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TWENTY-EIGHTH FAO REGIONAL CONFERENCE FOR EUROPE

Baku, Azerbaijan, 19 and 20 April 2012

Agenda Item 7

POLICIES FOR FOOD SECURITY IN THE REGION: CHALLENGES AND PERSPECTIVES - FOOD OUTLOOK TOWARDS 2050

Executive Summary

This paper discusses three long-term challenges for Europe and Central Asia based explicitly on FAO quantitative forecasts for 2030 and 2050 in Bruinsma (2012).

Dietary transition. As the region approaches 2030 there will be little undernourishment. However, within most subregions there will be a noticeable change in diets away from cereals, towards higher consumption of meat and dairy products. Coupled with the already fairly high levels of dietary energy supply, the change in diets will lead to increases in the prevalence of overweight and obesity and a corresponding increase in diet-related chronic Non-Communicable Diseases (NCDs). Projections of obesity rates in 2030 and 2050 indicate that the risk factors behind increased death rates from non-communicable diseases in the poorer countries will rise to levels not seen in the European Union (EU) countries even today. These increased risk levels will put even greater pressure on healthcare facilities in the poorer countries than in the EU countries. In brief, looking ahead to 2030 and beyond, the burden of diet-related non-communicable diseases will likely be higher in the poorer countries of the region, while the resources to address this burden will continue to be less.

Realizing the production potential of the region. A comparison of potential yields with current and projected yields for cereals in this region illustrates that there are three subregions which currently grow and will continue to grow cereals at yield levels far below their potential—Eastern Europe (Ukraine), the Caucasus and Central Asia and Turkey. Yield growth is important in the region because growth in yields is part of the process whereby farm incomes increase. While yield levels above 80 percent are not likely to be economically rational, growing at only 30-40 percent of potential is cause for concern. In the subregions identified, the degree of investment risk, largely a function of agricultural policies, and particularly their instability, may be excessive. It may therefore be prudent to re-examine short-term agricultural policies with the aim of ensuring long-term production growth and food security.

Sustainable resource use. Perhaps the main issues for countries of the European and Central Asian region is ensuring environmentally *sustainable* agricultural production in the long run. In the EU the

difficulties are illustrated by fertilizer use per hectare. Already quite high by world standards, this is set to grow by 20 percent by 2050 with current cultivation methods. Moderating chemical input use in this subregion, as well as in others, may require faster adoption of cultivation technologies that substitute knowledge for chemical inputs.

Though the Caucasus and Central Asian countries do not share the high levels of chemical applications of their more developed neighbours, they have highly intensive use of available water resources. In fact, after the Near East and North African region, the Caucasus and Central Asian subregion currently has the highest pressure on water resources due to irrigation, known as *water stress*. The problem of the region is not a shortage of water, but a dilapidated system of water delivery and application that loses up to half of water supplies en route and applies water inefficiently. The rehabilitation and maintenance of this system and the improvement of on-farm water management to reduce losses are the first steps towards reducing water stress in the region.

Guidance Sought

Alleviating food insecurity and malnutrition in the region is one of the priorities of the Organization. Member countries may wish to provide guidance on future work in the Europe and Central Asia region related to nutrition, commenting on the challenges presented by the **dietary transition in Europe and Central Asia** and the costs associated with control of non-communicable diseases in the member countries of the region.

Would member countries like to see more work by FAO on nutrition issues in this region? What should be the mix between normative, analytical and project-related work? In this connection, should FAO provide a special thematic joint FAO/WHO study by the next regional conference focusing on malnutrition in Europe and Central Asia and on recommendations for FAO, the World Health Organization (WHO) and member countries of the region

Promoting sustainable intensification of smallholder agriculture in this region is one of the priorities of the Organization. Member countries are invited to consider the challenges of **realizing production potential in European and Central Asian agriculture**, particularly of bridging the yield gaps in those countries where they are far below the average for the region of about 50 percent for wheat and barley. Member countries may also wish to provide guidance on future work in the region related to yield gaps.

Would member countries like to see more work by FAO on this topic in this region?

What should be the mix between analytical and project-related work?

Should FAO undertake a survey-based study on addressing yield gaps in the countries of the region in which actual yields as a portion of potential yields are particularly low and identify the capacity development requirements in these countries?

Promoting sustainable resource use is one of the priorities of the Organization in this region. Member countries have stressed to the Regional Office for Europe and Central Asia (REU) that **sustainable resource use in Europe and Central Asia** is of key importance. Member countries are encouraged to reflect on how they would like the issue addressed by FAO. Member countries are invited to comment on the challenges presented by high levels of chemical inputs in some countries and the sustainable use of water in other countries.

I. CHALLENGES OF EUROPEAN AND CENTRAL ASIAN FOOD AND AGRICULTURE TO 2050

1. The world has experienced a number of severe shocks in recent years with record high oil prices, agricultural commodity price spikes, dramatic droughts, food security fears and trade restrictions, as well as the most serious global economic recession since the 1930s (**Annex I**). As a reaction to these shocks many countries devoted considerable resources to short-term programmes designed to control domestic commodity prices. Some of these policies, such as trade bans, actually increased market volatility and raised fears of food shortages. Others, such as trade barriers, increased food price volatility, rather than diminished it, since domestic commodity production is far more volatile than world production.

2. While governments undoubtedly need to respond to short-term shocks they should not lose sight of the longer-term challenges of food and agriculture. This paper discusses three long-term challenges for Europe and Central Asia based on FAO quantitative forecasts for 2030 and 2050.[1] It differs from other works on the "future of agriculture" in that it is based explicitly on and consistent with FAO perspectives work.[2] While grounding the challenges in well-considered quantitative forecasts should increase their degree of realism, this also comes at a price. The FAO forecasts are based on specific assumptions, and the topics are limited to those covered by the forecasts for Europe and Central Asia in Bruinsma (2012), which are apparent food consumption, agricultural production and input use for the main regions and subregions of the world (**Annexes II and III**). Despite these limitations, FAO forecasts allow us to shed light on three long run challenges in Europe and Central Asia to 2050: (i) coping with the dietary transition; (ii) realizing the production potential for the region and (iii) ensuring the sustainable use of natural resources in the face of the need to increase production. The following three sections take up each of these topics in turn. The paper includes a decision box outlining possible actions for FAO and Member States in the region.

