Productivity growth and variability in KRU: evidence and prospects

Monika Tothova, William H. Meyers and Kateryna Goychuk[1]

Paper submitted for the Public Trade Policy Research and Analysis Symposium "Productivity and Its Impacts on Global Trade", Seville, Spain, June 2 – 4, 2013.

Contents

The surge in world agricultural and food prices in 2006-08, and again in 2011-12, have raised concerns about the ability of the world's ever-growing population to feed itself, satisfy demands for industrial use of agricultural products, and once again put emphasis on continuously growing demand facing lagging and easily disruptable supply. The price increases reduce real income of consumers and create increased hunger and malnutrition, with the world's poorest being the most vulnerable. The price surges raised the prospect that the continuous decline in real agricultural and food prices during many decades has been reversed, such that high rather than low food prices will become the new normal.

A standard prescription, originating from many international fora including the G20, has been to increase supply. Opportunities for land expansion are not yet fully exploited across the globe and additional land remains available although at varying costs, with the most land available in Brazil, DRC, Angola, Sudan, Argentina, Columbia and Bolivia (Bruinsma, 2009). However, not least owing to high prices of many crops, land use in many countries faces strong competition for allocation among crops. In addition, parts of land not cultivated are on marginal holdings with high potential for environmental degradation and possibly small production potential. As such, land expansion would raise environmental and sustainability concerns if marginal lands are brought into production.

[1] Affiliations as of May 2013: Tothova: FAO; Meyers and Goychuk: University of Missouri, Columbia, MO. This paper draws and updates material from a longer and more comprehensive study by the same authors (Meyers et all, 2012). The content of the paper only reflects views of the authors and not those of FAO or member countries.

Also, land expansion depends on appropriate investment and infrastructure which might be lacking. Many lands currently cultivated – but perhaps not cultivated for a long time – lack conditions or technical infrastructure making their eventual exploitation more expensive and requiring years of restoration. For example, previously cultivated land in parts of former Soviet Union and abandoned in the early 1990s may remain too costly to be brought back into production even at current elevated prices without the assurance of continuing high prices, and future price developments are indeed uncertain.

As land is a finite resource, policy prescriptions have focused on increasing productivity by increasing yields. Given the environmental considerations, the projections (e.g., OECD-FAO, 2012) indicate that most gains in production will be achieved by increasing yield growth and cropping intensity on existing farmlands rather than by increasing the amount of land brought under agricultural production. Globally, 90 percent of required production increases are projected to come from augmenting yields and cropping intensity, and only 10 percent by expanding arable land. For developing countries, FAO estimates that ratio at 80/20. But in land-scarce countries, almost all growth would need to be achieved by improving yields. A necessary step is to push the agricultural technology frontier, albeit not all countries face the same conditions (FAO, 2009).

Since the 1980s, for the first time in history the increase in production due to increases in productivity exceeded increases due to land expansion. Work on advancing and fine tuning agricultural technology to increase production or employ more environmentally sensitive methods is called for on the grounds of the need for increasing productivity. Whether it is because of competitiveness, food security or other considerations, the need is to close the gap between linearly growing supply and exponentially growing demand while ensuring sustainable resource management and environment preservation and taking into account resource constraints (land, water), climate change adaptation and mitigation. It is expected that the new price environment brings additional investment into technology development activities.

Many observers and analysts believe that the major countries of the former Soviet Union—specifically Kazakhstan, Russia, and Ukraine (abbreviated in this paper as the KRU countries, or KRU region)—are the part of the world with the most potential to increase food supplies and strengthen world food security. During the 2000s, the KRU region has become a major grain producer and exporter. Over 2006–11, the region provided 14 percent of the world exports of grain, and 21 percent of the world exports of wheat (USDA PSD, 2013). It could further increase its role as a major wheat exporting region (Liefert et al., 2010), and by 2019, its share in the global wheat trade could amount to almost 40%, which is an equivalent to more than 50 million tons.

The region has the potential to expand grain production by increasing both grain area and yields. The current KRU grain area remains well below the level of the late Soviet period (much of the agricultural land became idle during the 1990s), and as this paper will confirm, KRU grain yields are far below levels in the major grain-producing countries of the developed world, such as the European Union, the United States, and Canada.

In the current environment of high international grain prices, these countries strive to present themselves as reliable suppliers, even as many rely on other exports (e.g., hydrocarbons from Russia) to earn foreign currency. Thus, their interests are in increasing domestic production. From the global point of view, increases in their domestic production contribute to improving supply stability on world grain markets. Limited resources (water, land) and high input costs are constraints to a successful response. Nevertheless, in these regions production can be increased either by increasing yields on land already in the production by improving management practices or by adding land that can be brought into production without imposing undue environmental cost.

Their reliability as consistent suppliers, however, is often questioned due to their variability in production, general unpreparedness to deal with weather related events as well as propensity to react with trade restrictive policies adding to the tightness and volatility of world markets and reducing trust in the global trading system.

This paper discusses solely the supply side of the grain balance, focusing on three countries in the region which aim to gain advanced importance on international grain markets. The demand side of the equation and various aspects contributing to demand developments are not entertained. In the interest of brevity the paper also omits discussion on the current market environment and analysis of global high food prices as this is easily available elsewhere (e.g., analysis of factors contributing to high prices at Trostle (2008), Meyers et al. (2008); regular updates on prices available from the World Bank or monthly Global food price monitor from FAO/GIEWS)

The paper proceeds as follows: first, yields in the region are analyzed and compared with yield developments in other major crops and countries. Yield growth rates are compared across a set of countries, as are average yields, differences in national and world average yields, and yield variability. The second part discusses options within the country in terms of increasing area or improving technology, and the third part concludes with a discussion on prospects for the future and policies that could enhance these prospects for the way forward.

Analysis

The analysis part focuses on yields of a variety of commodities over the last 50 years in Kazakhstan, Russia and Ukraine as well as other countries in Europe (selected EU Member states treated individually, data permitting) and across the world for comparison. However, geopolitical changes in Europe and Central Asia do not lend themselves well to time series analysis. Average yield data for the Soviet Union stop in 1992 with the collapse of the Soviet Union after which data for individual states are reported. Yield data for the analysis were taken from FAOSTAT. Time series were limited by the data availability as of May 2013 to 1961 – 2011. The crop coverage extends to barley, maize, potatoes, rapeseed, soybeans, sunflower seed, and wheat, even if not all crops have comparative advantage in the countries of interest of this paper.

In the interest of comprehensiveness we explored:

1. yield growth rates;
2. average yields comparing countries in the region with the world and yield gaps between the actual yields in the region and the world average; and
3. variability of actual yields in selected countries.

Analysis of growth rates was done in two different time periods. In the first case we examined the whole available data set from 1961 to 2011, and focused on four equal 11-year time periods corresponding broadly to different economic periods:

- 1961-1972 capturing the green revolution,
- 1973-1984 the aftermath of the two energy shocks and stagflation,
- 1985-1996 the recovery of agricultural prices until their mid-1990s spike, and finally
- 1997-2008 representing the parallel boom in agricultural and other markets and agricultural price spike of 2007-2008.

In the second case we focused on the 1985 – 2009 period, and studied 5 year intervals. In all cases the end points were three-year averages except for the 1961 being only two years (1961 and 1962) because of data availability.

Analysis of average yields and yield gaps were only done using the entire data set and then focusing on four equal 11-year time periods (described as the first case above). Time periods for analysis of yield variability were chosen to accommodate collapse of the Soviet Union to receive at least two meaningful time periods in which to evaluate yield variability in the region. Thus, yield variability is studied for 1965-73, 1974-1982, 1983-91, 1992-2000, and 2001-09.

1. Yield growth rates

This part focuses on growth rate only. Table 1.1 summarises yield growth rates for a variety of commodities on the world level, while tables 1.2 – 1.8 focus on yield growth rates for individual commodities for a selected set of countries.

Table 1.1 Rates of yield growth for selected crops and periods from 1961-2010

World	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Barley	1.3%	**2.6%**	1.0%	0.4%	0.9%	0.8%	0.9%	-0.1%	0.8%	1.0%
Maize	2.0%	**2.9%**	2.3%	1.0%	1.6%	1.5%	0.2%	1.5%	0.8%	2.1%
Potatoes	0.9%	**1.6%**	0.5%	0.3%	0.8%	0.7%	-0.7%	1.5%	0.0%	1.1%
Rapeseed	2.4%	3.3%	**3.7%**	1.1%	2.4%	1.4%	1.2%	1.1%	1.7%	2.6%
Soybeans	1.6%	**2.8%**	1.4%	1.4%	0.7%	1.1%	0.6%	1.7%	1.1%	0.8%
Sunflower seed	0.7%	**1.2%**	0.3%	-0.3%	0.9%	0.2%	1.4%	-0.9%	-0.5%	2.0%
Wheat	2.0%	**3.3%**	2.6%	1.4%	1.0%	1.3%	1.9%	0.7%	0.4%	1.5%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

In table 1.1, yields are in most cases continuing to increase, and no straightforward conclusions can be drawn regarding the slowdown of yield growth for many commodities on the world level. While yield growth rates for wheat declined systematically from 3.6% in 1961 – 1972 to 1.1 % in 1997- 2008, other commodities experienced both upward and downward changes over the years. While declining wheat yield growth in the 11 year time period is apparent, a similar pattern does not appear to hold when focusing on the time period starting from 1985. There is a general pattern that in the 11 year intervals most commodities had their highest growth rate in 61-72, the green revolution period and in the 5-year intervals had their highest growth in the last period, the rising price period. This does not always follow the same pattern for country data. While yield growth rates of many commodities on the world level declined over the time periods studied compared to the period of 1961 – 1972 during the green revolution (for example barley, maize, and soybeans), the developments did not follow a steady decline like in case of wheat.

