global grain markets, with geographic proximity to the buyers in the EU countries, Middle East, and Northern Africa, stable export markets

and domestic prices showing close correlation with world reference prices (Liefert et al., 2009).

As the cereal production in Russia, Ukraine, and Kazakhstan is projected to increase (Table 1, EBRD-FAO, 2008; IKAR, 2010; USDA FAS, 2010), domestic demands are likely to continue to decline. Populations of Russia and Ukraine are projected to decline and the regional per capita incomes are expected to increase with consumer diets shifting from cereals. With appropriate policies, this combination of rising prices and demand on the international market and decreasing domestic demand is likely to benefit export opportunities in Russia, Ukraine, and Kazakhstan.

Table 1 OECD-FAO Projections of the world's grain exports

Country	Projected share in the world's grain exports in 2016
USA	34%
CIS	14%
EU-27	13%
Australia	11%
Canada	9%

Note: Adapted from Lioubimtseva, 2010

3 Key uncertainties about grain production scenarios

Several agencies have developed projections of food production and export by the CIS countries (EBRD-FAO, 2008; OECD-FAO, 2008; IKAR, 2010; USDA FAS, 2010). Grain production scenarios for 2016 for Russia, Ukraine, and Kazakhstan combined range from 159 million tons to 230 million tons (Table 2). The share of these countries is expected to reach 14%–15% by 2016 and surpass the share of the EU, Canada, and Australia (OECD-FAO, 2008). These projections, however, are highly uncertain, based only on the market analysis, and do not take into account effects of economic reforms, climate change, or CO_2 fertilization.

The "estimated maximum potential" scenario developed by EBRD-FAO (2008) is based on assumptions that 1) grain yields in Kazakhstan would be comparable to those in Australia; 2) yields in Russia will be similar to the current yields in Canada; and 3) yields in Ukraine will approach yields in France. These analogies are based on similarities in mean annual temperature and precipitation; however, they fail to take into account either agro-ecological and socio-economic differences between the "analogous" countries or climate change projections. The ERBD-FAO scenario also assumes that 13 million hectares of abandoned land would be returned to production and devoted to grain, and no change in crop distribution was assumed for already cultivated land (EBRD-FAO, 2008). As a result, the grain export potential is also likely to increase: wheat export projections for 2016/2017 vary in the assessments by different agencies between 11 and 17 million tons of wheat for Russia (OECD-FAO, 2008; USDA, 2009; World Bank, 2009), and between 6 and 10 million tons for Ukraine (OECD-FAO, 2008). Export of Kazakhstan and other Central Asian states of the former USSR is projected to approach 4–7 million tons of wheat (OECD-FAO, 2008). Export of coarse grains is also expected to reach about 1–2 million tons in Russia and 6–9 million in Ukraine (World Bank, 2009; USDA FAS, 2010). The OECD-FAO projected that wheat and coarse grain exports from Russia, Ukraine, and Kazakhstan would reach 35 million tons by 2016 (a 14% increase from 2007) (EBRD-FAO, 2008).

Table 2 Grain production scenarios

Countries	Grain production, million metric tons				
	1992–1994	2004–2006	Scenarios for 2016–2017		
			OECD-FAO	IKAR	EBRD maximum potential scenario
Russia	93	77	n/a	98	126
Ukraine	37	37	n/a	44	75
Kazakhstan	23	14	n/a	22	29
Total	152	128	159	164	230

Note: Adapted from Lioubimtseva, 2010

3.1 Policy assumptions

Food production projections assume no drastic institutional changes and continuation of current agricultural policies. However, the CIS countries are still in the process of restructuring their economies and there are many uncertainties surrounding their future agricultural policies. Underdeveloped land markets remain one of the major unresolved issues. For now, only Russia allows the sale of arable lands and their use as collateral. Although farmland sales have been allowed since 2006, the land market is heavily regulated by the government. Two other critical variables to increasing grain production and export are the development of credit institutions and the modernization of infrastructure (Sedik, 2004; Lissitsa and Odening, 2005; EBRD-FAO, 2008). Renewing existing agricultural machinery and purchasing the new equipment would require large investments, but the existing credit system and leasing arrangements limit the flow of capital for investments. According to IKAR, the total investment required for modernization of grain handling systems in Russia, Ukraine, and Kazakhstan would amount to approximately US$ 4.5 billion (EBRD-FAO 2008; IKAR 2010). Modernization of transportation networks and port infrastructure in Russia and Ukraine necessary for increasing export capacity would require substantially larger investments.