A. Challenge 1: The Dietary Transition in Europe and Central Asia

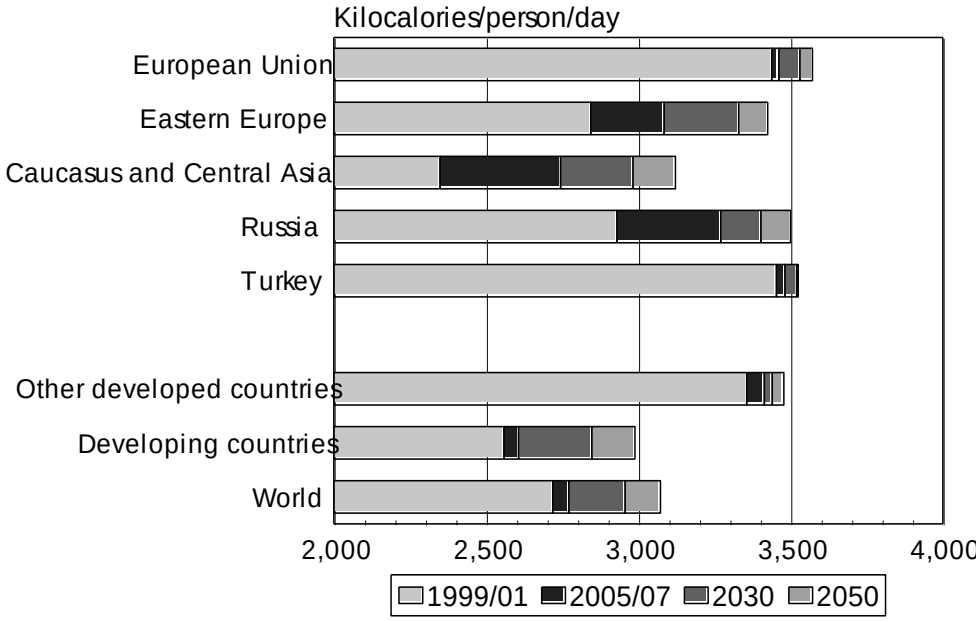
3. Economic development is normally accompanied by improvements in a country's food supply and the gradual elimination of dietary deficiencies, thus improving the overall nutritional status of the country's population. It also brings about qualitative changes in the production and marketing of food leading to the consumption of more processed food. Increasing urbanization also has consequences for the dietary patterns and lifestyles of individuals, not all of which are positive. Changes in diets, patterns of work and leisure – often referred to as the "nutrition transition" – contribute to the causal factors underlying non-communicable diseases even in the poorest countries (Pinstrup-Anderson and Watson, 2011). The adverse dietary changes include shifts in diet away from cereals and fibrous tubers, reduced fruit and vegetable intake, and increases in the consumption of saturated fat (mostly from meat and dairy products), vegetable oils, sugar and sodium.

With the exception of the Caucasus and Central Asian (CCA) countries, the Europe and Central Asia (ECA) region has long ago embarked on the nutrition transition. Average available dietary energy supply has long been over 3,000 kilocalories per day per person for most of the region's population, and has recovered to that level in the Russian Federation and Eastern Europe since economic growth resumed after 1998. The only subregion lagging behind is the Caucasus and Central Asian countries, which is expected to pass the 3,000 kilocalorie mark sometime between 2030 and 2050 (**Figure 1**).

[1] The end date of 2050 was chosen because current population forecasts indicate that world population will peak around 2075 at some 9.5 billion, with the bulk of the increase from the present (2005/07) 6.6 billion occurring by 2050.

[2] The FAO perspectives work includes papers presented at the 2009 expert meeting on "How to feed the world in 2050," later collected and published in Conforti (ed., 2011) and Bruinsma (2012).

Figure 1. **Per caput food consumption (kcal/person/day)**



* No FAOSTAT data are available for individual countries of the former USSR and Central and Eastern Europe for the period 1961 to 1991.

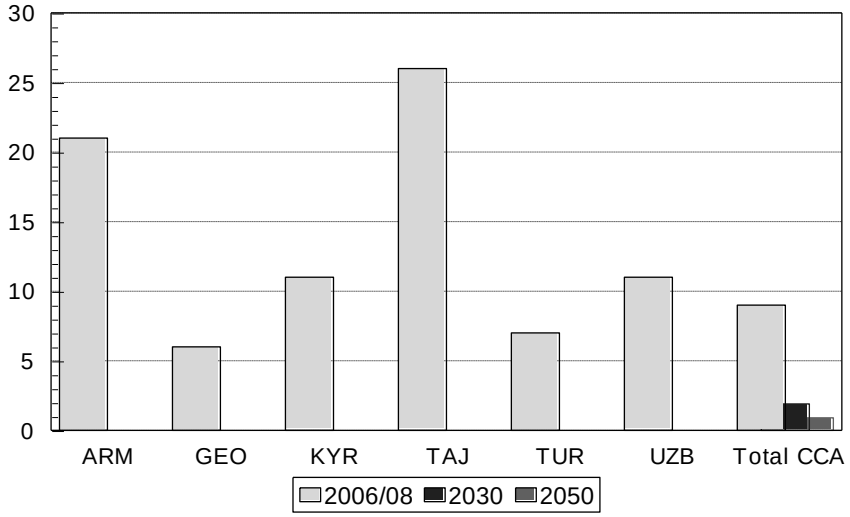
Source: Bruinsma, 2012.

4. The lower average level of available dietary energy supply in the CCA has implications for the level of hunger there. The latest available estimates of undernourishment indicate that hunger is a major issue in ECA only in the countries of the CCA.[3] In all other countries of the region the incidence of hunger is less than 5 percent of the population. A closer look shows that hunger appears to be a particularly significant problem in Tajikistan, Armenia, Uzbekistan and Kyrgyzstan. Poverty and malnutrition are a problem in these countries and in Georgia and Azerbaijan as well.

5. Projections of the prevalence of undernourishment show a diminishment of hunger in all subregions within the ECA with a decrease from 9 to 2 percent in the CCA by 2030 and a further halving by 2050 (**Figure 2**). By 2050 undernourishment in the CCA should be under one percent. This trend is shared by the developing countries which will see a halving of the incidence of hunger by 2030 and another halving by 2050 (Bruinsma, 2012). Certainly, the FAO indicator of undernourishment is only a partial indicator of malnourishment based on apparent caloric consumption. It does not cover micronutrient deficiencies, which may remain substantial after 2050. However, as a general indication of the degree of hunger, the FAO indicator is perhaps adequate for projections to 2050.

