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Wheat production and regional food security in CIS: The case of Belarus, Turkmenistan, and Uzbekistan

Zvi Lerman, David Sedik

Yuliy Yusupov, Ivan Stanchin and Irina Kazakevich

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Zvi Lerman is Sir Henry d'Avigdor Goldsmid Professor of Agricultural Economics, the Hebrew University of Jerusalem, Israel.

David Sedik is the Senior Agricultural Policy Officer in the FAO Regional Office for Europe and Central Asia.

Yulii Yusupov is the Director of the Center for Economic Development in Tashkent, Uzbekistan.

Ivan Stanchin is Professor of Financial Economics and Accounting at the Voronezh Economic-Legal Institute in Voronezh, Russia.

Irina Kazakevich is a Senior Economist at the Institute of System Research of the Agro-industrial Complex, National Academy of Science of Belarus, Minsk, Belarus.

Contents

Figures

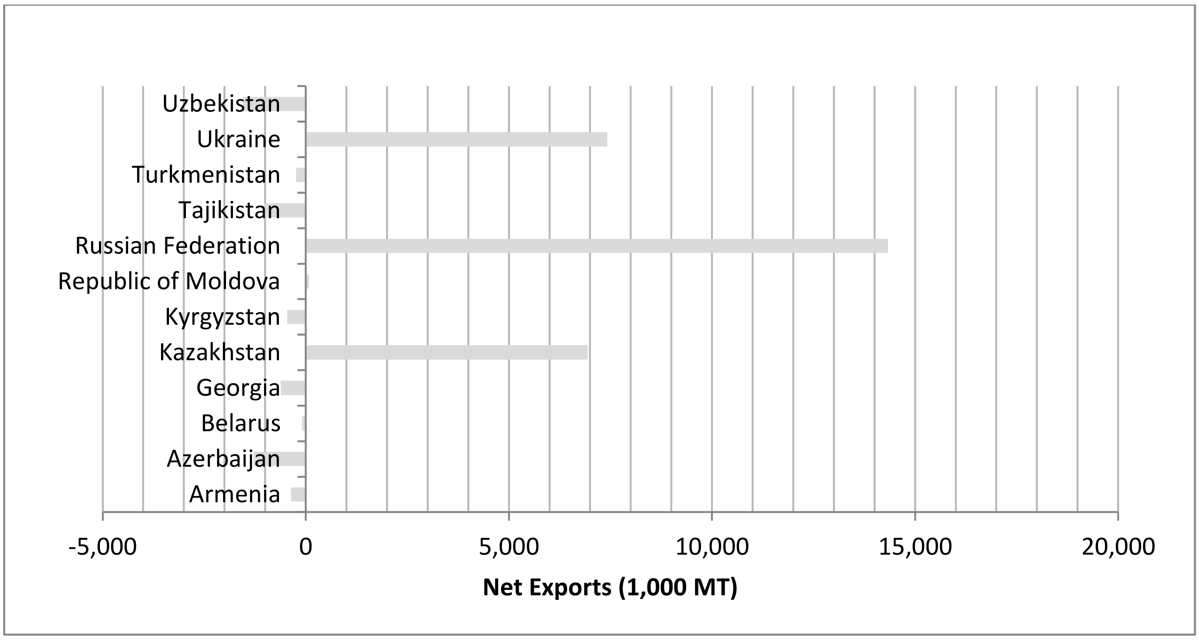
Tables

Boxes

1. Introduction

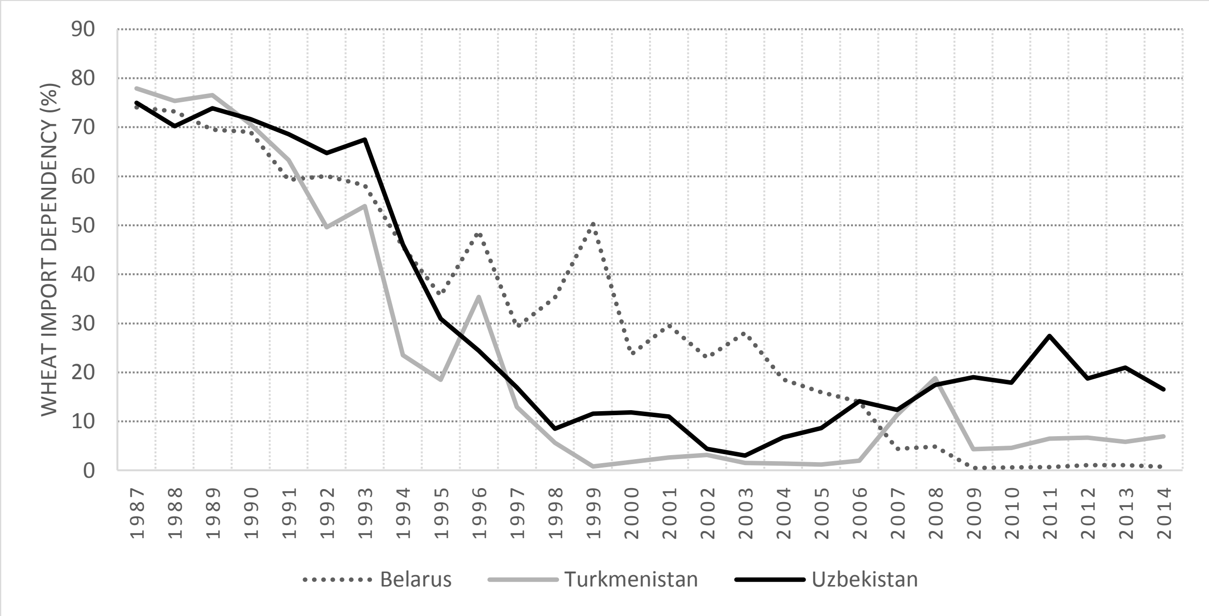
Belarus, Turkmenistan and Uzbekistan are not significant regional grain traders. In most years these countries have small net imports (Figure 1.1). However, production of wheat in the three countries has risen dramatically since 1992. This rise in production has been accomplished through huge increases in area, as well as (for Uzbekistan) significant increases in yields. The increase in production has diminished the import dependency in wheat and flour of the three countries from near 80% in 1987 to a mere 1%-20% in 2014 (Figure 1.2). Particularly in the case of Turkmenistan and Uzbekistan, this turnaround has freed up significant amounts of grain for potential export outside of the region from Kazakhstan, which has been the main grain supplier to other Central Asian countries. It is important to know to what extent these increases in wheat production can be foreseen to continue, or, alternatively, what is the limit of production increases for the three countries.

Figure 1.1. Net wheat exports from the NIS countries, average 2008-11



Source: FAOSTAT (2014).

Figure 1.2. Wheat import dependency ratios for Belarus, Uzbekistan and Turkmenistan, 1987-2014



Source: USDA/PSD (2014). Note: The import dependency ratio is defined as imports divided by the total availability of wheat.

The main objective of the study is to produce critical projections of domestic wheat production to 2024 for Belarus, Turkmenistan and Uzbekistan. This will allow us to answer the key question as to the limits of wheat production increases in the three countries. The main methodology of the study lies in a critical appraisal of the drivers of demand and supply for wheat in Belarus, Turkmenistan and Uzbekistan.

The first step in understanding the drivers of wheat demand and supply in these countries is to comprehend the farming system that produces wheat in these three countries. These countries are often cited as the least reformed economies of the Eurasian region. The purpose of Chapter II of the study is to explain the implications of the lack of reform in agriculture. This chapter first describes the aims, course and results of land and farm reform in the three countries and then compares factor productivity indicators for land and labor by farm type. In addition, total factor productivity by farm type is considered in corporate and individual farms. Chapter II also highlights where wheat is produced – in small farms that may have few administrative constraints and may operate on free markets or in large farms that may be saddled with administrative planning and fixed prices and be significantly less dynamic. The farming system for wheat production is important in considering future area and yield growth rates as well as overall sustainability issues.

Chapter III reviews the historical trends in wheat utilization, describes the wheat forecasting methodology and presents forecasts of wheat demand in Belarus, Uzbekistan and Turkmenistan to 2024. A consistent historical description of wheat supply and trade needs to include the historical utilization of wheat as well. This is because every year the following equation must be true:

Wheat use (for food, feed and other use) = wheat supply (from domestic production, net imports and stocks). (Eq. 1.1)

Historical supply and use tables (balances) for each commodity are built upon the above equation, and Chapter III begins with a critical examination of these balances for the three countries. It is important to understand historical patterns in supply and use, because they may reveal important behaviors (particularly in yields) that reflect policy changes. This critical assessment of historical data will also give us a historical base from which to start projections.

The simple methodology for forecasting wheat demand is also presented in Chapter III. For forecasting, we take the change in both sides of equation 1.1 and identify one of the variables as a residual to get:

Projected changes in wheat *demand* (for food, feed and other use) = projected changes in wheat *supply* from domestic production and stock changes + Residual (net imports). (Eq. 1.2)

Or, rewritten:

Projected changes in wheat *demand* (for food, feed and other use) – projected changes in domestic production of wheat – stock changes = Residual (net imports). (Eq. 1.2a)

In order to produce consistent projections of wheat production we need to project each element of the above equation except one (the residual). It is usual to take net imports as the residual, which will be the case in our modeling efforts as well.

In the wheat demand and supply forecasts made annually by the USDA Economic Research Service (USDA/ERS), FAO/OECD and universities (such as FAPRI, a joint venture of Iowa State University and University of Missouri), wheat forecasts are presented in partial equilibrium models that take into account assumed paths of changes in world prices for many commodities, country growth rates, and population growth, which are key framework assumptions of the models.[1] These models include matrices of food demand derived from consumer theory (including price and income elasticities), as well as modules on animal inventories, feeding efficiencies, etc., in order to produce theoretically consistent projections of commodity demand and supply.

Of the NIS countries, FAO/OECD projects wheat demand and supply for Russia, Ukraine and Kazakhstan. USDA/ERS projects wheat production for Russia, Ukraine and the rest of the Former USSR combined (excluding the Baltic countries). FAPRI provides separate forecasts for Russia and Ukraine and has a Kazakhstan module under development. Thus, none of the modeling efforts from these organizations includes specific models of wheat demand and supply for Belarus, Turkmenistan or Uzbekistan.

[1] Information on the ERS baseline model can be found at http://www.ers.usda.gov/publications/oce-usda-agricultural-projections/oce141.aspx. The OECD/FAO commodity projection model can be found at http://www.agri-outlook.org/. Information on FAPRI can be found at http://www.fapri.org/.

It was therefore necessary to develop our own simple partial equilibrium country wheat demand models using country and international data. We used per capita income growth projections from the IMF *World Economic Outlook Database* (IMF 2014b) and population forecasts from the UN *World Population Prospects* (UN Population Division 2013). Food demand for wheat was projected based on per capita GDP and population forecasts; feed demand was projected based on forecasts of livestock production; and other demand was assumed as a constant portion of total demand based on historical trends.

Chapters IV and V cover the policies and natural resource constraints underlying wheat supply projections. We first consider policies impacting on wheat production and trade, such as those related to food security, production planning and taxation (or subsidization) of wheat. We then focus on natural resource constraints under the assumption that basic policies remain constant. We consider climate issues, land and water, as well as rural population and migration issues. The focus of the review of policies and resource constraints is to assist in projecting wheat yields and sown area. The yield, area and production projections for the three countries are then discussed.

Chapter VI, the conclusion of the study, begins with a restatement of the questions posed in the introduction and an analysis of the wheat production and net trade forecasts. The significance of these forecasts is discussed and prospects for changes in wheat production and trade after 2024 analyzed.

Note on data sources

The statistical data in this study are derived from three groups of sources:

- Official statistical yearbooks of Belarus, Turkmenistan and Uzbekistan (for both Soviet and post-Soviet periods)
- The Statistical Database of the Commonwealth of Independent States (time-series data since 1980)
- International databases (FAOSTAT, World Bank’s World Development Indicators, IMF, USDA, OECD, and others).

See the list of references at the end for details. The references to “official statistical yearbooks (various years)” in the body of the text refer, in aggregate, to the first section of the list entitled “Country statistical yearbooks”. Other sources are cited explicitly.

2. Farming Structure for Wheat Production in Belarus, Turkmenistan and Uzbekistan[2]

Importance of the agricultural sector in Turkmenistan, Uzbekistan, and Belarus

The three Eurasian countries in this study – Turkmenistan, Uzbekistan, and Belarus – are in fact representatives of two different worlds. Turkmenistan and Uzbekistan are in Central Asia, whereas Belarus is in the European part of the former Soviet Union.[3] The striking differences between the countries are highlighted in Tables 2.1 and 2.2. Agricultural land in Turkmenistan and Uzbekistan is mostly desert pastures, with only a small share in arable land available for cultivation (as also in Kyrgyzstan, Tajikistan, and Kazakhstan). In Belarus, on the other hand, fully 62% of agricultural land is arable, with 2.5 hectares of arable land per rural resident (compared with less than 1 hectare in Turkmenistan and Uzbekistan). The agricultural potential of Belarus is thus much greater than in Turkmenistan and Uzbekistan.

Table 2.1. Selected characteristics of Turkmenistan, Uzbekistan, and Belarus compared to other NIS*

	Country area, thousand km^2	Ag land in use, million ha	Population, million	Population density, per km^2	Arable land per rural resident, ha	Arable land, % of ag land	Irrigated, % of arable[a]
Turkmenistan	**491**	**40.5**	**5.4**[b]	**13.2**	**0.5**[b]	**4**	**106**
Uzbekistan	**449**	**17.2**	**27.6**	**57.9**	**0.2**[c]	**24**	**100**
Kyrgyzstan	200	4.5	5.3	25.5	0.4	28	79
Tajikistan	143	4.0	7.4	47.6	0.2	21	81
Kazakhstan	2,725	85.5	15.8	5.5	3.1	27	7
Russia	17,075	190.9	141.9	8.4	3.0	60	5
Ukraine	604	36.6	46.0	78.0	2.1	84	8
Belarus	**208**	**8.9**	**9.5**	**46.0**	**2.5**	**62**	**<1**

Source: All countries except Turkmenistan and Uzbekistan from CIS Interstate Statistical Committee (2013); Turkmenistan and Uzbekistan data from official statistical yearbooks.
*The data are for 2008, except where indicated otherwise: [a]1990; [b]2007; [c]2005; [d]2006.

The size of the rural population is another measure of the importance of agriculture in each country, as agriculture is the main source of livelihood in rural areas. The rural population is increasing rapidly in both Turkmenistan and Uzbekistan (e.g., from 12 million in 1990 to 17 million in 2007 in Uzbekistan). In Belarus, on the other hand, the rural population is declining

[2] The data in Chapter II are from official statistical yearbooks of Belarus, Turkmenistan and Uzbekistan (data for Belarus are partially available on http://belstat.gov.by/ofitsialnaya-statistika/otrasli-statistiki/selskoe-hozyaistvo/). Comparisons with other Newly Independent States draw on the statistical database published in Moscow by the Statistical Department of the Commonwealth of Independent States (CIS Interstate Statistical Committee 2013, time series since 1980). Other sources are listed specifically where appropriate.
[3] The three countries are included in the group of Newly Independent States (NIS) – 12 countries that gained independence after the dissolution of the Soviet Union in 1992 (Belarus, Russian Federation, Moldova, Ukraine, Azerbaijan, Armenia, Georgia, Kazakhstan, Kyrgyzstan, Turkmenistan, Uzbekistan, and Tajikistan). The 12 NIS subsequently formed the Commonwealth of Independent States (CIS), but Turkmenistan regards itself as an "associated" member, while Georgia seceded from the CIS in 2009. We accordingly use the term NIS in preference to CIS in this study.

– both in absolute numbers (from 3.4 million in 1990 to 2.2 million in 2012) and as a share of total population (from 33% to 24% during the same period). It is difficult to establish the direction of causality between the decline in agriculture and the decreasing rural population: as agriculture declines, rural people emigrate to the cities in search for employment opportunities; simultaneously, decline in rural population leads to shrinking labor force and decline in agriculture. Whatever the causality, these indicators combine to show contraction of the rural economy in Belarus and its expansion in Turkmenistan and Uzbekistan.

Table 2.2. The agrarian profile of theNIS (2007-2008 data)

	Share of rural population (2008)	Share of agriculture in employment (2007)	Share of agriculture in GDP (2008)	Agrarian Index*	GDP per capita, constant 2000 US$ (2008)**
Tajikistan	73.7	66.5	21.8	54.0	245
Kyrgyzstan	65.4	34.5	25.8	41.9	375
Turkmenistan	**58.0**	**48.4**	**18.9**	**41.8**	***1705***
Uzbekistan	**63.9**	**27.9**	**23.2**	**38.3**	840
Georgia	47.4	53.4	8.9	36.6	1252
Moldova	58.6	32.7	8.9	33.4	578
Armenia	36.0	46.0	15.8	32.6	1520
Azerbaijan	48.2	38.6	5.7	30.9	2132
Kazakhstan	46.8	31.0	5.2	27.7	2378
Ukraine	31.8	16.7	6.8	18.4	*1156*
Belarus	**26.1**	**10.6**	**8.4**	**15.0**	**2483**
Russia	26.9	10.6	4.1	13.9	3074

*An ad hoc "agrarian index" is calculated as the simple arithmetic average of the three dimensions of a country's agrarian profile. The calculations produce a ranking of the 12 NIS, with Tajikistan the most agrarian and Russia the least agrarian.
**Per capita GDP from World Bank (2008).
Source: CIS Interstate Statistical Committee (2013).

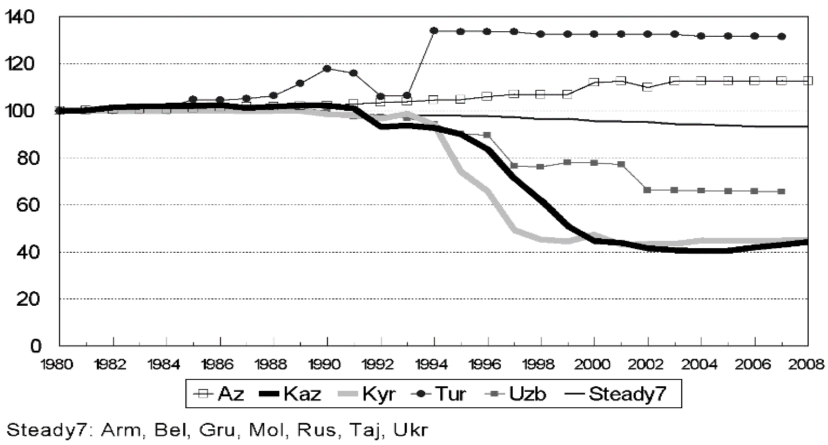
Turkmenistan and Uzbekistan are much more agrarian than Belarus (Table 2.2). They have a higher share of labor force employed in agriculture, with agriculture accounting for a substantially higher share of GDP than in Belarus (around 20% of GDP compared with 8% in Belarus).[4] Consistently with the general tendency of lower incomes in more agrarian countries, income per capita in Belarus is higher than in Uzbekistan and Turkmenistan (despite the contribution of Turkmenistan's gas and oil to this country's GDP).

Crop agriculture in Turkmenistan and Uzbekistan is critically dependent on water, with virtually all arable land covered by irrigation networks, albeit of questionable quality (Table 2.1). Intensive use of irrigation for agriculture (mainly cotton) in these two countries is the main cause of the dramatic reduction of water flow in Amu Darya and Syr Darya over time, which has led to the Aral Sea catastrophe. In Belarus, on the other hand, irrigation has no role

[4] In the early years of its independence, Uzbekistan could be characterized as a highly agrarian country, with its rural population at more than 60% and agriculture accounting, in 1995, for around 30%-40% of both GDP and employment. Subsequent economic developments have reduced Uzbekistan's initial dependence on agriculture. The share of agriculture in GDP declined steadily from 28% in 1995 to 17% in 2012; the share of agricultural employment similarly dropped from 41% to 27% during the same period.

and the main melioration efforts are directed at drainage of waterlogged soils. Turkmenistan (together with Azerbaijan in Transcaucasus) is one of only two NIS where the irrigated area in 2007-2008 was substantially above the 1990 level. The irrigation expansion efforts in Turkmenistan persisted for a short time in the late 1980s–early 1990s and then stopped in 1994, producing a one-time boost in irrigated area followed by stability at a new increased level of about 1.7 million hectares. Expansion of irrigation in Uzbekistan also stopped abruptly in 1990, stabilizing at about 4 million hectares thereafter. Uzbekistan (together with two other Central Asian countries – Kazakhstan and Kyrgyzstan) displays dramatic decreases in agricultural land after 1990, presumably due to abandonment of unproductive or inaccessible pastures (Figure 2.1). Belarus, as well as the group of six other NIS (Armenia and Georgia in the Transcaucasus, Tajikistan in Central Asia, Russia, Ukraine, and Moldova among the European NIS), are characterized by overall stability of agricultural land since 1990 (actually since 1980), with a slight downward secular trend. Scarcity of cultivable land and water are judged to be the two main constraints of agricultural development in Turkmenistan and Uzbekistan.

Figure 2.1. Evolution of agricultural land in the NIS 1980-2008



Source: CIS Interstate Statistical Committee (2013).

Despite the physical differences between Turkmenistan, Uzbekistan, and Belarus highlighted in Tables 2.1 and 2.2, the land policies of the three countries have one important aspect in common. In all three countries, agricultural land remains in state ownership and producers receive it from the state in use rights. There is a small exception in Belarus, where land in household plots may be privately owned (about 10% of agricultural land). The notion of private land ownership in Turkmenistan is legally opaque and, in practice, there is no private land in this country. State ownership of land accompanies pervasive government intervention in production practices in all three countries.

Despite the commonality of exclusive state ownership of land and government intervention, the three countries followed distinctly different paths of agricultural reform:

- Uzbekistan completely dismantled all large-scale enterprises and shifted to individual or family farming outside the collectivist framework

- Turkmenistan retained the collectivist framework in the form of peasant associations that provided an administrative shell for the operation of family leaseholds
- Belarus retained the Soviet model of large agricultural enterprises with a very small (and shrinking) individual sector

Legislative framework for agricultural reforms in Belarus, Turkmenistan, and Uzbekistan

Immediately with the dissolution of the Soviet Union in 1991-1992, the New Independent States (NIS) embarked on a program of reforms intended to achieve a transition from a command economy to an economy more in line with market principles. The reforms in the agricultural sector aimed to eliminate the traditionally wasteful use of resources and thus improve productivity. These goals were to be accomplished through the process of land reform and farm restructuring, implemented simultaneously with price and trade policy reforms. The reforms were expected to change producer incentives, strengthening profit orientation and thus increasing personal involvement and motivation.

Two salient features of inherited Soviet agriculture had to change to ensure greater consistency of the agricultural structure in NIS to the market model:

- *Ownership of land and other resources*: change from collective and state ownership of assets to private owner ship ("privatization")
- *Farming structure*: change from collectively organized large-scale farms to smaller individual and family farms ("individualization")

The essence of agricultural reform in all NIS involved writing laws and regulations to allow these epochal changes and launch their implementation. In this section we provide an overview of the reform process in Belarus, Turkmenistan, and Uzbekistan. The detailed lists of reform laws in chronological order appear in Annexes 1-3 at the end of the study.

Private landownership

During the Soviet era, all land was in exclusive state ownership. After 1992, the NIS began to make changes in their post-Soviet land codes and constitutions to recognize the option of private landownership. This by no means implied a universal transfer of state land to private owners: it only meant that land could now be privately owned (if obtained in some legal way – allocation or purchase – from the state). Private ownership was also allowed for non-land productive assets, such as farm machinery or farm buildings.

Most NIS allowed private landownership during the 1990s, some imposing moratoria on land sales as a measure of protecting the new, inexperienced landowners from exploitation by speculators (Ukraine is the only country that still retains the moratorium). Our three countries (together with Tajikistan) constitute a notable exception. Uzbekistan retains exclusive state ownership of all agricultural land: producers – both household plots and peasant farmers – receive ("lease") lands in use rights from the state. The Constitution of independent Uzbekistan adopted in 1992 reaffirmed the Soviet tradition of exclusive state ownership of all land; the new Land Code adopted in April 1998 introduced significant measures of land tenure and farm structure reform, but kept the absolute restrictions on transferability (alienation) of land. Belarus recognizes private ownership of land in household plots; all commercially cultivated land – land in agricultural enterprises and peasant farms – remains state owned and is given in use rights. Turkmenistan formally recognizes private land ownership (also with severe transferability restrictions), but virtually all land in the country is owned by the state and is given to farmers in use rights, as in Tajikistan and Uzbekistan where no private land ownership is recognized. Certain provisions initially envisaged transfer of land to peasant farmers into private ownership after a two-year probationary period, but this option was abandoned in 2006 after the government of Turkmenistan confiscated the land of most peasant farms on grounds of unsatisfactory farming performance.

The official rationale against private ownership of land is two-fold. First, in all the three countries under study, it revolves around the universal argument of the need to avoid speculation in land and accumulation of large tracts in the hands of absentee owners. Second, in the two Central Asian countries, it relies on the specific reality of arid regions, where land is useless without water, and water is a national resource delivered by a state-run irrigation system.

Individualization of farming structure

The farming structure during the Soviet era was characterized by strong duality: large agricultural enterprises—collective and state farms—coexisted with small household plots cultivated by the rural population—the traditional "private" sector of Soviet agriculture. The large enterprises produced most of the commercially traded output, while the household plots were largely subsistence oriented and sold only their surplus output that remained after satisfying the family's needs for food.

Two changes began to be implemented in this dual farming structure already in the early 1990s: the household plots were substantially enlarged by additional land allocations from the state and a totally new organizational form—the "peasant farm"—emerged after 1992. While household plots were typically managed on a part time basis by workers of agricultural enterprises, rural administrative employees, or pensioners and generally retained symbiotic links with the local agricultural enterprise, peasant farms were created as independent entities outside the existing collectivist framework. They were substantially larger than the household plots (although much smaller than the agricultural enterprises) and, unlike household plots, they had a clear commercial orientation. As a result, the dual farming structure that prevailed during the Soviet period evolved into a three-component structure: a "private" or individual sector that now consisted of both household plots and peasant farms and the corporate enterprise sector inherited from the Soviet era. The process involving enlargement of household plots and creation of new peasant farms constitutes "conventional" land individualization. The additional land for household plots usually came from the state land reserve; the peasant farms, on the other hand, were generally created on land extracted from large agricultural enterprises, a process that contributed to the shrinkage and breakup of the enterprise sector. Box 2.1 presents the classification of agricultural producers by organizational forms in two eras: the Soviet era and the period of reforms since 1991.

Box 2.1. Categories of agricultural producers in Belarus, Turkmenistan and Uzbekistan

	Soviet organizational forms	Post-Soviet organizational forms	Stylized characterization
Corporate farms	Collective farm (kolkhoz) State farm (sovkhoz)	Agricultural enterprise (joint stock company, limited liability company, partnership, agricultural cooperative)	Large-scale production (100-1000 hectares, 50-500 workers)
		Peasant associations in Turkmenistan	Production transferred to small leaseholders within association
Individual (family) farms	Household plots	Household plots (enlarged after 1990)	Originally, small plots of land around the house (0.05 ha) After 1990, enlarged by addition of plots outside the village (0.1-0.5 ha)
		Peasant farms (created after 1991)	Mid-sized farms (1-100 ha) created under special laws on land from enterprises or state reserves

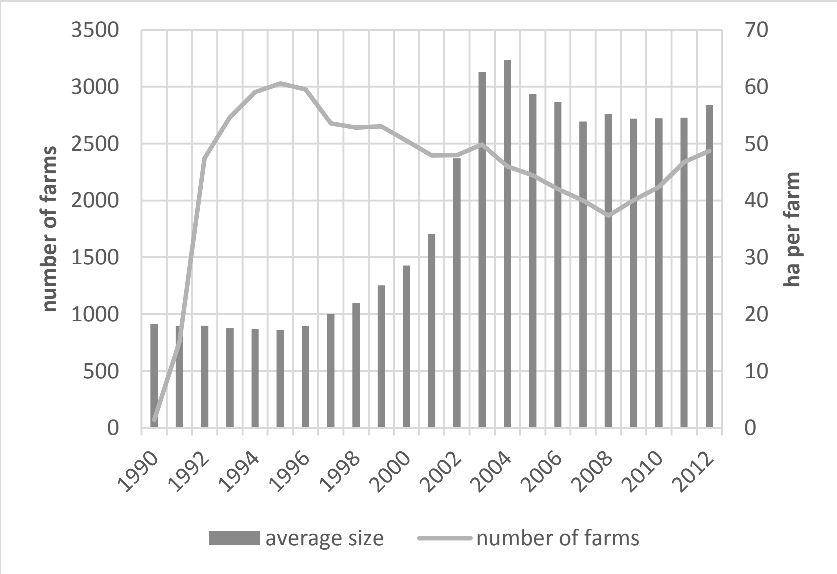
Source: Authors' compilation.

Belarus

The individualization of agriculture followed distinctly different paths in the three countries under study. The growth of the peasant farm sector in Belarus (Figure 2.2) is fairly typical of all NIS: rapid increase in the number of peasant farms after the adoption of enabling legislation (the 1991 Law of Peasant Farms, see Annex 3), stabilizing at a relatively constant level soon thereafter. However, a sector of 2,500 peasant farms averaging 55 hectares each is negligible in the country context: peasant farms control just 1.6% of agricultural land in Belarus, compared to 10% in household plots.

