Global Food Security and Grain Production Trends in Central Eurasia: Do Models Predict a New Window of Opportunity?

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Abstract:

The current global food crisis clearly indicates that the world's food balance and livelihoods are highly vulnerable to the existing economic instability and climate change. Climate and agro-ecological models project that the grain production in the countries of the former USSR, such as Russia, Ukraine, and Kazakhstan might increase due to a combination of winter temperature increase, extension of the growing season, and elevated levels of carbon dioxide (CO_2). However, these scenarios are based entirely on the biophysical parameters, are highly uncertain, and do not take into account institutional, social, cultural, and economic factors that affect agricultural production.

Grain production in the former USSR region sharply declined during the past two decades and has only recently started to recover. In the context of the current economic crisis, Russia, Ukraine and Kazakhstan might be presented with a new window of opportunities to reemerge on the global agricultural market if they succeed to increase their productivity, regardless of the validity of climate change scenarios. Recovery of agriculture will depend on many internal and external factors, such as agricultural policies, economy-wide changes, and global economic trends.

This paper examines the recent trends in land-use and grain production in the countries of the former USSR in the context of the AOGCMs (Atmosphere-Ocean General Circulation Models) scenarios,

political, and socio-cultural, and economic trends. The future direction of these trends might have a significant impact on the global and regional food security during the following decades.

Keywords: food security, global climate change, transitional economies, grain production

1. INTRODUCTION

Several food security studies suggest that temperate regions of Central Eurasia might benefit from the expansion of suitable croplands due to warmer winter temperatures, a lengthening growing season, CO_2 fertilization effect, projected increases in the water-use efficiency of agricultural crops, and possible, though uncertain, increases in winter precipitation simulated by the global and regional climate models (Parry et al., 2004; Fischer et al., 2002; Fischer et al., 2005; Schmidhuber and Tubiello, 2007). These agro-ecological projections imply increasing opportunities for the three major grain producers of the former USSR − Russia, Ukraine, and Kazakhstan − on the global grain market.

In the context of the current global food crisis and economic slow down, the increase of grain production in Central Eurasia could have a positive impact on the global food market. Even without considering the climate change scenarios, Russia, Ukraine, and Kazakhstan could potentially multiply their grain output several-fold by enhancing yield management and bringing some of arable lands abandoned in the 1990s back into production (IKAR, 2009; EBRD-FAO, 2008).

The projections of agro-ecological and climate models, however, are based entirely on the biophysical parameters and fail to take into account institutional, social, cultural, and economic factors , such as agricultural policies, economy-wide changes, cultural attitudes, and global economic trends. The purpose of this paper is to examine the current trends of wheat production in Russia, Ukraine, and Kazakhstan and evaluate some of the agro-ecological projections driven by climate change scenarios in the context of non-climatic factors, such as institutional transformation, culture, economic transition, and the recent changes in the global market.

2. GRAIN PRODUCTION DECLINE IN THE FORMER SOVIET UNION (FSU)

Russia, Ukraine and Kazakhstan used to be the key grain producers in the USSR. During the last decades of its existence, the USSR increased its cereal production from 119 million tons in 1961 to 155 million tons in 1991, with a maximum production of more than 170 million in 1980 (FAOSTAT, 2008). In contrast to the land expansion of the 1950s (the Virgin Land Campaign), the growth of production during the later years was entirely driven by the increasing productivity, while the area of cereal cultivation slightly contracted during the same period of time. Despite significant efforts of the Soviet government to increase the yields through the "agriculture intensification" program in the 1980s the USSR's yields were still significantly lower compared to the EU, USA, China, and Canada and slightly lower than of two other major cereal producers: Australia and Brazil (Table 1).

Although the production of cereals during the 1970s and 1980s had increased, the role of the USSR grain exports significantly declined during the same period of time due to increasing domestic consumption. The USSR wheat exports reached a peak of 8.5 million tones per year in 1971 but declined steadily during the 1980s dropping to less than 0.5 million tons in 1991 (see Figure 1). Increasing cereal production could not keep up with increasing consumption (both for human consumption and livestock feed) and the wheat imports grew up from 0.4 million tons in 1969 to 20 million tons in 1991 (FAOSTAT, 2008).

Since the collapse of the USSR in 1991, the agricultural systems of this vast region have undergone enormous land-use changes accompanied by the exclusion of approximately 23 million hectares of arable lands from production, 90 percent of which had been used for grain (FAOSTAT, 2008). This was the largest withdrawal of 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 by the end of the 1990s (Zhang, 1996; Meng et

al., 2000; Muratova and Terekhov, 2004; Spivak et al., 2005; de Beurs and Henebry, 2004; Uzun, 2005; Bokusheva and Hockmann, 2006**)**.