Changes in the trade policies incorporated in the global

and regional food production scenarios are difficult to project. Such policies may include price controls, quotas, tariffs, subsidies, and interventions using state reserves. In the face of rising international food prices, Russia, Ukraine, and Kazakhstan have already imposed some export restrictions to protect their domestic consumers. The Russian government made several agreements in 2007–2009 with retailers to freeze prices on some basic foodstuffs (IKAR, 2010). Ukraine has been using export quotas on wheat, barley, and maize to ensure sufficient supply for the domestic market (EBRD-FAO, 2008) and Kazakhstan has introduced licensing measures to control the exports of wheat and also lowered import duties on all basic foodstuffs. While such policies may protect domestic consumers in the short-term, they can also harm agricultural producers in the longer term, particularly in the CIS countries where agricultural subsidies are relatively low. By restricting the translation of international prices into the national markets, such policies significantly reduce the profits of domestic agricultural producers and limit opportunities for rural development.

3.2 Assumptions related to land-use and climate change

Projections of grain production and exports increases are also based on assumptions of increasing trends in yields and in arable land. However, it is unlikely that all 23 million hectares removed from production during the period of economic reforms would return to cultivation even under the most optimistic scenarios, because a considerable portion of this area was marginally productive.

The grain productivity projections also do not taken into account possible changes in the land suitability due to impact of climate change, such as CO_2 fertilization, changes in the growing season, temperature, precipitation, frequency of droughts and frosts, etc. Although several modeling studies have shown that a warmer climate would be beneficial in general for agriculture in Russia and other CIS countries (Pegov et al., 2000; Fischer et al., 2002; 2005; Parry et al., 2004), geographic distribution of benefits is unlikely to be uniform. Numerous CO_2 enrichment studies in greenhouses, growth chambers, and open-top chambers have suggested that growth of many crops could increase in the short-term about 30% on average with a doubling of the atmospheric CO_2 concentration. However, the results of Free Air CO_2 Enrichment (FACE) experiments suggest that CO_2 fertilization effects may be seriously overestimated by ecological models (Long et al., 2006). When the CO_2 fertilization is not taken into account, the warmer climate benefits for the CIS agriculture are modest at best and production gains due to theoretically possible expansion of arable lands might be lower than the losses caused by increasing aridity.

Although the agricultural productivity of non-chernozem zones is expected to increase (particularly in Siberia), it may be unrealistic to expect swift adaptation of the population to new agro-ecological conditions. Any projection of agricultural expansion based on climate change scenarios should be viewed with caution, if they do not take into account regional socio-economic factors (Lioubimtseva, 2010). Expansion of climatic zones suitable for agriculture does not necessarily imply that the local population currently employed in other sectors would seek out new opportunities in agriculture. On the other hand, declining productivity due to increasing aridity may result in the loss of human capital as skilled farmers may be forced to switch to other livelihoods. Assessment of human vulnerability and adaptations to climate change needs to become a key component of agricultural policies. Adaptations, such as introduction of drought resistant crop varieties and introduction of irrigation into rainfed croplands, may alleviate some consequences of increasing aridity and variability of climate.

3.3 Non-climatic global factors of uncertainty

Climate change and variability affect food production across the planet. Increasing variability in local and regional climates is likely to increase volatility in the food supply. Other global factors, including the rapidly expanding demand for biofuels, volatility of oil prices, increasing demand for agricultural products in the emerging economies, and changing diets in developing countries, are likely to continue increasing demand for agricultural production. Grain producers in Russia, Ukraine, and Kazakhstan are likely to benefit from this window of opportunity in the global market, only if national policies and international investments support the current trend of increasing productivity and assist in bringing back into production some of the arable lands idled during the transitional decade of the 1990s.

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