Peasant farms did not catch on in Belarus, presumably due to inadequate market infrastructure, administrative constraints, and preferential treatment of large agricultural enterprises (the Soviet model of agriculture). Furthermore, the household plot sector, although much more significant, did not flourish either: after the initial doubling of land in household plots from 6% in 1990 to 15% in 1993, the household plots did not grow between 1993 and 2005, and then started declining. By 2013, the share of household plots had dropped from 15% to 10% of agricultural land. This trend is usually explained by the decline of the rural population in Belarus, which shrank from 3.5 million in 1990 to 2.2 million in 2013.

Figure 2.2. Development of peasant farms in Belarus 1990-2012 (number and average size in ha)



Source: Official statistical yearbooks, Belarus (various years).

The new Civil Code that came into force on July 1, 1999, recognized three legal forms of business organization, which did not include the collective farm (the traditional kolkhoz) or the collective agricultural enterprise. The new legal forms were (a) limited-liability joint-stock companies (open or closed); (b) unlimited-liability partnerships; (c) production cooperatives. It is worth stressing that joint-stock companies are the only limited-liability organization recognized in Belarus; partnerships are always full-liability organizations. Since collective farms and collective agricultural enterprises were not included among the organizational forms in the new Civil Code, all collective farms in Belarus in principle were required to change their legal form after July 1, 1999. The Ministry of Agriculture was put in charge of the reorganization program, which originally was supposed to be finished within one year, by July 1, 2000. Although it was not clear to what extent such reorganization would involve genuine restructuring of collective farms into viable business organizations, the opportunities to speed up the process of reforms were clearly there. In reality, however, the general reorganization program was not implemented as envisaged in 1999-2000 due to lack of administrative and political consensus. There had been very little action on changing the legal form of the collective farms and by January 2001, only 219 kolkhozes and sovkhozes (out of 2,414) had been reorganized into collective-shared enterprises, shareholder companies, and agrofirms; 105 loss-making enterprises were merged with profitable producers.

The continued lull in 2001-2003 gave way to a spike of reorganization activity in 2004-2005, when 500 loss-making kolkhozes and sovkhozes were reorganized as part of the concerted government campaign to get rid of unprofitable enterprises. This campaign was driven by the Law "On reorganization of loss-making agricultural enterprises (June 9, 2003) and two presidential decrees (March 19, 2004 and June 14, 2004 – see Annex 3), which set out options for financial recovery, increased investment, and acquisition of loss-making enterprises by profitable corporations. The 2003-2005 government budget identified agricultural production as a priority sector for subsidies and other support.

Turkmenistan

In Turkmenistan, peasant farms were a transient phenomenon. Their numbers increased rapidly from zero in 1992 to 7,000 in 2000-2001. The land in peasant farms peaked in 1999 at about 4% of cultivable land and started declining thereafter (see Figure 2.7). The peasant farms were virtually wiped out in 2007, as the authorities began to enforce the legal provisions that made land grants conditional on satisfactory farming performance. In one fell swoop, state policy reduced the number of peasant farms to less than 2,500 and their share of cultivable land to 1%. The household plots increased their land in two stages: initial trebling from 2% to 6% of cultivable land in 1991-1992 (following presidential initiative, see Annex 1) and another jump to 8% after 2007, partly compensating for confiscation of land in peasant farms.

Thus, by 2013, nearly 10% of agricultural land in Turkmenistan had been transferred to the individual sector through “conventional” individualization—augmentation of household plots and land allocation to peasant farms. But the legal framework in Turkmenistan also contributed to so-called “unconventional” individualization. The summary conversion of collective and state farms to so-called “peasant associations” in mid-1995 led to the establishment of leasehold arrangements with all families in the former agricultural enterprises. The leaseholders cultivated their land individually, but within the general administrative framework of the peasant association and subject to state orders on wheat and cotton production, which were channeled to them through the peasant association. The lease contracts specified the quantities of wheat and cotton that had to be delivered and allocated the land area that had to be sown to these crops. The leaseholders were furthermore obliged to sell their output and buy their inputs through a system of parastatal marketers and suppliers. Commodities other than wheat and cotton (to the extent that such could be produced under the given constraints on land use) were exempt from state orders. Household plots and peasant farms (to the extent that such existed) were also exempt from state orders, although peasant farmers could voluntarily enter the state order system and thus enjoy access to subsidized inputs and credit.

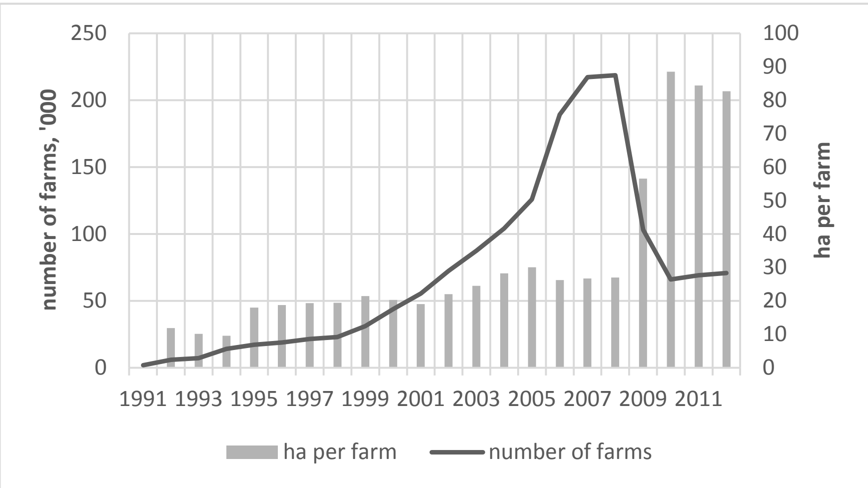
Uzbekistan

In Uzbekistan, crop agriculture today is completely individualized. Since the adoption of the Law on Peasant farms in mid-1992 (see Annex 2), agricultural enterprises have lost all their arable land to peasant farms and they retain only desert pastures (see Figures 2.4, 2.5). The process of individualization started in 1989, still during the Soviet era, when the total area in the household sector increased by 60% from 250,000 ha to 400,000 ha as the maximum plot size on irrigated land was raised to 0.25 ha from pre-1990 norms of 0.16 ha in collective farms and 0.08 ha in state farms.

Peasant farms, as an example of a fundamentally new farm structure, began to emerge in Uzbekistan in 1991, when members of large-scale collective and state farms were given the option of exiting with their share of land and assets to embark on independent private farming outside the existing collectivist framework. This new form of family farm received legal recognition in the Law of Peasant Farms adopted in July 1992, which led to a rapid increase in the number of peasant farms from less than 2,000 in 1990-1991 to 50,000 in 2000-2001 and then to a peak of 220,000 in 2007-2008. The average size of peasant farms trebled over the years, rising from less than 10 hectares in the early 1990 to about 30 hectares in 2004-2007 (comparable to the average farm of 20 ha in Ukraine and 40 ha in Russia). These trends of steadily increasing individualization were broken in 2008 with the adoption of the “farm size optimization” policy (see Annex 2). The government decided that fragmentation into small individual holdings was detrimental to agricultural growth and efficiency and forced small peasant farms to merge into larger, allegedly more efficient, units by administratively revoking their lease contracts. The farmers who lost their land (and independence) usually continued as hired workers in the larger units or left agriculture for other occupations.

The new policy, which in a certain sense can be regarded as “recollectivization”, reduced the number of peasant farms from 220,000 in 2008 to 70,000 in 2012 without any change in total land endowment. As a result, the size of the average peasant farm increased from 27 hectares in 2008 to 83 hectares in 2012 (Figure 2.3). So far, the “optimization” policy has not produced any clear breakthroughs in production. The share of peasant farms reached 30% of total agricultural output in 2005-2006, before the introduction of the “optimization” policy, and has remained at this level ever since (see Figure 2.42). The small household plots continue to be the mainstay of Uzbekistan’s agriculture, consistently producing more than 60% of total agricultural output.

Figure 2.3. Development of peasant farms in Uzbekistan 1991-2011 (number and average size in ha)



Source: Official statistical yearbooks, Uzbekistan (various years).

The fate of peasant farms in Uzbekistan is not much different from the fate of the leaseholders in Turkmenistan. The lease contracts specify the exact areas that have to be sown to cotton and wheat. The 1998 Law of Peasant Farms further stipulates that leased land should be cultivated with due diligence so as to yield a certain minimum harvest of cotton and wheat per hectare. Presidential Decree 3342 accompanying the new strategy for the development of peasant farms (October 2003) states bluntly that any deviation from the sowing pattern prescribed in the land lease contract is a grave violation constituting grounds for termination of the farm's lease. Through these tenure-linked obligations, the peasant farmers actually inherited the burden of fulfilling the state orders for cotton and wheat that had been traditionally borne by collective and state farms. Peasant farmers have become the state's official suppliers of the two strategic commodities. Household plots, on the other hand, are free from state orders. They are free to grow and produce anything that they wish on their small plots.

* * *

The legal framework that has been developing in Turkmenistan and Uzbekistan since the early 1990s has supported one of the striking features of agricultural transition from plan to market—the dramatic shift from the predominance of large corporate farms (agricultural enterprises) to individual or family agriculture based on a spectrum of small farms. The individual sector, combining the traditional household plots and the new peasant farms that began to emerge after 1992, controls a major share of arable land and accounts for most of agricultural production. This is a dramatic change from the pre-1990 period, when agricultural enterprises controlled over 90% of arable land and produced over 70% of GAO.

Contrary to the two Central Asian countries, Belarus remains locked in the Soviet model of agriculture. Its agriculture continues to be dominated by large enterprises, as in the Soviet period, while peasant farms and household plots remain a negligible sector.

Table 2.2A evaluates the agricultural reforms in Belarus, Turkmenistan, and Uzbekistan against four salient attributes of agriculture in market economies: private ownership of land, private ownership of other agricultural assets (e.g., livestock), ownership of farm output, and prevalence of family (or individual) farming.

Table 2.2A. Reform "score card" for Uzbekistan, Turkmenistan, and Belarus

	Uzbekistan	Turkmenistan	Belarus
Private land	No	Only formally: non transferable	Only household plots
Private livestock	Yes, predominantly in households	Yes, predominantly in households	Yes, predominantly in ag enterprises
Ownership of output	State orders (wheat, cotton)	State orders (wheat, cotton)	State orders (wheat, oil seeds)
Family farming	All ag enterprises dismantled; recent "optimization" policy	All production in family leaseholds	Small and decreasing share in land and GAO

Source: Authors' assessments.

The individualization of farm structure, while consistent with the dominant mode in market agricultures, clashes with the traditional Soviet philosophy of economies of scale. They also clash with the inherited ideology that views small family farms as an undesirable and even damaging deviation from the capital-intensive, highly mechanized, and commercially oriented mainstream. We therefore witness an ongoing debate, both among the NIS decision makers and within the NIS academic community, as to the performance advantages of the two main organizational forms in agriculture – large corporate farms and small family farms. The positions in this debate are further polarized by the emergence of “super-large” agroholdings in Russia, Ukraine, and Kazakhstan, which in some cases spread over hundreds of thousands of hectares of leased land but provide no information on their economic or financial performance. While the legislative framework pays considerable attention to new forms of individual farming, government policies show a strong bias in favor of traditional large enterprises and the playing field is far from level for farms of different organizational forms.

Land and crops

During the Soviet era, the farming structure in all the former republics of the USSR was dominated by large agricultural enterprises—collective and state farms (kolkhozy and sovkhozy), which coexisted with small household plots cultivated by the rural population—the traditional “private” sector of Soviet agriculture. The large enterprises, which were easier to control by central command, produced most of the commercially traded output, while the household plots were largely subsistence oriented and sold only their surplus output that remained after satisfying the family’s needs for food. Yet the large enterprises were notoriously inefficient for well-known institutional and organizational reasons. The agricultural sector had to undergo radical reforms to move it away from the Soviet model and closer to the market model. Because of the high share of agriculture in NIS, agricultural reforms were expected to improve agricultural performance and thus boost household incomes, especially in the poor rural areas.

Changes in land use

One of the striking features of transition from plan to market in NIS agriculture is the dramatic individualization[5] of land use since the early 1990s—a shift from the predominance of large corporate farms (agricultural enterprises) to individual or family agriculture based on a spectrum of small farms. The individual sector, combining the traditional household plots and the new peasant farms that began to emerge after 1992, accounts today for most of agricultural production and controls a large share of arable land. This individualization of agriculture constitutes a dramatic change from the pre-1990 period, when agricultural enterprises produced over 70% of GAO and controlled over 90% of arable land.

Post-Soviet individualization of land use is clearly illustrated by the case of Uzbekistan in Figure 2.4 (for arable land) and Figure 2.5 (for all agricultural land). While the total stock of arable land in Uzbekistan has remained constant at slightly over 4 million hectares, virtually all arable land has shifted from agricultural enterprises (the dark-grey bottom layer) to the individual sector (mainly the newly created “farmers”: the share of “dekhkans” – household plots in Uzbekistan nomenclature – has remained constant at about 3% since the Soviet period).

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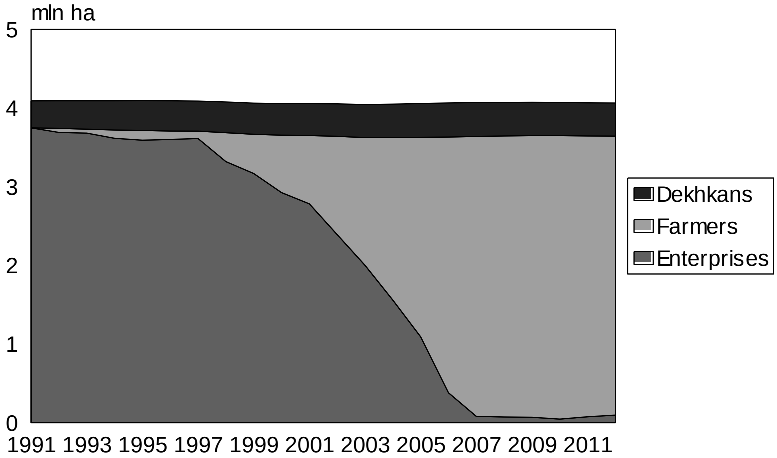
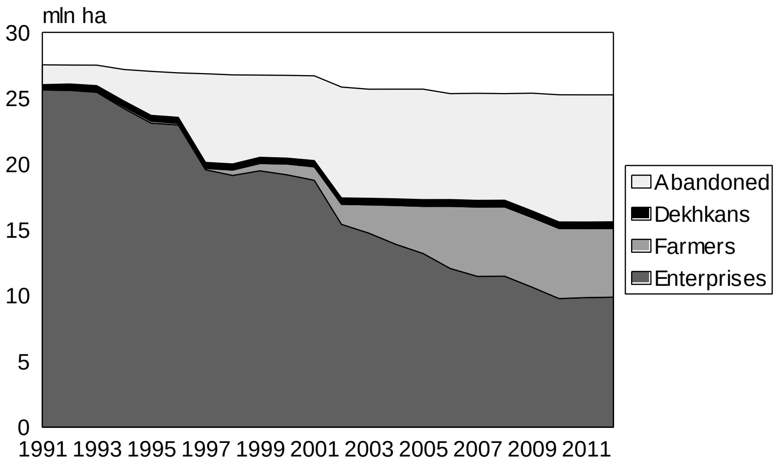
[5] Individualization refers to land use and is different from privatization of legal ownership of land. Agriculture is individualized even in countries that do not recognize full-fledged private land ownership, such as Uzbekistan, Turkmenistan, and Belarus. In other countries, legal landowners do not necessarily farm their private land, preferring to lease it out to tenants.

Figure 2.4. Uzbekistan: use of arable land by farms of different organizational forms 1991-2012



Source: Official statistical yearbooks, Uzbekistan (various years).

Figure 2.5. Uzbekistan: use of agricultural land by farms of different organizational forms 1991-2012



Source: Official statistical yearbooks, Uzbekistan (various years).

A generally similar pattern of change is observed for all agricultural land in Uzbekistan (Figure 2.5), which in addition to arable land also includes pastures, meadows, and land under perennial orchards and vineyards. Here the decline of agricultural enterprises is less pronounced than in arable land (compare Figure 2.4) due to their relatively high proportion of pastures: it is mainly arable land, not pastures, that is reallocated in the process of reform from agricultural enterprises to peasant farms. These desert pastures registered to agricultural enterprises are marginally used for grazing sheep: they are not suitable for grazing large ruminants (which in any event are not held by enterprises – see Figure 2.27). Another notable feature of changes in agricultural land in Uzbekistan is the overall decrease in land use by all categories of agricultural users: the top light-gray layer in Figure 2.5 is the difference between the land used in farms (as reported by the Ministry of Agriculture) and the available agricultural land as reported by Goskomzem (Uzbekistan's land monitoring authority). The gap represents abandoned land, i.e., land not claimed by agricultural users. The abandoned land has approached 10 million hectares in recent years. This is primarily former pastures declassified due to poor soil quality, as virtually all arable land appears to be allocated to users.

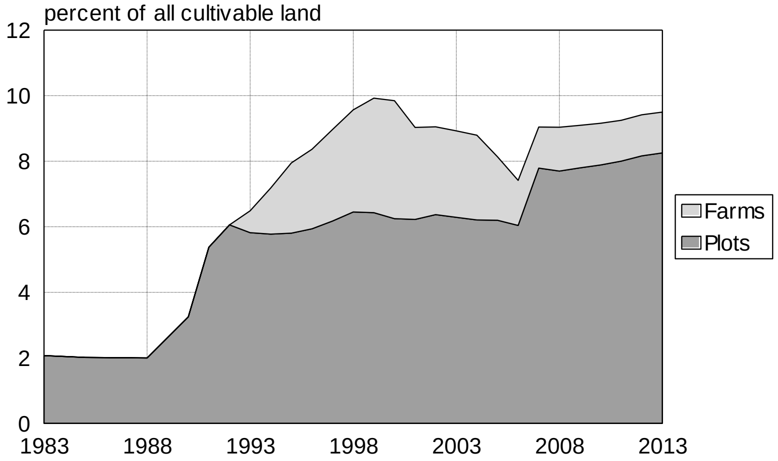
As a result of these changes in land use in Uzbekistan, the share of the individual farming sector – both household plots and peasant farms – increased from about 3% to 30% in agricultural land since 1991. The share of individual farms in arable land rose even more dramatically and it now approaches 100%. Given the information in Figures 2.4 and 2.5, we conclude that most of the land in the individual sector is represented by peasant farms, not household plots. The share of peasant farms in arable land reached the target set for 2007 in the 2003 strategy for the development of peasant farms (72.1% of irrigated land), which may be taken as a sign of state intervention in land allocation during reform.

Contrary to the situation in Uzbekistan, peasant farms never became a dominant force in the individual sector in Belarus or Turkmenistan. In Belarus, the share of peasant farms in agricultural land increased over time, but it has always remained below 2%, with another 12%-15% in household plots (which shrank slightly over time, see Figure 2.6). In Turkmenistan, the share of peasant farms in cultivable land since 2000 is similarly around 1%-2%, compared with 6%-7% for household plots (Figure 2.7). The peasant farms had all but disappeared in Turkmenistan by 2007 after a promising start in 1998-2002 due to government-imposed confiscation of farmers' privately owned land for reasons of unsatisfactory farming performance (in 2005-2006). This, of course, is an unthinkable policy in a market economy, yet in Turkmenistan policymakers justified its enforcement by the acute scarcity of cultivable land and the need to ensure that no cultivable land is left idle.

Figure 2.6. Belarus: structure of agricultural land in the individual sector (household plots and peasant farms), in percent

Source: Official statistical yearbooks, Belarus (various years).

Figure 2.7. Turkmenistan: structure of cultivable land in the individual sector 1983-2013 (household plots and peasant farms), in percent



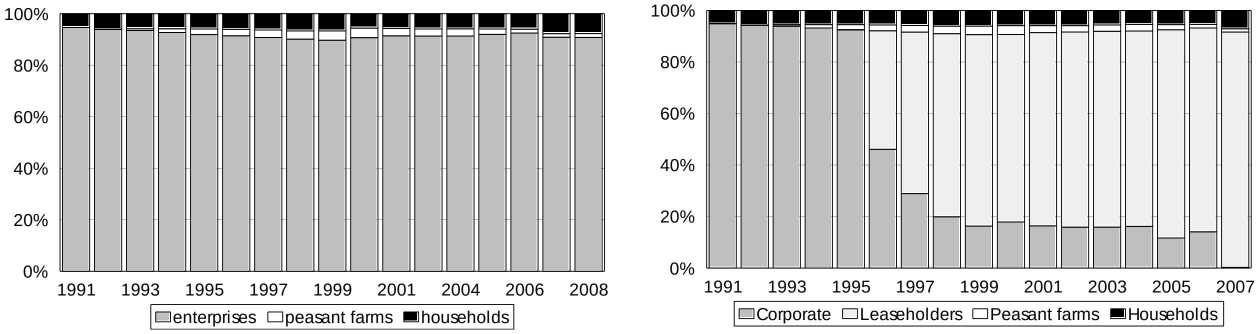
Source: Official statistical yearbooks, Turkmenistan (various years).

Given the small share of the individual sector in Belarus and Turkmenistan, we conclude that agricultural enterprises control about 80% of agricultural land in Belarus and nearly 95% of cultivated land in Turkmenistan (sown areas plus land under vineyards and orchards). Belarus agriculture indeed shows very little individualization, with strong adherence to the Soviet-era model of large enterprises, but for Turkmenistan, these official numbers are deceptive. The land in peasant associations (the term for agricultural enterprises in Turkmenistan since 1995) is operated almost in its entirety by individual and family leaseholders: there is virtually no collective production in peasant associations. The share of leaseholders went up from 75% in 2000-2001 to over 90% of cultivated land in 2008, while the share of collectively cultivated land is around 2%. Turkmenistan has opted for an unconventional land reform path, and today agriculture in Turkmenistan is dominated by individual or family leaseholders.

A striking visualization of the changes in the structure of land use in Turkmenistan is provided by Figure 2.7A. The left-hand panel is the conventional view, with 95% of arable land held in agricultural enterprises (peasant associations) and very little change since 1991. The right-hand panel, in contrast, shows the truly dramatic shift from collective land use in 1991-1995 to intra-farm leaseholding: in 2007 leaseholders cultivated virtually the entire land registered in peasant associations, i.e., 95% of arable land in Turkmenistan. There was virtually no collective agriculture in 2007 and less than 10% of collectively cultivated land in 2005-2006.

The leaseholders in Turkmenistan operate within large-scale peasant associations, which act as a conduit for the exercise of strict state controls on leaseholders. Leaseholders continue to be subject to state orders and are tied by restrictive links to state-controlled service providers and financial institutions. Differences between family leaseholders and traditional family farms are bound to remain as long as the playing field is not leveled for all producers. Turkmenistan's leaseholder agriculture, while close in many attributes to family farming, occupies an intermediate position in the spectrum between individual and corporate farms.

Figure 2.7A. Turkmenistan: Individualization through leaseholding



Note: Left panel: farm structure based on official statistics; right panel: de facto farm structure allowing for leaseholder arrangements, Source: Official statistical yearbooks, Turkmenistan (various years).

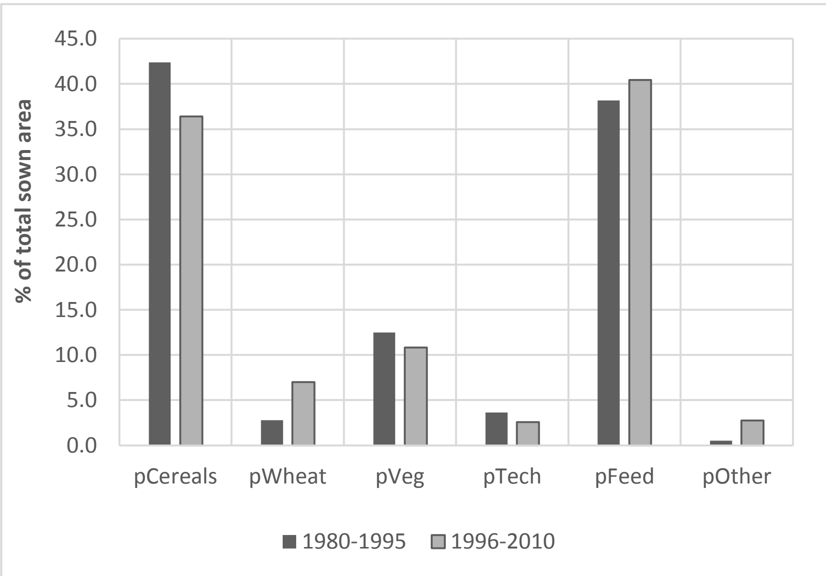
Cropping structure

Although agricultural production in the three countries under study is generally diversified, there is one major difference between Central Asia and European NIS: Uzbekistan and Turkmenistan grow wheat and cotton, whereas Belarus, by virtue of its northern location, grows wheat and other cereals, but no cotton.

Belarus: wheat and barley

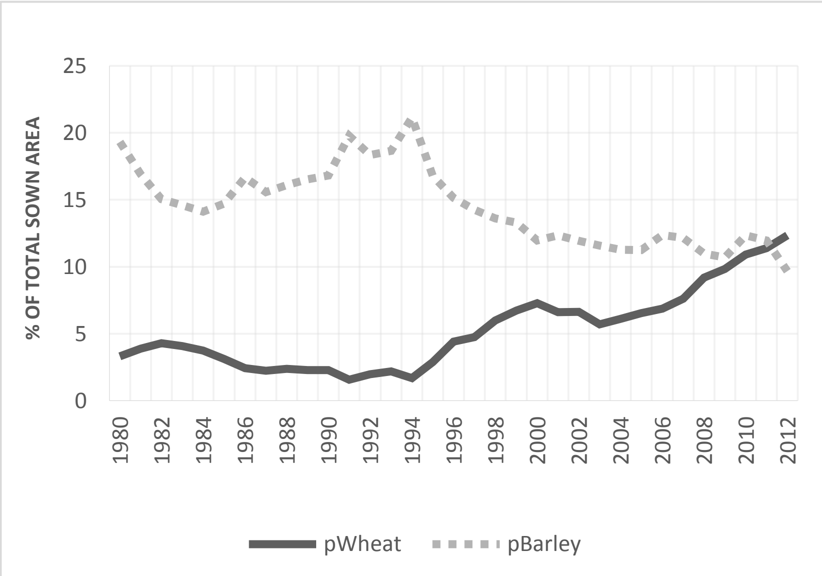
The major crops in Belarus are cereals and feed crops, which jointly account on average for 85% of the sown area (45% cereals and 40% feed crops; see Figure 2.8). The remaining 15% are under vegetables (including potatoes) and some technical crops (flax and sugar beet). The share of sown area in wheat is relatively small, but it has been rising steadily since 1994: from a low of 2% in the mid-1990s to 12% in 2012 (Figure 2.9).

Figure 2.8. Belarus: cropping pattern, averaged for 1980-1995 and 1996-2010 (in percent of total sown area; cereals excluding wheat)



Source: Official statistical yearbooks, Belarus (various years).

Figure 2.9. Belarus: share of sown area in wheat and barley, 1980-2013 (in percent)



Source: Official statistical yearbooks, Belarus (various years).

Table 2.3. Cereal mix in Belarus (averages for 2009-2012)

Variety	Share of sown area	Share of harvest
Wheat	24.3	25.5
Barley	24.4	24.2
Triticale	17.8	18.7
Rye	14.6	11.7
Oats	6.2	5.6
Maize	5.7	n.a.
Total cereals and legumes	100.0 (2,631 ha)	100.0 (8,249,500 ton)
Total cereals and legumes as % of total sown	46	--

Source: Official statistical yearbooks, Belarus (various years).

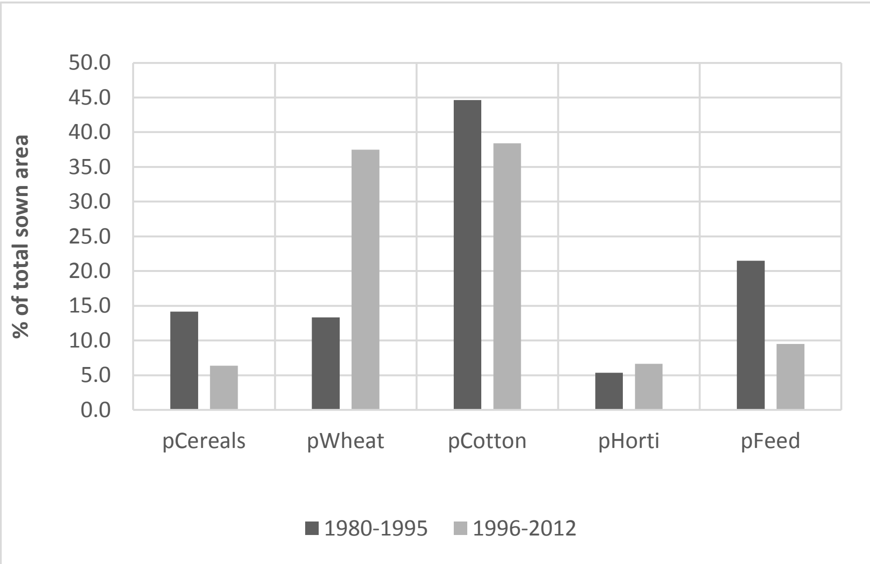
Wheat is one of the two most important cereals in terms of sown area; the other is barley, with sown area greater than that in wheat for all years between 1980 and 2011 (Figure 2.9). It is only in 2012 that the gap in sown areas disappeared and wheat finally overtook barley at around 12% of sown areas to barley's 10%. The dominance of barley over more than three decades indicates that, in the past, grain in Belarus was mostly used to feed livestock, with human consumption of domestic wheat emerging to the fore only recently. Next to wheat and barley come (in descending order) triticale (a wheat-rye hybrid) and rye, with oats and maize playing a relatively minor role (Table 2.3). The same ranking emerges by harvest of various cereals: wheat and barley are at the top with 24%-25% of total cereal harvest, followed in descending order by triticale, rye, and oats (Table 2.3).