In particular, globally in the 1961 – 2010 time period, the fastest growing yields were the ones of rapeseed (2.4%), followed by maize and wheat (2% each). The slowest yield growth was recorded for sunflower seed (0.7%) and potatoes (0.9%). Comparing growth rates globally for average yields, the highest growth rates for most of the commodities were observed in the 1961 – 1972 time period, capturing the green revolution. Rapeseed is an exception: although the growth rate for rapeseed was the highest among all commodities studied (on par with the growth rate of wheat) in the 1961 – 71 time period, the growth rate of rapeseed yields globally was even higher in the 1973 – 1984 time period. Focusing on the shorter time periods and the 1985 – 2010 time period, yield growths show slower rates of growth. The highest rates of growths were recorded for maize (1.5%), rapeseed (1.4%) and wheat (1.3%). Relatively speaking, higher growth rates for maize and rapeseed than for other crops are related by spread of biotechnology and widespread adoption of genetically modified crops. For those crops the adoption rates by 2003 were quite high, contributing to explaining the higher growth rate in the last five-year time period. At the same time sunflower seeds benefited from hybrid technology, in particular insect resistant varieties. Generally, insect resistant varieties usually result in yield increases, while the yield increase in case of herbicide resistant varieties is not that high. Contribution of herbicide resistant varieties is usually in decreasing the cost of production. Most of the soybean hybrids available currently are of herbicide resistant type with rather limited increases in yields, as demonstrated by rather limited increases in the soybean yields. Wheat yields appear to be levelling off, particularly also due to agricultural policy environment in major producing countries.

Tables 1.2 – 1.8 show national growth rates for commodities studied in table 1.1. For each commodity, countries which experienced the highest rates of yield growth in 1961 – 2010 are listed, in addition to the world average and countries which are of the main interest of this paper: Kazakhstan, Russia, and Ukraine. Some outliers are not presented as high rates of growth were recorded for countries starting from a very low base (e.g., Turkmenistan recording 9.1% increase in barley yields).

Table 1.2 Rates of yield growth for barley for selected countries from 1961-2010

Barley*	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Brazil	2.6%	-1.1%	4.5%	2.9%	1.9%	2.3%	1.9%	5.9%	0.6%	1.5%
Argentina	2.5%	2.7%	2.5%	2.0%	1.8%	2.5%	4.7%	-1.2%	-0.5%	1.7%
Portugal**	2.4%	4.6%	1.2%	1.1%	5.2%	1.5%	6.9%	-2.9%	3.2%	5.4%
Italy	2.0%	4.3%	3.9%	0.3%	-0.1%	0.0%	0.8%	-0.8%	-1.4%	0.3%
France	1.8%	3.4%	2.2%	1.3%	0.2%	0.9%	2.2%	0.2%	-0.7%	0.1%
Canada	1.7%	4.3%	1.4%	1.3%	0.3%	0.6%	0.8%	0.9%	-3.4%	2.5%
USA	1.6%	2.6%	2.3%	1.0%	1.0%	1.4%	0.6%	0.0%	-0.5%	1.4%
Kazakhstan					4.5%			-12.6%	9.5%	3.3%
Russia					3.6%			-5.5%	5.7%	3.0%
Ukraine					2.3%			-7.9%	4.3%	1.3%
World	1.3%	2.6%	1.0%	0.4%	0.9%	0.8%	0.9%	-0.1%	0.8%	1.0%

*To be interpreted with caution: mix of feed and malting barley
**Despite high growth rates, Portugal per ha yield still about 40% below world average.
Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 1.3 Rates of yield growth for maize for selected countries from 1961-2010

Maize	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Greece	4.5%	10.1%	8.7%	1.0%	0.3%	0.8%	1.9%	0.4%	1.1%	-0.2%
Portugal	3.6%	1.2%	3.1%	6.8%	1.5%	4.3%	6.5%	7.6%	1.7%	1.8%
France	2.9%	7.4%	2.4%	2.7%	0.7%	1.4%	1.5%	3.4%	-1.0%	2.3%
Argentina	2.6%	2.3%	2.5%	2.1%	2.7%	2.6%	-0.1%	1.7%	4.2%	0.8%
Brazil	2.4%	0.6%	1.9%	3.8%	3.3%	3.3%	1.7%	5.8%	4.7%	2.7%
Hungary	2.2%	4.9%	3.5%	-1.0%	-0.3%	0.1%	-1.5%	2.8%	-3.4%	1.9%
Australia	2.0%	1.4%	1.2%	5.1%	0.0%	2.3%	5.2%	4.4%	-0.2%	-1.0%
USA	1.8%	3.4%	1.5%	0.6%	1.7%	1.1%	0.0%	0.5%	1.1%	1.7%
Kazakhstan					8.3%			-10.4%	14.5%	2.9%
Russia					4.2%			-1.0%	3.8%	0.4%
Ukraine					4.3%			3.5%	3.7%	4.7%
World	2.0%	2.9%	2.3%	1.0%	1.6%	1.5%	0.2%	1.5%	0.8%	2.1%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 1.4 Rates of yield growth for potatoes for selected countries from 1961-2010

Potatoes	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Brazil	3.1%	2.5%	3.9%	2.0%	4.5%	3.0%	2.7%	1.4%	5.0%	4.0%
Greece	2.6%	5.8%	2.6%	0.8%	1.6%	1.4%	1.8%	0.0%	0.3%	3.2%
Argentina	2.3%	1.7%	3.6%	2.5%	0.6%	1.5%	1.2%	4.9%	0.6%	0.7%
France	2.2%	3.9%	2.1%	1.4%	1.5%	1.3%	-0.9%	2.3%	1.4%	0.5%
Australia	2.0%	3.9%	2.3%	1.4%	1.2%	1.1%	1.4%	1.3%	1.6%	0.4%
Spain	2.0%	1.6%	1.9%	1.5%	2.2%	2.0%	2.2%	0.9%	3.9%	0.7%
USA	1.4%	1.4%	1.6%	1.4%	1.4%	1.2%	0.4%	2.1%	0.9%	1.5%
Kazakhstan					5.8%			-4.2%	10.6%	2.3%
Russia					2.2%			0.4%	0.3%	4.2%
Ukraine					2.1%			-2.1%	0.1%	3.0%
World	0.9%	1.6%	0.5%	0.3%	0.8%	0.7%	-0.7%	1.5%	0.0%	1.1%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 1.5 Rates of yield growth for rapeseed for selected countries from 1961-2010

Rapeseed	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Romania	2.4%	16.1%	-8.4%	4.9%	1.3%	4.2%	3.7%	8.2%	-8.0%	5.8%
Argentina	1.8%	0.1%	3.4%	1.0%	2.3%	2.0%	4.3%	-1.2%	4.1%	3.5%
Canada	1.6%	0.9%	1.9%	0.5%	2.4%	1.3%	-0.3%	0.5%	-0.8%	5.0%
Germany	1.6%	2.0%	1.2%	0.2%	2.4%	0.9%	1.8%	0.0%	1.5%	2.9%
France	1.5%	2.1%	2.6%	1.2%	-0.1%	0.5%	0.3%	2.8%	-2.4%	0.3%
Hungary	1.4%	2.0%	2.4%	-0.3%	4.2%	0.6%	0.4%	1.4%	2.2%	3.6%
Belgium	1.3%	2.3%	-0.8%	1.8%	1.0%	1.2%	1.8%	4.0%	0.3%	1.0%
Poland	1.1%	0.6%	2.5%	-1.9%	3.5%	0.3%	0.8%	-2.3%	2.0%	3.7%
Kazakhstan					7.0%			-18.3%	17.4%	-2.2%
Russia					3.3%			-8.3%	2.9%	2.8%
Ukraine					5.5%			-14.1%	1.0%	10.4%
World	2.4%	3.3%	3.7%	1.1%	2.4%	1.4%	1.2%	1.1%	1.7%	2.6%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 1.6 Rates of yield growth for soybeans for selected countries from 1961-2010

Soybeans	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Brazil	2.0%	1.8%	1.6%	2.9%	1.7%	2.2%	1.4%	4.9%	3.5%	1.4%
Australia	1.9%	6.9%	-0.1%	0.4%	1.8%	0.5%	-0.4%	0.2%	-2.1%	3.3%
Argentina	1.7%	3.1%	3.2%	-1.0%	1.5%	0.8%	-1.4%	-2.7%	4.2%	0.0%
Italy	1.3%	1.9%	1.3%	1.5%	-1.0%	0.2%	1.8%	2.0%	-1.3%	-0.2%
USA	1.1%	1.1%	1.0%	1.4%	0.8%	1.0%	1.1%	1.1%	-0.7%	1.9%
Canada	0.6%	0.1%	1.1%	0.8%	-0.3%	0.2%	0.1%	1.4%	-5.4%	1.6%
Kazakhstan					4.5%			-5.0%	4.4%	3.6%
Russia					3.1%			-2.6%	6.6%	0.0%
Ukraine					2.5%			-3.3%	0.7%	2.5%
World	1.6%	2.8%	1.4%	1.4%	0.7%	1.1%	0.6%	1.7%	1.1%	0.8%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 1.7 Rates of yield growth for sunflower seed for selected countries from 1961-2010