The total grain production in its former member-states fell from 195 million tons in 1990 to 134 million tons in 1995, representing an average annual decline of more than 6%. While world average grain yields have risen since 1991 by approximately 1.5 percent per year with annual gains ranging from 0.6 percent in Western Europe to 3.7 percent in Brazil, the FSU region experienced a decrease in grain yields. Average yields in Ukraine and Kazakhstan are still below the 1991 level, while Russia was able to regain the 1991 level by 2002 (FAOSTAT, 2008). The decline in production that affected all FSU countries was due to the significant reduction of area planted and the loss of agricultural subsidies, such as fertilizers and pesticides. The use of arable lands in Russia, Ukraine, and Kazakhstan together dropped from 200 million hectares in 1991 to 177 million in 2003 (FAOSTAT, 2008), which constituted a withdrawal of 23 million hectares or 12% of the arable lands in 1991. Ukraine's economy has been dominated by grain production for many decades and almost 70% of the area was devoted to agriculture, and output of the most important agricultural products fell by 45% by 2001 (Lissitsa and Odening, 2005). Between 1988-90 and 1998-2001, grain production fell by 46% in Ukraine and by 35% in Kazakhstan (Osborne and Trueblood, 2002; Meng et al., 2000), and total grain area in Kazakhstan was contracting at the rate of nearly 2 million hectares per year (!) during this period. Fields that consistently failed to meet the threshold established by the government (typically 0.6 to 0.7 tons per hectare against a national average of about 0.9 tons per hectare), were taken out of grain production and converted to permanent pasture. However, precipitous declines in livestock significantly reduced grazing pressure, leading to further abandonment of these lands. For example, in Kazakhstan 33.9 million sheep were in stock 1992, but by 1999 that number had dropped 75% to 8.6 million (FAOSTAT, 2008). In addition, shrinking livestock inventories in all three countries caused the demand for feed-grain to plummet, which led to a 76% drop in barley area in 6 short years (USDA, 2008). The economy-wide decline and collapse of the agriculture sector also resulted in the drastic changes in the trade structure. Before 1991 Russia was consuming most

of the wheat imported by the USSR for food and especially for livestock feed; following the drops in demand and in purchasing power, its wheat imports fell from 18.9 million tons in 1992 to only 0.3 million tons in 2002, a decrease of over 98% (FAOSTAT, 2008).

The freefall in the agricultural production of Russia, Ukraine, and Kazakhstan slowed down by 2000 and signs of recovery have been observed in all three countries since 2002, that clearly coincides with economy-wide recovery (Figure 1). With an exception of the 2003 wheat crop failure in Ukraine and southern Russia because of unusually severe winter, and in Kazakhstan in 2004 due to severe drought, cereal production has rebounded in all three countries in recent years but remains below the 1991 levels. Russia has recorded several outstanding harvests since 2000 and grain yields arguably are showing signs of improvement. Although weather remains the single most important determinant for grain yield, improvements in crop management practices fueled by the growing state subsidies have contributed to the recent increase and stabilization of wheat and barley yields.

Another noteworthy recent trend in the FSU agricultural land use has been a significant increase of the production of oilseeds (sunflower seed, rapeseed, soybean, safflower, and cotton seed), mainly at the expense of cereals and forage (FAO-EBRD, 2008; FAOSTAT, 2008). For example, sunflower seed production increased from 2.7 to 6.8 million tons in Russia and from 2.3 to 5.3 million tons in Ukraine between 2001 and 2006 (FAOSTAT, 2008). This shift is a clear response to the global market signals and is linked to the higher profitability of oilseed crops. It is likely that this trend will continue into the future and it may negatively impact the potential for grain production.

3. CLIMATE CHANGE AND AGRO-ECOLOGICAL SCENARIOS

Climate change projections indicate both increasing opportunities and risks for the grain producing countries of the former USSR. Temperatures are projected to increase by 1.5-3.5º C by the period 2030-2050, with the greatest increase in winter; precipitation is projected to increase in European part of Russia, Siberia, and parts of Kazakhstan (IPCC, 2007). Climate change is also projected to increase the length of the growing season and increase the areas suitable for agriculture, particularly in this region.

Mendelsohn et al. (2000) constructed the Global Impact Model (GIM) that combined Atmosphere-Ocean General Circulation Model (AOGCM) scenarios, economic data, and climate-response functions by market sector and modeled responses of agricultural sector to climate change scenarios. Based on the GIM simulations, a 2^{o}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.