Uzbekistan: wheat and cotton

The sown area in Uzbekistan remained fairly constant over time, decreasing slightly from about 4 million hectares in the 1980s and 1990s to 3.5 million hectares since 2000. The main drop in sown area occurred around 1999-2000. Throughout the entire period, sown area represented 15%-20% of total agricultural land (which includes extensive pastures). Perhaps more importantly, the sown area was close to 100% of arable land between 1980 and 1999, dropping to about 90% of arable land in 2000, in response to the contraction of sown area at that time. This implies that Uzbekistan has very little unutilized reserves of land that can be opened up without major investment to expand production.

The major crops in Uzbekistan are wheat and cotton, which jointly accounted on average for 75% of the sown area between 1996 and 2012 (Figure 2.10). The remaining 25% were under feed crops, horticultural crops (vegetables, potatoes, and melons), and a mixture of other cereals.

Figure 2.10. Uzbekistan: cropping pattern, percent of total sown area (averages for 1980-1995 and 1996-2012)

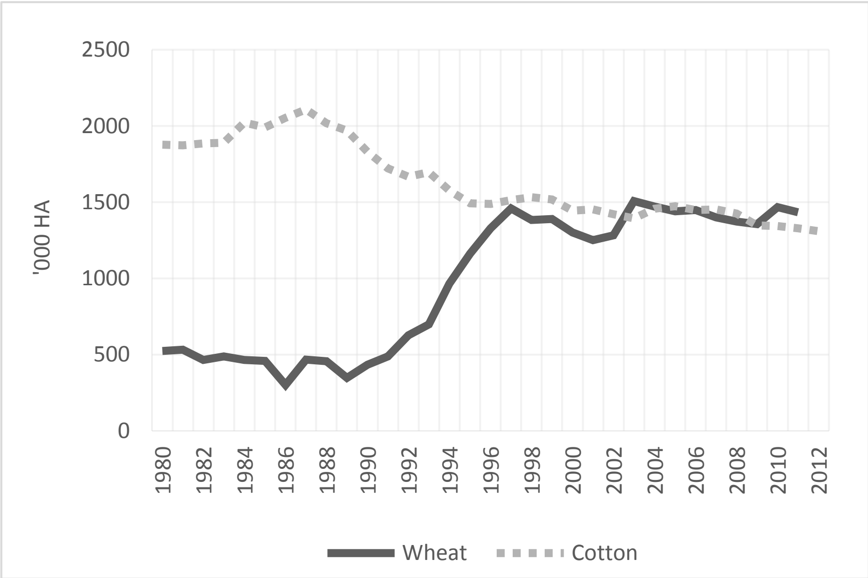


Source: Official statistical yearbooks, Uzbekistan (various years).

The area sown to wheat increased dramatically between 1980-1995 (less than 15% of total sown area) and 1996-2012 (more than 35% of total sown area). Since the total sown area remained fairly constant over time, the increase in wheat cropping came at the expense of other crops, mainly feed crops, other cereals, and cotton. This is clear from a comparison of blue bars (1980-1995) and orange bars (1996-2012) in Figure 2.10.

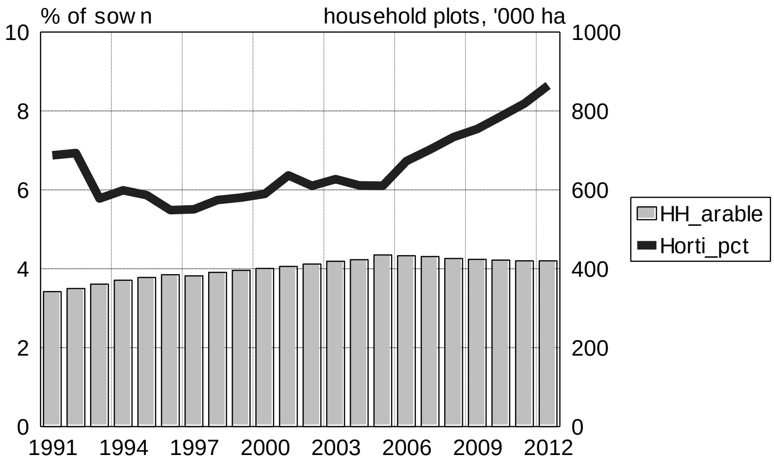
A continuous picture of the changes in the area cropped to wheat and to cotton since 1980 in absolute numbers is shown in Figure 2.11. The area in wheat increased from a steady level of 500,000 hectares in the 1980s to almost 1.5 million hectares since 1997, while the area in cotton dropped from 2 million hectares in the 1980s to about 1.5 million hectares in 1994 and continued to decline to 1.3 million hectares in 2010-2012. A rough balance of sown area shows that the decrease in cotton cropping (0.5 million hectares) supplied about half the increase in area under wheat (1 million hectares), while the remaining 0.5 million hectares came from the reduction of the area in feed crops and other cereals.

Figure 2.11. Uzbekistan: area in wheat and cotton, 1980-2012 ('000 ha)



Source: Official statistical yearbooks, Uzbekistan (various years).

Figure 2.12. Uzbekistan: share of cropped area in horticultural crops and the area of arable land in household plots 1991-2012



Source: Official statistical yearbooks, Uzbekistan (various years).

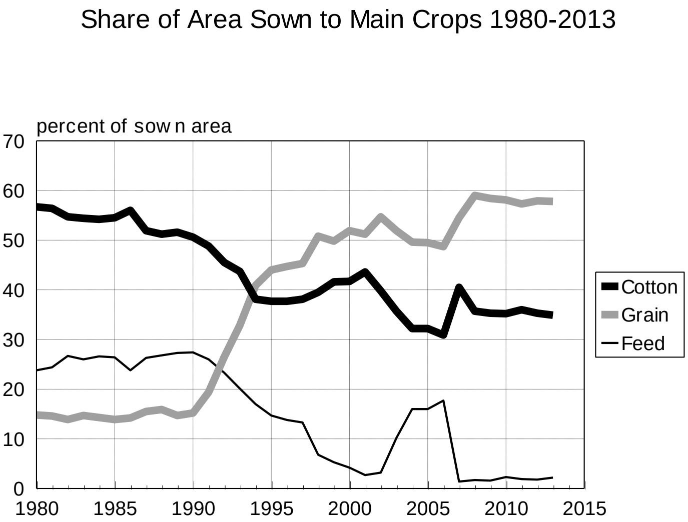
Another notable change in the cropping pattern in Uzbekistan is the pronounced increase in the share of area cropped to horticultural crops (vegetables, potatoes, and melons), which rose from 5.5% of the cropped area in 1996 to nearly 9% in 2012 (Figure 2.12, black line). The increase in land under horticultural crops is associated with the growing land endowment in small household plots (Figure 2.12, grey bars), where labor-intensive vegetables are the ideal choice for labor-rich rural families as both subsistence and cash crops. These high value added crops are exempt from state orders and constitute an important source of income for rural families. A similar phenomenon is observed in Turkmenistan (see Figure 2.16).

Turkmenistan: cotton and wheat

Cotton and grain are Turkmenistan's main scale crops, accounting for more than 95% of sown area in 2007. Value-added crops include a wide variety of vegetables, melons, fruits, and grapes, but their share of cultivable land is very small.

During the Soviet era, Turkmenistan was a cotton monoculture, ranking second (after Uzbekistan) in cotton production among the six cotton republics of the former USSR. Cotton accounted for more than 50% of the sown area all through the 1980s. Another 30% was under feed crops, which not only fed animals, but also played a very important role in crop rotation keeping the soil healthy for cotton. Grain (mainly wheat) was grown on a mere 15% of the cropped area. This cropping pattern remained largely static during the last centrally planned decade of the 1980s.

Figure 2.13. Turkmenistan: share of area sown to cotton, grain, and feed crops 1980-2013 (percent of total sown area)



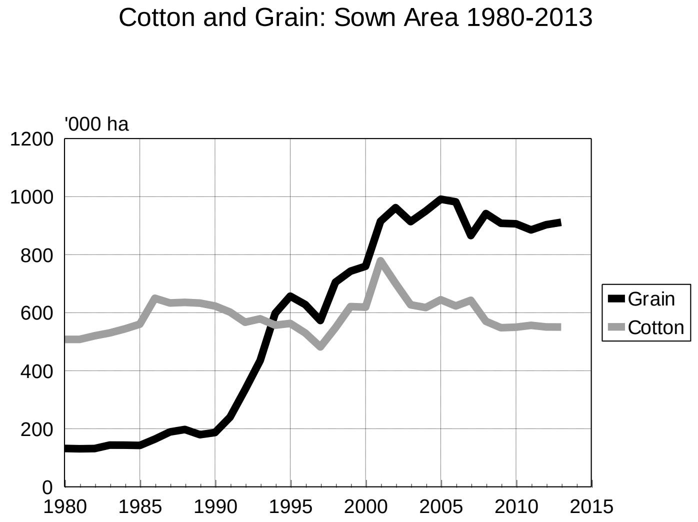
Source: Official statistical yearbooks, Turkmenistan (various years).

The situation began to change rapidly in the early 1990s, when the government decided to emphasize wheat production in the interest of food self-sufficiency.[6] The area under cereals (mainly wheat) was increased from 15% in 1990 to 50% in 1998 and it continued to grow to 55% in 2002 and then with some fluctuations to 60% of total sown area in 2008 (Figure 2.13). The increase in the share of grain areas between 1990 and 2002 came at the expense of some reduction in cotton cropping (which dropped further from 51% in 1990 to less than 40% after 2002), but mainly due to a sharp contraction of areas under feed crops, which dropped dramatically from 27% in 1990 to a mere 3% in 2002 and today stand at less than 1% after what looks like a series of statistical correction attempts.

[6] This decision was subsequently formalized in the 1999 National Presidential Program "Strategy of social-economic change in Turkmenistan to 2010" (Turkmenistan National Program to 2010 (1999)). The strategy set an incredibly ambitious target of 4 million tons of wheat by 2010, which would imply a doubling of wheat yields in 10 years.

Crop production in Turkmenistan today is diversified between two main crops — grain is the new leader with 60% of cropped area and cotton trails second with slightly less than 40%. This change in product mix was primarily achieved by the total elimination of feed crops from Turkmenistan's cropping pattern, but it was also supported in part by the steady expansion of irrigated area over time. Due to the expansion of irrigation, the actual area under cotton declined only temporarily in 1990-1997: today it is back to the level of 1990 (600,000 hectares, up from 500,000 hectares in 1980). The declining share of cotton in cropped area is not the result of a physical decrease in cotton cropping: it is a reflection of the much faster growth of areas cropped to grain, which increased from 130,000 hectares in 1980 to 190,000 hectares in 1990,skyrocketing to 1 million hectares in 2005-2006—a five-fold increase in 15 years, followed by a small contraction in 2007-2008 (Figure 2.14).

Figure 2.14. Turkmenistan: area sown to cotton and grain 1980-2012 ('000 ha)

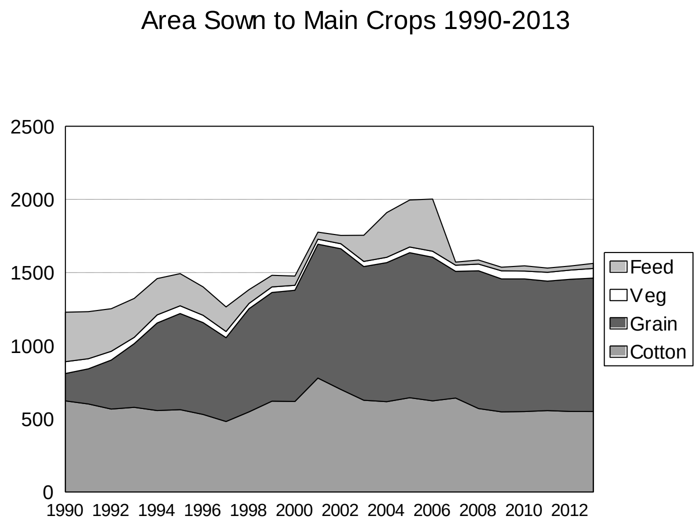


Source: Official statistical yearbooks, Turkmenistan (various years).

Figure 2.15 summarizes the main features of Turkmenistan's crop sector development in the 1990s. The expansion of irrigation led to a steady increase of arable land, which made it possible to expand dramatically the area cropped to grain (dark gray layer in Figure 2.15) without sacrificing the area under cotton (bottom medium-gray layer in Figure 2.15). Nevertheless, the expansion of grain outstripped the growth of arable land and the new favorite crowded out the feed crops (alfalfa and silage corn) and much of the vegetables between 1990 and 2001.

The inadequacy of areas sown to feed crops—both as a feed base for livestock and as a nutrient resource in crop rotation—was apparently recognized in 2002, after which year we witness a substantial reported increase in feed areas from 50,000 hectares to 350,000 hectares in 2006. However, the reported data for 2007-2008 again show reduction of feed crop areas to virtually zero, presumably because of an internal data review in the Department of Statistics, which reduced total arable area from 2 million ha to 1.5 million ha. For political reasons the wheat and cotton areas were not adjusted to reflect this reduction, which was subtracted in its entirety from the area sown to feed crops.

Figure 2.15. Turkmenistan: structure of sown area 1990-2013 ('000 ha)

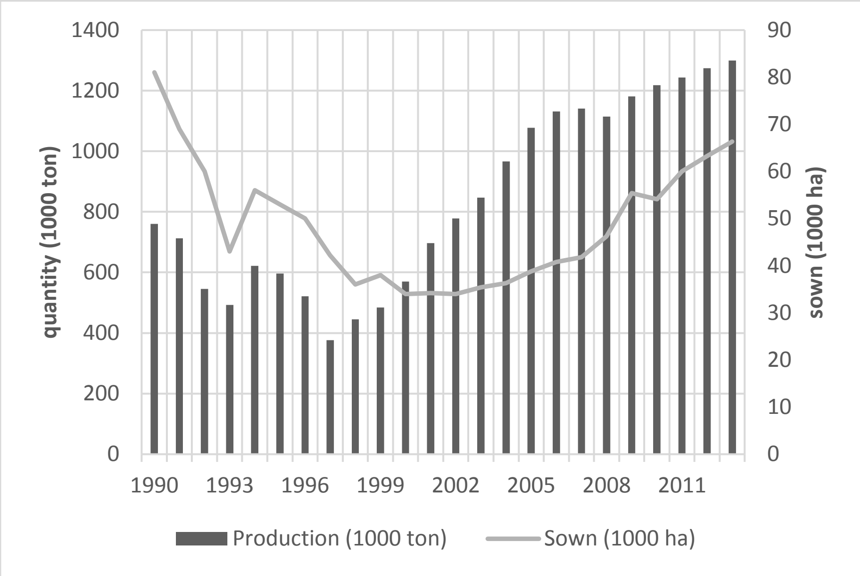


Source: Official statistical yearbooks, Turkmenistan (various years).

Vegetables as a high value added crop traditionally occupied a small share of sown area, which decreased from about 6% in 1990-1991 to less than 2% in 2001-2002. Like feed crops, vegetables lost ground to the galloping expansion of wheat between 1990 and 2001 (Figure 2.15). After 2001, the area in vegetables, potatoes, and melons slowly recovered, doubling their share of sown area from 2% to more than 4% in 2013 (Figure 2.16). This reflects the growing land endowment in small household plots, where labor-intensive vegetables are the ideal choice for labor-rich rural families as both subsistence and cash crops, especially as they are exempt from state orders. The increase in the share of sown area led to an increase in vegetable production, which doubled from about 500,000 tons in 1999-2000 to 1.3 million tons in 2013 (Figure 2.16).

The shift from cotton monoculture to diversified wheat–cotton agriculture may have contributed to the stabilization of water use, as wheat uses 40% less water per hectare than cotton (in 2004, wheat consumed 3,940 cu.m of water per hectare, compared with 7,040 cu.m per hectare for cotton). The national program that produced such a dramatic change in Turkmenistan's crop mix in less than 10 years may have inadvertently served as an important water-saving measure (in relative units, if not in absolute amounts). The value effect of the shift to lower-priced wheat was more than offset by the steep increase in quantities, as gross agricultural output (in constant prices) trebled between 1998 and 2007.

Figure 2.16. Turkmenistan: vegetable production and sown area 1990-2013



Source: Official statistical yearbooks, Turkmenistan (various years).

Crop production and yields

Changes in cropping structure inevitably led to changes in wheat and cotton production in the three countries under study. Belarus, Uzbekistan, and Turkmenistan are respectively the fourth, fifth, and sixth largest grain producers among the NIS (Table 2.4). This puts them far behind Russia, Ukraine, and Kazakhstan by grain volumes.

Table 2.4. Grain production in the NIS (averages for 2009-2012, million tons)

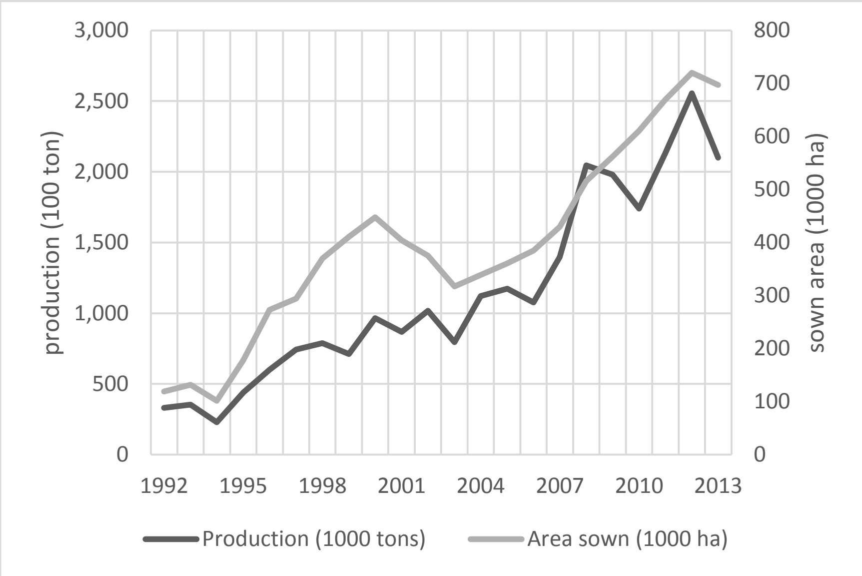
Rus	Ukr	Kaz	Bel	Uzb	Tur	Az	Mol	Kyr	Taj
80.8	47.1	18.2	8.3	7.3	3.5	2.5	2.1	1.6	1.2

Source: CIS Interstate Statistical Committee (2013).

Areas sown in wheat were increased in all three countries as part of government policies aimed to increase wheat production and thus improve food security and self-sufficiency. The increase of wheat production in Belarus generally tracked the increases in sown area (Figure 2.17). Since yields are calculated as the ratio of production to sown area, this points to relative constancy of wheat yields per hectare and absence of technological change. Wheat production followed extensive growth, driven by increases in wheat areas, not yields.

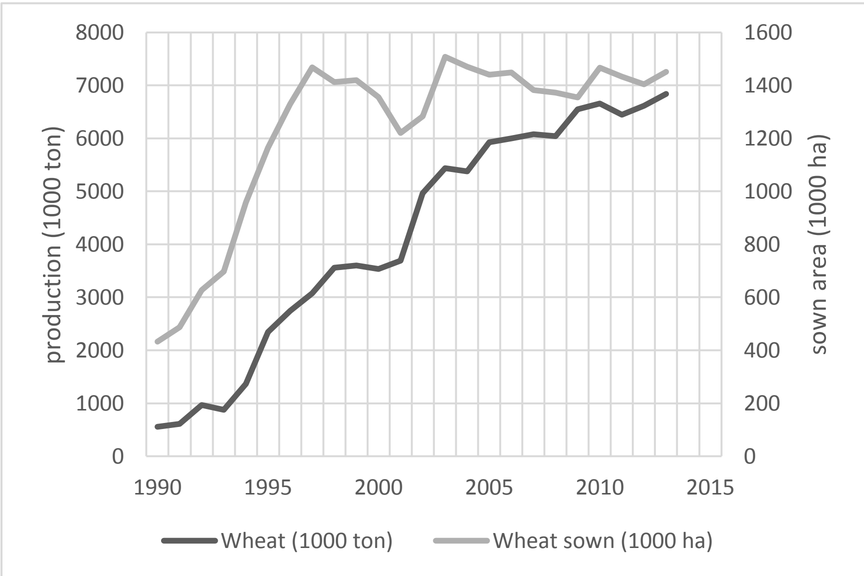
The picture in Uzbekistan is different. The major increases in wheat area came in the early 1990s, when the area cropped to wheat increased from 400,000 hectares in 1990 to more than 1.4 million hectares in 1997. Since 1997, the wheat area has remained constant, fluctuating around 1.4 million hectares (Figure 2.18, orange curve). Wheat production, on the other hand, has been increasing steadily since 1990, and the production growth has continued even after 1997 despite the stagnation of the wheat area (Figure 2.18, blue curve). This suggest that the growth in wheat production in Uzbekistan, unlike that in Belarus, was largely intensive, driven by technological change and improvement of yields rather than expansion of wheat area.

Figure 2.17. Belarus: wheat production and sown area



Source: Official statistical yearbooks, Belarus (various years).

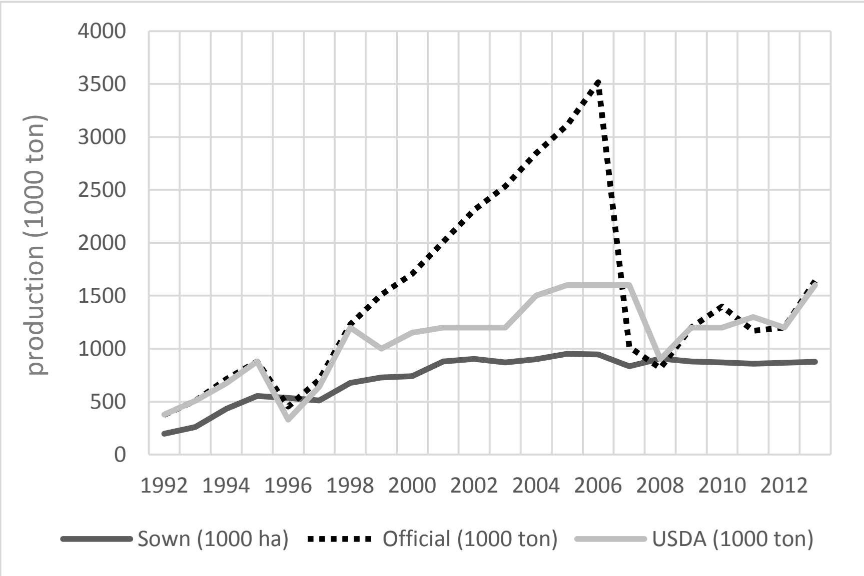
Figure 2.18. Uzbekistan: wheat production and sown area



Source: Official statistical yearbooks, Uzbekistan (various years).

The situation in Turkmenistan is complicated due to unreliable wheat production data. The wheat area increased from 200,000 hectares in 1992 to nearly 900,000 hectares in 2013 (Figure 2.19, orange curve). Wheat production also showed an upward response to area changes, but official statistics grossly exaggerated wheat production figures after 1998 in an attempt to demonstrate the success of President Niyazov's grain policy (Figure 2.19, grey curve). Wheat production numbers were artificially increased from 1.2 million tons in 1998 to 3.5 million tons in 2006, rapidly approaching the target of 4 million tons of wheat by 2010, as set in Turkmenistan National Program to 2010 (1999). Meanwhile, the sown area increased by only 35% (from 700,000 hectares to 950,000 hectares; Figure 2.19, orange curve). The target set by the National Program implied a doubling of wheat yields. In the absence of any investments in R&D infrastructure and total collapse of the scientific institutions in Turkmenistan during Niyazov's tenure, such technological change was unachievable.

Figure 2.19. Turkmenistan: wheat production and sown area



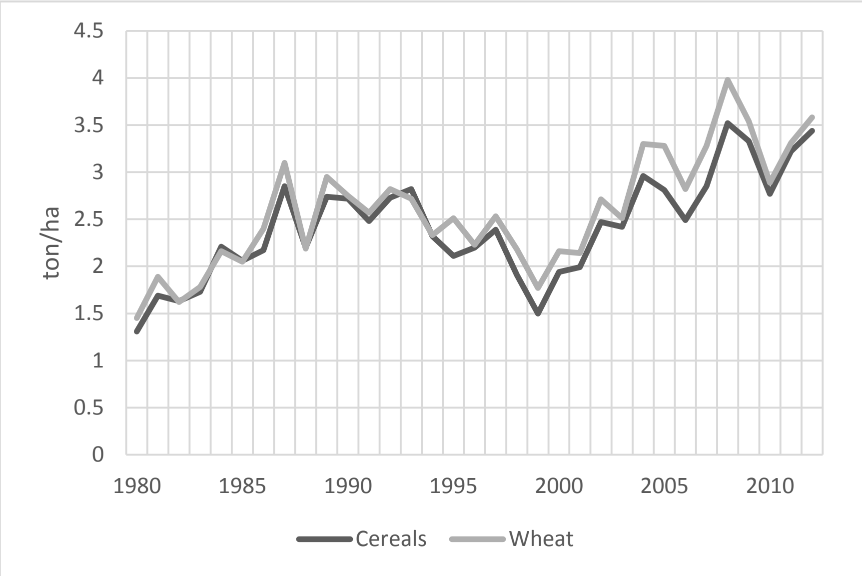
Source: Official statistical yearbooks, Turkmenistan (various years); USDA/PSD (2014).

In 2009, the new president (Kurbanguli Berdymukhamedov) ordered a cleanup of wheat production statistics (as well as the grossly inflated population numbers) to bring them down to believable levels (see, e.g., Turkmenistan Statistics Head Dismissed (2009) and Turkmenistan.ru (2009)). The retroactive adjustment started in 2007, reducing the official wheat production figures from 3.5 million to just 1 million and thus effectively rolling wheat volumes back to below the 1998 level. Since 2007, official wheat production increased from 1 million tons to 1.6 million tons in 2013. All through the period of Niyazov inflated statistics, US Department of Agriculture continued to publish its own estimates of wheat production, based on reasonable yield figures (USDA/PSD 2014). The USDA estimates are shown by the blue curve in Figure 2.19, which effectively truncates the "Niyazov pyramid" in 1998-2007 and closely matches the official statistics since 2008.

Belarus: wheat and other cereal yields

Wheat yields have generally tracked the yields of all cereals over time (Figure 2.20). The yields of both wheat and other cereals reveal three phases: the Soviet phase (1980-1989), with wheat yields rising from 1.4 ton per hectare in 1980 to 3.0 ton per hectare in 1989; the transition phase (1990-1999), with wheat yields dropping back to 1.8 ton per hectare in 1999; and finally the renewed growth phase (since 2000), with wheat yields rising to 3.6 ton per hectare in 2012.

Figure 2.20. Belarus: yields of wheat and all cereals, 1980-2012 (ton/ha)



Source: Official statistical yearbooks, Belarus (various years).

The average cereal and wheat yields for the recovery phase (2000-2012) were higher than for the Soviet phase and the transition phase combined (1980-1999) (see Table 2.5). No significant differences are observed in wheat yields across farms of different types – agricultural enterprises, peasant farms, and household plots. Between 2004 and 2012 wheat yields average 3,200-3,400 kg/ha in farms of all three types.

Table 2.5. Cereal and wheat yields in Belarus: averages for different periods

Period	Years	All cereals, kg/ha	Wheat, kg/ha
Soviet growth	1980-1989	2,059	2,159
Transition	1990-1999	2,318	2,441
Soviet growth and transition combined	1980-1999	2,189	2,300
Renewed growth	2000-2012	2,785	3,038

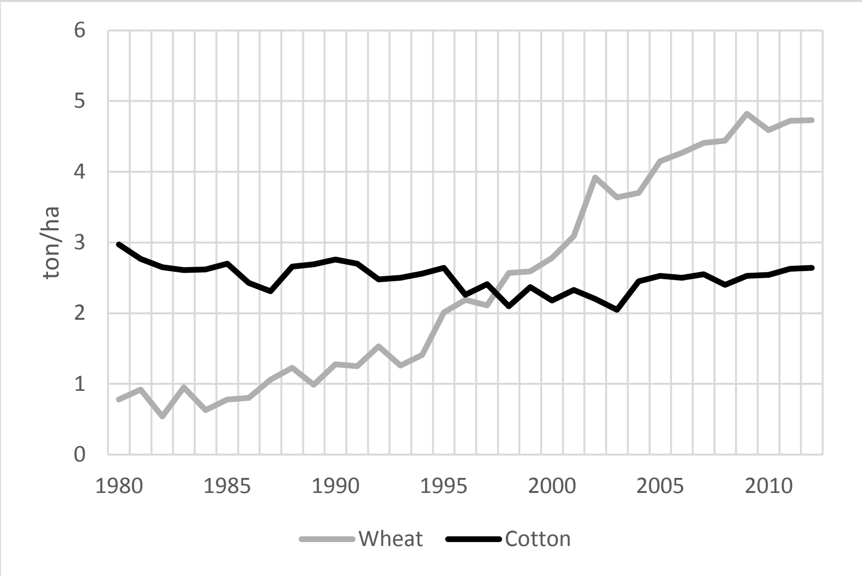
Source: Official statistical yearbooks, Belarus (various years).