[3] Undernourishment, the FAO measure of the incidence of hunger, refers to the condition of people whose dietary energy consumption is continuously below a minimum dietary energy requirement for maintaining a healthy life and carrying out light physical activity with an acceptable minimum body weight for attained height.

Figure 2. Prevalence of undernourishment in the Caucasus and Central Asia: base period and projections to 2050



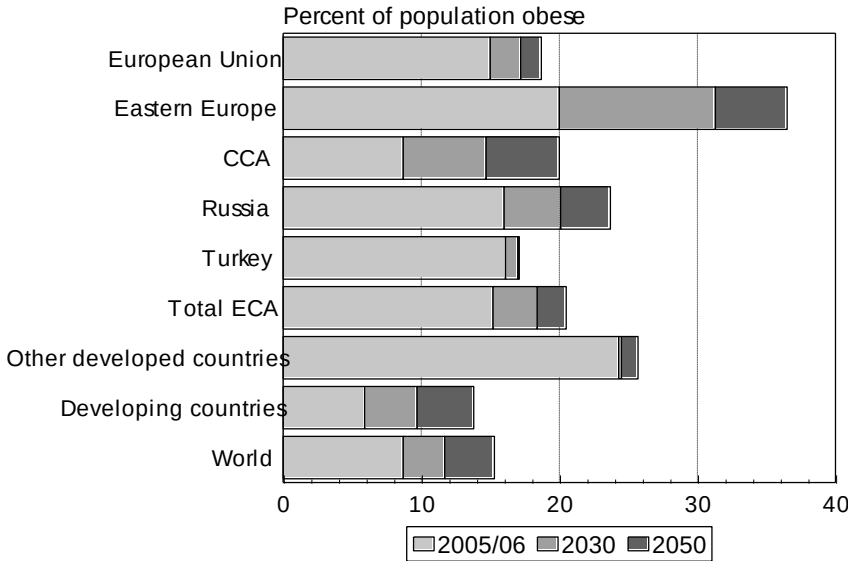
Key: ARM=Armenia, GEO= Georgia, KYR=Kyrgyzstan, TAJ=Tajikistan, TUR=Turkmenistan, UZB=Uzbekistan, Total CCA= Total Caucasus and Central Asia.

Sources: FAO Country Statistics on Food Security (http://www.fao.org/economic/ess/ess-fs/mdg/en).

Note: Undernourishment projections are available only for subregions of the region, not countries.

6. This is, of course, very good news. As the region approaches 2030 there will be little undernourishment. However, within most subregions there will be a noticeable change in diets away from cereals, towards higher consumption of meat and dairy products. Coupled with the already fairly high levels of dietary energy supply, the change in diets will lead to increases in the prevalence of overweight and obesity and a corresponding increase in diet-related chronic Non-Communicable Diseases (NCDs) (**Figure 3**).

Figure 3. **Prevalence of obesity in Europe and Central Asia and other regions in 2005/07, 2030 and 2050**



Notes: Obesity is defined as BMI>30; obesity data for 2005/07 are from WHO, Organisation for Economic Co-operation and Development (OECD) and the International Obesity Task Force (IOTF).

Source: Bruinsma, 2012.

7. There are major health inequalities within Europe and Central Asia, which centre on differences between countries of the European Union and the former Soviet countries (WHO Regional Office for Europe, 2010). However, in one respect, the countries of Europe and Central Asia are very similar: throughout the region the primary cause of death is non-communicable diseases.[4] As a general indicator of longevity, life expectancy at birth in the EU is usually higher than in the countries to the East. However, the big difference between the EU and other countries is in age-standardized death rates from NCDs, which in the EU are quite a bit lower than in the countries of the former Union of Soviet Socialist Republics (USSR). This difference reflects dietary habits and other lifestyle factors (including alcoholism) on either side of the border as well as better health care (**Table 1**).

8. The projections of obesity rates in **Figure 3** indicate that the risk factors behind increased death rates from non-communicable diseases (**Table 1**, columns 4 and 5) in the poorer countries will rise to levels not seen in the EU countries even today. These increased risk levels will put even greater pressure on healthcare facilities in the poorer countries than in the EU countries, while the financial resources to cope with these risks will continue to be far lower in the poorer countries. In brief, looking ahead to 2030 and beyond, the burden of diet-related non-communicable diseases will likely be higher in the poorer countries of the region, while the resources to address this burden will continue to be less.

Table 1. Non-Communicable Disease Deaths in Europe and Central Asia

Country	Life expectancy at birth		% of all deaths from NCDs	Age Standardized Death Rates from all NCDs	
	(2008 or latest year)		2010	(Deaths from NCDs in 2010 per 100,000 population)	
	Males	Female		Male	Female
Sweden	79.3	83.4	90	390	267
Italy	78.8	84.4	93	400	245
Germany	77.2	82.4	91	460	290
Tajikistan	71.2	76.3	59	678	759
Armenia	70.4	76.8	90	1,156	693
Hungary	70.0	78.3	93	845	457
Turkey	69.4	74.3	85	708	405
Uzbekistan	68.2	73.0	79	938	734
Kyrgyzstan	64.6	72.7	77	1,088	758
Belarus	64.6	76.3	87	1,067	518
Ukraine	62.3	74.0	86	1,122	583
Russian Federation	60.5	73.3	83	1,109	562

Sources: WHO Non-communicable diseases country profiles 2011 (http://www.who.int/nmh/countries/en/); WHO Regional Office for Europe, 2010; Bruinsma, 2012.

[4] The exception is Tajikistan, the poorest country of the region, where only 59 percent of deaths in 2010 were caused by non-communicable diseases. In 2010, 37 percent of deaths were caused by communicable diseases, maternal, perinatal and nutritional conditions, and 4 percent were caused by injuries.