Several food security studies employed the AOGCMs driven by the IPCC SRES (Inter-Governmental Panel on Climate Change Special Report on Emission Scenarios) socio-economic scenarios (Nakicenovic et al., 2000), combined with agro-ecological zoning system (AEZ) developed by the Food and Agriculture Organization, and the Basic Link Combination economic models (BSLs) developed by the International Institute for Applied System Analysis (Parry et al., 2004; Fischer et al., 2002; Fischer et al., 2005; Schmidhuber and Tubiello, 2007). Agro-ecological scenarios based on the AEZ-BSL approach are fairly consistent with the earlier GIM scenarios, indicating that Russia, Ukraine, and Kazakhstan might be among the larger beneficiaries of expansion of suitable croplands due to increasing winter temperatures, longer growing seasons, CO_2 fertilization effect, and projected increases in the water-use efficiency by agricultural crops, and possibly, though uncertain, increases in winter precipitation projected by some climate models. The Basic Linked System models driven by the HadCM3-A1FI scenario[1] suggest that due to the 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 the adjacent Central Asian region due to changing regional climate (primarily due to temperature increase and the CO_2 fertilization effect on C_3 plants). A crop suitability index, 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 (Fischer et al., 2005). However, the magnitude of any increase is highly uncertain ranging from 9% in the CCC-A2 scenario to 60% in the HadCM3-A1FI (Parry et al. 2004; Fischer et al., 2005). The recent modeling study by Dronin and Kirilenko (2008) also suggests that large portions of

Russia would increase their agricultural potential under warming scenarios, particularly in Siberia. These authors, however, also project significant declines of the grain production in the traditional "breadbasket" semi-arid chernozem zone of European Russia between the Black and the Caspian Seas, arising from the increasing frequency of droughts and higher summer temperatures.

Global and regional food security assessments based on AOGCM scenarios are extremely uncertain. Despite significant differences in the ranges of change among the scenarios, the majority of the recent AOGCM experiments tend to agree that precipitation is likely to increase in European Russia and Siberia. However, many models also project the increasingly dry conditions in the semi-arid grain-growing belt of southern Russia and northern Kazakhstan. These areas with high concentrations of arable lands are projected to experience a slight increase in winter rainfall, but decreases particularly in spring and summer. Food production scenarios driven by global or regional climate take into account only biophysical changes, without considering social, cultural, economic, and political factors.

4. IMPACT OF NON-CLIMATIC FACTORS ON FUTURE GRAIN PRODUCTION

The agricultural sector is very sensitive not only to climate and agro-ecological changes, but also to many non-environmental factors, such global market variations, country-scale political and economic changes, local policies, culture, and other factors. Internal factors, such as institutional changes (agricultural reforms, management practices, policies, subsidies, legislation, etc.), and the subsequent regional land-use changes can be intimately interconnected with external or global factors, such as the changes on the international markets.

4.1 Agricultural reforms

Many studies have correctly attributed the decline of the FSU agriculture in the 1990s to its rapid institutional transformation (Baydildildina et al., 2000; Meng et al., 2000; Osborne and Trueblood, 2005; Lissitsa and Odening, 2005; de Beurs and Henebry, 2004; Lioubimtseva and Henebry, 2008). Factors, such as the removal of input subsidies, absence of the land market, counterproductive taxation, and the

lack of stakeholders' support, can be named among the key causes that led to widespread declines in the agricultural sectors across the countries of the former Soviet Union. At the beginning of the 1990s, there was a general expectation that trade liberalization would lead to removal of price subsidies and expose the FSU agriculture to the global competition and, as a consequence, some contraction of agricultural production during the initial years of reforms. It was, however, also expected that this initial contraction of the agricultural sector would be soon offset by an increase in productivity as soon as the management system adjusted to the new, market-oriented price signals. In a long run, agriculture was expected to recover in a few years, leading to an increase in productivity and exports (Osborne and Trueblood, 2005). The actual result of the reforms was a much larger than expected drop in production once agricultural subsidies were eliminated during the early stages of economic transformation, though no corresponding rise in productivity occurred. The implementation of reforms and adjustments to a market economy took much longer than it was expected by the FSU and western experts (Lerman et al., 2004).

Until the end of 1990s the land reforms in Russia, Ukraine and Kazakhstan had been mostly limited to transforming state ownership into collective ownership and had little impact on the size and internal structure of large farms. During the Soviet era, agriculture had been supported by budget subsidies and favorable relative prices, and the benefits from fuel and transportation subsidies were not specific to only 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, then falling to roughly zero in the following few years (OECD-FAO, 2008). Although agricultural subsidies have increased in the FSU countries in the recent years and are now comparable with the US level of producer support, they are significantly lower than in Europe or Japan. According to the 2008 FAO statistics, the level of overall support given to agricultural producers as a share of their total farm receipts amounted to 15 percent and 12 percent

respectively in Russia and Ukraine, compared to 33 percent in the EU, 55 percent in Japan and 16 percent in the USA (FAOSTAT, 2008).