Uzbekistan: wheat and cotton yields

Wheat yields increased steadily from less than 1 ton/ha in 1980 to nearly 5 ton/ha in 2012 (Figure 2.21), which unquestionably points to significant technological progress. Cotton yields, on the other hand, fluctuated between 2 ton/ha and 3 ton/ha since 1980, hitting a low of 2 ton/ha during 1996-2000 and rising thereafter to 2.6 ton/ha in 2012. There were no signs of technological progress in cotton production, but at least it did not collapse in the same dramatic way that cotton yields in Turkmenistan did.

Reflecting the double effect of higher yields and greater sown area, wheat production in Uzbekistan increased dramatically from 2.3 million ton in 1995 to 6.6 million ton in 2012 (see Figure 2.18).

Figure 2.21. Uzbekistan: wheat and cotton yields, 1980-2012 (ton/ha)



Source: Official statistical yearbooks, Uzbekistan (various years).

Turkmenistan: wheat and cotton yields

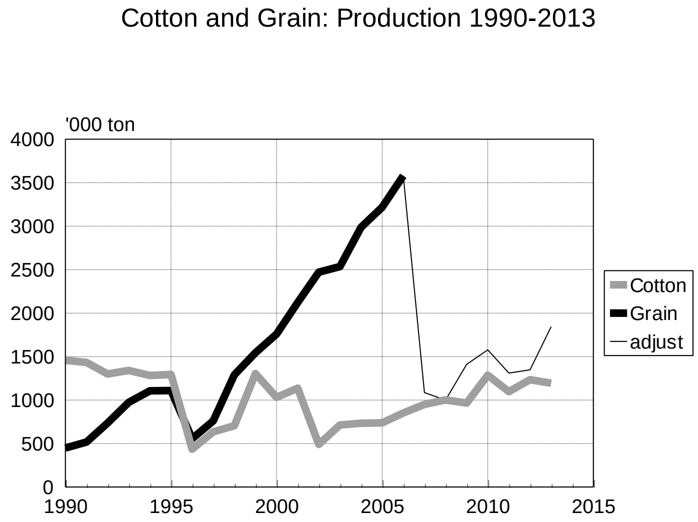
Production volumes of cotton and grain remained fairly static during the 1980s, like the land sown to these crops. Cotton harvests fluctuated around 1.2 million tons, while grain production stayed around 350,000 tons. The big changes began after 1990. Reflecting the increases in sown area in line with government policies, grain production soared from 400,000 tons in 1989-1990 to 1.1 million ton in 1994-1995, and continued to climb, with some fluctuations, to 3.5 million ton in 2006 (Figure 2.22, thick black curve). Reported grain production increased seven-fold between 1990 and 2006, outstripping the five-fold increase in sown area from 200,000 hectares in 1990 to 1 million hectares in 2006. The grain yields increased to 3.7 ton/ha in 2006, rising to 1.5 times the 1990-2002 levels of 2.5 ton/ha and astonishingly surpassing East European grain yields (Figure 2.23, thick black curve, and Table 2.7).

The dramatic growth of grain harvests and grain yields after 1996, and especially after 1998, when the two indicators began to rapidly exceed the 1990 level, raised serious doubts in the validity of the officially reported grain statistics during the Niyazov period. We may have been witnessing a symptom of "pripiska", the Soviet-era practice of inflating reported numbers to meet the declared targets and thus satisfy the political leadership.[7] These suspicions and the lack of confidence in grain statistics between 1998 and 2006 were confirmed by the huge downward adjustment published in the agricultural yearbook of Turkmenistan for 2006-2007 without a word of explanation. The 2007 downward adjustments are summarized in Table 2.6 and are shown in Figures 2.22 and 2.23 by thin lines

[7] Gaps between the optimistic grain production statistics and the true situation on the ground became apparent back in 2006, during the last months before Niyazov's death. Press reports in May 2006 focused attention on shortages of flour and bread in the country and Niyazov was reported saying that "in 2007, there won't be enough bread for everyone" ("Bread shortage grips Turkmenistan," *Eurasia Insight* on EurasiaNet.org, 12 May 2006 [http://www.eurasianet.org/departments/insight/articles/eav120506a.shtml]

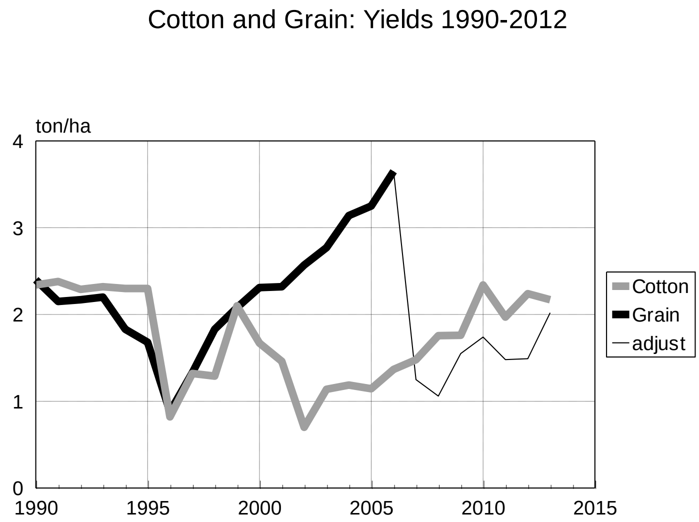
emphasizing the 2006-2007 discontinuity in the grain series. The phenomenon of inflated reporting seems to have only affected grain: there had been no extraordinary growth in cotton up to 2006 and therefore no adjustment was called for in 2007. After 2007, both grain production and grain yields resumed their growth, but now at a sane rate.

Figure 2.22. Turkmenistan: cotton and grain production 1990-2013 ('000 ton)



Note the sharp adjustment of grain production in 2007-2008.
Source: Official statistical yearbooks, Turkmenistan (various years).

Figure 2.23. Turkmenistan: cotton and grain yields 1990-2013 (ton/ha)



Note the sharp downward adjustment of yields in response to the adjustment of production in 2007-2008.
Source: Official statistical yearbooks, Turkmenistan (various years).

Table 2.6. Turkmenistan: adjustments in grain production 2006-2007

	Grain			Cotton	
	2006	2007	Adjustment, %	2006	2007
Sown area, ‘000 ha	982.0	865.7	−12	623.2	642.7
Harvest, ‘000 ton	3579.7	1085.9	−70	851.9	949.8
Yield, kg/ha	3650	1250	−66	1370	1480

Source: Agriculture of Turkmenistan 2006-2007, Table 4.7.

Cotton production replicated neither grain’s ebullient growth during the 1990s nor its dramatic contraction after 2006. As can be seen from Figures 2.22 and 2.23 (gray curves), the cotton harvest peaked in 1990 at an all-time high of nearly 1.5 million tons with yields of 2.3 tons/ha (virtually equal to grain yields). Cotton output declined somewhat between 1990 and 1995 in direct response to the reduction of sown areas. As a result, yields remained constant at 2.3 ton/ha until 1995. The six years of stability came to an abrupt end in 1996, when cotton harvests collapsed to 435,000 tons (down from 1.3 million ton the year before). Cotton yields never returned to the steady pre-1996 levels of 2.3 ton/ha, generally staying below 1.5. Cotton yields during the highly volatile period 1996-2008 averaged 1.4 ton/ha, compared with the average of 2.1 ton/ha during the period of long-term stability 1953-1995.

Table 2.7. Cotton and wheat yields: comparison of Turkmenistan with selected countries

Cotton producing countries	Cotton (lint yields on a relative scale)	Wheat producing countries	Wheat, ton/ha (2000-2005 averages)
Middle East	3.2	EU-15	5.81
Mexico	2.9	Eastern Europe	3.45
Egypt	2.6	USA	2.77
USA	2.1	Developed Africa	2.45
Uzbekistan	2.0	Canada	2.28
Tajikistan	1.4	NIS	1.87
South Asia	1.1	Sub-Saharan Africa	1.62
Azerbaijan	1.0	**Turkmenistan (2007-13)**	**1.51**
Turkmenistan	**1.0**		

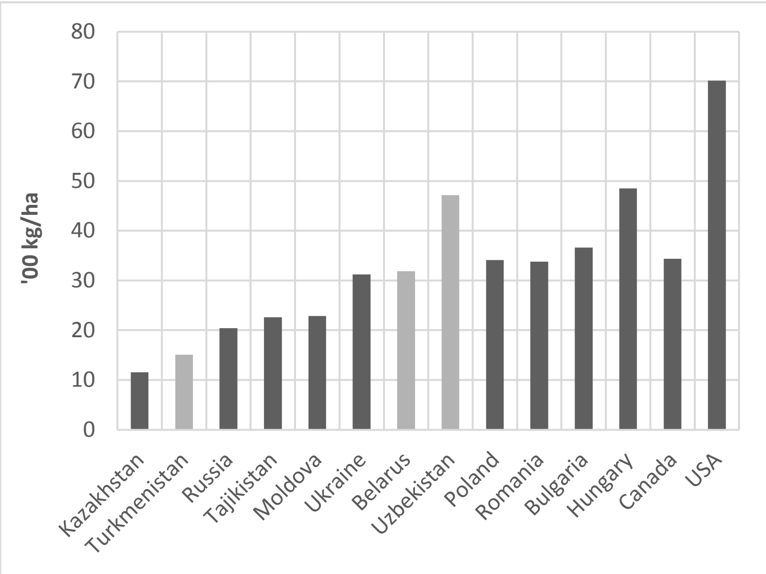
Source: Cotton lint yields from International Cotton Advisory Committee (2002); wheat yields for Turkmenistan from USDA/PSD (2014) and official statistical yearbooks (various years); all other countries from FAOSTAT (2014).

Turkmenistan’s cotton yields are not only decreasing over time, but they are also very low compared to other cotton-producing countries (Table 2.7). The yields of cotton lint achieved by Middle East countries, Egypt, and Mexico are around three times higher than the yields in Turkmenistan; the yields in the United States and Uzbekistan are double the Turkmen yields; and only South Asian countries (India, Afghanistan, Bangladesh, Pakistan) and Azerbaijan report yields equivalent to those of Turkmenistan. The situation is the same with wheat yields: Turkmenistan’s wheat yields after post-Niyazov adjustment are around 1.5 tons per hectare, the lowest among the countries and regions selected in Table 2.7. The reliance on rain-fed cropping, shortage of fertilizers and chemicals during the transition, and the collapse of the R&D and extension services in independent Turkmenistan are among the factors responsible for such low yields.

Cross-country comparison of wheat yields

Among the three countries under study, Uzbekistan ranks first by cereal yields, closely followed by Belarus, with Turkmenistan a distant third. Uzbekistan's cereal yields are the highest among all NIS grain producers (Figure 2.24). They are also higher than in East European countries, with only Hungary achieving the same level of cereal yields. Compared to North American countries, Uzbekistan's cereal yields are higher than in Canada, but substantially lower than in the USA. The observed advantage of Uzbekistan in wheat yields may be attributable to the effect of irrigation: in Uzbekistan wheat is an irrigated crop, whereas in other countries in Figure 2.24 it is generally grown on rain-fed fields. Although Turkmenistan also irrigates its wheat, the leasehold-based farm structure in Turkmenistan is more constrained and less conducive to manifestation of the advantages of individual farming than Uzbekistan's structure based on peasant farms. Beyond irrigation, Uzbekistan's exceptional grain yields can be attributed to the government's intensive efforts to maintain and rehabilitate the Soviet R&D system for agriculture, including seed selection institutes. These efforts directly contribute to technical progress in crop production.

Figure 2.24. Grain yields in NIS, Eastern Europe, and North America ('00 kg/ha)



Note: Averages for 2007-2013 (Turkmenistan), 2009-2012 (other NIS), 2009-2011 (rest of the world).
Sources: Turkmenistan from official statistical yearbooks (various years); other NIS from CIS Interstate Statistical Committee (2013), rest of the world from FAOSTAT (2014).

Cereal yields in Belarus are comparable to those in a number of transition countries (Ukraine, Poland, Romania, and Bulgaria) and even to the yields in Canada (Figure 2.24). Belarus has higher yields than some other transition countries, most notably Russia and Kazakhstan. On the other hand, cereal yields in Belarus are lower than those in Uzbekistan and Hungary as well as the USA. In a world perspective, Belarus occupies a respectable place in the middle with regard to cereal yields.

For purposes of cross-country comparison, Turkmenistan's yields were calculated for the post-Niyazov period 2007-2013. In this way, the yields were not distorted by the inflated production figures between 1998 and 2006. The average yield for 2007-2013 is 1.5 tons per hectare based on adjusted production statistics (see Figures 2.19, 2.22, 2.23). These yields are among the lowest in the world. Although all grain in Turkmenistan is irrigated, the yields are comparable to Kazakhstan, where wheat is produced under rain-fed conditions, and much lower than in neighboring Uzbekistan, where grain is also irrigated. The low yields in Turkmenistan may be attributed to the almost complete collapse of the agricultural R&D system, contrary to the situation in Uzbekistan, and to less radical individualization of farming structure, as noted above.

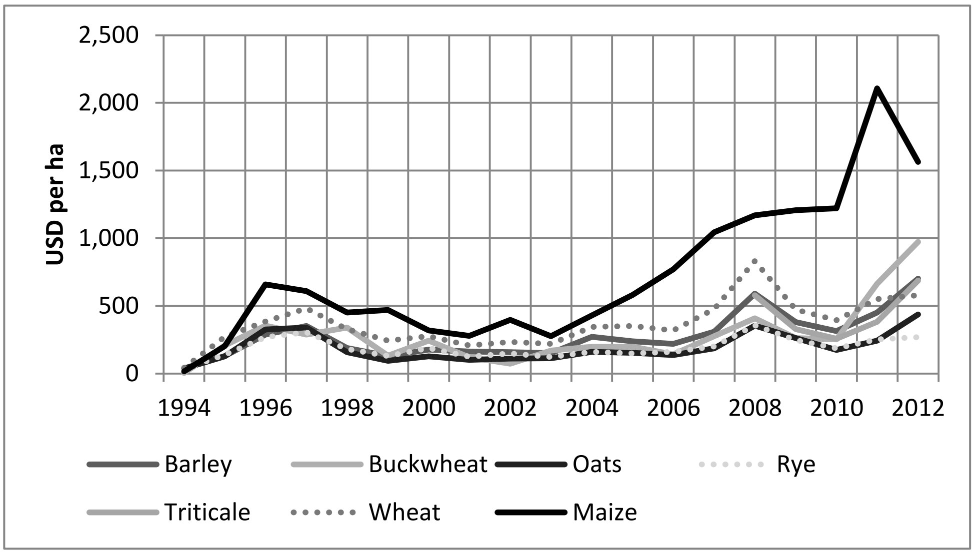
Gross returns per ha in Belarus, Uzbekistan and Turkmenistan and crop areas

In market economies changes in crop areas should reflect expectations of net returns per hectare. The expected net return of a given crop per ha can be defined as the expected value of crop sales per ha minus expected costs of production per ha. The difference can be compared across crops to give an idea of relative incentives to plant one crop or the other. For Turkmenistan, Uzbekistan and Belarus we do not have information on expected net returns with data on costs of production per ha by crop, though we do have information on *ex post* gross returns, the value of crop sales per ha. Though this indicator is far from what we would like to have, we might expect at least a rough correlation between sowing trends and gross returns per ha by crop. In fact, in cases where sowing trends differ from ex post gross returns we can identify plausible reasons for the deviation from what we would roughly expect to be true.

Belarus. Evidence on gross returns per ha for various grains in Belarus indicates that the movement into wheat and maize appears to have been quite rational in the 2000s up until about 2012, for these were the two grains with the highest returns per ha (Figure 2.25). In 2011 buckwheat overtook wheat as the grain with the second highest return, but the area in buckwheat is quite small. Triticale and barley returns grew above those of wheat in 2012 as well. If this trend continues it may slow the movement into wheat in Belarus, though not necessarily. The expansion of wheat sown area may be a policy decision based on considerations beyond gross returns.

The big mystery is of course maize, a good feed grain for hogs that can be fed as a supplement to cattle as well as a concentrate. The returns to maize in Belarus seem so high that it seems surprising that Belarus does not raise more of it. The tiny area devoted to maize underlines the distortions in supply response that characterize Belarusian agriculture. Maize seeds in Belarus are likely imported hybrids (maize yields in Belarus are relatively high—over 5 tons per ha since 2011), which may be difficult to either obtain or afford for foreign currency-strapped agricultural enterprises. Moreover, switching to maize cultivation requires specialized seeders, harvesters and knowledge which also should be imported. This represents a sizeable investment and Belarusian agricultural enterprises my face credit constraints for foreign currency making this difficult. Third, Belarus has not traditionally raised much maize, a crop that is more suited to longer growing seasons as in Ukraine, Romania and Hungary.

Figure 2.25. Belarus: gross returns per ha of harvested crop, USD per ha, 1994-2012



Source: FAOSTAT (2014). Note: Gross returns per ha is computed as the price received by farmers per ton*yield (tons/ha).

Uzbekistan. There are no available statistics on producer prices for crops in Uzbekistan. However, prices from farmer markets exist. These are the prices of commodities and animals raised on household and family farms and sold on local markets, including wheat, maize and barley. Although these prices are not the same as producer prices for family farmers, they should at least reflect the relative scarcity of these three commodities. We thus use them as indicators of the relative levels of gross returns from these crops by multiplying these prices by yields per ha (Figure 2.26). Evidence on gross returns per ha for various grains in Uzbekistan indicates that there are other concerns besides gross returns behind sown area. Though wheat returns seem to dominate those of barley, maize returns have been growing at a faster rate since 2005 and clearly dominate both wheat and barley. However, area under maize has remained constant at about 33,000 to 38,000 ha, about 2% of that devoted to wheat.

These data on gross returns once again illustrate that the supply response of Uzbek agriculture is deeply affected by government policies. In the case of wheat (and cotton), farmers can obtain land only by agreeing to fulfill state orders. On this basis they are granted land on which they have the right to grow only wheat (or cotton), and they must deliver the wheat (cotton) they contract for to the state at the end of the year. Thus, the planned nature of wheat and cotton production in Uzbekistan prevents family farmers from responding to prices reflecting the relative scarcity of crops. Certainly, farmers would like to sow crops with higher gross returns, but they are obligated by government contracts to sow and deliver wheat and cotton on the land allotted to them specifically for the purpose of raising those two crops.

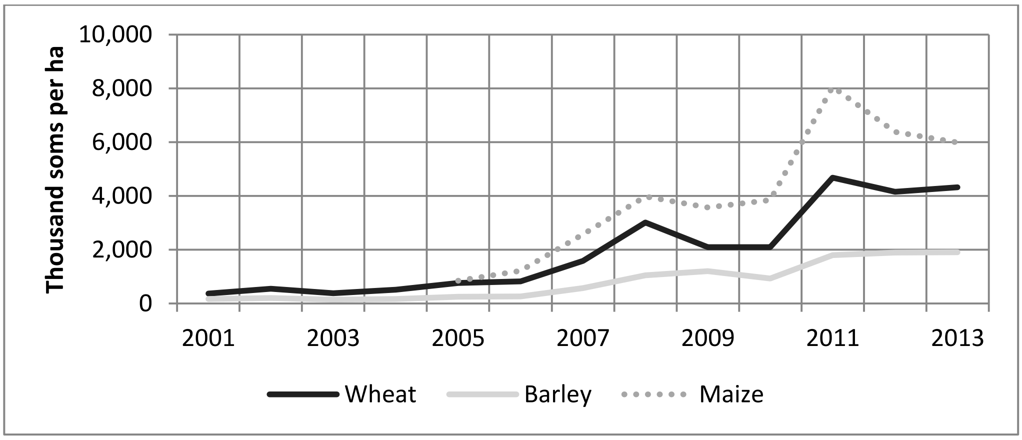
A second consideration why Uzbek sown area shows that there are virtually only two crops, despite higher putative gross returns to maize cultivation lies in the nature of farmers decisions. Farmers actually make decisions based on the *net* income from alternative crops, not the gross returns. Though maize production is not subsidized, the state provides subsidies for fertilizers, fuel and seeds for state orders of wheat, as well as making water and subsidized credits available. So, the gross returns in Figure 2.26 do not really reflect relative incentives for farmers.

In addition to this basic policy issue, there are a number of statistical issues that either diminish or raise gross returns to wheat and maize. We are not able to tell which of these considerations is more important, and thus whether gross returns to wheat and maize are actually lower or higher. However, these considerations illustrate the limitations of official statistics.

1. Yields of wheat are probably lower than official statistics indicate for the following reason: The family farmer is obliged to deliver approximately 50% of the amount of wheat for which he has contracted (and received inputs). The other half of his crop he can use for seeds or sell on the free (dekhan) market. The statistical authorities use the amount delivered by the farmer as an indicator of wheat delivered and produced, doubling the amount delivered to obtain an estimate of that produced. It is not known in reality how much the farmer has produced, but the estimate by the statistical authorities probably overestimates actual production. This implies that the actual yield is probably lower than that published by the statistical authorities and, consequently, the gross returns to wheat are probably lower than that shown in Figure 2.26. How much lower we do not know.

2. Though farmers receive land and inputs to raise wheat and cotton, they have incentives to raise more profitable crops on these lands, and, at the margin, they may do so. This implies that in reality the area sown to wheat is probably lower than official statistics report, though we do not know by how much, and the area sown to more profitable crops is probably higher. This means that the wheat harvest is actually grown on less area than stated in official statistics, meaning that yields and gross returns per ha of wheat are higher. In addition, farmers who contract for wheat probably grow maize on some of this land, which implies that the area in maize is probably higher than reported in official statistics. Consequently, the yield and gross return figures for maize are probably inflated, though we do not know by how much.

Figure 2.26. Uzbekistan: relative gross returns per ha of harvested crop, thousand soms per ha, 2001-2013

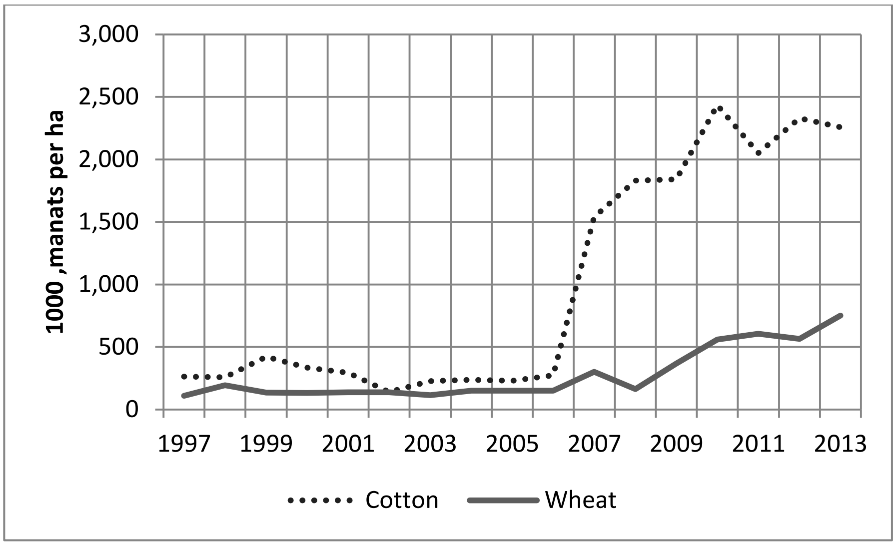


Source: Authors' calculations based on official statistical yearbooks, Uzbekistan (various years).

Turkmenistan. Unlike for Belarus and Uzbekistan, for Turkmenistan we do not use official figures to characterize wheat production and use. Instead, we use independent estimates of wheat production published by the US Department of Agriculture (USDA/PSD 2014).[8] The reason for this is the falsified information on grain production in Turkmenistan official statistics that came to light in 2009 (see above the discussion around Figure 2.19 in the section *Crop production and yields*).

The importance of planning rather than price incentives in Turkmenistan seems to be underlined by the relative stability of cotton and wheat area harvested, despite the raising of cotton procurement prices from parity with those of wheat (per ha) to 3-4 times above that of wheat between 2007 and 2009 (Figure 2.27). In a market economy, such a change would cause a substantial increase in sown area of cotton at the expense of wheat, while in Turkmenistan the portions of these two crops in overall harvested area remained constant.

Figure 2.27. Turkmenistan: gross returns per ha of harvested crop, thousand manats per ha, 1997-2013



Source: Stanchin (2014), based on official statistical yearbooks, Turkmenistan.

Livestock production

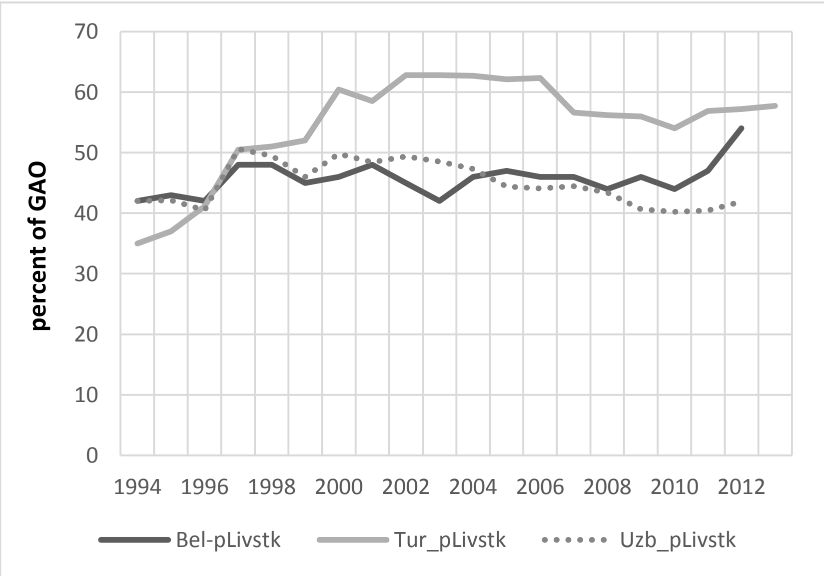
Of the three countries in this study, Turkmenistan has the highest share of livestock production in its agricultural output (Figure 2.28). Furthermore, it shifted from strong crop specialization to clear livestock specialization, as the share of livestock production went up from 35%-40% in the mid-1990s to over 60% between 2000 and 2006, stabilizing thereafter at about 55%. No such dramatic changes are observed for Belarus and Uzbekistan, where the share of livestock production stayed between 40% and 50% during the two decades 1994-2012. In Belarus the share of livestock production maintained a steady course until 2010, and them increased from 45% to 55% in 2011-2012. It remains to be seen if this is a stable trend that will continue in the future. In Uzbekistan, on the other hand, the share of livestock

[8] FAOSTAT is an alternative source for wheat production data in Turkmenistan. However, FAOSTAT data closely replicate the Turkmenistan official statistics.

production actually displays gradual decline from about 50% in the late 1990s to 40% since 2009.

The persistent shrinking of livestock production shares in Uzbekistan since 2000 may have triggered the 2006 livestock sector reform (Presidential Decree 308 of March 2006), which was intended to provide strategic and tactical instruments for the improvement of milk yields and overall livestock efficiency. If so, the reform has not produced noticeable increases in the share of livestock production in Uzbekistan, and at best may have arrested further decline of livestock production shares below 40% since 2009. The increase of livestock production shares in Turkmenistan may also be linked to government policies, which abolished state orders on livestock products and furthermore removed restrictions on the number of animals in a household.[9]

Figure 2.28. Share of livestock in agricultural production in Belarus, Uzbekistan, and Turkmenistan, 1994-2013 (percent of GAO)



Source: Official statistical yearbooks, Belarus, Turkmenistan, Uzbekistan (various years)

Changes in livestock inventories and ownership structure

Turkmenistan and Uzbekistan

The development of the livestock sector in Turkmenistan and Uzbekistan is completely different from that in Belarus. Two features characterize the dynamics of livestock in Turkmenistan and Uzbekistan. First, the livestock herd in Turkmenistan and Uzbekistan shows dramatic increase over time. In Turkmenistan, animal inventories of all species (measured in standard head[10]) almost trebled between 1990 and 2013, increasing from about

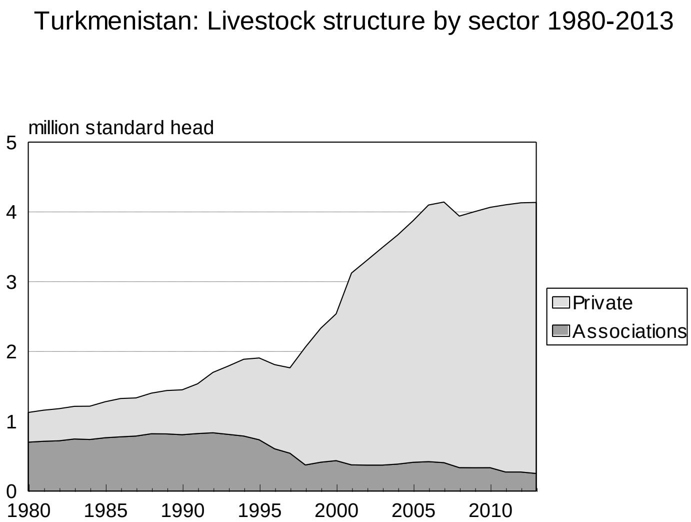
[9] Comparison of average livestock production shares for pre-1990 and post-1990 periods shows increases for Turkmenistan and Uzbekistan and a decrease for Belarus. This comparison over time, however, is not entirely valid as the shares for the pre-1990 period are based on production in constant prices, whereas the shares for 1992-2013 are calculated from production in current prices.