Sunflower seed	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Argentina	1.8%	0.5%	4.8%	3.2%	-1.0%	0.8%	3.6%	3.5%	-0.1%	-2.3%
Spain	1.7%	3.1%	2.9%	-0.2%	-0.1%	0.9%	0.4%	-0.6%	-2.9%	2.2%
Hungary	1.7%	2.8%	4.1%	-2.4%	3.7%	0.2%	-0.3%	-4.3%	4.0%	2.5%
Greece	1.3%	0.5%	4.3%	-2.2%	1.3%	-0.4%	0.0%	-3.6%	1.3%	0.2%
Australia	1.2%	-1.9%	3.4%	1.3%	2.5%	1.9%	4.7%	-2.7%	-4.1%	11.5%
Canada	1.2%	0.0%	2.6%	1.6%	0.7%	0.2%	4.8%	-1.2%	0.4%	4.0%
USA	1.0%	0.7%	0.7%	1.0%	0.4%	0.4%	0.4%	0.3%	-2.7%	4.5%
Kazakhstan					4.9%			-6.3%	15.1%	-3.4%
Russia					3.5%			-4.3%	2.7%	3.3%
Ukraine					2.8%			-1.5%	0.8%	5.9%
World	0.7%	1.2%	0.3%	-0.3%	0.9%	0.2%	1.4%	-0.9%	-0.5%	2.0%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 1.8 Rates of yield growth for wheat for selected countries from 1961-2010

Wheat	Yield growth rates, 11 year periods					Yield growth rates, 5 year periods				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1985-2010	1985-1990	1991-1996	1997-2002	2003-2008
Spain	2.3%	2.6%	5.1%	-0.8%	1.5%	0.9%	-0.3%	-0.2%	-0.1%	1.0%
Canada	2.0%	4.4%	0.8%	1.8%	1.4%	1.5%	2.6%	0.3%	-2.4%	3.4%
France	1.9%	4.2%	2.3%	1.1%	-0.2%	0.8%	1.7%	0.7%	-1.0%	-0.4%
Argentina	1.8%	0.6%	2.0%	1.6%	0.4%	2.6%	0.9%	1.2%	-1.0%	0.8%
Germany	1.8%	2.9%	2.4%	1.7%	0.4%	0.9%	1.0%	2.4%	-0.4%	1.2%
Italy	1.3%	2.0%	1.2%	0.6%	1.0%	1.0%	0.4%	-1.3%	-2.3%	2.6%
USA	1.2%	2.7%	2.1%	0.1%	0.8%	0.8%	-0.8%	-0.3%	0.1%	1.1%
Australia	0.8%	-0.4%	2.4%	2.6%	-3.0%	0.9%	1.4%	3.5%	-3.3%	-1.4%
Kazakhstan					4.9%			-12.1%	10.0%	3.2%
Russia					3.4%			-3.5%	4.2%	3.6%
Ukraine					1.4%			-2.7%	-0.4%	3.5%
World	2.0%	3.3%	2.6%	1.4%	1.0%	1.3%	1.9%	0.7%	0.4%	1.5%

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Yield growth rate developments on the country level remain rather heterogeneous. Although in many cases we do observe slowing yield growth rates (particularly on the world level), it is impossible to say with certainty whether decreasing yield growth on the country level was due to technology, weather related events or others. Yield analyses also fail to account for climatic, soil and other conditions. Generalised conclusions of declining growth rates across countries and commodities cannot be drawn, in particular as the analysis fails to account for climatic conditions and institutional changes. Institutional changes are particularly remarkable in countries of the former Soviet Union and other transition economies. While data for the former Soviet Union do not allow for detailed analysis, consecutive data for transition economies show bottoming yield growth rates in the 1985 – 1996 period, followed by a recovery in 1997 – 2008. The decline in yield growth is noticeable in economies transitioning from a planned to market economies in the analysis, focusing on 1985 – 2008 data in 5 year growth increments. Growth rates in many transition economies during the 1991 – 1996 and 1997 – 2002 were in fact negative. With the entry to the EU many former transition economies reversed their declining growth rates. Nevertheless, in many cases the growth rates in the period 1997 – 2008 were lower than in 1961 – 1972.

In summary, following negative growth rates immediately after post-Soviet disinvestment in agriculture, more recent yield growth rates in the KRU region are stronger than elsewhere. However, this masks a standard problem across transition economies where yields (and production in general) declined following the collapse of planned economy and disinvestment following structural changes in Eastern Europe and former Soviet Union.

2. Average yields and yield gaps

While growth rates tell the story of progression between the ending and the starting point, they do not tell the full story, in particular when the growth occurs from a very low base. Although some countries experience two digit growth rates, their average yields still lag behind even the world average. Looking at average yields in a simplified manner is biased as it does not account for the differences in natural conditions. A more appropriate measure would be to calculate a yield gap between the actual and potential yield but it is beyond the scope of this paper, and a simplified analysis fits the purpose and allows drawing preliminary conclusions. Tables 2.1 – 2.7 illustrate average yields and yield gaps measured as a percentage deviation from the world average in respective time periods as described in the general description of analysis above for the 1961 – 2010 time period. The selection of the countries in this section might not overlap with the selection in the growth rate analysis. Countries listed in the tables 2.1 – 2.7 are listed according to their ranking based on the deviation from world average in 1997 – 2008 time period. Countries of the main interest of this paper are highlighted in ***bold italics.***

Table 2.1 Average yield and yield gaps for barley for selected countries from 1961-2010

Barley	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Belgium	5.52	3.70	4.71	5.86	7.06	158.86%	123.23%	139.07%	161.59%	182.05%
France	4.80	3.08	3.98	5.51	6.24	125.11%	85.80%	101.78%	146.00%	149.14%
Switzerland	5.04	3.53	4.55	5.62	6.13	136.43%	113.14%	130.64%	150.92%	144.92%
Netherlands	5.12	3.85	4.70	5.60	6.00	140.20%	132.68%	138.30%	150.03%	139.59%
Germany	4.73	3.30	4.19	5.19	5.87	121.81%	99.29%	112.74%	131.75%	134.38%
USA	2.79	2.15	2.58	2.89	3.27	31.10%	30.10%	31.16%	29.08%	30.57%
Canada	2.55	1.92	2.33	2.85	2.94	19.71%	15.77%	18.22%	26.94%	17.24%
Argentina	2.01	1.19	1.46	2.16	2.87	-5.80%	-28.40%	-26.07%	-3.74%	14.55%
Ukraine	***2.24***			***2.57***	***2.09***	***5.10%***			***14.82%***	***-16.45%***
Russia	***1.79***			***1.53***	***1.83***	***-15.87%***			***-31.62%***	***-26.89%***
Kazakhstan	***1.11***			***0.98***	***1.09***	***-48.06%***			***-56.22%***	***-56.56%***
World	2.13	1.66	1.97	2.24	2.50					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 2.2 Average yield and yield gaps for maize for selected countries from 1961-2010

Maize	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Belgium	7.85	5.04	6.27	7.79	11.27	122.81%	123.18%	102.30%	109.86%	144.35%
Netherlands	7.30	4.00	4.88	8.70	10.37	107.23%	76.88%	57.55%	134.19%	124.88%
Greece	7.22	2.23	6.06	9.63	10.00	104.82%	-1.50%	95.84%	159.22%	116.88%
USA	6.91	4.75	5.96	7.31	8.91	96.02%	110.26%	92.52%	96.68%	93.19%
Germany	6.64	4.14	5.64	7.19	8.83	88.49%	83.13%	82.14%	93.52%	91.53%
Canada	6.35	4.93	5.51	6.52	7.79	80.29%	118.35%	77.91%	75.50%	68.90%
Argentina	3.90	1.99	2.98	3.86	6.10	10.74%	-11.79%	-3.70%	4.03%	32.30%
Australia	3.77	2.21	2.83	4.22	5.34	7.08%	-2.13%	-8.49%	13.71%	15.85%
Kazakhstan	***3.66***			***2.45***	***3.86***	***3.88%***			***-33.95%***	***-16.21%***
Ukraine	***3.57***			***2.67***	***3.50***	***1.30%***			***-28.00%***	***-24.03%***
Russia	***2.90***			***2.40***	***2.92***	***-17.74%***			***-35.39%***	***-36.59%***
World	3.52	2.26	3.10	3.71	4.61					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 2.3 Average yield and yield gaps for potatoes for selected countries from 1961-2010

Potatoes	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Belgium	39.57	32.08	37.88	42.04	44.73	161.60%	143.74%	161.54%	171.74%	170.03%
Netherlands	39.15	32.50	36.79	42.01	43.75	158.85%	146.94%	154.01%	171.56%	164.12%
USA	33.16	23.77	29.37	34.78	41.88	119.24%	80.60%	102.82%	124.80%	152.80%
UK	34.42	24.84	30.96	38.21	41.41	127.55%	88.79%	113.75%	146.97%	149.94%
France	30.95	20.05	26.05	33.28	40.83	104.60%	52.35%	79.86%	115.11%	146.49%
Germany	29.82	22.05	22.12	31.00	40.76	97.16%	67.57%	52.71%	100.37%	146.05%
Australia	25.77	16.13	22.34	28.45	33.74	70.39%	22.56%	54.23%	83.91%	103.67%
Ireland	27.20	25.08	24.05	25.59	32.81	79.83%	90.58%	66.04%	65.41%	98.05%
Kazakhstan	***12.34***			***9.42***	***12.70***	***-18.44%***			***-39.14%***	***-23.31%***
Ukraine	***12.11***			***11.53***	***11.71***	***-19.95%***			***-25.49%***	***-29.31%***
Russia	***11.58***			***11.09***	***11.42***	***-23.42%***			***-28.32%***	***-31.05%***
World	15.12	13.16	14.48	15.47	16.57					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 2.4 Average yield and yield gaps for rapeseed for selected countries from 1961-2010