9. The difficulties of projecting obesity rates forty years from now should not be underestimated. There are many factors contributing to these rates, as well as the death rates from non-communicable diseases. It may certainly be argued that food production in itself is not the most important factor behind obesity. Rather, lifestyle habits, poverty and medical care are the chief contributing factors to obesity rates and their connection to non-communicable diseases and death. Concentrating on food production and consumption while ignoring or keeping these factors relatively stable may not be a realistic assumption, particularly while overweight and obesity rates climb dramatically. It may even be argued that obesity issues are not within the mandate of FAO because of the predominant role of other factors.

10. Malnutrition issues are undoubtedly not solely the mandate of FAO, and there is a lot more to them than can be covered in this short summary. However, because they are multi-faceted, they have a tendency to fall through the cracks. As the less developed countries of Europe and Central Asia are expected to have some of the highest rates of overweight and obesity in the world by 2050 the issue may, at the very least, require further study.

B. Challenge 2: Realizing Production Potential in European and Central Asian Agriculture

11. Growth in agricultural production in the long run perspective to 2050 will be driven by the growth of domestic and export demand. In Europe and Central Asia as a whole demand is projected to grow slowly for two reasons. First, population growth in the region is very close to zero over the entire projection period, turning negative towards the end (**Table 2**). Stagnant population growth would not limit the growth of food demand if incomes were low and growing quickly. However, a large share of the region's population has already attained a fairly high level of per capita food consumption, beyond which the scope for further increases is rather limited. Recall from **Figure 1** that average daily energy supply (DES) in the European Union, Other Europe and Turkey in 2005/07 already exceeded 3,450 kcal.

Table 2. Population: data and projections

	1961/63	**2005/07**	**2030**	**2050**	**2005–50**	**2005–10**	**2045–50**
	million persons				annual growth (% p.a.)		
European Union	411	492	506	494	0.00	0.31	-0.17
Eastern Europe	66	73	65	57	-0.57	-0.52	-0.67
Caucasus and Central Asia	37	75	91	96	0.58	0.93	0.12
Other Europe	12	19	23	26	0.64	1.03	0.36
Russian Federation	123	143	129	116	-0.47	-0.39	-0.51
Turkey	30	72	90	97	0.69	1.24	0.20
Total Europe and Central Asia	678	874	904	886	0.03	0.27	-0.16
Other developed countries*	337	539	613	641	0.39	0.73	0.16
Developing countries**	2 127	5 179	6 792	7 623	0.89	1.39	0.41
World	3 141	6 592	8 309	9 150	0.75	1.19	0.34

Source: World Population Prospects: The 2008 Revision (United Nations, 2009; Medium Variant)

* Canada, USA, Japan, New Zealand, Australia, South Africa

** In all tables 'developing countries' excludes Turkey

12. These two factors – low population growth and already high consumption – will limit annual growth in both per capita and total production in the region to levels quite a bit lower than in other

regions of the world. Nevertheless, total agricultural production in Europe and Central Asia is still expected to grow by about 20 percent by 2050 in order to feed the population of the region and to satisfy export demand. The highest rates of growth will come in the poorer parts of the region, outside of the EU. While production in the EU will grow by 11 percent, that in the CCA is expected to increase by 52 percent and by 44 percent in Turkey (Bruinsma, 2012). How will the region accomplish this, through increased land use or by further intensification of production?

Land use in Europe and Central Asia

13. The world's arable land area has been steadily expanding since the early 1960s by about 4 million ha per year. This trend is result of two divergent developments. While in developing countries land has been expanding by over 5 million ha per year, the arable area in developed countries peaked in the late 1960s and has been declining ever since at over 1 million ha per annum (**Table 3**). This trend is slated to continue over the projection period as land will be taken out of every subregion except for Eastern Europe and Other Europe. Overall arable land use will decline by nearly 10 percent by 2050.

Table 3. Land with rain-fed crop production potential (million ha)

	Land suitable for agriculture*	In use	Not usable**	Available, but not used	
				Million ha	Portion of land suitable (%)
European Union	182	101	47	33	18
Eastern Europe	91	47	22	21	23
Caucasus and Central Asia	103	32	7	65	63
Other Europe	2	1	1	0	0
Russian Federation	404	115	208	81	20
Turkey	34	21	3	10	29
Total Europe and Central Asia	816	318	287	210	26
Other developed countries	810	257	306	247	30
Developing countries	2834	680	1208	947	33
Rest-of-world***	35	4	23	8	23
World	4495	1260	1824	1412	31

Source: Global Agro-Ecological Zones (GAEZ) v3.0 in Fischer *et al.*, 2011.

* Crops considered: cereals, roots and tubers, sugar crops, pulses and oil-bearing crops.

** Land under forest, built-up or strictly protected.

*** Countries not included in the regions above.

14. The decline in land use in this region is not because of falling land availability. On the contrary, the region currently uses only 75 percent of the land available for agricultural use, and that percentage is slated to fall, as unprofitable land is taken out of use. The net available land in the region is some 210 million ha, most of it in the Russian Federation and the Caucasus and Central Asia, with virtually no land left in the group Other Europe. Much of this net balance is not actually readily available to agriculture, as lands may suffer from ecological fragility, be remote and inaccessible and lack infrastructure. Moreover, even if such land is fit to till, it may quite well be unprofitable to till. Overall, however, it is fair to say that there are considerable areas with agricultural potential left in the European and Central Asian region.

15. The availability of land, particularly in the Russian Federation and Ukraine, has prompted some authors (European Bank for Reconstruction and Development (EBRD)-FAO, 2008) to note that these countries have the potential to provide plentiful land for expansion of production. However, the same could be said for most other subregions of the region, including the EU. But none of this is very relevant, because in fact each subregion has been taking land out of production over the past few decades and is likely to do so in the future, with the single exception of Ukraine (in Eastern Europe). Even in that country the increase will be marginal.

Crop yields and yield gaps in Europe and Central Asia

16. With land use set to fall, it is expected that growth in crop yields will continue to be the mainstay of crop production growth.[5] Although both crop production and yield growth are expected to fall over the projection period, such growth will continue to be needed. But will yield increases continue to be possible and what is the potential for a continuation of such growth?