[10] Standard head is a measure of livestock headcount aggregated over animal species, with one head of cattle equivalent to 10 sheep and 100 birds.

1.5 million st. head to more than 4 million st. head (Figure 2.29). In Uzbekistan, the cattle headcount doubled between 1990 and 2012, rising from 5 million to 10 million head (Figure 2.30). The livestock sector in Turkmenistan and Uzbekistan did not suffer from transition-induced disruptions after 1990 and animal numbers have shown particularly strong growth since 1996-1997.

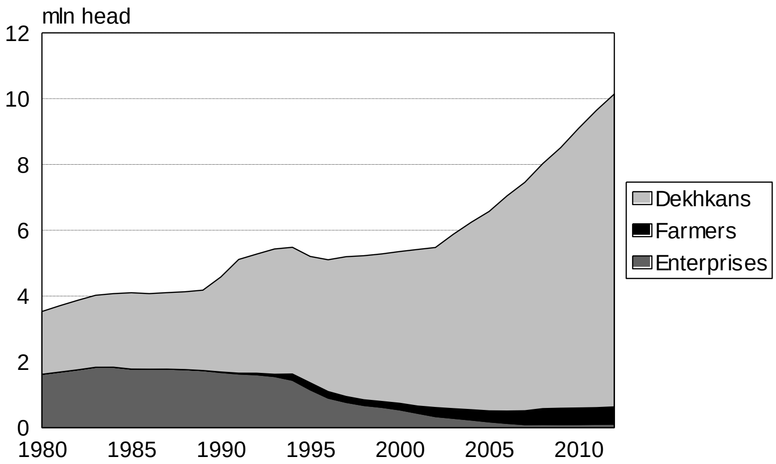
The second feature in both countries is the increasing concentration of livestock in the private sector (light gray top layer in Figures 2.29, 2.30), accompanied by the shrinking role of agricultural enterprises (dark gray bottom layer). In fact, Figures 2.29 and 2.30 clearly show that the increase of headcount in Turkmenistan and Uzbekistan was driven entirely by the growth of the private sector, which more than offset the shrinkage of the enterprise sector. The private sector played a relatively important role in household production even during the Soviet period, when household plots controlled 40%-50% of animal inventories in Turkmenistan and Uzbekistan. This was much more than their share of farmland at that time, e.g., 3% of agricultural land and 10% of arable land in Uzbekistan (see Figures 2.4, 2.5). By 2012, however, the private sector had reached almost 95% of the total herd in Turkmenistan and 99% of all cattle in Uzbekistan (most of it in household plots). The livestock sector in Turkmenistan and Uzbekistan is entirely dominated by the individual sector, and specifically by household plots.

Figure 2.29. Turkmenistan: changing ownership structure of the livestock herd by farm type 1980-2013 (st. head)



Source: Official statistical yearbooks, Turkmenistan (various years).

Figure 2.30. Uzbekistan: changing ownership structure of the cattle herd in farms of different organizational forms 1980-2012



Source: Official statistical yearbooks, Uzbekistan (various years).

Peasant farms play a distinctly marginal role in livestock in Turkmenistan and Uzbekistan compared to household plots. In Turkmenistan, this is attributable to the virtual wiping-out of the peasant farms by government policy (see Figure 2.7 and the discussion around it). In Uzbekistan, the cattle headcount in peasant farms increased over time, but to this day it does not exceed 5% of the total herd in the country (the thin black layer in Figure 2.30). This is in stark contrast to the share of peasant farms in land use in Uzbekistan, which had reached 85% of arable land and nearly 35% of agricultural land by 2012 (see Figures 2.4, 2.5). Peasant farms play a much more central role in crop production in Uzbekistan, due to their large endowment of arable land.

While household plots in aggregate are the dominant force in Uzbekistan's livestock sector, the average household plot has just 3 head of cattle and 1.3 cows, compared with 42 head of cattle and 13 cows in livestock-oriented peasant farms. The bulk of cattle in Uzbekistan is thus held in a huge number of very small household farms: 3 million rural households keep 10 million head of cattle and 4 million cows – 95% of Uzbekistan's herd (2012 data).

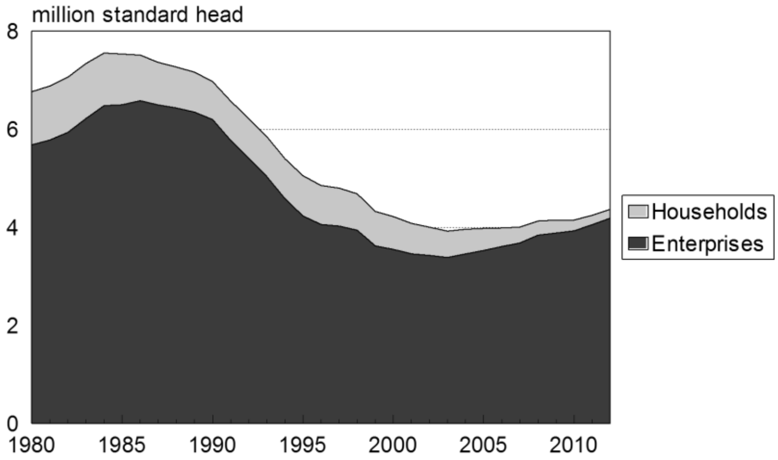
We are witnessing a very significant concentration of livestock in rural households in both Turkmenistan and Uzbekistan, and almost total depletion of agricultural enterprises from livestock production. Before transition, all through the 1980s, fattening operations were mostly handled by agricultural enterprises, while households concentrated on dairy production. In recent years, the share of both dairy and beef cattle in household farms converged to levels above 90%, and the enterprise sector has lost its relevance also for beef production. All livestock production—dairy and beef—is virtually concentrated in the private sector since 1998.

Belarus: Livestock changes

The livestock dynamics in Belarus follows a totally different pattern from that in Turkmenistan and Uzbekistan. While the two Central Asian countries did not suffer any transition decline in their livestock sector, the cattle headcount in Belarus dropped from a high of 7.5 million in 1984 to a low of 3.9 million in 2003, and then recovered very slightly rising to 4.4 million in 2012. The dramatic shrinkage of almost 50% of the Soviet-era herd during the transition in part reflects greater responsiveness to market signals. Livestock in Belarus was traditionally a loss-making sector, a phenomenon that could not be sustained once policy makers became aware of the damage caused by soft-budget constraints.

More significantly, in the context of agrarian reforms, we observe that the share of the individual sector (mainly household plots) is miniscule: less than 5% in recent years, down from around 15% in the 1990s (Figure 2.31). In both respects, livestock in Belarus presents a completely different picture from what we see in Central Asia where 98% of the total herd is in the individual sector (also mainly in household plots) and the livestock headcount is rapidly growing. The Belarus livestock pattern is typical of a country with very sluggish reforms and continued emphasis on large-scale farms.

Figure 2.31. Belarus: cattle headcount by farm type (enterprises and households), 1980-2012



Source: Official statistical yearbooks, Belarus (various years).

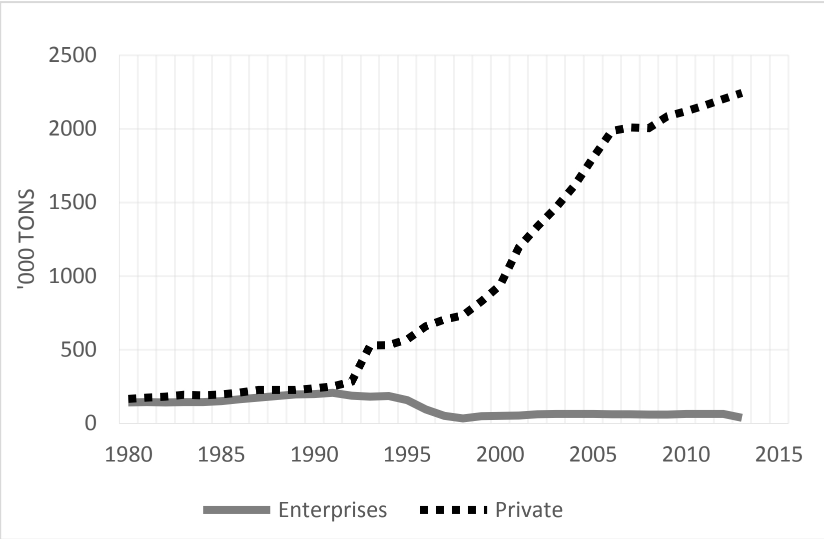
Milk production

The increase in animal inventories after 1990 in Turkmenistan and Uzbekistan naturally led to an increase in milk production. Moreover, livestock in these countries is largely concentrated in the private household sector, and as a result, small private farms dominate milk production, while the quantities produced by large-scale enterprises are vanishingly small since 2000.

Milk production in household farms (household plots) in Turkmenistan increased by a factor of 10 between 1990 and 2013, rising from 200,000 tons in 1990 to 2.2 million tons in 2013 (Figure 2.32). In Uzbekistan, the increase was by a factor of 4, starting from a much higher base of 2 million tons in 1990 and rising to 8 million tons in 2013 (Figure 2.33). In both countries, the private sector now produces virtually 100% of milk output.

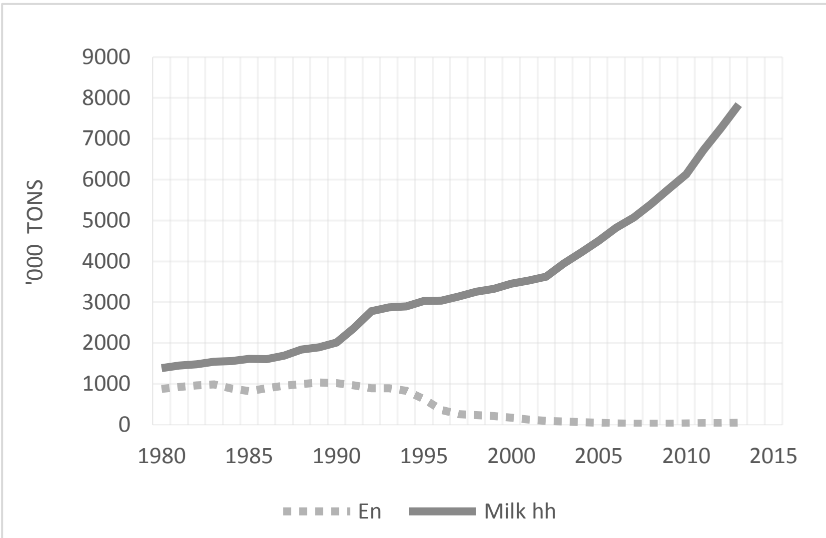
In Belarus, total milk production also has been increasing in the recent decade, following the turnaround in livestock headcount in 2004. Milk production rose from 5.1 million tons in 2004 to 6.8 million tons in 2012 – an increase of more than 30% (Figure 2.34).

Figure 2.32. Turkmenistan: milk production by farm type 1980-2012 (in '000 tons)



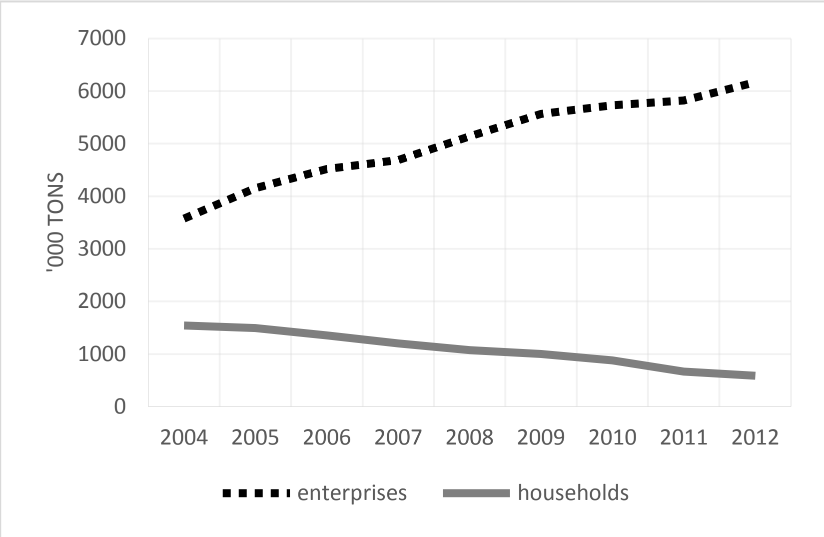
Source: Official statistical yearbooks, Turkmenistan (various years).

Figure 2.33. Uzbekistan: milk production by farm type 1980-2012 (in '000 tons)



Source: Official statistical yearbooks, Uzbekistan (various years).

Figure 2.34. Belarus: milk production by farm type 2004-2012 (in '000 tons)



Source: Official statistical yearbooks, Belarus (various years).

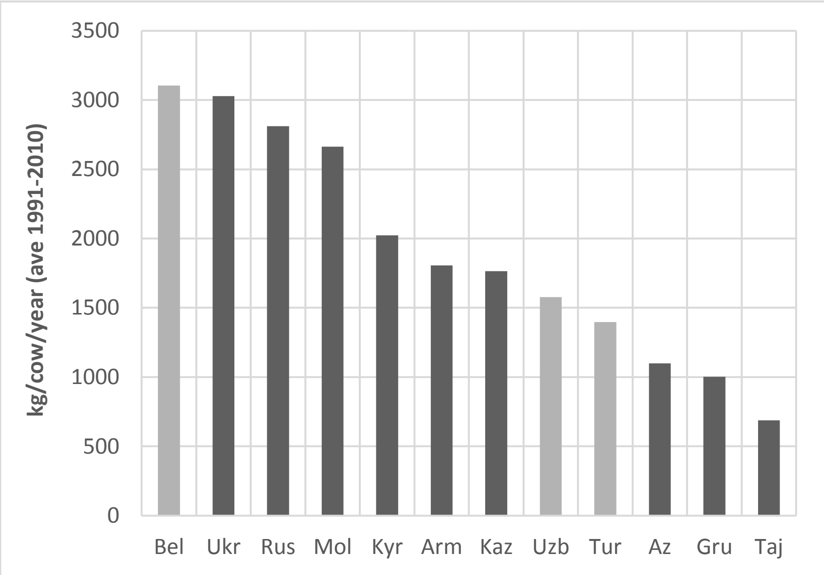
Contrary to Turkmenistan and Uzbekistan, however, the main driver of growth in Belarus is the agricultural enterprises, which have most of the cows and accordingly produce most of the milk (80%-90% of total milk production in recent years). Milk production in agricultural enterprises increased by 72% between 2004 and 2012 (from 3.6 million tons to 6.2 million tons; see Figure 2.34). Milk production in household plots, on the other hand, has been decreasing since 2004, reflecting the decrease in livestock headcount in rural households (compare Figures 2.31 and 2.34). In stark contrast to Turkmenistan and Uzbekistan, the share of households in milk production in Belarus dropped from 30% in 2004 to 9% in 2012 as their production volumes shrank from 1.5 million tons to 0.6 million tons (a decrease of more than 60% of the 2004 volume). The main reason for this trend is the shrinking rural population in Belarus that reduces the number of household plots (this is also the reason for the decrease of land in household plots, see Figure 2.6). The share of peasant farms in both headcount and milk production is negligible (less than 0.5% of milk output).

The robust growth of milk production in the private sector in Turkmenistan and Uzbekistan is a sign of successful agricultural reforms leading to individualization of agriculture. It has been enabled by basic policy measures that eliminated state orders on livestock products and removed restrictions on the maximum number of animals allowed in household plots. No such reforms have been undertaken in Belarus, which may be the cause for the shrinking milk production in the private sector. Overall increase in total milk production is attributable to strong government support and investment in the dairy sector, which has become a major agricultural export of Belarus.

Milk yields

Milk yields (in kg per cow per year) are calculated by dividing total milk production in any year by the number of lactating cows. Belarus achieves on average (1991-2010) the highest milk yields among the NIS, closely followed by Ukraine and Russia (Figure 2.35).

Figure 2.35. Milk yields for Belarus, Uzbekistan, and Turkmenistan compared with other NIS



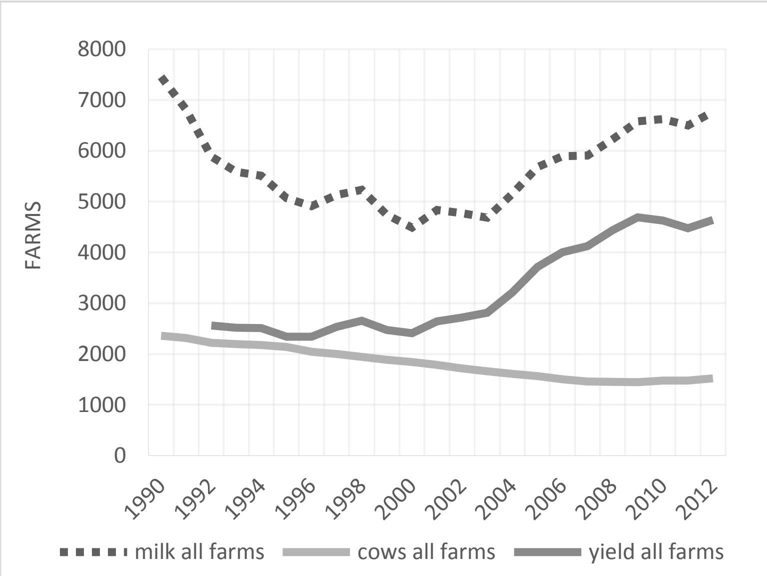
Note: Averages for 1991-2010. Source: CIS Interstate Statistical Committee (2013).

Uzbekistan and Turkmenistan, on the other hand, show average milk yields that are below the NIS median – a steady 1,600 kg per cow per year since 2005 in Uzbekistan and 2,000 kg/per cow per year in Turkmenistan. These are very low yields by comparison with Europe and the U.S. (8,000 kg per cow per year) or Israel (11,000 kg per cow per year). More troubling than the comparison to Western economies is the fact that the Uzbek and Turkmen milk yields are substantially lower than in other NIS (2,000-3,000 kg per cow per year in Belarus, Ukraine, Russia, Moldova, and Kyrgyzstan) and exceed only those in Azerbaijan, Georgia, and Tajikistan (Figure 2.35).

In Belarus, milk production increased steadily since 2000 despite the continuing decline in the number of cows (Figure 2.36). This implies robust increase in milk yields, which rose from 2,400 kg per cow per year in 2000 to 4,650 kg/cow/year in 2012. The increase in yields is clearly due to technological change, and not larger herd. The technological change is probably linked to government investments in the livestock sector, as there have been very few changes in incentives due to the negligible pace of individualization.

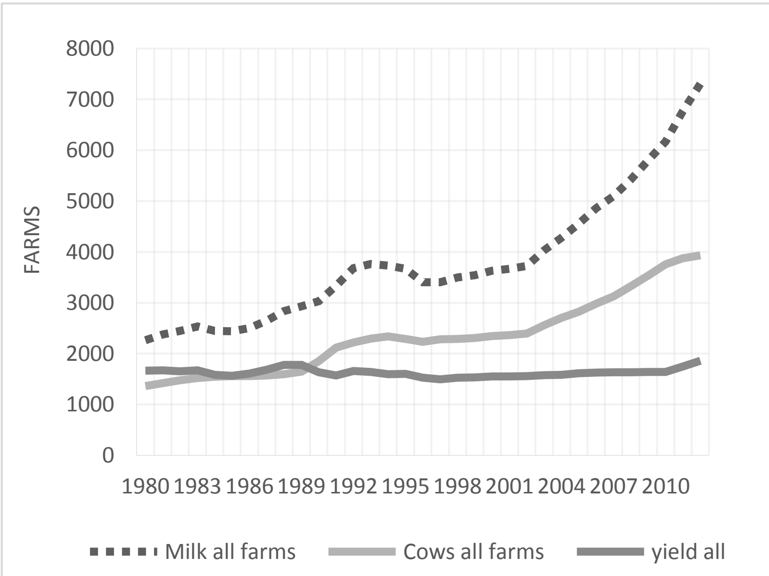
In Uzbekistan, on the other hand, there has been virtually no technological change in milk production. Increases in milk production since 1990 have been matched by increases in the number of cows (blue and orange curves in Figure 2.37), and milk yields (gray curve) have remained fairly constant (and very low) at about 1,600 kg per cow per year since 1990. Ongoing reform efforts in Uzbekistan do not seem to have had an effect on milk yields, possibly because of poor market infrastructure, including inadequate feed (both quality and quantity) and difficulties with access to sales channels for small producers.

Figure 2.36. Belarus: milk production, number of cows, and milk yield 1990-2012 (all farms)



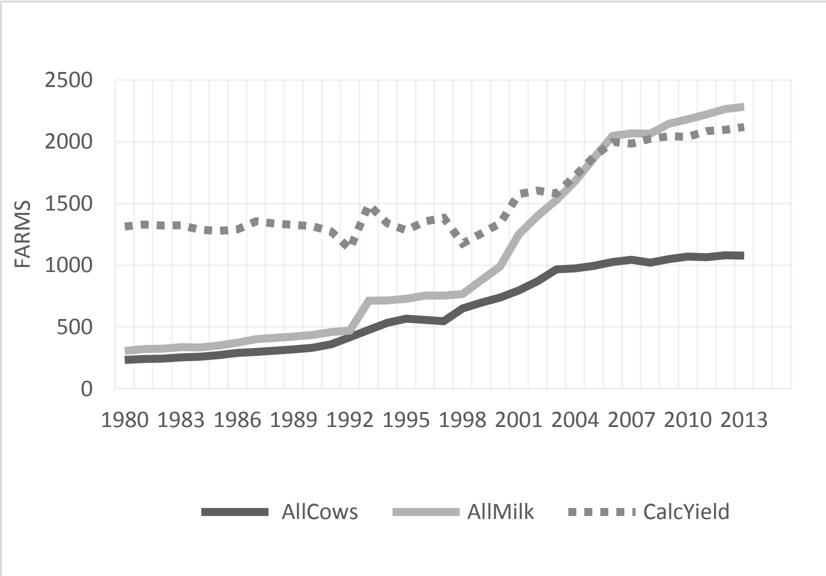
Source: Official statistical yearbooks, Belarus (various years).

Figure 2.37. Uzbekistan: milk production, number of cows, and milk yield 1980-2012 (all farms)



Source: Official statistical yearbooks, Uzbekistan (various years).

Figure 2.38. Turkmenistan: milk production, number of cows, and milk yield 1990-2013 (all farms)



Source: Official statistical yearbooks, Turkmenistan (various years).

In Turkmenistan, the picture of the milk sector is more complex. The growth in physical output did not always match the growth of the livestock resource base, and we observe significant divergences in the productivity of milk production during the decade. Up to 1998, the growth in physical output of milk generally matched the increase of the cow herd. Milk yields stayed around 1,300 kg/cow. Since 1998, however, milk output has been growing faster than the number of cows, leading to significant improvements in milk productivity (Figure 2.38). Between 1998 and 2013, milk output nearly trebled, increasing from less than 800,000 tons to 2.3 million tons, while the number of cows grew by only 65%. Milk yields accordingly rose from the pre-1998 level of 1,300 kg per cow to 2,200 kg per cow in 2011-2013.

In Turkmenistan, contrary to Belarus, the technical change driving yield increases was definitely associated with land and farm reforms initiated in 1998. These reforms strengthened the family farm sector and led to a change in incentives attributable to greater household accountability. In a regional perspective, Turkmenistan milk yields were among the lowest in Central Asia (better only than Tajikistan) until the turnaround point in 1998. In recent years, Turkmenistan’s position has shifted diametrically and it is now close to the milk yields in Kyrgyzstan—the best milk producer in Central Asia consistently since 1980.

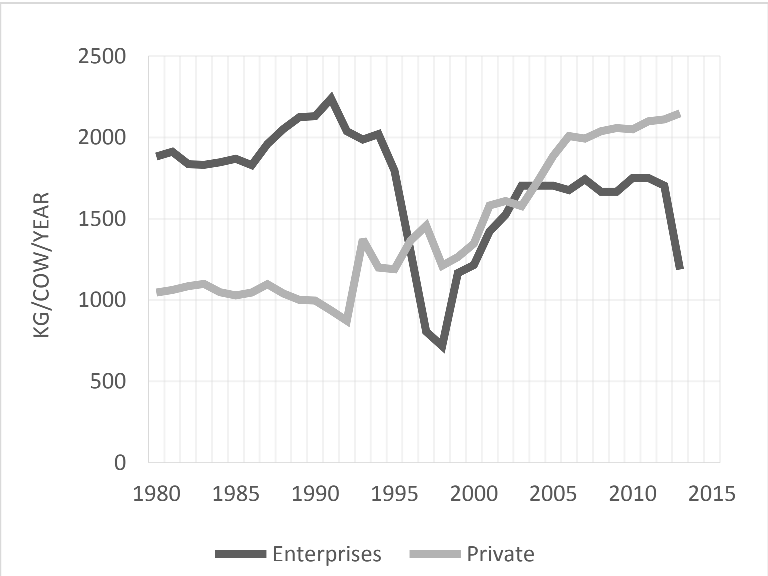
Milk yields in farms of different types

The logic behind individualization-oriented agricultural reforms is supported by the ample evidence that family farms, with their special incentive structure, are more efficient and more productive than corporate farms (agricultural enterprises). In the livestock sector, we accordingly expect to see higher milk yields in private farms (household plots and peasant farms).

In Belarus, no significant differences in yields are observed between the two main farm types that produce milk. Milk yields achieved by both agricultural enterprises and households average 4,100-4,200 kg per cow per year between 2004 and 2012. This may be attributable to the negligible role of the private sector in livestock production, which is crowded out by the enterprise sector.

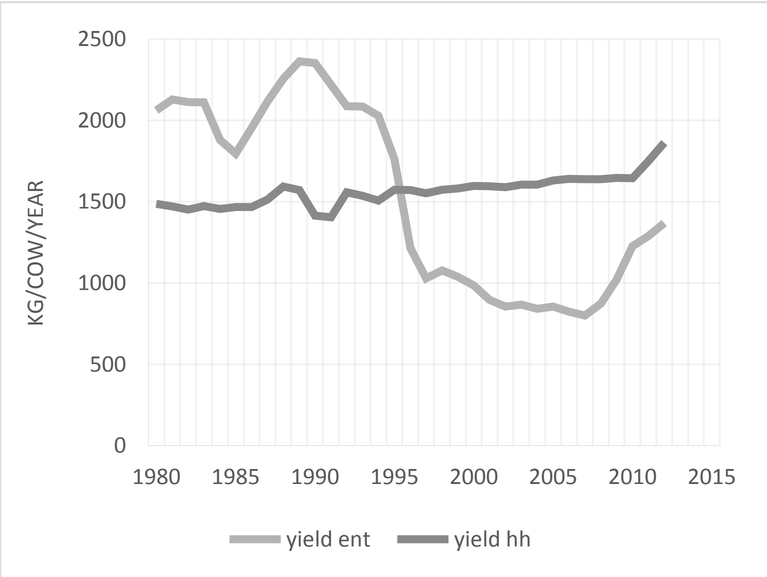
The situation is totally different in Turkmenistan and Uzbekistan, where livestock production in recent years has been dominated by the private sector. Up to the early 1990s, the milk yields achieved by collective farms ("enterprises") in these two countries were substantially higher than the milk yields in individual farms (household plots at that time). Thus, in Turkmenistan, collective farms averaged around 2,000 kg per cow per year, compared with 1,000 kg per cow per year for household plots (Figure 2.39); in Uzbekistan the yield gap was smaller, but still substantial – 2,000 kg/cow/year in enterprises and 1,500 kg/cow/year in individual farms. The "reverse" yield gaps during the Soviet period can be explained by the preferential attitude toward agricultural enterprises and the restrictions imposed on private agriculture. The situation began to change after 1992-1994, when augmentation of household plots resulted in a substantial increase of the livestock herd and especially the number of cows kept by rural families. In Turkmenistan, milk yields rose from 1,000 kg per cow in 1992 to around 2,000 kg per cow since 2007, while the milk yields in enterprises collapsed, bottoming out at a miserable 700 kg per cow in 1998 and subsequently recovering to 1,700 kg per cow (below the Soviet-era level of 2,000 kg per cow). Overall, the milk yields in the private sector in Turkmenistan have been higher than in enterprises since 1996 in line with theoretical expectations.

Figure 2.39. Turkmenistan: milk yields in farms of different types 1980-2013



Source: Official statistical yearbooks, Turkmenistan (various years).

Figure 2.40. Uzbekistan: milk yields in farms of different types 1980-2012.



Source: Official statistical yearbooks, Uzbekistan (various years).