Rapeseed	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Belgium	3.34	2.59	3.73	3.14	3.65	176.78%	269.77%	283.80%	133.29%	122.79%
Netherlands	3.18	2.68	2.91	3.35	3.56	163.81%	282.42%	199.48%	149.04%	117.65%
Germany	2.76	1.95	2.46	2.90	3.47	128.39%	179.13%	153.10%	115.52%	112.33%
France	2.61	1.85	2.19	2.98	3.20	116.33%	164.91%	125.39%	121.26%	95.34%
UK	2.80	2.30	2.60	3.00	3.11	132.12%	229.11%	167.27%	123.14%	89.80%
USA	1.54			1.43	1.54	27.34%			6.56%	-5.92%
Canada	1.27	0.94	1.14	1.30	1.53	5.04%	34.79%	16.94%	-3.66%	-6.35%
Argentina	1.06	0.70	0.81	1.21	1.37	-12.27%	0.29%	-16.72%	-10.29%	-16.31%
Ukraine	***1.27***			***1.12***	***1.21***	***5.04%***			***-17.16%***	***-26.16%***
Russia	***0.99***			***0.78***	***1.03***	***-17.65%***			***-41.84%***	***-36.84%***
Kazakhstan	***0.53***			***0.44***	***0.57***	***-55.99%***			***-67.62%***	***-64.92%***
World	1.21	0.70	0.97	1.35	1.64					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 2.5 Average yield and yield gaps for soybeans for selected countries from 1961-2010

Soybeans	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Italy	2.92	1.93	2.79	3.38	3.44	58.79%	45.76%	69.08%	74.62%	50.45%
USA	2.19	1.72	1.91	2.32	2.65	19.48%	30.12%	16.02%	19.56%	16.26%
France	2.30		1.88	2.34	2.58	25.26%		14.15%	20.53%	12.91%
Argentina	1.95	1.14	1.90	2.08	2.55	6.13%	-13.94%	15.15%	7.54%	11.75%
Brazil	1.85	1.13	1.59	1.90	2.51	0.71%	-14.89%	-3.39%	-1.75%	10.13%
Canada	2.31	1.97	2.15	2.52	2.50	25.69%	48.74%	30.26%	29.80%	9.32%
Spain	2.08	1.34	1.76	2.15	2.47	13.50%	1.29%	7.05%	10.72%	8.03%
Kazakhstan	***1.46***			***1.00***	***1.45***	***-20.69%***			***-48.27%***	***-36.51%***
Ukraine	***1.25***			***0.93***	***1.25***	***-32.08%***			***-52.16%***	***-45.43%***
Russia	***0.95***			***0.70***	***0.97***	***-48.46%***			***-64.06%***	***-57.64%***
World	1.84	1.32	1.65	1.94	2.28					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 2.6 Average yield and yield gaps for sunflower seed for selected countries from 1961-2010

Sunflower seed	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Austria	2.36	1.91	2.31	2.55	2.57	93.34%	69.06%	96.63%	99.87%	105.31%
France	2.07	1.62	1.96	2.25	2.35	69.31%	43.49%	67.02%	76.02%	87.09%
Germany	2.41			2.66	2.28	97.31%			108.08%	81.78%
Italy	2.04	1.87	1.84	2.32	2.09	67.26%	65.34%	56.76%	81.41%	66.77%
Argentina	1.27	0.78	0.92	1.55	1.74	3.98%	-30.68%	-22.05%	21.10%	38.41%
Canada	1.22	0.77	1.15	1.39	1.51	-0.20%	-31.91%	-2.42%	8.57%	20.62%
USA	1.31	1.04	1.26	1.38	1.49	7.48%	-7.92%	7.36%	7.69%	18.54%
Brazil	1.09	0.80	0.77	1.22	1.39	-10.38%	-29.16%	-34.76%	-4.44%	10.83%
Ukraine	***1.23***			***1.19***	***1.15***	***0.93%***			***-6.70%***	***-8.05%***
Russia	***1.00***			***0.91***	***0.99***	***-18.48%***			***-28.49%***	***-21.02%***
Kazakhstan	***0.47***			***0.31***	***0.52***	***-61.82%***			***-75.42%***	***-58.24%***
World	1.22	1.13	1.17	1.28	1.25					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Table 2.7 Average yield and yield gaps for wheat for selected countries from 1961-2010

Wheat	Average yield per period (t/ha)					% deviation from world average				
	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008	1961-2010	1961-1972	1973-1984	1985-1996	1997-2008
Ireland	6.49	3.73	5.36	7.53	8.73	200.01%	176.13%	189.60%	210.69%	212.66%
Belgium	6.21	3.99	5.08	6.81	8.27	186.98%	195.16%	174.55%	180.98%	196.10%
Netherlands	6.78	4.44	6.19	7.85	8.19	213.78%	228.27%	234.76%	223.87%	193.30%
UK	6.14	4.04	5.41	6.98	7.76	183.73%	199.15%	192.46%	188.29%	177.81%
US	2.37	1.88	2.23	2.45	2.78	9.80%	38.96%	20.49%	1.16%	-0.56%
Ukraine	***2.81***			***3.05***	***2.66***	***30.12%***			***25.77%***	***-4.81%***
Argentina	1.96	1.38	1.70	1.98	2.44	-9.38%	1.88%	-8.32%	-18.18%	-12.62%
Canada	2.01	1.55	1.84	2.05	2.39	-7.05%	14.85%	-0.60%	-15.25%	-14.62%
Brazil	1.37	0.78	0.93	1.55	1.92	-36.80%	-42.23%	-49.78%	-36.05%	-31.36%
Russia	***1.86***			***1.61***	***1.89***	***-14.01%***			***-33.45%***	***-32.51%***
Kazakhstan	***0.99***			***0.85***	***1.00***	***-54.03%***			***-64.85%***	***-64.08%***
World	2.16	1.35	1.85	2.42	2.79					

Source: Calculated by the author from FAOSTAT data (accessed May 2013)

The tables present average yields in selected countries between 1961 – 2010 (divided into 11 year intervals as before), together with the percentage deviation from the world average. Although possibly with some room for improvement, in terms of yields the EU15 countries are generally faring rather well compared to the world average, often producing on average more than double the world average (clearly depending on the climatic and geographical conditions). However, many countries with presumably large potential for grain production are producing below the world average, and Kazakhstan, Russia and Ukraine are nearly always at the bottom of these lists. In addition, as the world average remains relatively stable, large differences in countries' deviations from the world average point to a large yield variability within many countries. Also notable are remarkable yield improvements in emerging countries, in particular Argentina and Brazil, which are gaining an increasing importance as suppliers.

Although the analysis does not differentiate between varieties and qualities of commodities produced and does not account for different geographical and climatic conditions, it does provide an indication of the potential should improvements in technologies (both seed and management) be adopted. Nevertheless, although many crops experienced bumper harvests (e.g., wheat in 2008) it is possible that it was due to positive weather developments positively limiting the difference between the actual and real yields, rather than changes in the seeds. While the supply response following the price hikes was rather positive and the production increased, it is highly unlikely this was due to investment technology, which takes longer to be realized.

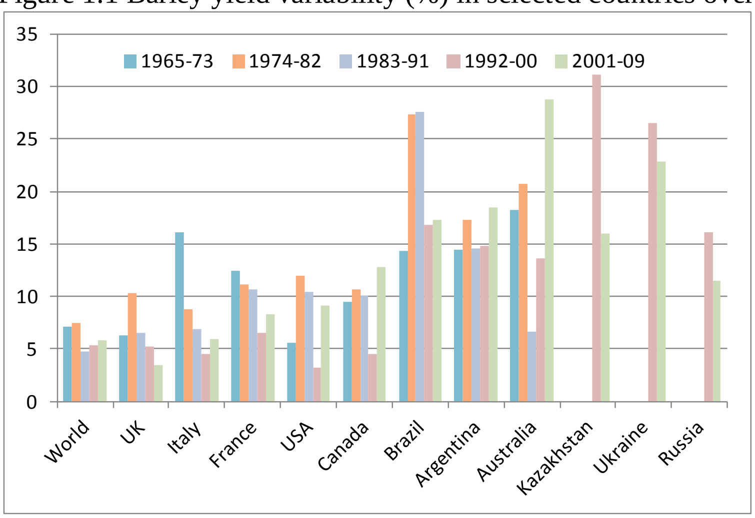
In summary, average yields in the KRU region for selected commodities are generally bellow world averages with a significant room for improvement.