17. Such concerns are often based on the observed global slowdown in yield growth for major crops, in particular cereals (World Bank, 2008). Though some researchers point to supply-side issues, such as exhaustion of the easy gains from adopting green revolution inputs (Bezanson, 2011), the reasons for the slowdown are more likely to be found in the observed deceleration in world cereal demand than in resource constraints becoming binding. Growth in cereal demand is decelerating in response to a slowing population growth and to an ever-increasing share of world population attaining medium to high levels of food intake. This generalization is not only true for cereals, but for both crops and livestock, perhaps with the exception of livestock production in Sub-Saharan Africa and South Asia (World Bank, 2008).

18. Additional evidence that the slowdown in yield growth is more a consequence of the slowing of demand growth rather than of supply constraints can be found in the literature on "yield gaps." Yield gaps can be defined as the difference between actual yields of any given crop and those that are agronomically attainable given a country's specific agro-ecological endowments for that crop. **Table 4** shows the potential yields (for high input rainfed farming) on prime and good land for wheat and barley, and compares them with actual prevailing yields. It is obvious that in most cases actual yields are still far below potentially attainable ones. For example, average wheat yields in Europe and Central Asia are at present some 50 percent of agronomically attainable ones, and this could go up to some 70 percent by 2050.[6]

19. The reasons why country average yields differ from the agro-ecological potential yields are to be found in farm economics. It is often not profitable for farmers to provide the inputs needed to attain substantially higher yields, given the current level of risk, investment, marketing infrastructure and agricultural policies (Lobell, Cassman and Field, 2009). But why the apparent differences in yield gaps between, for example, EU countries and the less developed areas of Europe and Central Asia? The answer is most likely to be found in (i) the level of farm management and marketing knowledge, (ii) the degree of investment and production risk, largely a function of agricultural policies, (iii) the level of marketing infrastructure in place, and (iv) marketing chain efficiency.

[5] Between 1961 and 2007 yield growth accounted for between 70 and 80 percent of production growth in wheat, rice and maize in developing countries (Conforti, ed., 2011).

[6] This statement needs two important qualifications which elucidate that these ratios are upper limits. First, the attainable yield used here is an average of the yields on prime and good land. If, for example, we assume that all of the 77 million ha currently under wheat would be on prime land, then the actual and projected yields would be 'only' 36 and 49 percent respectively of the attainable yield on prime land. Second, the attainable yield concept used in the GAEZ is a static one, i.e. they are yield estimates based on current knowledge. It is reasonable to assume that given the resource base, technical progress will cause attainable crop yields by 2050 to be considerably higher than what they are at present.

Table 4. Actual and potential land and yields for wheat and barley

	suitable land		attainable yields		actual and projected yields		as percent of attainable yields	
	prime	good	prime	good	2005/07	2050	2005/07	2050
	million ha		ton/ha		ton/ha		percent	
wheat								
European Union	72.9	103.3	9.15	6.07	5.02	5.98	68	81
Eastern Europe	36.8	39.5	9.06	6.85	2.71	3.13	34	40
Caucasus and Central Asia	3.0	53.2	8.69	4.22	1.25	1.52	28	34
Other Europe	0.5	1.7	8.39	5.24	4.26	4.76	72	81
Russian Federation	95.0	325.6	7.14	3.99	1.96	3.94	42	84
Turkey	3.6	21.9	7.03	5.92	2.03	2.44	33	40
Total ECA	211.6	545.2	8.19	4.70	2.92	4.05	51	71
barley								
European Union	68.3	107.5	9.10	6.03	4.07	4.58	56	63
Eastern Europe	40.1	48.0	9.11	6.99	2.07	2.81	26	35
Caucasus and Central Asia	3.0	52.1	8.65	4.04	1.15	1.64	27	38
Other Europe	0.4	1.7	8.39	5.08	3.63	3.96	63	69
Russian Federation	81.0	339.5	6.83	4.00	1.83	2.20	40	48
Turkey	4.4	21.0	6.98	5.91	2.46	2.45	40	40
Total ECA	197.2	569.7	8.12	4.71	2.82	3.18	50	57

Note: Based on GAEZ estimates for rainfed high-input agriculture. 'Prime land' is GAEZ Very Suitable land with attainable yields between 80 and 100 percent of maximum; 'good land' is GAEZ Suitable land (yields between 60 and 80 percent of maximum) and GAEZ Moderately Suitable land (yields between 40 and 60 percent of maximum). Actual and projected yields as a percentage of attainable yields were calculated as a percentage of the average weighted attainable yield on prime and good land.

Source: Bruinsma, 2012.

20. To put this seemingly theoretical discussion into policy terms, three subregions in the ECA are currently growing and will continue to grow cereals at yield levels far below their potential—Eastern Europe (Ukraine), the Caucasus and Central Asia, and Turkey. Yield growth is important in the region because growth in yields is part of the process whereby farm incomes increase. The large yield gaps in the less developed countries of the region are a cause for concern because of this link with farm incomes. While yield levels above 80 percent are not likely to be economically rational (Lobell, Cassman and Field, 2009), growing at only 30-40 percent of potential is cause for concern. In these countries the degree of investment risk, largely a function of agricultural policies, and particularly their instability, may be excessive. It may therefore be prudent to re-examine short-term agricultural policies with the purpose of ensuring long term production growth and food security.

C. Challenge 3: Sustainable resource use in Europe and Central Asia

21. Europe and Central Asia is divided into two subregions with regard to input use: a subregion of highly intensive farming and one of considerably more extensive farming. The former includes the

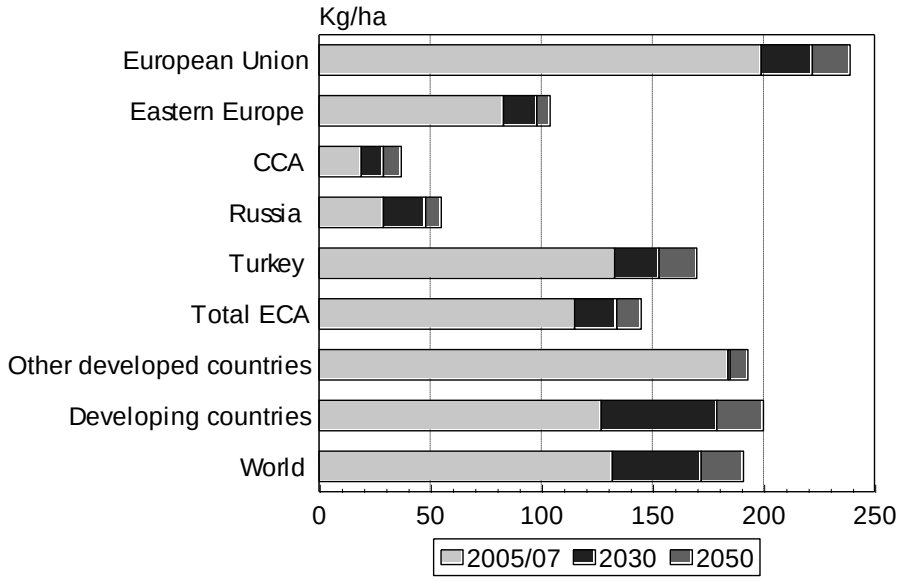
EU, which is the home to some of the most intensive farming in the world, Turkey and, in the case of water use, Central Asia.