Russia has recently declared agriculture a national priority area and increased federal support for agricultural development this past year from US$ 2.6 billion to US$ 5.2 billion (EBRD-FAO, 2008). The same shift ocurred in Kazakhstan, and to a lesser extent in Ukraine. Among the three countries, Ukraine had most drastically reduced its agricultural subsidies during the years of transition. Although the governmental financing to the agricultural sector has been expanding in the recent years up to US$ 1.4 billion in 2008, the amount of agricultural subsidies in Ukraine is the lowest among the three FSU grain producers.

4.2 Farm transformation

The reforms hoped to spur agricultural development within the private small and medium-size business sector. In reality, however, the land privatization was quickly followed by an emergence of super-large agricultural companies, such as agrofirms and agroholdings, who employ thousands of impoverished farmers and are typically owned by non-agricultural investors ranging from oil and gas companies to private equity firms (Rylko and Jolly, 2005; Uzun, 2005). Agroholdings control the most favorable lands and absorb a large share of agricultural subsidies. For example, in Russia in 2004 1.4% of the largest corporate farms received 22.5% of all agricultural subsidies, while 15% medium and small size farms did not receive any subsidies at all (Uzun, 2005). Small non-commercial farms are not entitled to any financial support, despite their very high productivity. According to the Russian Institute for Agricultural Market Studies (IKAR), Russia's 350 agroholding farms own about 8 million hectares, including those controlled by companies such as Gasprom and at least 12 major holding companies occupy 150,000 hectares or greater. Based on various estimations, large corporate farms averaging more than 6000 hectares control today between 80 and 90 percent of Russia's arable land (Uzun, 2005; IKAR, 2009; EBRD-FAO, 2008). In Kazakhstan, agroholdings currently control about 80% of total grain output, while in Ukraine they specialize in grain and oilseed processing and broile meat production (EBRD-FAO,

2008). According to EBRD and FAO projections, the expansion of agroholdings and large corporate farms is likely to continue in future, at the expense of former independent collective farms and family farms. This might represent an opportunity for considerable production increases, due to increasing specialization and management efficiency, but is also likely to cause social, environmental, and political tensions, due to the disconnects between the interests of the local rural communities and large companies owning corporate farms.

4.3 Land market

The lack of fully developed land market is continuing to have a negative impact on the agriculture of many FSU countries. The question of sales of agricultural land has been the subject of heated debate in all three countries and land market reforms took much longer than other economic reforms. In Russia the land code finally passed in 2002 after several unsuccessful attempts to legalize land transactions and the use of land as collateral. The sale of agricultural land, however, was not allowed until 2006. Current Land Code of Russia allows private land ownership and treats foreign individuals and legal entities equally 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, i.e., mollisols, is ten times cheaper than a similar plot in Iowa or Kansas). It also fuels the growth of agroholding firms and is likely to attract foreign investors, if the bureaucracy of land acquisition can be simplified.

The directions of institutional changes during the first decade of reforms were occasionally inconsistent in the areas of 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 rights of citizens and legal entities was cancelled and the duration of long-

term land-use rights was reduced from 99 to 49 years (Almaganbetov, 2004). 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 (Almaganbetov, 2004).

Among the three FSU 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 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).

4.4 The role of stakeholders

Perhaps one of the more serious problems associated with the 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 to the land reform and rather negative public perception of land ownership and the land market (Koester and Brummer, 2006; Koester and Striewe, 1998; Uzun, 2005). 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 FSU 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 the poor economic situation and increasing food prices on the failure of the central government (Lissitsa and Odening, 2005; Uzun, 2005; Koester and Brummer, 2006). There is a generally negative

attitude of the population to the removal of agricultural subsidies and the institution of the land market. These attitudes of stakeholders might be the key factor explaining why the three countries was quite slow and inconsistent in implementation of their new land codes, and reverted some agricultural policies that are not in line with market orientation.

4.5 Impacts of globalization

Many national-scale institutional changes in the post-Soviet economies have developed as direct or indirect responses to globalization after the newly independent states emerged from the closed and highly regulated economic space of the USSR and COMECON into the more open and volatile space of 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, 1998; 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 the production of export commodities. However, many small to medium size farms in the post-Soviet states are threatened by 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.

Globalization brought significant changes in 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, 2004). Only after 2000 have the standards of living begun to recover. However, as indicated by several assessments and datasets (FAOSTAT, 2008; WHO, 2009; World Bank, 2009), globalization has not 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 sixteen years, anthropometric and

dietary indicators show that food consumption in terms of calories remained steady, and indicators of diet inadequacy were very moderate (Sedik, 2004; Dudwick and Fock, 2007). The predominant dietary problems are similar to ones before independence: namely, a high prevalence of overweight 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 developing countries (WHO, 2009). From 1992 to 2000 Russia's agricultural production 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, one study suggests that this reduction reflects a shift from overconsumption of meat rather than burgeoning malnutrition (Wehrheim and Wiesmann 2006). 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 sometimes 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 the 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 prior to 1991,when food prices were kept extremely low.