3. Yield variability

Finally, we examined yield variability in major producing countries and compared it with yield variability in major producing countries in Europe and Central Asia. Medium term outlooks (e.g., OECD-FAO, 2012) indicate that the production is shifting from "traditional" countries to countries with higher yield variability which is likely to create conditions for greater price volatility. Yield variability was calculated as a coefficient of variation (a ratio of standard deviation to the mean) for wheat, barley, maize and rapeseed on the world level as well as for France, Germany, Netherlands, Poland, USSR up to 1991, and Kazakhstan, Russian Federation and Ukraine after 1992 (graphed on figures 1.1 – 7). Due to consistency, charts presented in this part use non-detrended data.[2]

As expected, yield variability on the world level is lower than yield variability in individual countries since world average yields are unlikely to undergo major adjustments. While no generalisations can be made, in many countries yield variability has a decreasing trend over the years. However, in countries that aim to play an increasingly important role on the world market (Kazakhstan Russia, Ukraine), yield variability is often higher than in other countries studied, perhaps with the exception of maize.

Figure 1.1 Barley yield variability (%) in selected countries over several periods 1965 to 2009.

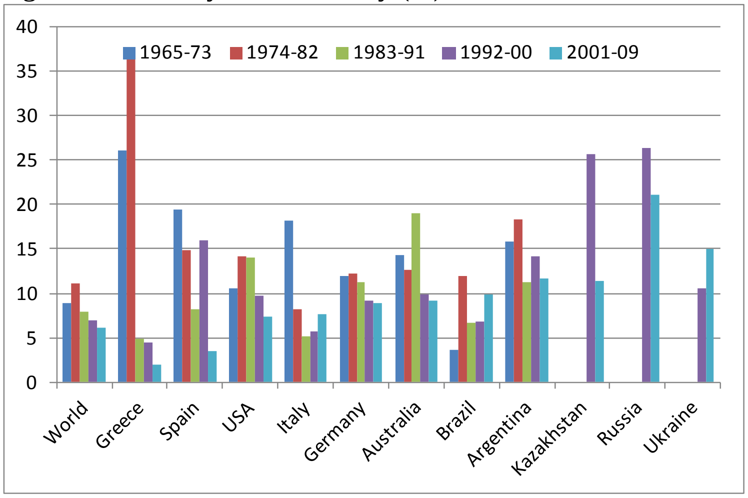


Source: Calculated by the author from FAOSTAT data (accessed May 2013)

---

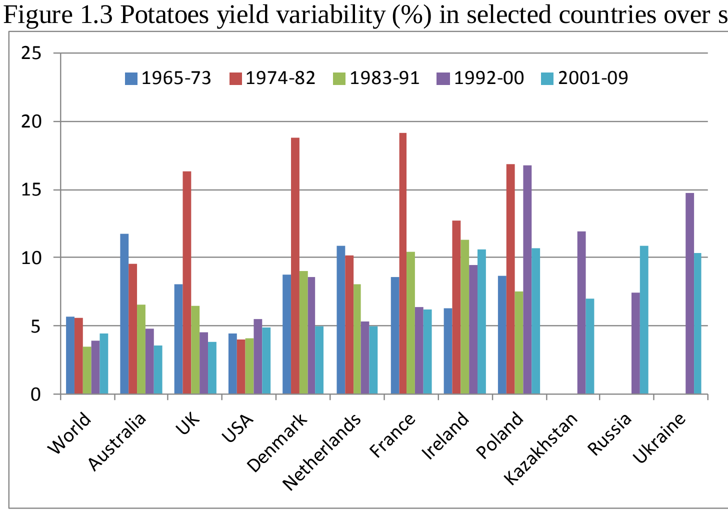
[2] We also analysed de-trended data assuming linear time trend. However, considering time series for KRU countries are only available for 18 years and contain a number of extremes (significant drop in yields following the collapse of Soviet Unit followed by a recovery and again drops and spikes depending on weather conditions), linear trend does capture the developments. For example, in Kazakhstan, wheat yield in 1998 dropped to about 0.5 t/ha from over 1.3 t/ha in 1992, and rebounded to 1.3 t/ha in 1999. If a linear trend were removed from the series, yield variability for 1992 – 2000 period in Kazakhstan would be around 90 percent. Similar results were obtained for other crops in the KRU region.

Figure 1.2 Maize yield variability (%) in selected countries over several periods 1965 to 2009.



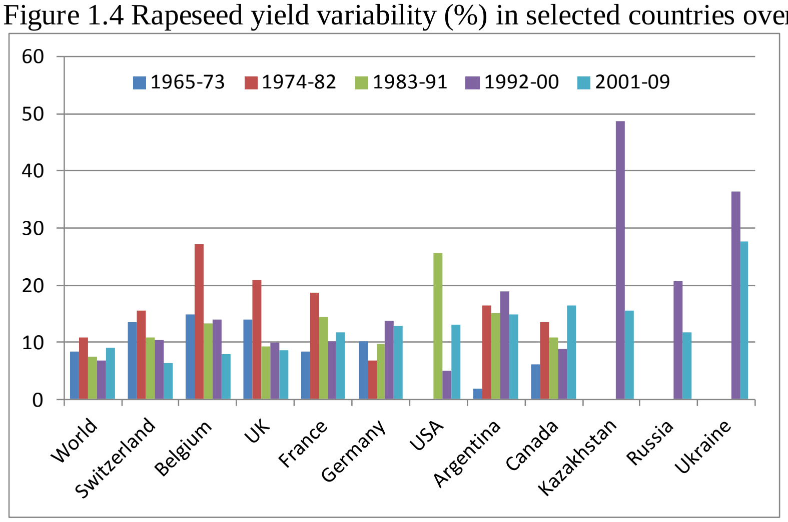
Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Figure 1.3 Potatoes yield variability (%) in selected countries over several periods 1965 to 2009.



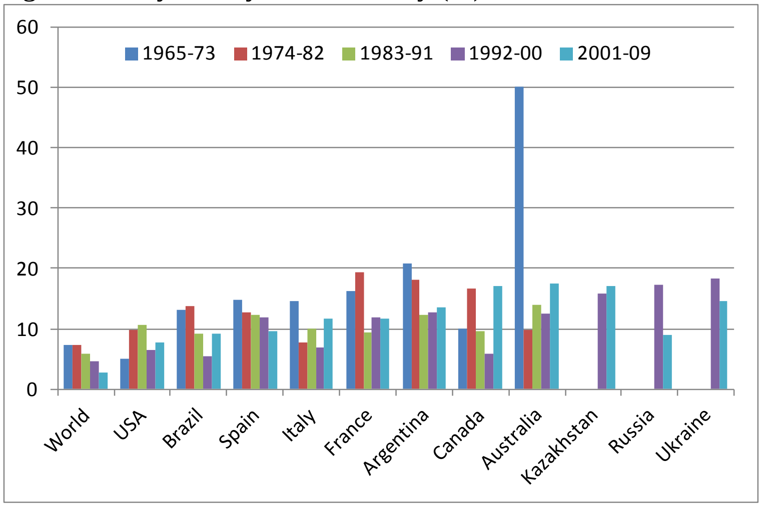
Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Figure 1.4 Rapeseed yield variability (%) in selected countries over several periods 1965 to 2009



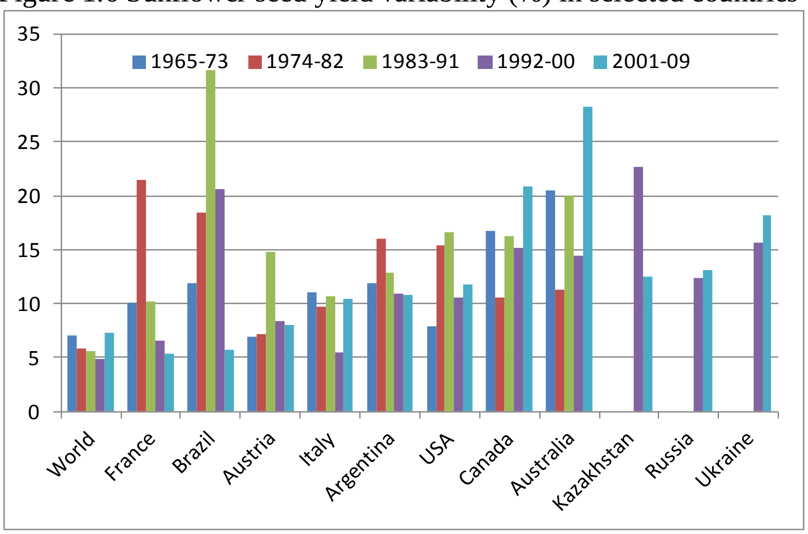
Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Figure 1.5 Soybeans yield variability (%) in selected countries over several periods 1965 to 2009



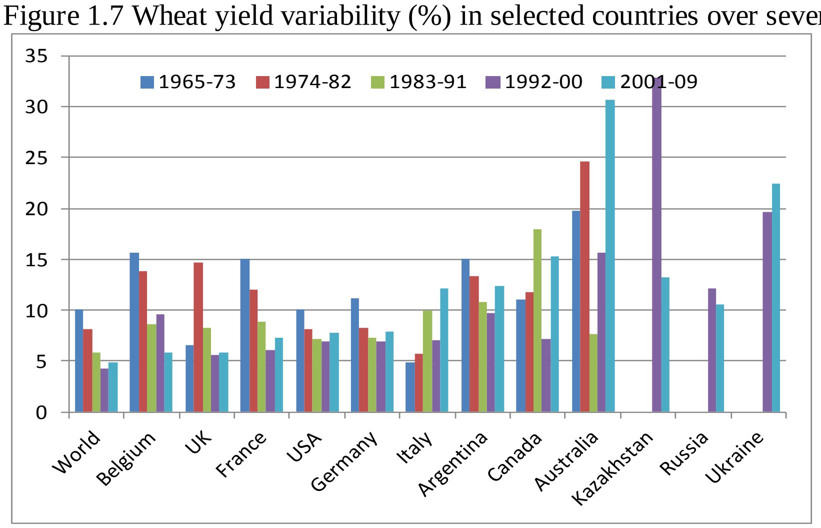
Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Figure 1.6 Sunflower seed yield variability (%) in selected countries over several periods 1965 to 2009



Source: Calculated by the author from FAOSTAT data (accessed May 2013)

Figure 1.7 Wheat yield variability (%) in selected countries over several periods 1965 to 2009



Source: Calculated by the author from FAOSTAT data (accessed May 2013)

What can be done

Although this paper focuses on the KRU countries, conclusions about how to increase yields and limited their variability are valid across the board. Action can be pursued in several different areas, including research and development, investment climate, support to agriculture, climate change adaptation and mitigation. This part focuses on the main steps which can be taken in the region itself. For a broader discussion, refer to Meyers et al (2012).