22. Contrary to what is sometimes believed, intensification of agricultural production per se need not cause environmental degradation. It is rather the *mismanagement* of resources and inputs that causes environmental damage: overgrazing, inefficient use of water, overuse and untimely application of fertilizers and pesticides, etc. Certainly, the more intensive is agricultural production in a given area, the more need there is for proper regulation, incentives for internalizing environmental externalities, and for collective action by stakeholders (such as non-governmental organizations (NGOs)) to monitor possible environmental damage. This system of regulation, incentives and collective action does not arise overnight. Even countries with relatively low levels of farming intensity need to develop their control and monitoring system in step with intensification of production. Otherwise, there is a risk of large-scale environmental damage, even in less intensive production farming systems.

The Two Worlds of Farming in Europe and Central Asia

23. **Figure 4** illustrates the dividing lines between intensive and extensive farming in Europe and Central Asia from the point of view of fertilizer use per hectare, which is here employed as an indicator of chemical inputs. Clearly, one of the most important issues for countries of the EU and other developed countries is making farm production sustainable by providing incentives and regulation, as well as collective action by stakeholders, to ensure that environmental externalities are internalized in farming decisions. Europe's concern with environmental sustainability should continue through 2050, as fertilizer use per ha is projected to grow by 20 percent. Though the amount of fertilizer and presumably other chemical inputs consumed per ha in other regions of Europe and Central Asia is not as high as in the EU, environmental externalities should still be a concern, particularly in Turkey and Eastern Europe.

Figure 4. **Fertilizer consumption: base year and projected**



Source: Bruinsma, 2012.

24. Though the Caucasus and Central Asian countries do not share the high levels of chemical applications of their more developed neighbours, they have highly intensive use of available water resources. In fact, after the Near East and North African region, the Caucasus and Central Asian subregion currently has the highest pressure on water resources due to irrigation, known as *water stress*. This situation is considered critical by experts, as the threshold for calling water use 'critical' is

a stress factor of 40 percent. This mainly concerns the countries around the Aral Sea which has been subject to continuing depletion. Water stress is set to continue for the Caucasus and Central Asian countries through 2050.

Table 9. **Annual renewable water resources and irrigation water withdrawal**

	renewable water resources	water withdrawal for irrigation			pressure on water resources due to irrigation (stress)		
		2005/07	2030	2050	2005/07	2030	2050
	cubic km				**percent**		
European Union	1498	64	68	71	4.3	4.5	4.7
Eastern Europe	201	23	24	24	11.2	12.1	12.1
Caucasus and Central Asia	287	140	139	141	48.6	48.3	49.0
Other Europe	606	1	2	2	0.2	0.3	0.3
Russian Federation	4404	42	41	40	1.0	0.9	0.9
Turkey	232	30	31	32	12.8	13.4	13.9
Total Europe and Central Asia	7228	300	305	310	4.1	4.2	4.3
Other developed countries	7109	280	283	283	3.9	4.0	4.0
Developing countries	27663	2182	2274	2334	7.9	8.2	8.4
Of which: Near East and North Africa	600	347		374	58		62
World	42000	2761	2862	2926	6.6	6.8	7.0

Source: Bruinsma, 2012.

Coping with the risk of environmental degradation due to intensive input use

25. As discussed in the preceding sections, the bulk of the projected increases in crop production will have to come from higher yields. In the agricultural input projections in Bruinsma (2012) higher yields will require higher fertilizer and other chemical input applications. Water for agricultural purposes in the Caucasus and Central Asian countries will also continue to be exploited at unsustainable levels to support substantial rates of crop growth in the region of 0.81 percent per year, second only to that of crop growth in Other Europe (0.99 percent).

26. Managing the stress on natural resources caused by these levels of growth will be a challenge for the region. One way to manage this situation is government incentives and regulation, as well as collective action by stakeholders, to ensure that environmental externalities are internalized in farming decisions. However, farmers operate within an environment set partly by government decisions, some of which are not possible to change in the short term. For instance, the near disappearance of the Aral Sea is associated with the Soviet decision to develop crop production in Central Asia supported by an economically unsustainable (in a market economy) irrigation and drainage system in the 1960s, as well as the rapid and severe decline in the efficiency of that system since the late 1980s. In the EU limited cultivation of genetically modified herbicide-tolerant and insect-resistant crops probably maintains the level of chemical plant protection products required for raising rapeseed, maize, sugar beets, cotton and soybeans at a level higher than it would be if such crops were more widely cultivated. The experience of Spain, the United States and other countries has been decreased insecticide and herbicide use in the cultivation of transgenic insect-resistant and herbicide-tolerant crops (FAO, 2003; United States Department of Agriculture (USDA)-Economic Research Service

(ERS), 2006; European Commission, 2008). These examples point to the role that policy could play in reducing the risks to the environment inherent in intensive crop production.[7]

27. Part of reducing the risk of environmental externalities is the adoption of techniques in which the use of chemical inputs can be replaced with knowledge inputs to make agricultural growth more sustainable. Some of these techniques are highlighted below.

Reducing pesticide use through knowledge-based inputs

28. There are three main approaches to pest control: (i) augmenting host plant resistance by growing plants resistant to a particular pest either by nature or as a result of agricultural research; (ii) integrated pest management through better maintenance of the balance between pests and their natural enemies and employing crop production systems that reduce losses from pests, such as crop rotation, and (iii) chemical pesticides (Pinstrup-Andersen and Watson, 2011).