While the rate of protein consumption in Russia, Kazakhstan, and Ukraine have been comparable to the European Union-15 levels, the proportion of fruits and vegetables in the diet remains significantly lower than recommended. However, this is a cultural problem, 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 in all three republics it was significantly below western standards. During the past few years, the consumption of fruits and vegetables has significantly grown compared to the Soviet period; in 2000 it reached the same level in all three countries for the first time. 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., 2002; Sedik, 2004). This perceived threat might be one of the key reasons for the continuing opposition to agricultural reforms.

Globalization impacts after independence have led to changes of import and export partners and the 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 United States and European Union. 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 the Russia, Ukraine, and Kazakhstan have also impacted food security worldwide due to the changes in their trade structure. The USSR was an important exporter of grain in the 1960s but became a major importer of grain in the 1970 and 1980s due to increasing meat consumption and a growing need for feed grains to support livestock. During the past few years Russia, Ukraine and Kazakhstan are becoming once again important players in global grain markets, due to 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. Depending on the factors affecting world grain demand, various agencies forecast grain exports from the FSU region to increase to 30-40 million tons by 2016 (EBRD-FAO, 2008; IKAR, 2009; USDA, 2008). This would increase the market share of these countries from 12% in 2004-05 to 14-15% in 2016 and would surpass the share of the EU, Canada, and Australia (Table 2). These projections are based only on the market

analysis and do not take into account possible changes caused by climate change or effects of CO_2 concentration increase on crops.

Since the cereal production in Russia, Ukraine, and Kazakhstan is projected to increase, domestic demands are likely to continue to decline. The 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 to more meats and dairy. With appropriate policies these combinations of the rising prices and demand on the international market and decreasing domestic demand is likely to benefit export opportunities in Russia, Ukraine, and Kazakhstan.

The scenarios of food production and export by the CIS countries are generally optimistic (OECD-FAO, 2008; IKAR, 2009; EBRD-FAO, 2008, IFPRI, 2008; USDA, 2008). The 2016 grain production projections for Russia, Ukraine and Kazakhstan together vary from 159 million tons projected by OECD-FAO to 164 million projected by the Russian Institute for Market Studies (IKAR). The estimated maximum potential scenario developed by EBRD brings this number to 230 million tons of grain (Table 3).

The "estimated maximum potential" scenario recently presented by the EBRD (EBRD-FAO, 2008), that projects up to 230 million tons production of wheat and coarse grains by 2016 is based on several assumptions: grain yields in Kazakhstan would be comparable with the current yields in Australia, yields in Russia will be similar to the current yields in Canada, and yields in Ukraine will approach yields found in France. These analogies are based on similarities of mean annual temperature and precipitation. However, they do not take into account agro-ecological and climatic differences between the "analogous" countries and differences in the climate change projections. The maximum potential 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 were assumed for already cultivated land (EBRD-FAO, 2008).

As a result, the grain export potential is also likely to increase in the future: wheat export projections for 2016/2017 vary in the assessments by different agencies between 11 and 17 million tons of wheat for Russia (FAO-OECD, 2008; USDA, 2008), and between 6 and 10 million tons for Ukraine (FAO-OECD, 2008; IFPRI, 2009). Wheat export of Kazakhstan and other Central Asian states of the FSU is projected to approach 4-7 million tons (OECD-FAO, 2008; USDA, 2008). Export of coarse grains is also expected to reach about 1-2 million tons in Russia and 6-9 million tons in Ukraine (USDA, 2008, IFPRI, 2009). The OECD-FAO projected that wheat and coarse grain exports of Russia, Ukraine and Kazakhstan together will reach 35 million tons by 2016, what would be a 14% increase from 2007 (EBRD, 2008; IFPRI, 2009). The ability of the FSU grain producers to realize their full potential will depend on four groups of factors discussed in the previous section: success of the recent institutional changes, land-use trends, climate change and variability, and the economic status on the global market.

CONCLUSIONS

Agro-ecological models driven by climate change and greenhouse gases emission scenarios suggest that the grain production in the countries of the former Soviet Union, particularly Russia, Ukraine and Kazakhstan is likely to increase due to a combination of winter temperature increase, extension of the growing season, and CO_2 fertilization effect on agricultural crops. However, these projections are highly uncertain and do not take into account institutional, social, cultural, and economic factors that affect agricultural productivity. Projections based on biophysical modeling should be considered with caution as they do not to take into account how human adaptations to climate change will likely take several generations - much longer than the agro-ecological responses to climate change. Although the agricultural productivity is expected to increase in many parts of the FSU (particularly in Siberia), it may be unrealistic to expect swift human adaptations to the 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. 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.