1. Support to agriculture and policy environment

Like the policy goals, country coffers and agricultural support budgets differ across countries, even as some (developed in particular) countries continue to fight structural imbalances in their budgets and face uncertainty in their budgetary outlays. Farmers in developed countries are often seen as stewards of nature, ensuring environmental protection in a multifunctional agriculture and policies increasingly reflect this. On the other hand, farmers in transition and developing economies are often perceived as producers, and more of the support is coupled to production.

The OECD figures for Producer Support Estimate (PSE, OECD (2011a)) show PSE as a percentage of receipt in Russia in 2008 – 2010 was on par with the EU (22%), while in Ukraine the PSE was only 7%. For comparison, higher PSEs were recorded for example for Norway (60%) and Switzerland (56%). Although the level of support in Russia and Ukraine was relatively low, over 80% of it in each country was reported under potentially most disturbing support.

The OECD also calculates a General Services Support Estimate (GSSE) indicator which includes research and development, financing for agricultural schools, inspection services, infrastructure, marketing and promotion and public stockholding (OECD, 2011b). In the EU the share of research and development in 2010 represented approximately 21% of the GSSE, while in Norway it accounted for over 40% and only 8 and 10% in Ukraine and Russia, respectively.

While some countries in the former Soviet Union aim to increase their productivity for domestic self-sufficiency reasons, some – such as Russia, Kazakhstan and Ukraine – aim to produce to become or maintain and enhance their positions among the leading world exporters. However, despite their efforts to be active exporters, these countries in particular have been inclined to use export taxes, quotas and bans in reaction to domestic production shortfalls or world price spikes. To allow farmers to react to increased prices by increasing their production, it is important to assure complete price transmission. At times the prices from international markets are not fully transmitted to farmers in these countries because of a variety of border protection measures, weak infrastructure, agricultural policies, structure of the supply chain, etc. Above all, assuring a stable macroeconomic and policy environment is of the utmost importance.

2. Increases in productivity

On the macroeconomic level, a frequent policy prescription to the challenge of enhancing farm productivity while taking into account social and environmental resource constraints and considerations is to increase funding for research and development.

Various steps that can be taken on a practical level to increase yields require various costs in terms of investment:

1. Seeds:

   a. improved seeds: Often one of the few possibilities in mature agricultural production systems, requires good technology policy and national research systems .
   b. adoption of existing seeds: Certification systems often are the main constraint that prevents or slows transfer of existing technology.
2. Changes in the environment: advance in environment management systems, irrigation and other environmental aspects, interaction between seed and environmental conditions
   a. changes with significant investment, e.g., irrigation, precision agriculture, etc.
   b. changes possible without significant investment, e.g., conservation agriculture, no tillage practices, adoption of good agricultural practice, etc.

In addition to innovation, significant gains in closing gaps between actual yields lie in management and good agricultural practices adjusted to particular environmental and geographical locations. While new advances in seeds are often necessary but often take a long time and financial resources, an immediate solution of harvesting the low hanging fruit is employment of better management, conservation techniques and facilitation of technology transfer and potential. For example, Saskatchewan has climate and agronomic conditions quite similar to Kazakhstan but better management practices lead to less production variability. Nevertheless, in the light of changing environmental conditions and climate change effects, what are considered best agricultural practices are also likely to change over time.

Farm characteristics often play a significant role in determining the degree of technology adaption, and consequently in determining actual increases in yield and productivity. For example, in the sector of field crops, small farmers might be less likely to invest in machinery than big farms because of their lack of access to capital and perhaps because they might not have the necessary collateral to secure the capital. At times countries with atomised farm structure might be also lacking a well-functioning credit market. In addition, some productivity increasing enhancements might not necessarily call for high investment in capital but farmers farming on rented land might be less likely to adopt these measures (for example, to install irrigation systems).

Good weather and ideal conditions for seed and crop development help to achieve strong yields. In the simplest agronomic terms, yields can be influenced by the attributes of the seed itself (gene), the environment itself (e.g., by irrigation), or the interaction between gene and environment. While in Western Europe and other mature agricultural systems, influencing the environment is unlikely to bring large increases in yields, elsewhere in Europe (and the rest of the world) bringing actual yields on par with potential yields by influencing the production environment and the interaction between the seed and environment remain an option.

The FAO (2009) identified the following priority areas for action where enhanced farming techniques and new technologies could be tapped to boost production:

• Improving efficiency in farmers' use of agricultural inputs.
• Developing improved crop varieties.
• Heavily investing in agricultural research and development.
• Closing existing "yield gaps".

Productivity can be increased by a range of interventions with varying degrees of investment needed. Developing new seed varieties is a longer term process and is likely to be costlier than to substitute primary production through adoption and improved management of existing technology, reduction of post-harvest losses, and reduction of losses in the whole supply chain. Nevertheless, the latter still calls for some investment into adaptation research and innovation and possibly a large investment in extension and other agricultural knowledge systems.

3. Supporting and increasing investment in agriculture

It is well known that much of the adjustment that occurred from about 1990 onward in transition economies was that under state control or partial state control, there was very likely over-investment in agriculture for many of these countries, so the rapid decline occurred to rationalize production with market conditions reflected in product and input prices. Not only was investment often too high, but also not in the most efficient places. Table 3.1 shows average annual growth in agricultural capital stock in the Europe and Central Asia region.

One area where overinvestment was greatest was in the livestock industry, so it is the sector that also saw the greatest disinvestment during transition. There were much larger declines in ACS for livestock as compared with all other investments. In the EU-15 and Turkey, the differences are not so great, but for the transition economies the decline in livestock ACS was far greater in every period (Meyers et al., 2012). It can also be noted that one reason for the strong growth of grain exports from places like Kazakhstan, Russia and Ukraine in recent years, is the decline of domestic feed use related to this liquidation of livestock.

The admonition by FAO and others that investment in agriculture is critical in the future does not mean that it should be driven by arbitrary or centrally directed decisions. It means that governments and international institutions and NGOs and private business should all play their role in this, and the government’s primary role is to create and preserve a business environment where public goods are provided, investors are encouraged by sound governance and the rule of law, and policies are stable and predictable.

Table 3.1. Average annual growth in agricultural capital stock in ECA, percent per annum[3]

Country	**1992-96**	**1996-00**	**2000-04**	**2004-07**	**1992-2007**
Czech Republic	-2.77	-1.61	-1.60	-1.22	-1.84
Hungary	-1.85	0.69	-0.01	-0.92	-0.50
Latvia	-7.92	-3.10	0.38	0.95	-2.71
Lithuania	-4.80	-0.98	-3.09	0.94	-2.20
Poland	-0.35	-0.26	0.09	1.33	0.12
Romania	-1.14	-0.88	0.28	0.88	-0.29
Slovak Republic	-6.76	-2.82	-1.20	-1.95	-3.29
Slovenia	1.71	3.46	-1.03	-0.99	0.88
Turkey	0.37	0.83	0.67	1.42	0.78
Belarus	-4.58	-2.64	-2.54	-0.75	-2.77
Georgia	-0.94	0.22	0.19	0.57	-0.03
Kazakhstan	-2.37	-3.50	0.51	0.53	-1.34
Kyrgyzstan	-1.90	0.03	-0.52	-0.18	-0.68
Russian Federation	-4.34	-3.58	-1.24	-1.53	-2.76
Tajikistan	-0.75	-0.16	0.45	0.61	0.00
Turkmenistan	4.34	0.37	1.28	0.62	1.71
Ukraine	-3.80	-4.83	-2.37	-1.89	-3.32
Uzbekistan	0.12	-0.02	0.31	0.33	0.17
Average for the region	**-2.09**	**-1.85**	**-0.35**	**0.06**	**-1.16**
EU New Member States	**-1.53**	**-0.62**	**-0.10**	**0.63**	**-0.48**
Other European	**-2.71**	**-2.76**	**-0.67**	**-0.65**	**-1.77**
Austria	-0.24	-1.20	-0.10	0.17	-0.38
Belgium-Luxembourg	0.68	-2.17	-0.91	-0.17	-0.68
Denmark	-0.26	-1.35	-0.20	-0.64	-0.61
Finland	-1.26	-1.25	-0.62	-0.37	-0.90
France	0.07	-0.59	-0.64	-0.28	-0.37
Germany	-1.74	-2.47	-1.07	-0.48	-1.51
Greece	1.37	0.55	0.21	0.25	0.62
Ireland	0.99	0.82	0.72	-0.77	0.52
Italy	-0.50	3.41	-0.10	-0.02	0.73
Netherlands	-1.15	-1.83	-1.90	0.32	-1.24
Portugal	-0.41	-0.88	-1.46	-1.10	-0.95
Spain	1.11	1.56	0.90	0.61	1.07
Sweden	0.37	-1.25	-0.25	-0.42	-0.39
United Kingdom	-0.33	-0.93	-1.51	-1.09	-0.96
EU-15 average	**-0.16**	**-0.04**	**-0.34**	**-0.09**	**-0.17**

Source: Cramon-Taubadel, S. et al. (2009)

[3] Annual growth rates for a given period were calculated using the following formula: $r = ((X_t - X_0)^{(1/t)}-1)*100$, where r is the growth rate for a given period, X_0 is the ACS in the first year of the period, X_t is the ACS in the last year of the period, t is the number of years between X_0 and X_t.