29. Though the initial gains in yields from green revolution technologies came partly as a result of a sizeable increase in pesticide use, subsequent public research on *host plant pest resistance* reduced the need for chemical pesticides for rice and other crops substantially. Private research has successfully developed host plant pest resistance as well (Pinstrup-Anderson, 2011).

30. *Integrated pest management* (IPM) programmes have demonstrated that pesticide use often can be reduced considerably without affecting yields or farmer profits. IPM emphasizes the use of non-chemical measures to discourage the development of pest populations with the least possible disruption to agro-ecosystems, encouraging natural pest control mechanisms. The following main steps can be considered as typical for an IPM approach (FAO, 2012):

- crop rotation; inter-cropping for pest control;
- use of adequate cultivation techniques (e.g. seedbed sanitation, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing);
- use of pest resistant/tolerant cultivars and standard/certified seed and planting material;
- balanced soil fertility and water management, making optimum use of organic matter;
- prevent spreading of harmful organisms by field sanitation and hygiene measures (e.g. by removal of affected plants or plant parts, regular cleansing of machinery and equipment);
- protection and enhancement of important beneficial organisms, e.g. by the utilization of ecological infrastructures inside and outside production sites.

Reducing fertilizer use through precision agriculture

31. Precision agriculture can be defined as a farm management in which input use and cultivation methods – including seeds, fertilizer, pesticides, water, variety selection, planting, tillage and harvesting – can be varied to match varying soil and crop conditions across a field (Srinivasan, 2006). For example, this practice allows the farmer to vary the rate of fertilizer across the field according to the need identified by Global Positioning System (GPS) guided grid or zone sampling. Fertilizer that would have been spread in areas that do not need it can be placed in areas that do, thereby optimizing its use. Precision agriculture allows for the supply of field-level recommendation maps to precisely guide fertilizer applications. The adoption of variable rate technology for fertilizer application is highest in the United States, Canada and Australia, followed by the United Kingdom and France.

32. Precision agriculture management practices involve three steps. First, farmers collect information on field characteristics through yield monitors, which calculate location-specific yields during the process of harvesting. Next, the farmer creates soil and topological maps of fields using sampling techniques. Last, soil and yield maps are then used together to guide variable rate application

[7] There are, of course, other issues that need to be considered in evaluating transgenic crops. FAO (2000) supports a science-based evaluation system that would objectively determine the benefits and risks of each individual genetically modified organism (GMO). This calls for a cautious case-by-case approach to address legitimate concerns for the biosafety of each product or process prior to its release.

of fertilizer. After the initial investment, farmers can obtain higher yields and profits, providing a return on their investment. Yield monitors are now used in nearly half of maize and soybean fields in the United States, while adoption of the entire suite of technologies has been more limited. Nevertheless, variable rate application was used on about 20 percent of maize and soybean area in the United States by 2005 (Schimmelpfenning and Ebel, 2011).

Reducing water loss and erosion damage through no till or low till farming

33. Tilling is used to remove weeds, shape the soil into rows for crop plants and furrows for irrigation. Tilling a field reduces the amount of water loss, via evaporation, by around 0.85 to 1.9 cm per pass. Tilling also leads to unfavourable effects, such as soil compaction, loss of organic matter, death or disruption of soil microbes and other organisms and soil erosion. No-till farming is a technique for growing crops without disturbing the soil through tillage. In no-till agriculture seeds are directly deposited into untilled soil that includes the residues from the previous crop on the soil surface as mulch. Special no-till seeding equipment with discs or narrow tine coulters open a narrow slot into the residue covered soil which is only wide enough to put the seeds into the ground and cover them with soil. The aim is to move as little soil as possible in order not to bring weed seeds to the surface and not stimulating them to germinate. No-till preserves the water and organic matter in the soil and decreases erosion. Adequate weed management is the key to successful application of the system. Weed control is performed in this system using herbicides and through the adoption of appropriate crop rotations including the use of cover crops (Penn State, 2006).

Reducing water stress in Central Asia

34. There are two main rivers in Central Asia: the Amu Darya and the Syr Darya. The Amu Darya River rises mainly in Tajikistan and Afghanistan and flows to the Aral Sea through Uzbekistan and Turkmenistan. The Syr Darya River rises mainly in Kyrgyzstan and flows to the Aral Sea through Uzbekistan and Kazakhstan. The rivers are formed from runoff from snow and glacier melt in the mountainous upstream countries. However, arable land is mainly concentrated in the more populous downstream countries. (United Nations, 2004).

35. During the Soviet era, the central government in Moscow controlled the entire network of rivers shared among its republics through water-use quotas. The collapse of the Soviet Union drastically weakened water management in the region. In an effort to avert destabilization and possible conflict, all five Central Asian countries agreed to keep the water use quotas from the Soviet era in place, signing the Almaty Agreement in 1992. The 1995 Nukus Conference Resolution, signed by the five Central Asian countries, ratified these Soviet-era water allocations.

36. According to water allocations, Kyrgyzstan and Tajikistan are entitled to 3.97 percent and 10.69 percent of the combined Amu Darya and Syr Darya flows. This is equivalent to a mean annual flow of about 4.63 and 12.45 km^3. However, from 1990 to 2005, actual Kyrgyz diversions reportedly declined, from 13 to 6 km^3. This is widely attributed to deteriorating infrastructure. Furthermore, system-level inefficiencies imply annual consumption is only 2 to 3 km^3 (United Nations Development Programme (UNDP), 2008).