During the 1990s and early 2000s, the agricultural systems of this vast region underwent enormous land-use changes accompanied by massive withdrawals of arable land, contraction of livestock inventories, and catastrophic decline of grain production. The decline of agriculture in the FSU countries had little to do with climate change but was a direct result of ineffective agricultural and economy-wide reforms, lack of competition, loss of agricultural subsidies, non-existent land market, poor infrastructure, and a lack of support by the stakeholders.

As agricultural production in several FSU countries has stabilized in the recent years, several national and international organizations including the Food and Agriculture Organization, the Organization for Economic Cooperation and Development, Russian Institute for Agricultural Market Studies, and the European Bank for Reconstruction and Development, have developed very optimistic scenarios for this region. It has been projected by several international agencies that within the next 7-8 years the FSU region would become the second major grain exporter after the United States and also surpass the European Union. The most optimistic scenarios (such as EBRD-FAO, 2008) are based on climatic analogies but do not take into account climate change scenarios, since they compare the Ukraine, Russia, and Kazakhstan to grain-growing areas with similar climatic conditions in France, Canada, and Australia. Scenarios based on the present-day climatic analogies are also very uncertain, as they do not take into consideration cultural differences, the role of stakeholders, the continuous changes in the land code of the CIS region, slow land market development, national financial systems, local infrastructure, and price fluctuations of the international market.

The current economic crisis and growing grain prices might present Russia, Ukraine and Kazakhstan with a new opportunity to increase agricultural productivity, reclaim at least part of the arable lands abandoned in the 1990s, and reemerge on the global agricultural market. However, to realize

their full potential as the major grain producers, the FSU countries still have to overcome many challenges. Underdeveloped land markets remain one of the major unresolved issues. As for now, only Russia allows the sale of arable lands and their use as collateral. In Ukraine, the moratorium on farmland sale has been extended once again in 2008, while in Kazakhstan there is no clear policy on any future agricultural land market. Even in Russia, where farmland sales have been allowed since 2006, land market is heavily regulated by the government. Another uncertainty concerns the dynamics of larger agroholding firms and smaller producers and possible tensions arising between them. The governmental policies currently clearly favor large agricultural companies, particularly in Russia and Kazakhstan. Two other critical variables to increasing grain production and export are the development of credit institutions and the modernization of infrastructure. Renewing existing agricultural machinery and purchasing new equipment would require very significant investments, but the existing credit system and the current financial crisis in the FSU nations and world-wide are likely to limit the flow of capital available for investments.

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References:

Almaganbetov N., 2005. The impact of land reforms on economic development of Kazakhstan. The Center for Policy Studies, Central European University/ Open Society Institute, Budapest, 41 p.

Baydildina, A. A. Akshinbay, M. Bayetova, L. Mkrytichyan, A. Haliepesova, and D. Ataev, 2000. Agricultural policy reforms and food security in Kazakhstan and Turkmenistan. Food Policy 25 (6): 733-747 .

Bokusheva R. and H. Hockmann, 2006. Production risk and technical inefficiency in Russian agriculture, European Review of Agricultural Economics 33(1):93-118; doi:10.1093/erae/jbi036
Castells, M., 1999. End of Millenium, Malden, MA, Blackwell. 512 p.

de Beurs, K.M., and G.M. Henebry, 2004. Land surface phenology, climatic variation, and institutional change: Analyzing agricultural land cover change in Kazakhstan. Remote Sensing of Environment, 89:497-509.

Dronin, N. and A. Kirilenko, 2008. Climate change and food stress in Russia: what if the market transforms as it did during the past century. Climate Change 86 (1-2): 123-150.

Dudwik N. and K. Fock, 2007. Land reform and farm restructuring in transition countries: the experience of Bulgaria, Moldova, Azerbaijan, and Kazakhstan. World Bank Publications, Washington DC, 87 p.

EBRD-FAO, 2008. Grain production and export potential in CIS countries. Fighting food inflation through sustainable investment. European Bank for Reconstruction and Development/ Food and Agriculture Organization, London, 8 p.

FAOSTAT, 2008. Food and Agriculture Organization Statistics, http://www.fao.faostat.org last access December 2009.

Fisher G., M. Shah and H. van Velthuizen, 2002. Climate Change and Agricultural Vulnerability. International Institute for Applied Systems Analysis, Vienna, 152 p.

Fischer G.M., M. Shah, F.N. Tubiello, and H. Van Velhuizen, 2005. Socio-economic and climate change impact on agriculture: an integrated assessment, 1990-2080. Philosophical Transactions of Royal Society B 360, 2067-2083.

IKAR, 2008. Institute for Agricultural Market Studies. http://www.ikar.ru/eng/ last access April 2009.

IFPRI, 2009. International Food Policy Research Institute Dataset. http://www.ifpri.org
Last access April 2009.