With respect to the general investment conditions, there are a wide range of factors that could affect the quality of the investment climate. Among them are levels of taxation, quality of legislation, extent of corruption, and the duration and complexity of the procedures needed to start, close and maintain a business. Creating a reliable investment climate is one of the major prerequisites for the investment inflow in a country as well as for domestic investment.

4. Why invest in agriculture?

Are all investments good investments? Clearly, the standard for evaluating any investment, whether public or private, is the rate of return on investment; but research on returns to investment in agriculture have invariably confirmed it as a high payoff investment (World Bank, 2008). However, we also know from seeing the waste and dismal failure of public investment in parts of this region that were under a command economy system for so long that some investment can also be wasteful of resources. The concern in current times in this region and others is the rise of large investments from both private sources and foreign sovereign wealth funds or state funds that may not be adequately vetted with respect to their externalities. Of particular concern are the social consequences of displaced farmers or workers or the sustainability of the investments from an environmental standpoint.

One of these new forms of investment is the agriholdings in places like Russia, Ukraine and Kazakhstan. As the role the KRU region plays in satisfying the growing need for global food production increases, the emergence of these new farm structures, agriholdings, has been invoking interest among the experts.

Agriholdings are the large farms (often larger than 100,000 ha) that are often vertically integrated with processors and/or exporters. Some of these mega farms have managed to attract financing through IPO and borrowing from private investors or European Bank for Reconstruction and Development.

Unfortunately, there are no official statistics on the number of agriholdings in the KRU region, or the amount of land in their use. A growing number of the studies, however, provide a useful approximation. For example, according to Akimbekova (2006), the agriholdings in Kazakhstan control about 30 percent of the farmland used for grain production, and produce close to 70 percent of all the grain sold in the country and abroad. In Russia 196 agriholdings operated on approximately 11.5 million hectares in 2009 and controlled about a quarter of grain production in the country (FAO-EBRD, 2009; IKAR, 2010). As to Ukraine, in 2011 there were 79 agriholdings with the total land use of 5 million hectares (Gagalyuk, 2011). This accounted for more than 25 percent of country's total sown area.

The reasons for the investors' interest in the agriholdings are quite numerous. Among the economic ones are vast availability of relatively cheap fertile land, sufficient level of infrastructure development, world market access, productive and relatively cheap labor, and finally, increasing commodity prices as a promise of higher profits. However, a number of experts who study the emergence and development of such formations point out that there are also reasons for the agriholdings to be a post-USSR (rather than a Western) phenomenon. Among those are underdeveloped institutional conditions and political-economic forces pertaining to the transition economies that allow for such large capital accumulation (Demyanenko, 2008; Epshtein et al., 2013). For example, in Ukraine, there is a moratorium on the sale of land. This allows the owners of the agriholdings to rent a large amount of land at a relatively cheap rental rate. Moreover, there are cases where land contracts are secured and allowed to remain idle as the agriholding company uses the land holdings to attract investments in exchange markets. This is clearly not in the interests of the nation nor the small land holders and workers in rural areas. The leasing law should prevent this practice from continuing, but routinely such laws are not enforced.

The major benefit of the agriholdings is that they allow attracting a large amount of investment in the agribusiness sector both from domestic and international investors, which as was mentioned earlier in our study is crucial for increasing the food production. Additionally, one would expect that the economies of scale of the agriholdings should allow them to decrease the cost and increase the efficiency of production, while the extent of their integration allows for the fast and smooth product movement from a farm to an exporter or domestic user. However, massive land holdings that are usually widely scattered geographically and not always well managed as farming enterprises are very likely to be more inefficient than smaller holdings in the 10-20,000 hectare scale as shown in research by Demyanenko (2008). In addition, a recent study by Epshtein et al. (2013) that focused on the agriholdings in Belgorod region of Russia, suggests that agriholding farms lag behind smaller independent farms in terms of profitability and are exposed to a higher risk of default comparing to the latter ones.

There are also socio-economic and environmental risks associated with the creation of such mega farms. The main one is the disconnect between agriholdings and the rural areas where they operate. First, they displace significant numbers of agricultural workers, which reduces employment and incomes in the rural areas. Also, the major headquarters of such holdings are usually located in the larger cities and not in the areas where the production takes place. Therefore, agriholdings pay taxes to the cities, which, in turn, decreases the stream of financing to the rural territories. This results in lower levels of financing of infrastructure and public goods provision in the rural areas of the region. Another risk is the tendency of agriholdings to engage in monoculture practices that lead to deterioration of land quality and other environmental externalities. Additionally, some experts (Visser et al., 2011) fear that the emergence of agriholdings might be an example of “land grabbing” practices, where a big share of land is owned or under long-term lease by foreign or domestic investors. As a result, this might cause even further loss of revenues on the part of the local population.

Whether the benefits that agriholdings provide outweigh the risks or vice versa is yet to be determined. However, at this point it is already clear that they are major players in the grain sector of Kazakhstan, Russia and Ukraine, and shape their production and exports.

A good example of growing investment and its impact on food security of local populations is in a recent study of the North-Kazakh Grain Region (Petrick, 2011). Since 2000 investment in agricultural fixed assets, cropland expansion as well as growing input use in this region of Kazakhstan has contributed to growing production but also to rising wages, and rising consumption expenditures that well exceeded cost of living increases. During the same period the share of households below the poverty line in this region fell from over 35 percent in 2001 to about 5 percent in 2010.

5. Climate change

The World Bank (2010) report states that Europe and Central Asia (ECA) are already experiencing a number of consequences of climatic changes, such as increasing variability, higher temperatures, changing hydrology, and extreme events, e.g., droughts, floods, heat waves, windstorms, and forest fires. There are many challenges for the agricultural sector, especially in countries facing the problem of environmental mismanagement and under-investment in infrastructure and housing resulting in higher vulnerability, further accentuated by additional uncertainty for farmers as the limited ability to predict local impacts and the timing of particular weather events, negatively impacts farmers’ decisions about their production practices and inputs. While some parts of the KRU region (e.g., Siberia) are likely to benefit from increased temperatures, equally likely are water shortages in other parts of the region. In Russia, most of the precipitation is projected for the winter time, thus, it is possible that higher summer temperatures could offset precipitation and lead to drought. Although climate change in the region could create benefits and new development chances for the agricultural sector, due to low agricultural performance, the current yield gap for the former Soviet countries in Europe (including Ukraine and European Russia) is 4.5 times higher than the potential increase in production from climate change by 2050 (Olesen and Bindi, 2002).

Equally important is to consider impact of climate change on transport infrastructure which in many parts of the region is in need of improvement. Intense precipitation can weaken the road pavements and retaining walls while droughts can cause earth settling underneath the roads and transportation lines or extreme road deterioration through high temperatures. For example, in Kazakhstan truck travel is limited on hot summer days due to the softening asphalt.

Conclusion and policy priorities

Results of this paper indicate that:

- following negative growth rates immediately after disinvestment in agriculture after the collapse of former Soviet Union, more recent yield growth rates in the KRU region are stronger than elsewhere. However, this masks a standard problem across transition economies where yields (and production in general) declined following the collapse of planned economy and disinvestment following structural changes in Eastern Europe and former Soviet Union.
- In Kazakhstan, Russia and Ukraine – countries that aim to play an increasingly important role on the world market – yield growth is slow and yield variability is often higher than in other countries studied.

In addition to the production challenges, given the length of the experience with the market economy, there are relatively more obstacles and inefficiencies in the marketing channels. Some of these are due to lack of experience of market agents (farmers, traders, etc.), some - to poorly developed or lacking market institutions, some - to lack of infrastructure, and some - to government policies.

An inefficient market raises the cost of obtaining farm inputs and reduces the prices farmer receive for products at the farm gate. The best example is the gap between the farm price and the export price (for an exporting country), which is essentially transport and handling costs. The gap is higher if market infrastructure is bad, if inspections, grades and standards are poorly developed or administered, or if the government introduces excessive fees or barriers (such as export quotas, duties or bans). If the farm credit market is not well developed or if it serves only a favored group of farmers, then it impedes production growth and sometimes leads to credit provided by input suppliers, produce buyers or others. Swinnen (2011), for example, developed an analytical framework to show how contracting by upstream or downstream firms can emerge endogenously to provide such credit when the credit market fails. Either way, the cost of credit very likely increases. Petrick et al (2011) also provide numerous examples of the interdependencies across different types and sizes of farms in Kazakhstan for obtaining inputs or machinery services.