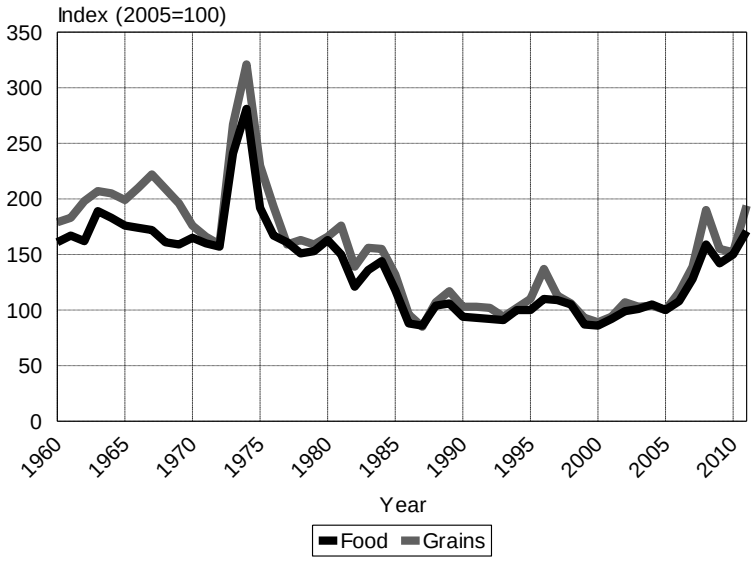
This calculation points to the key issue of Central Asian water stress: The problem of the region is not a shortage of water, but a dilapidated system of water delivery and application that loses up to half of water supplies en route and applies water inefficiently. The rehabilitation and maintenance of this system and the improvement of on-farm water management to reduce losses are the first steps towards reducing water stress in the region. As pointed out in the 2010 ECA document on "Challenges of Water Scarcity in the Europe and Central Asia Region and Recommendations for Adaptation," Central Asia has sufficient water resources for the population, agriculture and industry use.

ANNEX I

Recent price rises and volatility

In recent years, rising food prices and their volatility have caused worldwide concern about global food security, and have shaken the complacency caused by many years of falling commodity prices. Up until 2006 the cost of a global food basket fell by nearly half over the previous 40 years when adjusted for inflation. This long decline in world commodity prices ended in 2000, and the world has seen two price spikes since then. Though the 2006–08 and 2010–11 price spikes did not reach the level of the mid-1970s, real prices for food now are at a level not seen since then. The OECD-FAO Agricultural Outlook for 2011–20 projects that prices are likely to remain on a higher plateau in real terms compared to the previous decade (OECD/FAO, 2011).

Figure. World Bank Indices of Real Food and Grain Prices, 1960–2011



Source: World Bank, 2012.

There are numerous reasons for the recent increased level and volatility of food prices and an ongoing debate over what is important. There seems to be a consensus, however, on five main elements driving high and volatile prices:

1. **Supply shocks with low stock levels.** A critical trigger for price rises was the decline in the production of cereals in major exporting countries in 2005 and 2006, as well as in 2009 and 2010, both due to unfavourable weather. At the same time, world stocks have reached historically low levels compared to annual consumption.
2. **Energy prices**. Recent food price increases have occurred during a period of rising energy prices. Energy prices affect other commodity prices through rising costs of inputs, rising transportation costs and higher demand for biofuels.
3. **Trade restrictions.** As food prices began to rise in 2008 many governments faced pressure from consumers. Staple foods such as wheat and rice rose so fast that governments attempted to contain domestic food inflation in many ways. An FAO survey based on information from 77 countries found that in 2008, after the first price spike, about 25 percent of countries imposed some type of export restrictions.
4. **Exchange rates**. Most commodity prices are expressed in US dollars. For countries whose local currencies are pegged to or are weaker than the US dollar, depreciation of the US dollar increases the cost of importing food.
5. **Biofuels**. Many analysts (Mitchell, 2008; Alexandratos, 2008) stress the effect of biofuels in raising demand for grains and oilseeds since 2002, leading to lower stocks and higher commodity prices.

ANNEX II

Critical Assumptions of the FAO Forecasts of Bruinsma (2012)

The forecasts for Europe and Central Asia in Bruinsma (2012) are based on some strong assumptions that are critical to understanding them.

1. **Positive, not a normative approach, to projections**. The FAO projections to 2030 and 2050 describe the future as it is likely to be (to the best of our knowledge), and not as it ought to be from a normative point of view. In this respect, it differs from, for instance, the Agrimonde scenario, which traces out the consequences of a normative scenario of the way things ought to be (Agrimonde, 2009).

2. **An expert-judgment estimate of food production, trade and input use**. The FAO 2030 and 2050 projections are based on an iterative process of expert judgment, rather than on a quantitative model. In this respect, these long-term projections differ from the medium-term OECD/FAO Agricultural Outlook Projections (OECD/FAO, 2011) and the USDA Baseline Projections (USDA/ERS, 2012), which are both model based 10-year forecasts. The *projection* work for the long-term projections concerns drawing up Supply and Utilization Accounts for 2030 and 2050. This involves estimating ***Domestic Use of Food*** (for food, feed, industry, seed and waste) for 32 commodities for each country based on exogenous variables, such as population and income growth and assumptions about how demand changes as incomes increase. Domestic Use of Food for each commodity for each country is assumed to drive the ***Availability of Food*** (production, net imports and stock change). Initial estimates are revised based on FAO expert assessments in an iterative process. Accounting consistency controls at the commodity, land resources, country and world levels are respected throughout. The end-product may be described as a set of projections which meet conditions of accounting consistency and to a large extent respect constraints and views expressed by the specialists in the different disciplines and countries.

3. **FAO projections in Bruinsma (2012) are limited** to (i) apparent consumption, (ii) commodity production, yields and trade, and (iii) land, fertilizer and labour input use. This allows discussions of nutrition, production and input use issues consistent with the projections.

4. **Commodity demand for biofuels is limited in scope and time**. The FAO projections take into account the use of agricultural commodities (cereals, vegetable oils, sugar) for biofuels, as foreseen in the 2010 OECD/FAO Agricultural Outlook (OECD/FAO, 2010). This mainly reflects the use of biofuels as mandated in the United States and the EU up to 2020, after which biofuel demand is held constant.

5. **The FAO forecasts are agnostic about climate change**. FAO 2030 and 2050 projections in Bruinsma (2012) do not explicitly take into account the (largely unknown) impacts of climate change in 2030 and 2050.

Source: Bruinsma, 2012.

ANNEX III

Subregions defined for the Europe and Central Asian (ECA) Region

The following subregions were defined for the projection forecasts in Bruinsma (2012). The number of countries in each aggregate is shown in parentheses.

EU (27). Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

Eastern Europe (9). Albania, Belarus, Bosnia-Herzegovina, Croatia, Montenegro, Republic of Moldova, Serbia, The Former Yugoslav Republic of Macedonia and Ukraine.

Caucasus and Central Asia (CCA) (8). Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Other Europe (4). Iceland, Israel, Norway and Switzerland.

Russian Federation (1). Russian Federation.

Turkey (1). Turkey.

Source: Bruinsma, 2012.

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