IPCC, 2007. Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the IPCC [B.Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, UK and New York, NY, USA.

Koester, U. and B. Brümmer, 2006. Institutional changes for agricultural and rural development in the CEEC and CIS region. Electronic Journal for Agricultural and Development Economics 2(2):144-179.

Koester U. and L. Striewe, 1998. Huge potential, huge losses – The search for ways out of the dilemma of Ukrainian agriculture. In: Siedenberg, A., Hoffmann, L. (eds.) Ukraine at the Crossroads: Economic Reforms in International Perspective. Physica-Verlag, Heidelberg/New York, pp.259-270.

Leichenko R.M.and K.L.O'Brien, 2002. The dynamics of rural vulnerability to global change: the case of southern Africa. Mitigation and Adaptation Strategies for Global Climate Change 7:1-18.

Lerman, Z., Csaki, C., Feder G. 2004. Agriculture in Transition: Land Policies and Evolving Farm Structures in Post-Soviet Countries. Lexington Books: Lanham, MD, 254 p.

Lerman, Z., D. Sedik, N. Pugachev, and A. Goncharuk, 2007. Rethinking agricultural reform in Ukraine. Leibniz Institute of Agricultural Development in Central and Eastern Europe, IAMO, Vol.38, 178 p.

Lioubimtseva, E. and G.M. Henebry. 2008. Potential impact of climate change on the grain productivity in Central Eurasia: human vulnerability and adaptations. Proceedings of the International Conference on Global Changes, Sofia, Bulgaria, Sofia University Kliment Ordinski.

Lissitsa, A. and M. Odening, 2005. Efficiency and total factor productivity in Ukrainian agriculture in transition, Agricultural Economics 32 (3) 311 – 325.

Mendelsohn, R., Morison, W. Schlesinger, M.E., Andronova, N.G., 2000. Country-specific market impact of climate change. Climatic Change 45 (3-4) 553-569.

Meng E., J. Longmire, and A. Moldashev, 2000. Kazakhstan's wheat system: priorities, constraints, and future prospects, Food Policy 25 (6): 701-717.

Muratova, N. and A.Terekhov, 2005. Estimation of spring crops sowing calendar dates using MODIS in Northern Kazakhstan. IEEE, 4019-4020.

Nakicenovic N., J. Alcamo, G. Davis, B. de Vries, J. Fenhann, S. Gaffin, K. Gregory, A. Grübler, T. Y. Jung, T. Kram, E. L. La Rovere, L. Michaelis, S. Mori, T.Morita, W. Pepper, H. Pitcher, L. Price, K. Riahi, A. Roehrl, H.-H.Rogner, A. Sankovski, M.Schlesinger, P. Shukla, S. Smith, R. Swart, S. van Rooijen, N. Victor, Z. Dadi , 2000. IPCC Special Report on Emissions Scenarios, IPCC Special Reports, Cambridge University press, Cambridge, 599 p.

OECD-FAO, 2008. OECD-FAO Agricultural Outlook*:* 2008-2017, OECD Publishing, Paris, 230 p.

Osborne S. and M.A. Trueblood, 2002**.** Agricultural productivity and efficiency in Russia and Ukraine: building on a decade of reform. Market and Trade Economics Division, Economics Research Services, USDA, Agricultural Economics Report No.813.

Parry M.L., C. Rosenzweig, A. Iglesias, V.Livermore, and G.Fischer, 2004. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. Global Environmental Change 14: 53-67.

Rylko D. and R. Jolly, 2005. Russia's New Agricultural Operators: Their Emergence, Growth and Impact, Comparative Economic Studies 47, 115–126.

Schmidhuber, J. and F. Tubiello, 2007. Global food security under climate change. PNAS, 104 (50): 19703-19708

Sedik, D., Michael Trueblood, and Carlos Arnade, 2002. Corporate Farm Performance in Russia, 1991-95: An Efficiency Analysis. Journal of Comparative Economics, 27 (3): 514-533.

Spivak, L.F., O.P. Archipkin, I.S. Vitkovskaya, and G.N. Sagatdinova, (2005). Land use space monitoring in Kazakhstan. IEEE, 2395-2400.

USDA, 2007, 2008. Global Crop Production Review. USDA's Joint Agricultural Weather Facility. http://www.usda.gov/oce/weather/pubs/**,** last access December 2008.

Uzun, V., 2005. Large and small business in Russian agriculture: adaptation to market. Comparative Economic Studies 47:85-100.

Wehrheim, P. and D. Wiesmann, 2006. Food security analysis and policies for transition countries. Journal of Agricultural and Development Economics 3 (2): 112–143.

WHO, 2009. Wold Health Organization Databases, http://www.who.org last access April 2009.

World Bank, 2009. The World Bank Data. http://www.worldbank.org last access April 2009.