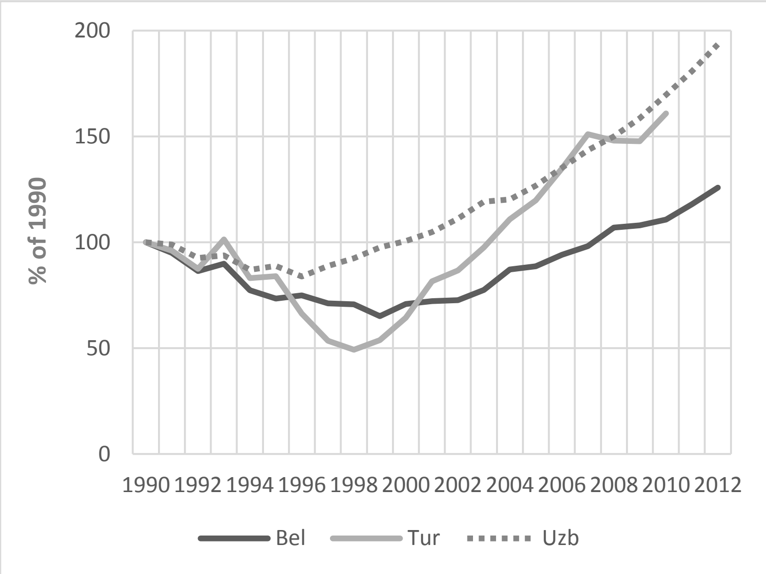
In Uzbekistan, milk yields of agricultural enterprises collapsed even more dramatically from nearly 2,500 kg per cow in 1990 to about 1,000 kg per cow since 1997. Yields in the private sector (mainly household plots) remained relatively constant over time (Figure 2.40), showing small increases from about 1,600 kg per cow in 1997 to 1,800 kg per cow in 2011-2012. Because of the dominant role of the private sector in livestock production, these constant yields determined the constancy of milk yield for the entire country (see Figure 2.40).

Outcomes of reform

All NIS experienced a decline in agricultural production during the early 1990s. This initial decline was attributable to the disintegration of the traditional Soviet system of agricultural services that left agriculture in disarray. Eventually, however, the transition decline switched to recovery as the cumulative effects of market reforms began to be felt in the late 1990s. The patterns of decline and recovery in agriculture for Belarus, Turkmenistan, and Uzbekistan are shown in Figure 2.41.

The recovery in different countries began at different times: in 1996 for Uzbekistan, 1998 for Turkmenistan, and 1999 for Belarus. The magnitude of the transition decline in agriculture was also different. Turkmenistan suffered the greatest decline: by 1998, its GAO had dropped to 50% of the 1990 level (orange curve in Figure 2.41). In Uzbekistan, the transition decline reduced GAO to about 85% of the 1990 level (gray curve). Belarus occupies an intermediate position in this respect: by 1999, its GAO had dropped to 65% of the 1990 level (blue curve in Figure 2.41).

Figure 2.41. Gross Agricultural Output (GAO) in Belarus, Turkmenistan, and Uzbekistan 1990-2012 (percent of 1990)

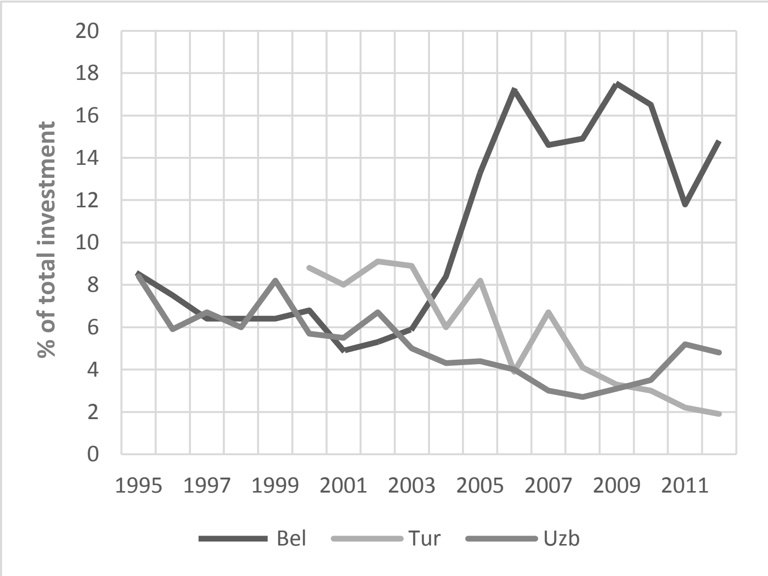


Source: Authors' calculations from official statistical yearbooks (various years).

All three countries appear to have experienced extraordinary growth after the turnaround point. The growth in Turkmenistan appears to have been particularly spectacular, with its GAO trebling between 1998 and 2010. In both Uzbekistan and Belarus GAO roughly doubled between the turnaround point and 2012. The growth in Turkmenistan and Uzbekistan cannot be attributed to massive investments, as the share of agricultural investment in these countries was generally low, at a level of 2%-5% of total investment in recent years, and declining (Figure 2.42). We therefore tend to attribute the observed growth in Turkmenistan and Uzbekistan to the effect of ongoing reforms, and especially to the sweeping individualization that radically changed the producer incentive structure. In Belarus, on the other hand, in the absence of real individualization, we may attribute agricultural recovery and growth since 1999 to massive government investments in agriculture: the share of agricultural investment in Belarus increased from 7% of total government investment in 2000 to 15% in 2012 (Figure 2.42). This is still far below the level of agricultural investments during the Soviet period (20%-30% before 1990), but it is apparently sufficient to produce a positive response due to the development of agricultural infrastructure for growth.[11]

[11] The change in investment policies may have contributed to both collapse and recovery of agricultural output. Agricultural decline in the 1990s may have been precipitated by the steep decrease of investment in agriculture, as agriculture's share of total investment dropped precipitously from 29% in 1990 to 7% in 2000 (**Figure 2.42**). The shrinking investment prevented replacement of equipment and modernization of technology, and thus had a detrimental effect on the role of agriculture in the economy.

Figure 2.42. Share of agricultural investment in total government investment in Belarus, Turkmenistan, and Uzbekistan 1995-2012, in percent of total investment



Source: Authors' calculations from official statistical yearbooks (various years).

Changing shares of production in farms of different types

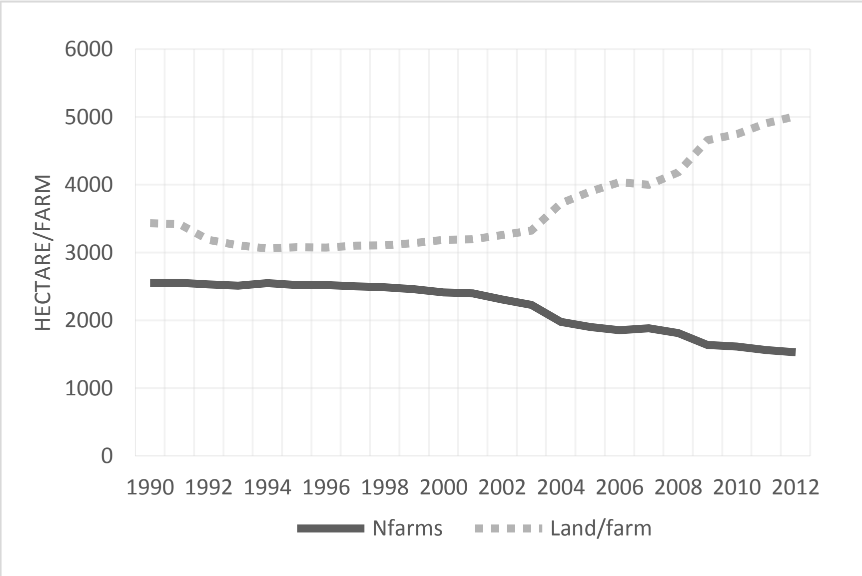
In this section, we examine the effect of reforms on the shares of individual farms and enterprises in GAO. The results are presented for Belarus and Uzbekistan only, as the required data are not available for Turkmenistan.

Belarus

Unlike Uzbekistan, where large farm enterprises disappeared, and Turkmenistan, where large farm enterprises were transformed into associations of family leaseholders, Belarus persists in its adherence to the Soviet model of agriculture with its belief in economies of scale. The reforms in Belarus (like those in Russia and Ukraine) follow the strategy of so-called "horizontal transformation": attempting to transform inefficient large-scale enterprises into efficient ones without radical internal restructuring and downsizing for better manageability.

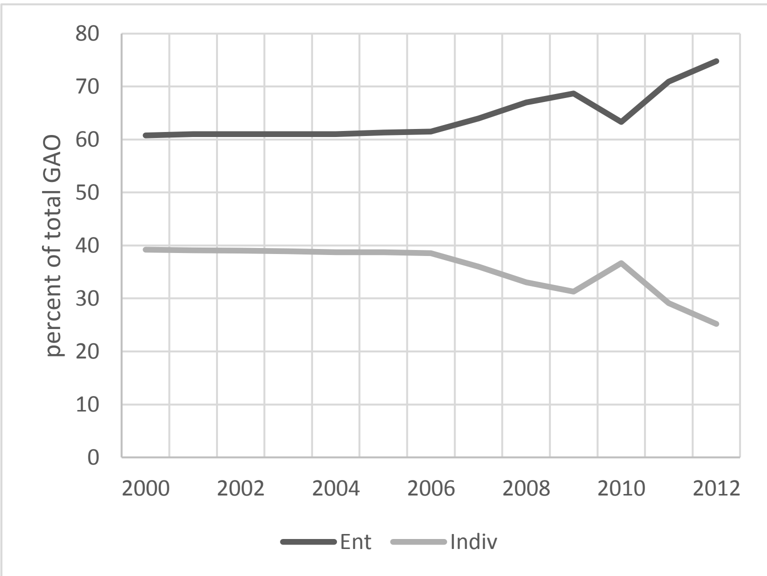
During the first decade of reform, between 1990 and 2001, the number of large-scale farm enterprises – former collective and state farms – remained constant at around 2,500, with average size of 3,100 hectares of agricultural land (Figure 2.43). It is only after 2001 that large farm reorganization accelerated: the number of farm enterprises decreased from 2,400 in 2001 to 1,530 in 2012, while the average land holdings per agricultural enterprise increased from 3,200 hectares to 5,000 hectares. This highlights the strategy of merging loss-making large farms into profitable enterprises. Because of this strategy, the percentage of loss-making enterprises dropped from a staggering 65% in 2001 to just around 1% in 2011-2012.

Figure 2.43. Belarus: number and average size of agricultural enterprises



Source: Official statistical yearbooks, Belarus (various years).

Figure 2.44. Belarus: structure of agricultural production by farm type (in percent of total GAO in current prices)



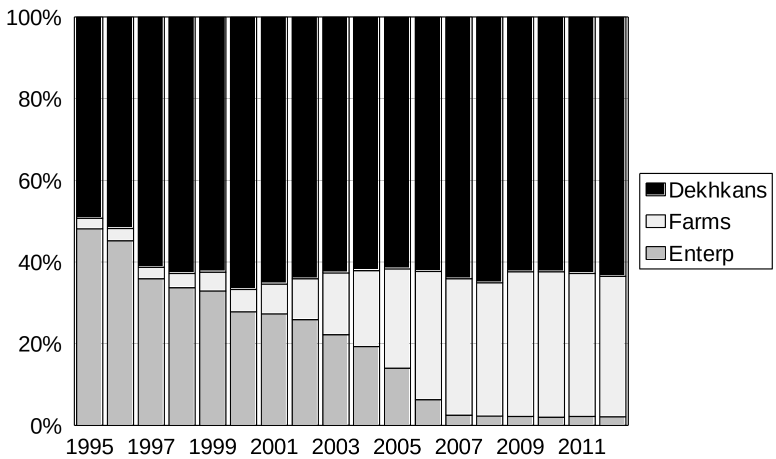
Source: Official statistical yearbooks, Belarus (various years).

The share of the individual sector in agricultural production in Belarus has always exceeded its share in agricultural land. Thus, at the end of the Soviet period (1989-1990), household plots controlled about 6% of agricultural land, producing 25% of agricultural output, which points to higher productivity of land in the individual sector. The share of the individual sector in GAO had increased to 40% by 1995 and remained at this level until 2006. After that year, the share of the individual sector GAO began to decline, dropping from 40% 1995-2003 to about 25% in 2012, while the share of agricultural enterprises increased accordingly from 60% to 75% in the same period (Figure 2.44). The decrease of the share of production in the individual sector is associated with the general reduction of land holdings and livestock inventories in household plots after 2004 (see Figures 2.6, 2.31).

Uzbekistan

The differential changes in the distribution of land and livestock by farms of different types have led to striking changes in the structure of agricultural production in Uzbekistan, especially after 1997-1998. Production in enterprises dropped from about 35% of the total in 1997 to just 6% in 2006 and continued to decline to nearly zero in 2012 (Figure 2.45). Production in rural households remained fairly stable at slightly over 60% since 1997, while that in peasant farms grew from 3% in 1997-1998 to nearly 32% in 2006. We see from Figure 2.45 that agricultural production has in fact shifted from enterprises to peasant farms since 1997: the decrease in production in agricultural enterprises (bottom dark gray layer) has been compensated by a corresponding increase in production in peasant farms (light gray layer above it). The household plots (top black layer) have retained their dominant – and relatively constant – share throughout the entire period (prior to 1997, with peasant farms at their initial formative stage, it is the household plots that were increasing their share of agricultural output at the expense of the shrinking enterprises).

Figure 2.45. Uzbekistan: structure of agricultural production (GAO) by farm type, 1995-2012



Source: Official statistical yearbooks, Uzbekistan (various years).

After 1998 we observe a dramatic shift of production (mainly crops) from agricultural enterprises to peasant farms, but it is clearly household plots that come out as the star player of the process of reform. The households maintained their leading role in agricultural production throughout the period, contributing nearly 65% of gross agricultural output. The role of household plots is particularly prominent in livestock production, where they account for more than 90% of output, but they are also a very significant player in crop production, contributing more than 40% of crop output since 2007.

Changes in productivity

Productivity is calculated as the ratio of output to input used in the production of the output. Standard productivity measures are the partial productivity of land and the partial productivity of labor. For agriculture, these partial productivities are calculated as the ratio of the output (expressed in value terms in constant prices) to agricultural land (in hectares) or the number of employed in agriculture. More sophisticated measures rely on total factor productivity (TFP), which aggregates the partial measures into one index that allows for the entire basket of resources and inputs used in agriculture. TFP is technically difficult to calculate, but even the calculation of partial productivity measures involves certain problems as it requires good knowledge of resources – the area of agricultural land used for production and the number of employed in agriculture (both hired workers and self-employed).

Belarus

In Belarus, the improved profitability of farm enterprises (see above) was achieved through mergers and acquisitions of unprofitable enterprises, and it does not necessarily point to improvements in productivity. Table 2.8 sets out some data for roughly calculating changes in partial productivities of land and labor in agricultural enterprises in Belarus. While agricultural output increased by 21% between 1990 and 2012, the average size of enterprises (represented by their land use) increased by 45% in the same period, which suggests that the partial productivity of land declined by 17% (1.21/1.45 = 0.83) during the transition decade. The number of workers per enterprise, on the other hand, decreased by 35% during the same period, which points to an increase of 86% in partial productivity of labor (1.21/0.65 = 1.86) due to attrition of labor in agricultural enterprises. Decrease in machinery may also have exerted an upward pressure on farm productivity. Further study of enterprise production functions is required before we can decide how these conflicting changes affected total factor productivity of agricultural enterprises in Belarus.

Table 2.8. Main characteristics of farm enterprises in Belarus (data per farm enterprise)

	1990	2000	2005	2012	1990-2012 change, %
Agricultural output in constant prices, % of 1990	100	54	73	121	+21
Land, ha	3430	3189	3900	5011	+45
Number of workers	357	234	202	229	-35
Number of tractors	50	30	28	29	-42
Number of combines	14	7	7	8	-43
Fertilizer use, kg per ha	271	169	185	283	+4

Source: Official statistical yearbooks, Belarus (various years); Kazakevich (2014).

Turkmenistan

In Turkmenistan, GAO increased by 51% between 1990 and 2007 according to official statistics. Cultivable land in that period increased by just under 30%, while agricultural labor grew by almost 70%. Since GAO growth exceeded the growth of land resources and lagged behind the growth of agricultural labor, partial productivity of land increased between 1990 and 2007 (by 17%), while partial productivity of labor decreased during this period (by 11%).

The weighted average productivity of both land and labor depends on the weights of these factors in the production function, which could not be estimated due to lack of necessary data.

Table 2.9 presents weighted average productivity estimates calculated by simulating production functions with factor weights varying from 0.3 for labor, 0.7 for land at one extreme to 0.7 for labor, 0.3 for land at the other extreme. Assuming that land and labor have equal weights in the production function (50% each), the weighted average productivity is estimated to increase by 3.1% between 1990 and 2007. Weighted average productivity increases when land accounts for more than 40% of factor inputs in the production function; it remains practically unchanged (between 1990 and 2007) when the factor weight of land is between 30% and 40% (and the factor weight of labor is correspondingly between 70% and 60%).

Table 2.9. Turkmenistan: weighted average productivity of land and labor from simulated production function

Factor weight of labor	Factor weight of land	Weighted average productivity of land and labor (1990=100)
0.0	1.0	117.3
0.3	0.7	108.8
0.4	0.6	106.0
0.5	0.5	103.1
0.6	0.4	100.3
0.7	0.3	97.5
1.0	0.0	89.0

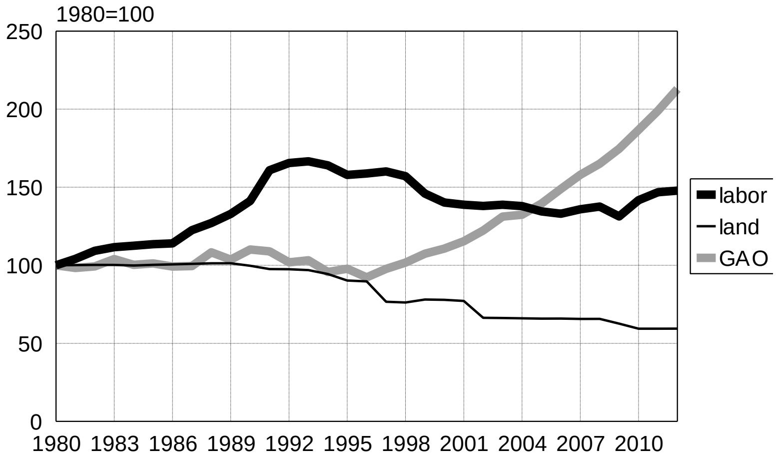
Source: Authors' calculations.

Uzbekistan

For Uzbekistan, the three time series that constitute the basis for partial productivity calculations are shown in Figure 2.46: agricultural production (gray curve), agricultural land in use (thin black curve), and agricultural employment (thick black curve). The curves span the period 1980-2012 and they are all normalized to index numbers with 1980=100, thus eliminating problems due to differences in units of measurement.

Agricultural output has increased dramatically since 1996. Agricultural land, on the other hand, has declined: this is evident from Figure 2.5, where we see that both land in use and available land decline over time (land in use declining much more rapidly). This essentially means that the partial productivity of land has increased, and at that by much more than the 110% increase in agricultural production since 1997. In fact, the productivity of agricultural land increased by 250% between 1997 and 2012 due to the combined effect of increasing production and decreasing land base (Figure 2.46, gray curve).

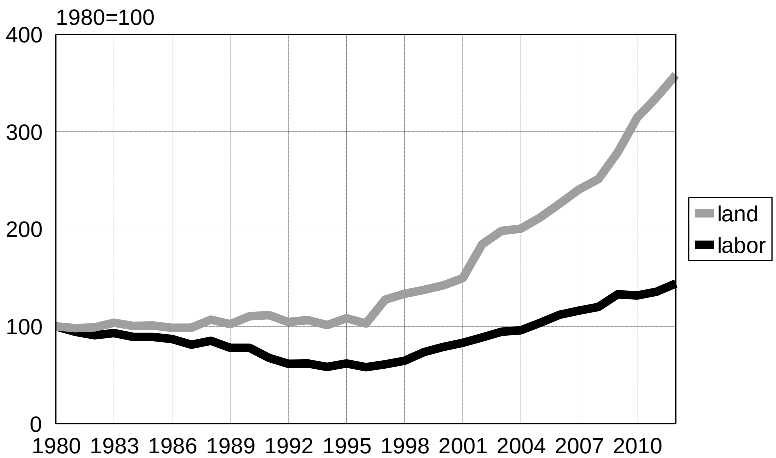
Figure 2.46. Uzbekistan: GAO, agricultural labor, and agricultural land 1980-2012 in percent of 1980 (1980=100)



Source: Authors' calculations based on official statistical yearbooks, Uzbekistan (various years).

Agricultural employment also seems to have declined slightly since 1997, although the reasons for this are not entirely clear (Figure 2.46). Based on the given curve of declining agricultural employment in Figure 2.47, we conclude that the partial productivity of labor has also increased strongly since 1997 (after declining between 1980-1997 due to the increase in agricultural labor in the face of stagnating production; see black curve in Figure 2.47). Since both partial productivities increase after 1997, we conclude that the agriculture in Uzbekistan is becoming more productive in its use of resources in the course of reform.

Figure 2.47. Uzbekistan: productivity of agricultural land and labor 1980-2012.

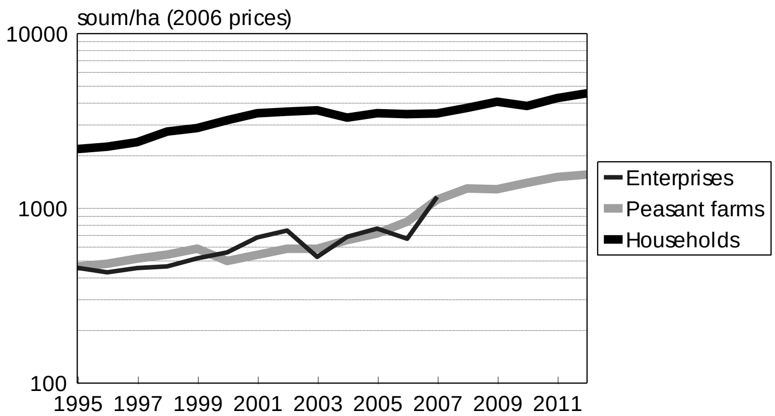


Source: Authors' calculations based on official statistical yearbooks, Uzbekistan (various years).

The calculations above have been carried out on the country level for Uzbekistan, covering the period 1980-2012 that includes the end of the Soviet era and the entire transition. More detailed data available for the shorter period 1995-2012 make it possible to calculate land productivity in absolute values (soum per hectare) for each of the three farm types separately:

household plots, peasant farms, and agricultural enterprises. The results are presented in Figure 2.48. Land productivity for all three farm types increased steadily over time, consistently with the all-farms gray curve in Figure 2.47. Household plots (the thick black curve in Figure 2.48) attain productivity levels that are orders of magnitude higher than the land productivity of agricultural enterprises and peasant farms. The combined effect of high productivity and increasing land in household plots has been responsible for the sustained agricultural growth in Uzbekistan (Figure 2.46, gray curve).

Figure 2.48. Uzbekistan: productivity of land in farms of different organizational forms, 1995-2011.



Source: Authors' calculations based on official statistical yearbooks, Uzbekistan (various years).

Ultimately, the success of agricultural reforms is measured first by growth in production and second by changes in agricultural productivity. The agricultural output in Uzbekistan essentially stagnated between 1980 and 1997 (see Figure 2.46, gray curve), but then it took off, more than doubling between 1998 and 2012. Moreover, the increase in agricultural production was entirely attributable to the individual sector – household plots and peasant farms combined – as the production of agricultural enterprises steadily eroded since 1990, dropping by 2012 to 10% of the 1990 level. The process of agricultural reform encouraging and emphasizing transition from the traditional large-scale enterprises to individual farms – both household plots and peasant farms – has produced remarkable results in terms of production growth in agriculture. This effect of agricultural growth spurred by individualization of agriculture is not unique to Uzbekistan: it is observed in other NIS that have encouraged transition to individual farming (even though Belarus seems to be an exception to this pattern).

3. Wheat Utilization and Medium-Term Outlook for Demand

The main objective of this study is to present critical projections of wheat production and trade to 2024 for Belarus, Turkmenistan and Uzbekistan using simple models to project wheat demand and supply, with net imports as the residual. This, in short, is the projections methodology:

Total demand for wheat – domestic production of wheat =
Net imports + changes in wheat stocks.

A description of the wheat production and trade outlook for Belarus, Turkmenistan and Uzbekistan should properly begin with a consideration of wheat demand, both historical trends and projections. When discussing historical trends we will use the term "utilization" to denote the putative demand for wheat, while in discussing projections we will use the term "demand." Thus, in Chapter III we review food wheat utilization since 1992 and present the model used to project demand for wheat, along with the resulting projections. In simplified form,

Total demand for wheat =
(1) food demand for wheat + (2) feed demand for wheat + (3) other demand for wheat.

These three components of wheat demand can be seen in the supply and utilization tables compiled by FAO for each country based on official statistics. Because other demand is so small, we assume that it is held constant as a portion of total demand. Thus, we model explicitly only food and feed demand.

Though Belarus, Uzbekistan and Turkmenistan are some of the least reformed of all the NIS economies, it would be a mistake to treat the farm and food sectors of these three economies as those of a planned economy where demand is not a significant factor in the growth of production and imports. In fact, the robust growth of income in these countries has led to increases in per capita consumption of food products just as in more market-oriented economies. The impact of the lack of reform shows up in the supply response and in the cost of production. However, on the whole, the agricultural sectors of these countries are faced with market demand for wheat, just as in other countries.

Food wheat utilization and forecasts

Food demand for wheat can be analyzed as food wheat demand per capita multiplied by the total population. A model of food demand, therefore, should include projections of wheat food demand per capita multiplied by a projection of total population:

Food demand for wheat = food demand for wheat per capita*total population

In large commodity projection models, per capita food demand for wheat is often modeled as part of a complete demand system that includes per capita demand for the major food groups or food items. Demand for each of these food groups or items depends on GDP per capita and the prices for the food items, as well as for their substitutes and complements. A consumption demand matrix, consisting of income elasticities as well as own and cross price elasticities, provides a theoretically consistent means of projecting wheat product demand, as well as the demand of many other food products.

This approach to food demand modeling was not practical for this study, for the following reasons:

- Consistent time series and projections for consumer prices for many foods were not available for these countries.
- Demand price and income elasticities for food for these countries were not available.

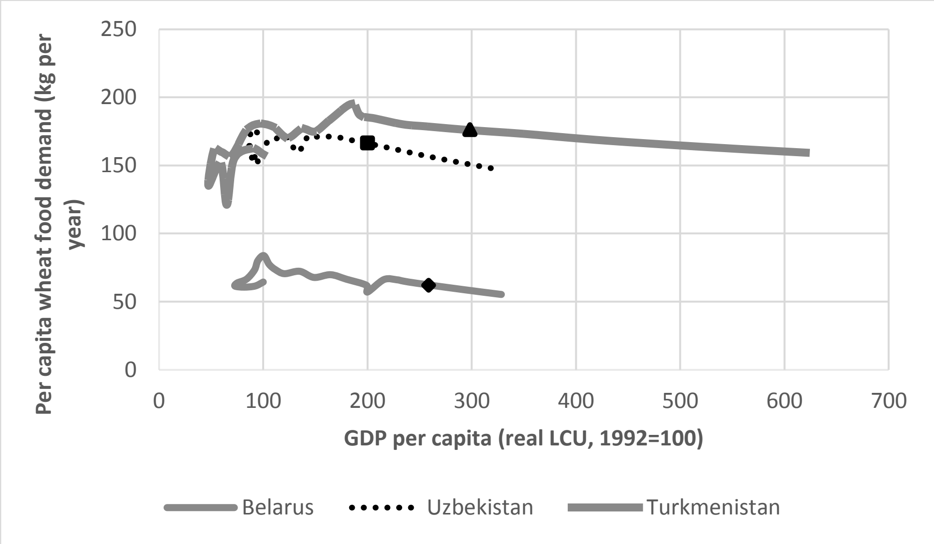
The (imperfect) solution to this issue was to project food demand for wheat based on per capita income increases alone. The income elasticity of demand for food wheat was estimated based on historical trends. Per capita income projections through 2019 from the International Monetary Fund World Economic Outlook Database (April 2014) were used. These projections were extended to 2024 using the 2014-19 growth rates. The historical and projected wheat “consumption” figures here represent apparent disappearance (use) of wheat each year per capita. This is different from actual consumption, since consumption is collected from survey material. The historical figures are taken from FAOSTAT and USDA wheat balances.

Figure 3.1 illustrates the behavior of per capita food wheat demand in the three countries as a function of GDP per capita. The points for each country are connected in chronological order. Thus, we can follow the movement of per capita wheat consumption as income changes over time. It is clear from Figure 3.1 that over the period as a whole per capita consumption for food use decreases slightly as income increases. The overall results are understandable, as bread and wheat products are generally viewed as inferior goods, meaning that after a certain level of income we expect to that the per capita consumption of these products declines as income rises.

The apparent anomaly in Figure 3.1 is the behavior of per capita wheat consumption in the early transition years after 1992, when food utilization first fell due to falling incomes per capita and then rose as recovery ensued. The important issue to recall in this context is that bread (and wheat) consumption is usually viewed as an inferior good *after a certain level of income per capita is reached*. It may well be that the transition recession of the early 1990s pushed the population below the point where bread becomes an inferior good. Thus, the population treated bread as a normal good for a few years, and afterwards as an inferior good.