Finally, when land sales are not permitted, leasing becomes more important as a means to adjust land use patterns and farm operating units. The rise of agro-holdings in Russia, Ukraine and Kazakhstan is itself an example of market agents developing farming systems that would rarely if ever be seen in a well-functioning market. The emergence of these mega-farm operations can be seen as a way to overcome the deficiencies in land and commodity market institutions in these countries, and their rapid growth may also reflect lack of transparency and poor enforcement of existing laws.

Whether market inefficiencies are due to government action or inaction, lack of functioning institutions or to the "learning by doing" of market agents, improved institutions and government policy are the means to improving market performance. Improving market efficiency is one of the most effective and low-cost means to increase farm production and income and stimulate more investment in agriculture. In some cases improving market efficiency means the government doing less and in some case it means doing more. We provide short lists of means for

1) correcting deficiencies: One of the clearest examples of benefit from clarifying rights to agricultural land is that private investment in farms is the dominant source of agricultural investment, and such investment is stifled as long as land right are not clear. Whether it be ownership or clear and long term leasing contracts, lack of clarity only delays needed private investment. In Western Europe and North America there is also a large amount of land leased by owners to other users, but the property rights are well defined and well protected, so investment is not impaired.
2) removing barriers: The most obvious barriers recently have been export bans, quotas and taxes, and these are also the easiest to remove, but also rather easy to install. Another type of business environment that is unfavorable to investment and agricultural development is policy bias, such as when certain types of farms are favored based on size, ownership structure or management system. The best way to foster the conditions that encourage competitiveness and increased productivity is to let farms of different types, sizes, ownership and locations compete on a level playing field. It is the best way to know which type of farm is best in different conditions or locations.
3) supporting policies: Give priority to public goods that enhance the ability of farmers and investors to access markets, market information, technology, risk management tools and credit. Such public goods include data collection, market information systems, extension and advisory services, agricultural R&D, roads, as well as education and health services in rural areas.

Responding to climate change, smaller private farms seem to be more flexible in responding to changing climate conditions, however, larger farms generally would have superior climate information and expanded access to credit; while government-owned farms would have better access to state sources of information and finance. Corporate farms in Russia, and northern Kazakhstan represent the largest type of farm and have the greatest physical and human capital resources. The cooperative or group farms can use economies of scale, however, their managers may lack the technological know-how (also about financing these farms), which makes them more vulnerable to changing climatic conditions. The largest and fastest growing farm group is small family farms producing for commercial market at a small scale, which have a high share in the Balkan countries, Turkey, Caucasus, and Central Asia, as well as in Central and Eastern Europe and Russia. These farms may be highly vulnerable to climate change due to their size, the farmers' limited technical knowledge, and poor access to public and private information and financial services, poor environmental management, ill-defined property rights, as well as increasing demand for standardized and safe products (Easterling et al., 2007).

In setting priorities, a guiding principle should be to give priority to policies that contribute to long-term development goals and avoid policies that conflict with long-term development. One way to focus priorities is to emphasize good governance and provision of public goods (Meyers et al., 2012).

Farmers, consumers and the national economy gain from improvements in market efficiency, improved transport infrastructure and market information systems, and increased competition, efficiency and transparency in the marketing chain. The government's role is to create this enabling environment.

It has been asserted that the future will most likely see a continuation of the kind of price and market volatility that we have seen in recent years. Risks associated with yield and price variability can be mitigated with good risk management tools such as yield, price and/or revenue insurance, market information systems and contract facilitation. Government can provide assistance to the private sector in developing and offering such tools and use prudent incentive measures to encourage adoption.

References

Akimbekova, G. 2006. "Formirovanie Effektovnoy Sistemy Proizvodstva, Pererabotki i Sbyta Sel'skokhozyaystvennoy Produkcii," Almaty, Kazakhstan.

Bruinsma, J. 2009. "The Resource Outlook to 2050: By How Much Do Land, Water and Crop Yields Need to Increase by 2050?". Prepared for the expert meeting on How to Feed the World in 2050. Available at ftp://ftp.fao.org/docrep/fao/012/ak971e/ak971e00.pdf. Accessed May 25, 2013.

Demyanenko, S. 2008. "Agriholdings in Ukraine: Good or Bad?" The Institute for Economic Research and Policy Consulting. Kiev, Ukraine. Available online at http://www.ier.com.ua/en/publications/consultancy_work/?pid=1497. Accessed 28 October 2011

Epshtein, D., Hahlbrock, K. and Wandel, J. 2013. "Why are Agroholdings so Pervasive in Russia's Belgorod Oblast'? Evidence from Case Studies and Farm-level Data." *Post-Communist Economies*, 25:1: pp. 59-81

FAO. 2009. "The Technology Challenge," Rome, Italy. Available at http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Technology.pdf. Accessed May 25, 2013.

FAO-EBRD. 2009. "Grain Markets in Kazakhstan, the Russian Federation and Ukraine", prepared by D. Pryhodko. Rome, Italy. Available online at http://www.eastagri.org/files/Grain-Markets-KZ_RU_UA.pdf.Accessed May 25, 2013.

FAOSTAT. 2013. Available online at http://faostat.fao.org/default.aspx. Accessed May 25, 2013.

Gagalyuk, T. 2011. "Structure, Main Characteristics and Development of Ukrainian Agroholdings". Available online at https://moel.uni-hohenheim.de/fileadmin/einrichtungen/moel/Downloads/Gagalyuk_Hohenheim_Oct_2011.pdf. Accessed May 25, 2013

IKAR (Institute for Agricultural Market Studies). 2010. Available online at http://www.ikar.ru/eng/. Accessed May 25, 2013

Liefert, W., Liefert, O., Vocke, G. and E. Allen. 2010. "Former Soviet Union Region to Play Larger Role in Meeting World Wheat Needs." *Amber Waves*, 8 (2): pp. 12–19

Meyers, W. and S. Meyer. 2008. "Causes and Implications of the Food Price Surge" FAPRI-MU Report, 12.

Meyers, W.H., Ziolkowska, J., Tothova, M. and Goychuk, K. 2012. "Issues Affecting the Future of Agriculture and Food Security for Europe and Central Asia." *FAO Regional Office for Europe and Central Asia. Policy*

Studies on Rural Transition No. 3. Available at http://www.fao.org/docrep/017/aq343e/aq343e.pdf. Accessed May 25, 2013.

OECD. 2011a. "Agricultural Policy Monitoring and Evaluation 2011: OECD Countries and Emerging Economies". OECD Publishing, Paris.

OECD. 2011b. "Producer and Consumer Support Estimates Database." Available online at http://www.oecd.org/document/59/0,3746,en_2649_37401_39551355_1_1_1_37401,00.html. Accessed May 25, 2013.

OECD-FAO. 2012. "Agricultural Outlook 2012-2020," OECD Publishing. Available online at http://www.agri-outlook.org/pages/0,2987,en_36774715_36775671_1_1_1_1_1,00.html. Accessed May 25, 2013.

Olesen, J., Bindi, M. 2002. "Consequences of Climate Change for European Agricultural Productivity, Land Use and Policy." *European Journal of Agronomy* 16 (2002): p. 239-262.

Petrick, M., Wandel, J., and K. Karsten. 2011. "Farm Restructuring and Agricultural Recovery in Kazakhstan's Grain Region: An Update", Leibniz Institute of Agricultural Development in Central and Eastern Europe, Leibniz, Germany. Available online at http://www.iamo.de/dok/_3903.pdf. Accessed 25 November 2011.

Swinnen, J., Vandemoortele, T., and A. Vandeplas. 2011. "Food Market Instability and Market Failures: A Theoretical Analysis with Endogenous Institutions." Paper prepared for presentation at the EAAE 2011 Congress, August 30 to September 2, 2011, ETH Zurich, Zurich, Switzerland.

Trostle, R. 2008. "Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices." USDA/ERS Report WRS-0801. 23 July 2008 (revised). Available online at http://www.ers.usda.gov/Publications/WRS0801/. Accessed May 25, 2013.

USDA. 2013. Production, supply and distribution online. http://www.fas.usda.gov/psdonline/. Accessed May 15, 2013.

Visser, O. and Spoor, M. 2011. "Land Grabbing in Post-Soviet Eurasia: the World's Largest Agricultural Land Reserves at Stake". *The Journal of Peasant Studies*, Volume 38(2), pp. 299-323.

von Cramon-Taubadel, S., Anriquez, G., de Haen, H. & Nivyevskiy, O. 2009. "Investment in Developing Countries' Food and Agriculture: Assessing Agricultural Capital Stocks and their Impact on Productivity," Paper prepared for FAO's Expert Meeting on "How to Feed the World in 2050," 24-26 June 2009, Rome, Italy. Available online at ftp://ftp.fao.org/docrep/fao/012/ak975e/ak975e00.pdf. Accessed May 25, 2013.

World Bank. 2008. "World Development Report 2008: Agriculture for Development," World Bank Publications, Washington, D.C.

World Bank. 2010. "The Business Environment and Enterprise Performance Survey At-a-Glance 2008 Cross Country Report," World Bank Publications, Washington, D.C. Available online at http://siteresources.worldbank.org/INTECA/Resources/BEEPS_Cross_Country_Report_2010.pdf. Accessed May 25, 2013.