Zhang B. 1996. Total factor productivity of grain production in the former Soviet Union. Journal of Comparative Economics, 24: 202-209.

Footnotes:

[1] HadCM3 is a General Circulation model of Hadley Center of the United Kingdom Meteorological Organization; A1FI scenarios assume globalization, economic development priorities, and reliance of fossil fuels (Special Report on Emission Scenarios, IPCC, 2002).

[2] CCCM is a General Circulation model of Canadian Climate Change Center; A2 scenario assumes increasing environmental awareness, sustainable development priorities, and increasing fragmentation of the global economy

Table 1: The top wheat producers in 1991

	wheat yields in 1991, t/ha	Wheat production, tons
China	4.2	95,953,781
USSR	1.5	71,991,008
EU-15	5.0	55,315,486
USA	4.6	53,890,000
Canada	2.6	31,945,600
Australia	1.6	10,557,400
Brazil	1.6	2,916,823

Source: (FAOSTAT, 2008)

Table 2 OECD-FAO Projections of the world's grain exports

Country	Share in the world's grain exports in 2016 (OECD-FAO projection)
USA	34%
EU-27	13%
Australia	11%
Canada	9%
CIS	14%

Source: OECD-FAO, 2008

Table 3 Grain production scenarios

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

Compiled from OECD-FAO, 2007, IKAR, 2008; EBRD, 2008.

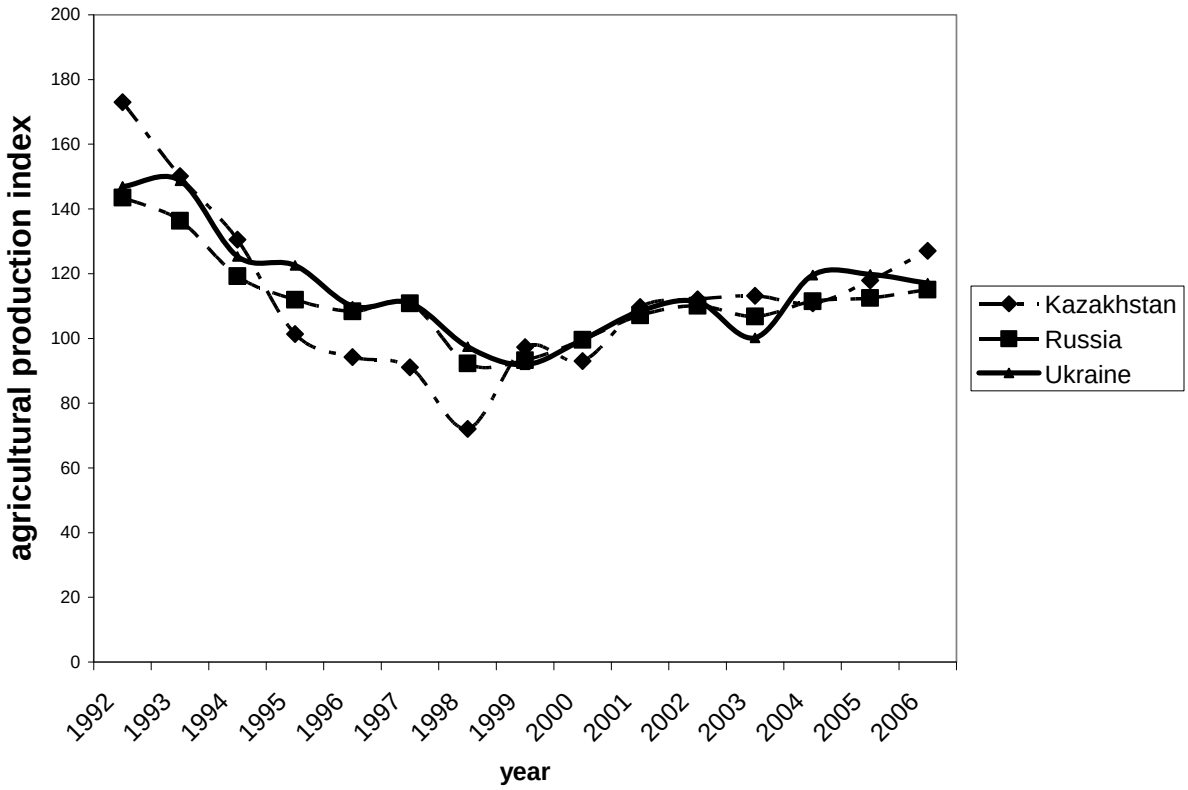

Figure 1 Agricultural production index trends in Russia, Ukraine, and Kazakhstan. Source of data: FAOSTAT, 2008

Figure 2 Author visiting a winter wheat field in Kazakhstan shortly after the harvest (photo courtesy Geoffrey M. Henebry)