Turning to a comparison between countries, Figure 3.1 illustrates that the per capita utilization of wheat is far less in Belarus than in Uzbekistan and Turkmenistan. The reason for this is that Belarusians consume a more varied cereal diet. Wheat utilization as a portion of total cereal consumption in Belarus in 2011 was only 55%, while in Uzbekistan and Turkmenistan it was 93% and 79%.

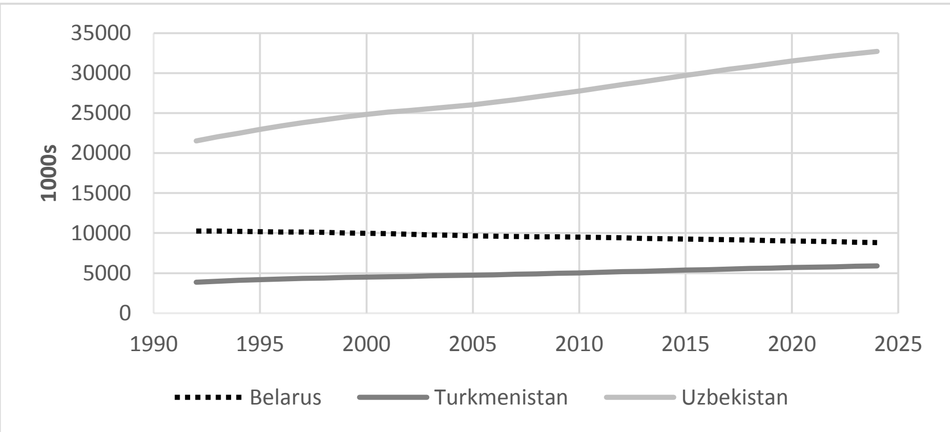
Figure 3.1. Per capita wheat use for food in Belarus, Turkmenistan, and Uzbekistan, 1992-2024 (forecasts begin in 2014, indicated in black)



Source: FAOSTAT (2014), USDA/PSD (2014), IMF (2014b) and model projections.

With the relative stability of per capita food use over time, overall trends in food use of wheat are determined mostly by population changes. Population in Uzbekistan and Turkmenistan is increasing, while that in Belarus has been and will continue to decline (Figure 3.2). This is why we see the overall decline in food use of wheat in Belarus and the increases in Uzbekistan and Turkmenistan in Figures 3.10, 3.11 and 3.12 at the end of this chapter.

Figure 3.3.2. Population trends in Belarus, Uzbekistan and Turkmenistan, 1992-2024



Source: UN Population Division (2013).

To summarize this short analysis of food utilization in Belarus, Uzbekistan and Turkmenistan, while per capita utilization of wheat is relatively stable in all three countries, population is growing in the two Central Asian countries and falling in Belarus. These divergent trends account for the increasing total utilization of wheat for food in Uzbekistan and Turkmenistan (Figures 3.11 and 3.12) and the decreasing trend in Belarus (Figure 3.10). The pattern of population growth is in line with the differences in population growth in the Eurasian region as a whole: In Central Asia populations are rising, in the Transcaucasus they are stagnant, while in the European NIS (Russia, Ukraine, Moldova and Belarus) population is falling (Lerman, 2010).

Feed wheat utilization and demand

Feed demand is ultimately a function of the production of livestock products. In the simplest case, we could imagine a constant feed conversion ratio for livestock products, such that the production of 1 ton of product (beef/veal, pork, sheep or goat meat, poultry meat, eggs or milk) requires, for example, 2 tons of wheat. By summing up the total tons of livestock product produced each year and multiplying by the feed conversion ratio we could arrive at an estimate of total feed wheat demand for each year in the past or future which would be 2 times the weight of livestock product produced each year.

However, such a simple methodology ignores important issues which impact on the relationship between total livestock production and wheat demand. First, not all animals are fed. Rather, particularly in small farms, the majority of animals are grazed, and perhaps fed supplements. Moreover, the portion of livestock fed may change over time as feeding practices change in small and large farms. Second, different livestock products require different conversion ratios. Poultry is far more efficient at converting feed to meat than beef cattle. We therefore require individual feed conversion rates for each type of livestock product. Third, feed conversion rates are likely to change over time as other factors, such as the quality of feed, animal health or animal breeds, change. Another complication is that feed is made up of many elements including concentrates (wheat, rye, barley, etc.), roughage (straw, hay, cut feed, etc.), and vitamin supplements (Box 3.1). Therefore, it is important to know what portion of fed feed is concentrates such as grain and what portion is roughage. All these factors impact on the overall demand for wheat in the country.

Box 3.2 Animal feed utilization in Belarus, Uzbekistan and Turkmenistan

Feeds can be broadly classified as concentrates or roughages, depending on their composition. Concentrates are feeds that contain a high density of nutrients, low in crude fiber and high in total digestible nutrients. Concentrate feed is made of a number of ingredients, including cereals, milling by-products, roots and tubers, oil meals and cakes, processed livestock products, and processed harvested forages. Roughages are feeds with a low density of nutrients, with a higher crude fiber content, including most fresh and dried forages and fodders. Some examples of roughage feeds are hay, silage, root crops, straw and hulls.

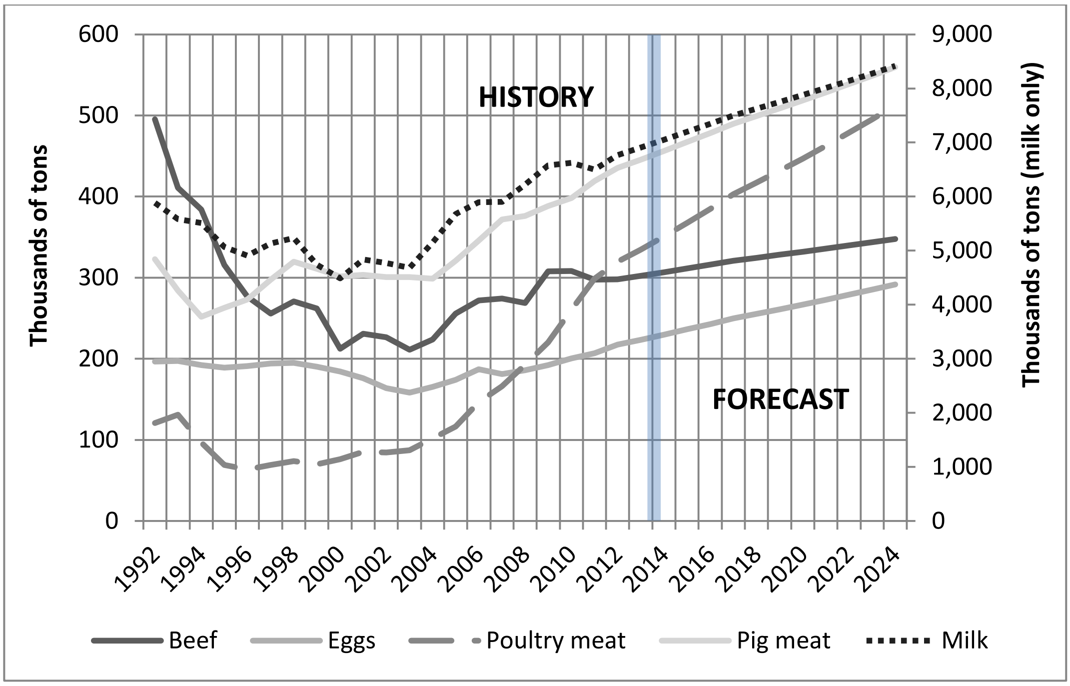
Intensive livestock husbandry is characterized by a relatively high level of concentrates, including grain, in feed diets. This type of production is most common in Belarus, where animals are kept in barns, fed mixed feed, and have relatively high productivity, compared to Uzbekistan and Turkmenistan. Thus, a comparison of the portion of grain in feed in the three countries shows that feed diets in Belarus are far more grain (and concentrate)-intensive than in Uzbekistan and Turkmenistan. This reflects Belarus' role as the most efficient milk producer of all NIS countries, and its greater endowment of grain. In Uzbekistan, we observe a relatively dramatic improvement in the portion of grain in feed across the board to 2012. This may be the effect of policy efforts in the past five years to increase feed quality (Lerman, 2008). In Turkmenistan we see stagnation in the quality of feed, taking into account the grain production problems of the 2000s, which are projected to continue through 2024.

An additional complication is that feed use of wheat can be conceptually divided into two elements--feed use for herd maintenance and feed use for weight gain. Herd maintenance is feeding in order to maintain the body weight of animals without growth, while feed use for weight gain is used to produce livestock products, such as meat, milk and eggs. Weight gain normally accounts for 60%-95% of feed use.

Livestock production history and forecasts, 1992-2024

The first item required for forecasting wheat feed demand is a forecast of livestock product production. Forecasts of total livestock production for Belarus, Uzbekistan and Turkmenistan are shown in Figures 3.3, 3.4 and 3.5. Feed use of wheat in these countries is a function of how animals are fed to achieve the production levels of these livestock product projections. These forecasts are estimates based on historical trends and what we know about livestock production in these countries, and are the basis for deriving forecasts of feed wheat demand.[12]

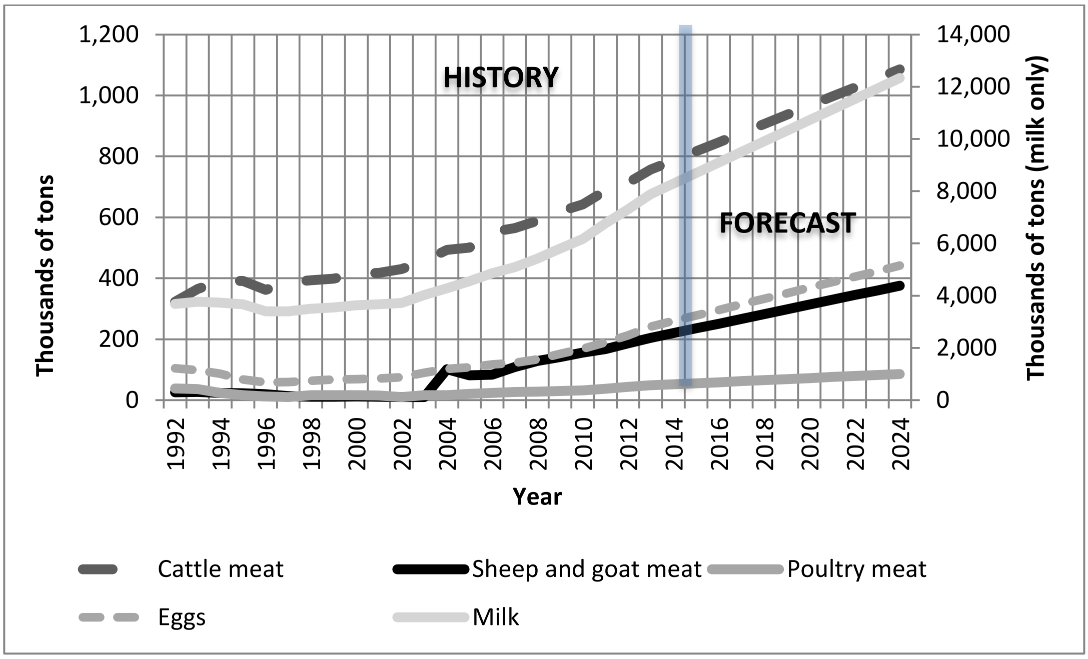
Figure 3.3. Belarus: Livestock production and forecasts, 1992-2024 (forecasts begin in 2014)



Source: FAOSTAT (2014) and model projections.

[12] In a large, complex model, forecasts of livestock product production could be estimated using an inventory and slaughter rate model based on estimated series of future prices for fed animals and feed. As feed prices rise the slaughter rate (portion of animals slaughtered as a percent of total inventories) should increase, while as expectations of prices for fed animals increase slaughter rates should fall, reflecting the decision of feeders to hold on to cattle in anticipation of better returns in the future. In the absence of price series for feed and fed animals it was felt that forecasts of livestock production would be adequate for our purposes.

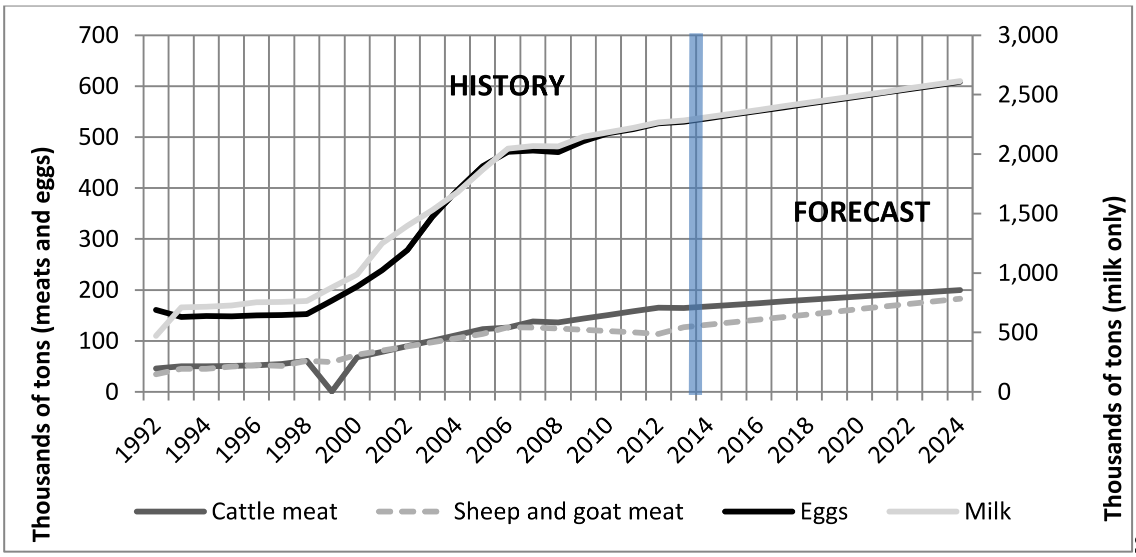
Figure 3.4. Uzbekistan: Livestock production and forecasts, 1992-2024 (forecasts begin in 2014)



Source: FAOSTAT (2014) and model projections.

The most important series for feed use in these figures are those of milk, the production of which in all three countries is an order of magnitude greater than for the meats. For this reason, the amount of milk production is shown on the right axis, while meat production is shown on the left axis. In Belarus poultry meat production is growing the fastest of the meats, while in Uzbekistan the fastest growing meat production is that of beef and veal. In Turkmenistan, surprisingly, egg production, which is entirely in the small household sector, is growing faster than all the meats.

Figure 3.5. Turkmenistan: Livestock production and forecasts, 1992-2024 (forecasts begin in 2014)



Source: USDA/PSD (2014) and model projections.

Estimation of feed wheat demand from livestock product production

The variety of factors impacting on the relationship between total livestock production and wheat demand make the projection of feed wheat demand based on projections of livestock product production rather speculative and complex. It may be worthwhile, therefore, to present an example of the estimation methodology for the three countries based on one year (2011). From national data we can estimate the feed required to produce one kg of meat, eggs or milk, for instance. Table 3.1 shows the feed conversion rates used in the forecast model for Belarus, Uzbekistan and Turkmenistan in 2011.

Feed use per kg of weight gain, however, is not sufficient information to derive the utilization of wheat demanded per kg of weight gain. There are many different diets for feeding animals, ranging from grazing with concentrate supplements to various combinations of cut and mixed feed fed to animals in cow or cattle sheds. Poultry and hogs are usually fed primarily in housed structures in industrial-type operations. Though hogs may be kept in small farms and fed scraps, even in small farms they are usually housed and are fed a combination of mixed feed and scraps. Thus, it would not be correct to attribute all the weight gain embodied in milk and meat output to grain consumption.

Table 3.1. Belarus, Uzbekistan and Turkmenistan: feed conversion rates (kg feed required to produce 1 kg of weight gain or 1 kg of milk or eggs), 2011

	Belarus	Uzbekistan	Turkmenistan
Beef	11.11	19.69	23.67
Milk	1.16	2.43	3.19
Pork	4.30	7.13	9.57
Poultry	3.21	3.07	4.14
Eggs	3.22	2.56	4.14

Source: Model assumptions based on Cabmin of Belarus Regulation (2010) (annex 10) adjusted over time according to FAOSTAT livestock efficiency statistics.

Table 3.2 illustrates the issue by showing the grain portion of feed use by product by country. Since beef cattle are often grazed, the portion of grain as a portion of total feed is quite small. Only 19% of total feed is assumed to be grain in Belarus in 2011. The portion of grain out of total feed used for weight gain for dairy cows, hogs and poultry are progressively higher, because these animals are grazed less than beef cattle more often being kept in barns. In barns they are fed a mixture of grain and cut feed, depending on the animal and on the farm structure in the country. In Belarus, where nearly all animals are raised in large agricultural enterprises, the portion of grain tends to be higher, while in Turkmenistan, where nearly all animals are kept in private plots, the portion of grain fed is lower, because animals are grazed or fed scraps.

Table 3.2. Belarus, Uzbekistan and Turkmenistan: grain as a portion of feed use for weight gain, 2011 (%)

	Belarus	Uzbekistan	Turkmenistan
Beef	19	14	5
Milk	34	21	16
Pork	60	43	16
Poultry	64	76	28
Eggs	64	91	28

Source: Model assumptions.

There are a large variety of grains to feed animals, and the preference for wheat (vs. barley or maize, for example) depends on which grain is grown domestically. Uzbekistan and Turkmenistan raise predominantly wheat, while Belarus cultivates a large variety of grains. In 2011, therefore, only 22% of total grain use was assumed to be wheat in Belarus, while 86% was assumed in Uzbekistan and 79% in Turkmenistan. These figures correspond to the percent of wheat in the total feed grains fed to animals in each country in 2011 (DM basis) in the FAOSTAT grain balances.

Using the information from Tables 3.1, 3.2 and the calculations of the portions of wheat in grain utilization in the three countries in the previous paragraph, we can derive the figures in Table 3.3, kilograms of wheat fed to animals to produce 1 kilogram of weight gain, by country and livestock product.

Table 3.3. Belarus, Uzbekistan and Turkmenistan: wheat utilized per kg of weight gain or 1 kg of milk or eggs, 2011 (kg)

	Belarus	Uzbekistan	Turkmenistan
Beef	0.46	2.34	0.96
Milk	0.09	0.43	0.40
Pork	0.57	2.65	1.19
Poultry	0.45	2.01	0.91
Eggs	0.45	2.01	0.91

Source: Calculated from Tables 3.1, 3.2 and portion of wheat in total feed grains fed to animals in each country in 2011, according to FAOSTAT grain balances.

We can use the coefficients in Table 3.3 and national figures on livestock product production to calculate the tons of wheat fed to animals for weight gain. However, we know that not all livestock are fed; many are grazed. For this reason, we need to take only the livestock product production that was produced from fed animals. Table 3.4 shows the portion of animals fed, the remaining portion of animals being grazed.

Table 3.4. Belarus, Uzbekistan and Turkmenistan: portion of livestock fed, 2011 (percent)

	Belarus	Uzbekistan	Turkmenistan
Beef cattle	83	27	6
Dairy cows	91	35	27
Hogs	90	36	0
Poultry for meat	90	54	26
Poultry (layers)	90	56	30

Source: Model assumptions.

We can use the wheat conversion ratios of Table 3.3 multiplied by the tons of livestock production from fed animals in Table 3.5 to obtain, in Table 3.6, tons of wheat utilized to produce the weight gain that becomes livestock product after the animals are slaughtered, milked or lay eggs.

Table 3.5. Belarus, Uzbekistan and Turkmenistan: production of livestock products from fed animals, 2011 (tons)

	Belarus	Uzbekistan	Turkmenistan
Beef	247,391	182,856	9,218
Milk	5,922,855	2,397,475	605,075
Pork	377,080	6,393	0
Poultry	267,449	20,240	3,196
Eggs	185,079	105,443	154,762

Source: Official statistical yearbooks, Belarus, Uzbekistan and Turkmenistan (various years), Table 3.4.

Feed for herd maintenance is calculated as the difference between feed for weight gain and total feed use (Table 3.7). Figures 3.6, 3.7 and 3.8 show estimates of wheat feed consumption for production and maintenance for Belarus, Uzbekistan and Turkmenistan. We see from these figures that the majority of wheat for feed in Belarus is used to produce milk and pork, the overwhelming majority of feed in Uzbekistan is used to produce milk, and virtually all feed in Turkmenistan is used for producing eggs and milk.

Table 3.6. Wheat utilization for weight gain, by livestock product, 2011 (tons)

	Belarus	Uzbekistan	Turkmenistan
Beef	114,295	427,736	8,885
Milk	521,211	1,030,914	239,005
Pork	215,690	16,933	0
Poultry	120,620	40,731	2,903
Eggs	83,471	212,194	140,602
Total wheat utilized for weight gain	1,055,286	1,728,507	391,394

Source: Calculated from Tables 3.3 and 3.5.

Table 3.7. Calculation of wheat utilized for herd maintenance, 2011 (thou. tons)

		Belarus	Uzbekistan	Turkmenistan
1	Wheat fed for weight gain	1,055	1,729	391
2	Total wheat utilized for feeding	1,182	3,065	400
3	Total wheat utilized for herd maintenance	127	1,336	9

Sources: Line 1 from Table 3.6; line 2 from FAOSTAT (2014) for Belarus and Uzbekistan, USDA/PSD (2014) for Turkmenistan; line 3 is calculated as the difference between lines 1 and 2.

To summarize this short example of the estimation methodology of feed utilization of wheat, feed use ultimately depends on the production of livestock products, but the relationship between wheat feed use and livestock product production is not constant, nor is it simple. A variety of factors need to be taken into account in projecting wheat feed demand from projections of livestock product. These factors are taken into account using various assumed coefficients that change over time in ways that seem to make sense. In this way, an estimate of the distribution of wheat consumption by livestock product can be made.

Table 3.8. Uzbekistan: demand for feed wheat for poultry meat production in 2024

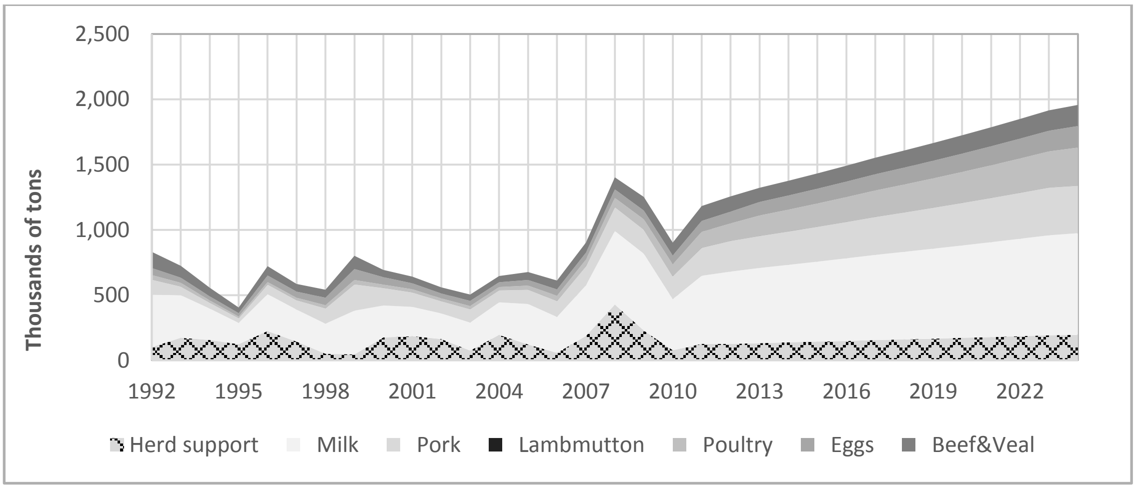
	Coefficient	Corporate farms	Individual farms	All farms (sum of corporate and individual farms)
1	Production of poultry meat in 2024 (tons)	27,420	58,460	85,880
2	*% production from fed animals (%)	100	55	
3	*feed requirement per ton of animal product (tons)	2.99		
4	=total feed for weight gain (tons)	81,735	96,811	178,546
5	*percent of total feed for weight gain that is grain (%)	63		
6	*of fed grain, % that is wheat (%)	81		
7	=total wheat for weight gain (tons)	41,884	49,610	91,494
8	+Total wheat for herd support (13% of total for projections)	10,471	12,402	22,873
9	=total wheat required to produce poultry meat in 2024 (tons)	52,355	62,012	114,367

Source: Model projections and assumptions.

It may be easiest to understand the use of the "model" (the net operation of the various coefficients on the production of livestock products to derive an estimate of wheat use or demand) to produce projections by following an example. Table 3.8 illustrates the estimation of the wheat required for the production of poultry meat in Uzbekistan in 2024. Such an exercise is carried out for each year and for each product – meat, milk and eggs.

Starting from projected poultry meat production in 2024, the model can project the derived demand for wheat in 2024 by applying a series of coefficients. Using such coefficients for each of the projection years for each livestock product we can sum over all livestock products for each year to get an annual estimate of feed wheat demand shown in Figures 3.6, 3.7 and 3.8. From these figures we infer that the driving forces of wheat feed demand in Belarus are hogs and cows, in Uzbekistan, cows and in Turkmenistan cows and poultry.

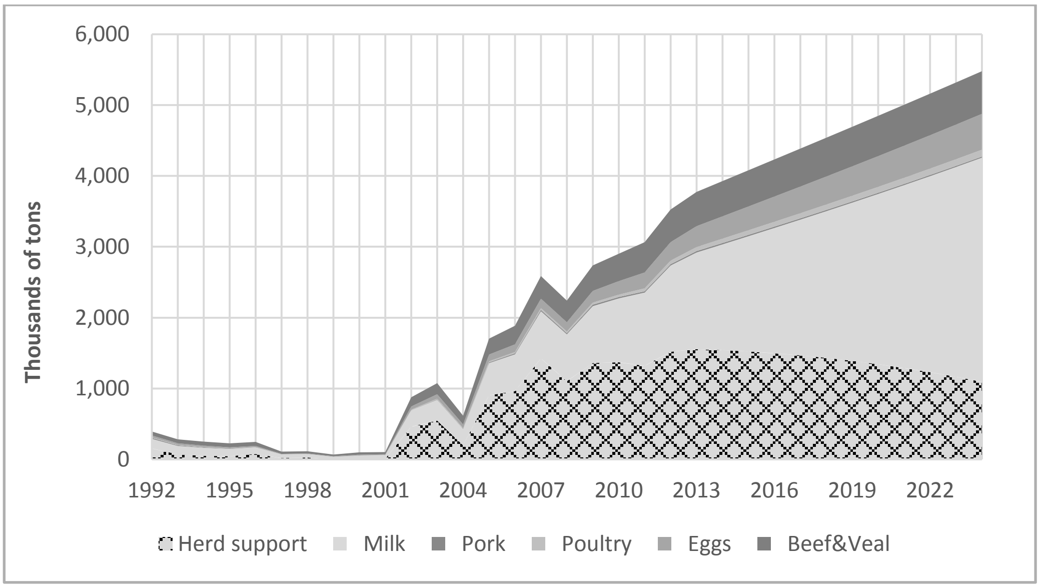
Figure 3.6. Belarus: Wheat feed demand, by livestock product and herd support, 1992-2024



Source: FAOSTAT (2014) for overall historical feed utilization; model projections for forecasts and division by livestock product.

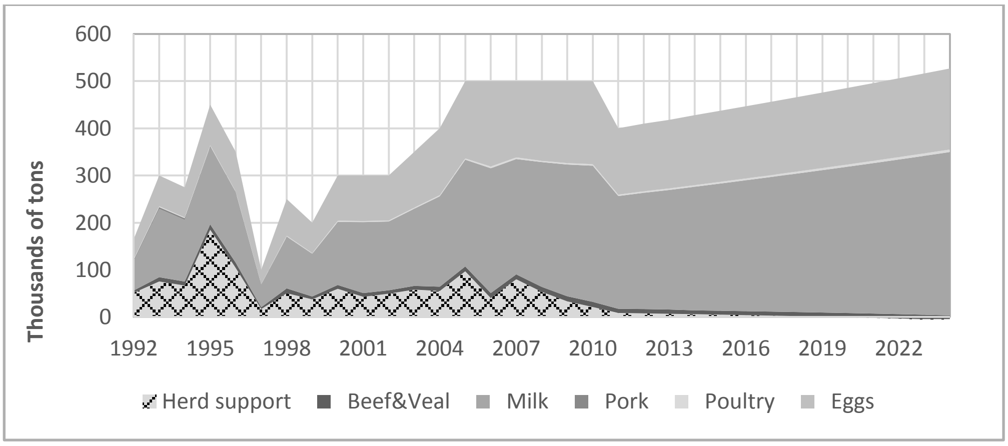
The dominance of milk in feed demand is because milk production in all three countries is of an order of magnitude larger than production of meats and eggs. The overwhelming significance of milk in wheat demand can be seen clearly in the two Central Asian countries where grazing is common and nearly all animals are kept in small individual farms. In Central Asia, with low feeding rates for all animals, tonnage of production is what matters, and milk dominates all other livestock products in this respect. In Turkmenistan milk and eggs, both nearly exclusively in private plots of the population, dominate wheat use estimates.

Figure 3.7. Uzbekistan: Wheat feed demand, by livestock product and herd support, 1992-2024



Source: FAOSTAT (2014) for overall historical feed utilization; model projections for forecasts and division by livestock product.

Figure 3.8. Turkmenistan: Wheat feed demand, by livestock product and herd support, 1992-2024



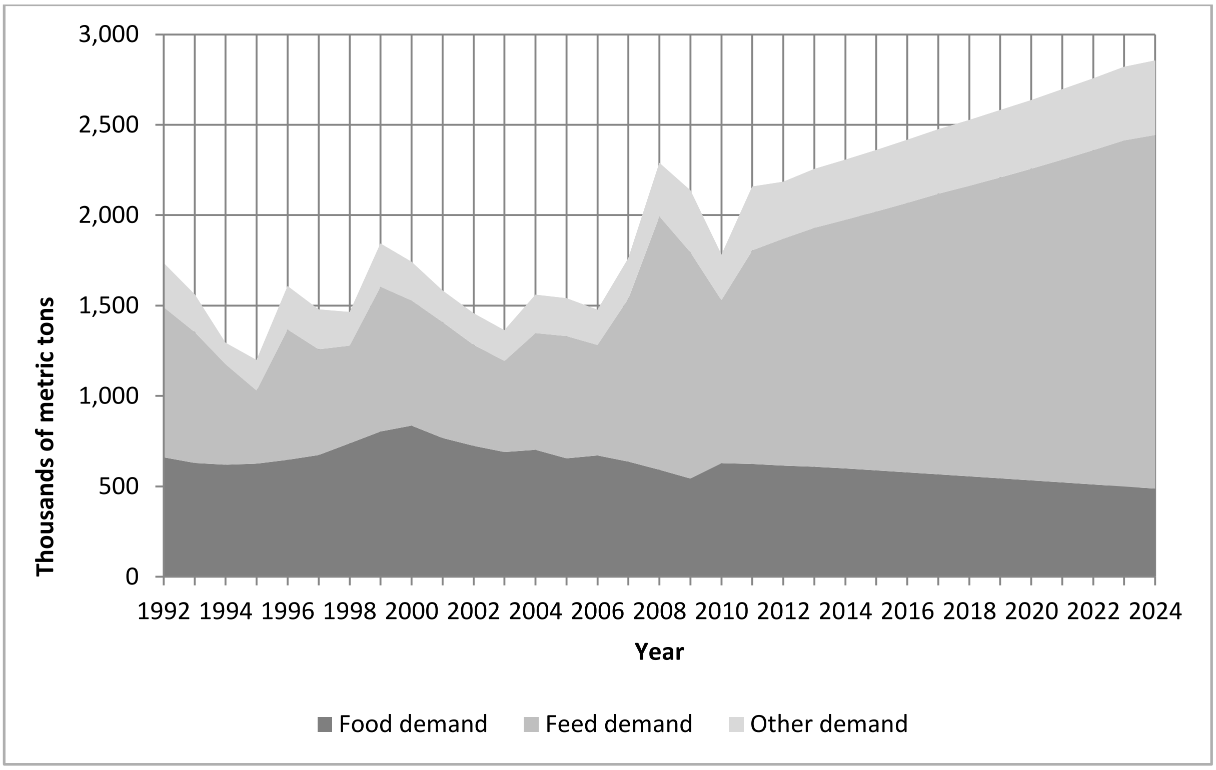
Source: USDA/PSD (2014) for overall historical feed utilization; model projections for forecasts and division by livestock product.

Wheat demand medium term outlook

As explained in the introduction to this section, the total demand for wheat consists of food, feed and other demand. Because other demand is so small, we assume that it remains a constant portion of total demand. Figures 3.9, 3.10 and 3.11 show forecasts of aggregate demand for wheat in Belarus, Uzbekistan and Turkmenistan, the sum of food and feed demand from previous sections, as well as an estimate of other demand.

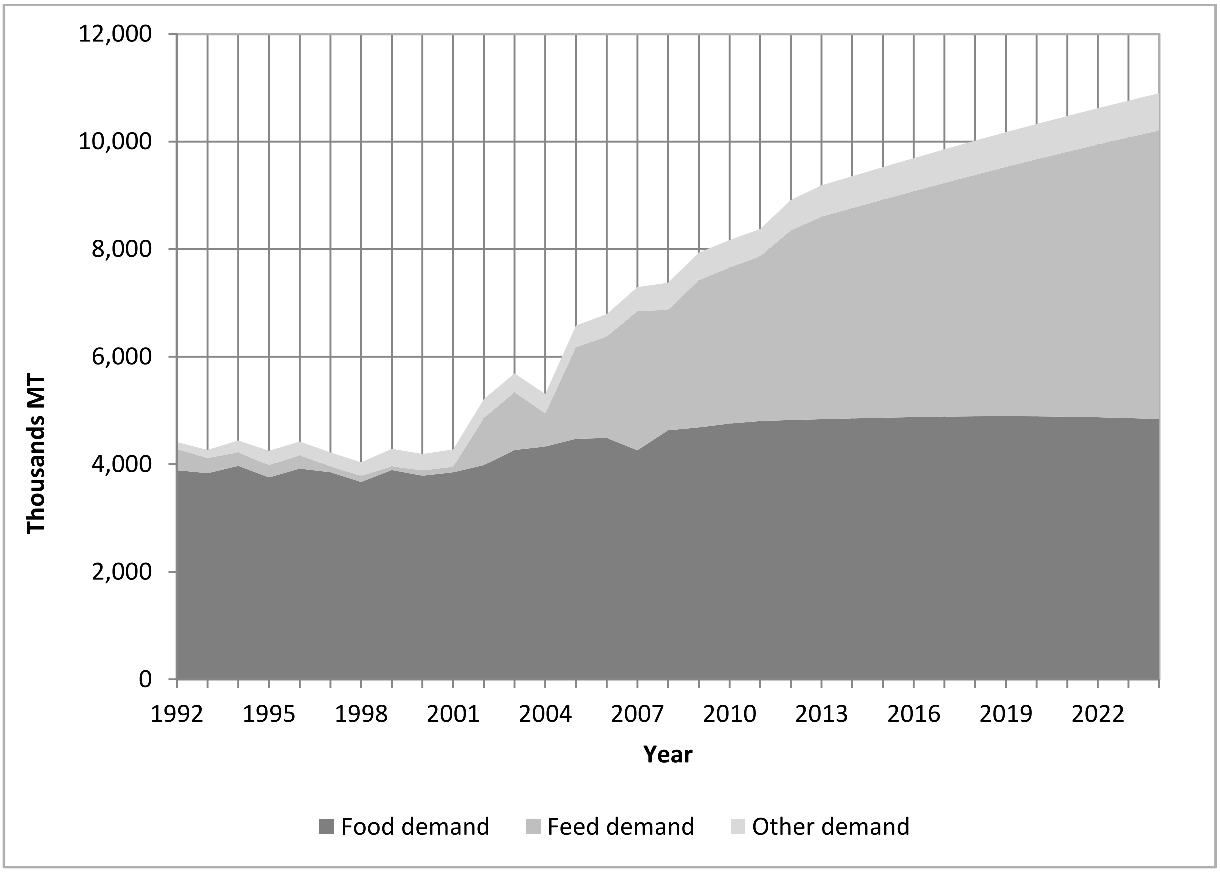
Figure 3.9 shows that overall demand for wheat in Belarus is slated to expand in the forecast period (2012-2024) by 2% per year. This is approximately the same rate of growth from 2000-2012, but quite a bit slower than recent growth. From 2006-2012 overall wheat utilization expanded at the rate of 6.9% per year. A second important issue visible in Figure 3.9 is that feed demand drives overall growth of demand for wheat. While food demand for wheat falls from 2012 to 2024, feed demand expands at 3.4% per year. This is lower than recent growth in feed demand, which expanded at the rate of 13% per year between 2006 and 2012, but it still makes for very robust growth.

Figure 3.9. Belarus: wheat food, feed and other demand, 1992-2024



Source: FAOSTAT (2014) and model projections.

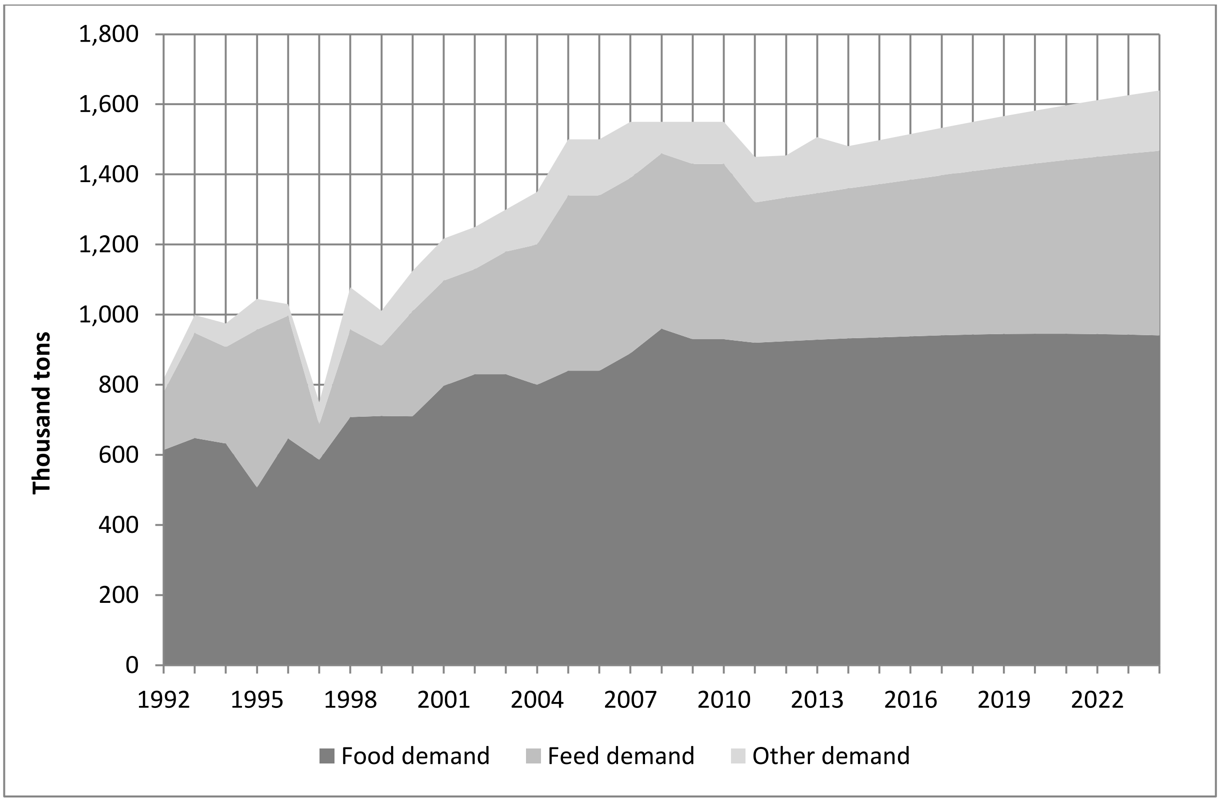
Figure 3.10. Uzbekistan: wheat food, feed and other demand, 1992-2024



Source: FAOSTAT (2014) and model projections.

The pattern of wheat demand in Uzbekistan (Figure 3.10) is quite similar to that in Belarus: Feed demand drives overall demand for wheat, while food demand stagnates. Overall demand for wheat in Uzbekistan will expand in the forecast period (2012-2024) by 1.9% per year. However, this aggregate is made up of two separate growth patterns. While feed demand grows by 4.1% per year, food demand grows by less than 1% per year. These future rates of growth represent a slowing of wheat demand growth compared to 2006-2012. In these years food demand grew at 1% per year, while feed demand grew at nearly 10% per year. The astonishing growth rate of feed demand in 2006-2012 is surpassed, however, by the overall growth rate of wheat for feed from 2000-2012: During this period feed demand grew at a whopping 34% per year! We will see later that Uzbekistan enacted a number of policy changes regarding feeding practices that contributed to very robust feed demand growth.

Figure 3.11. Turkmenistan: wheat food, feed and other demand, 1992-2024



Source: USDA/PSD (2014) and model projections.

Wheat demand for Turkmenistan (Figure 3.11) differs from that in Belarus or Uzbekistan. Wheat is consumed mostly for food use in Turkmenistan, while wheat use for feed purposes grows quite slowly over time. Still, the driving force of increased wheat use over the projection period is feed consumption, though the overall growth in wheat use and particularly that for feed purposes grows more slowly than in either Belarus or Uzbekistan.

4. Wheat Supply Medium-Term Outlook: Policies

Chapters IV and V are devoted to a critical review of the factors shaping the supply of wheat in Belarus, Uzbekistan and Turkmenistan. Chapter IV begins with a review of the main policies shaping wheat production in these three countries. Chapter V focuses on natural resource, climate and labor issues impacting on wheat production in the future.

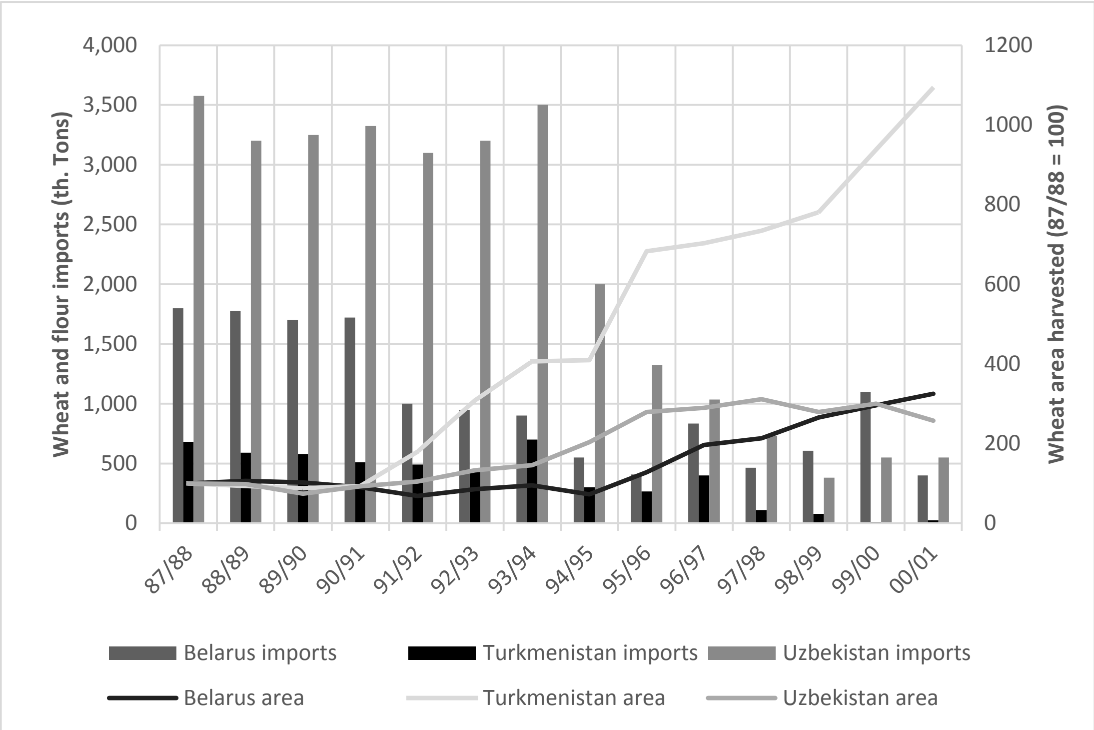
Wheat supply policies in these countries were crafted as a response to the deterioration of the state trading system of the Soviet Union that underlay the specialization of production across the USSR. Uzbekistan and Turkmenistan had specialized in the production of cotton, fruits, vegetables and feed, while importing grain and flour from Russia, Kazakhstan and Ukraine. Belarus had specialized in dairy, livestock and feed production, while importing grain for feed. The deterioration of the state trading system meant that the three countries under consideration were forced to ensure their own supplies of food wheat to feed their population. This led to a sudden increase in the area devoted to grain in the three countries.

While the mantra of the market economy was proclaimed by leaders throughout the NIS, in reality the abrupt changes in area were accomplished through traditional planning methods, rather than through markets. In the text we analyze the evolution of the main policies impacting on wheat production in these countries, but these should be understood as a practical response to a supply shock.

The "Washington consensus" in agriculture for transition countries called for (1) an end to the central planning system with its state-set prices for commodities and food, including the elimination of state procurement and input supply agencies, (2) the creation of viable agricultural producers through land reform and farm restructuring, and (3) a liberal trade system emphasizing the efficiency-related gains to be made from international competition and the distortionary effects of subsidies under the Soviet system (Lerman and Sedik, 2013). These policy prescriptions can be found in the definitive study of Soviet agricultural reform of the period written by a World Bank team that visited Moscow in November 1991 (World Bank, 1992).

The World Bank mission policy discussions were carried on in Moscow and the policy reforms were aimed at dismantling central agricultural planning institutions and providing for policies to replace planning with markets. Little attention was paid to food security issues in the periphery, in the Uzbek or Turkmen Soviet Socialist Republics. However, the deterioration of state planning and supply relations beginning in the late 1980s forced policy changes upon the Central Asian republics by undermining the specialization of food production in the USSR. Under the Soviet system, the four Central Asian republics (without Kazakhstan) were large net importers of grain either in the form of grain or flour. In return, Turkmenistan, Tajikistan and Uzbekistan produced cotton primarily for Russian industry.

Figure 4.1. Belarus, Turkmenistan and Uzbekistan: wheat import and area, 1987/88-2000/01



Source: USDA/PSD (2014).

Figure 4.1 illustrates the dilemma that Uzbekistan and Turkmenistan found themselves in the late 1980s and early 1990s. As wheat and flour imports from other republics fell, these republics were forced to increase area under wheat. We previously (Figures 2.11, 2.13 and 2.14) showed that cotton and wheat in these two countries are substitutes. Increasing the production of wheat required taking area out of cotton.

Given the dire situation in regard to inter-republic wheat and flour imports, which effectively ceased after 1995, there was a pressing need to increase wheat area in Belarus, Uzbekistan and Turkmenistan quickly to ensure food security. Thus, just as the "Washington consensus" called for an end to planning, Belarus and the two Central Asian republics needed to effect radical changes in sown area. It may come as no surprise that the reaction of the Central Asian republics, as well as Belarus, to the need for change was more cautious than the Gaidar government in Moscow. After all, none of the leaders of these countries had asked for the end of the planning system, nor were they consulted about the reforms planned in Moscow.

As the President of Turkmenistan Saparmurat Niyazov noted in 1995 at a meeting with government officials,

> We chose an evolutionary path of development. Without destruction, we will gradually reform the old society, while building a new society. . . Our path is neither shock therapy, nor total privatization. Our choice is the smooth transition to the market economy without destroying the current system. We

> will form a private sector and market structures on the basis of it (Niyazov 1995).

Niyazov's words may be applied to all three of the agricultural sectors described in Chapter II in the sense that limited and cautious reform was the approach to change taken in these countries. To call this a "smooth transition to a market economy" is, of course, a gross exaggeration. The new system built in this period limited central planning to only certain crops and livestock products, and sought to alter the incentive structure at the farm level. Only Belarus maintained the large farm system, renaming collective and state farms as agricultural enterprises, which remained under the control of the state; Turkmenistan switched to a system similar to the household responsibility arrangement in China, while maintaining full state control over the shell peasant associations, as well as state suppliers and procurement; Uzbekistan dismantled collective farms, but replaced them with a strict state order and supply system for strategic crops, including wheat.

State control over the structure of sowing in Belarus, Uzbekistan and Turkmenistan was maintained by the state order and supply system for the main crops. In Turkmenistan this included cotton, wheat, rice and sugar beets, in Uzbekistan cotton and wheat, while in Belarus the list of "strategic crops" included wheat, as well as many other crops (Table 4.2). The result of the expansion of wheat area can be seen in Figure 1.2, which shows the rapid decline of wheat import dependency ratios in the three countries starting in the late 1980s. From 1987-89 imports accounted for over 70% of the availability of wheat in Belarus, Uzbekistan and Turkmenistan. By 2000 in the Central Asian countries and by 2008 in Belarus import dependency ratios had fallen below 10%.

To summarize, although there is no longer planning in the classical Soviet sense in these countries in agriculture, the state has maintained a dominant role in agriculture and food. The most visible tool of state domination is the state order system, but the state role goes much deeper than mere purchases of commodities for state needs. Agricultural producers buy inputs and machinery from monopsonistic state supply agencies at state-set prices. They receive water for their crops from a state irrigation agency. They apply for loans from a state agricultural bank that provides credits at special rates. Finally, the state owns the land they till, and has used that right to take away land for poor performance.

This system of limited planning is justified by appeals to food security, which is seen as obtainable only through state control over land use and trade policies that stress wheat self-sufficiency. The desire to ensure the food supply through state intervention has over time eroded what dedication there once may have been in the policy area to a liberal trade regime and market prices. It has also made the creation of viable agricultural producers quite doubtful. Accumulation of debt or (in the case of Belarus) a significant fall in the liquidity of farms' financial statements incurred as a result of raising "strategic crops" leaves little room for the development of a market-based agricultural financial system for farms. Thus, the partial planning regime found in these three NIS has created a dysfunctional hybrid food system—not planned in the Soviet sense, but certainly not free market.

Food security policies

Food security is viewed similarly in the three countries. In all three countries, food security is treated as an element of national security, in order to preserve the sovereignty and independence of the country. The FAO definition of food security as a state that "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" is not the basis for the official definition of food security in these countries (Karimov 1999; Government Resolution Belarus 2004). In the approach of Belarus, Uzbekistan and Turkmenistan, the purpose of state policy in the field of food security is to achieve maximum food self-sufficiency, reducing dependence on imports. In Uzbekistan, for instance, a range of strategic food needs of the population should be satisfied through domestic production alone: bread, cereals, pasta and meat. All these products require grain. Therefore, the achievement of grain self-sufficiency has become one of the most important goals in the field of food security. In Belarus, the food security concept paper calls for 80%-85% self-sufficiency in agricultural commodities, including a maximum import level of 15%-20% of availability, and a further target of 15%-20% exports for each commodity. In Turkmenistan, from the very beginning of independence the goal of self-sufficiency in food production, including wheat, was proclaimed by the President.[13]

The food security concept in Uzbekistan outlines the following strategic food items for which the state aims for 100% self-sufficiency: bread, groats, macaroni and meat. In Belarus, the strategic crops are defined as grains, potatoes, vegetables, fruits, sugar, vegetable oil, milk, meat and eggs. In Turkmenistan the main strategic crops are cotton, wheat, rice and sugar beets, all of which are planned and procured by the state.

Table 4.1. Instruments for the achievement of food security in Uzbekistan, Belarus and Turkmenistan according to official policy

Uzbekistan	Belarus	Turkmenistan
Production support for crops and livestock products (wheat, fruits and vegetables, grapes, poultry and others)	Trade barriers (protectionism) for food products	Institutional changes to set up the new state planning of input supply and procurement
Trade policy (import tariffs on meat and milk, candy and others)	Production support for crops and livestock products	State control over agricultural enterprises
Subsidies for consumers (below market prices for bread, special food outlets in urban areas with lower prices)	Raising the competitiveness of domestic producers	Land and irrigation water reform
Food fortification (flour, iodized salt)	Stimulation of exports	State investment support to expand production facilities
	General sustainable development throughout the entire economy	State monopoly on trade in food products

Sources: Karimov (1999) for Uzbekistan; Government Resolution Belarus (2004) for Belarus; Stanchin (2014) for Turkmenistan's *Zerno (Grain) Program*.

[13] Speech of the President of Turkmenistan Niyazov at the session of the Khalk maslakhaty (Peoples' Council, the highest representative organ of the population) on 14 December 1992. At this forum President Niyazov announced the new policy of the country, "10 Years of Prosperity," one of the basic economic premises of which would be the achievement of food self-sufficiency (Niyazov 1994).

Table 4.1 lists the instruments to achieve food security in the official policy documents of the three countries. Clearly the food security strategies of these countries leave much to the discretion of the state on how to achieve food security. However, the goals of complete self-sufficiency in grain production in Uzbekistan and Turkmenistan, and 80-85% self-sufficiency in Belarus are clear targets, which imply near grain autarky.

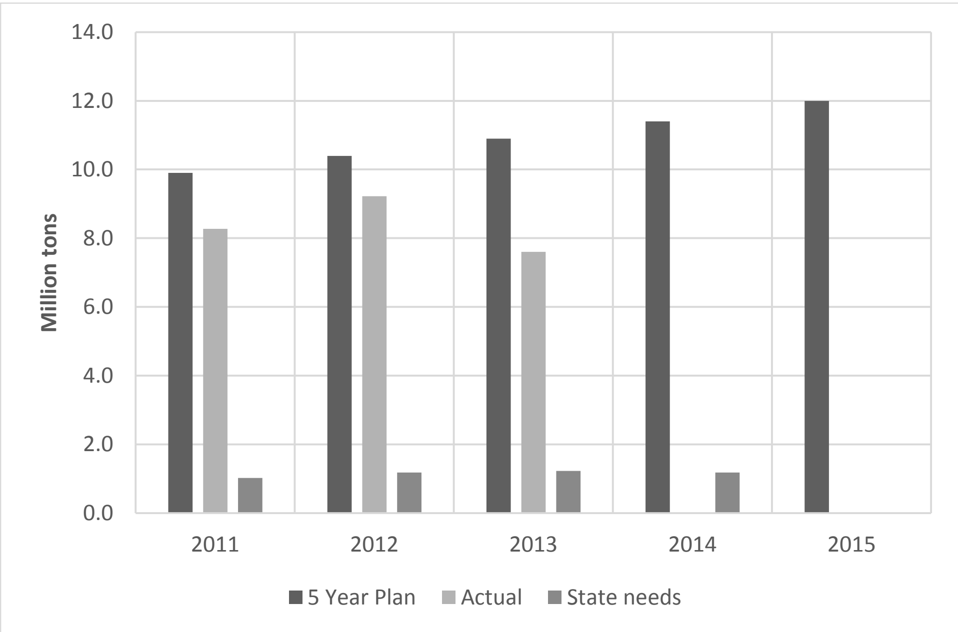
Partial planning system for wheat and its implications for wheat markets

The partial planning system in these three countries is based on the implementation of various long-term programs that include production targets, as well as on annual operational plans.

Belarus

The "State Program for Sustainable Development of Rural Areas" is a five-year government program that includes production targets for various agricultural commodities. In 2011 the President of Belarus issued a decree with plan targets for cereals, sugar beets and potatoes for the period 2011-15, broken down by year and oblast. Plan targets are referred to as "economically rational production targets" (Belarus Presidential Decree 2011).

Figure 4.2. Belarus: planned and actual production of cereals and state needs procurement, 2011-15



Source: Belarus Government Resolutions for each year (Kazakevich 2014).

The program includes activities aimed at raising the efficiency of agricultural production. For example, by 2015 cereal yields are slated to rise to 4.3 tons per ha, and cereal profitability to 25%. In addition, sown area of cereals in agricultural enterprises is to be stabilized at 2.5 to 2.6 million ha. Finally, the "economically rational levels of cereal production" are shown, broken down to the oblast level. Figure 4.2 shows the overall 5 year plan figures for cereal production from 2011-2015, actual production figures for 2011-2013, as well as the figures for cereal production from the "operational" 1 year plan. It is clear from Figure 4.2 that the five-year "State Program" is not obligatory, but rather exhortative in nature.

Beyond this longer term planning, the government issues an "operational" annual state production and procurement plan that includes cereal production broken down by type of grain, including wheat. In Belarus the government (Cabinet of Ministers of Belarus) issues a "forecast for social-economic development," every January, and later a "list of state needs," which includes a list of procurement targets, mostly for agricultural commodities (Table 4.2). For instance, in the annex to the 2012 "list of state needs" the following agricultural procurement targets were included. The second two columns indicate actual production in 2012 and state needs as a portion of actual production.

Table 4.2. Belarus: state needs procurement target and actual production for 2012

Commodity, 1000 tons	Procurement target	Actual production	State needs, % of actual production
Cereals	1184	8828	13
Of which,			
Wheat	630	2554	25
Rye	400	1082	37
Barley	42.5	1917	2
Buckwheat	32	39	82
Oats	53.5	422	13
Peas	8		
Millet	12	18	67
Maize	6		
Rapeseed	280	704	40
Grain for manufacture of spirits	222		
Maize for manufacture of starch and starch products	14		
Sugar beets	3680	4772	77
Barley for beer production	150		
Flax fiber	21.1	52	41
Of which, long fiber	6.1		

Source: Belarus Government Resolution (2012).

In addition to the above physical indicators, the "list of state needs" also includes a procurement budget broken down by institutions contained in the annual state budget. The procurement prices for "state needs" are set by a decree of the Cabinet of Ministers and the Ministry of Agriculture and Food, and are periodically reviewed and changed (sometimes many times per year). Before 2011 "minimum procurement prices" were issued by the Cabinet of Ministers, in 2011 "maximum procurement prices", in 2012 "fixed procurement prices" and in 2013-14 "maximum procurement prices". Agricultural production above the procurement targets is sold at market prices.

For cereals and wheat the following procurement targets for state needs were issued by the Cabinet of Ministers each year since 2004 (Table 4.3).

Table 4.3. Belarus: state needs procurement targets for cereals and wheat (1000 tons)

	Procurement Target (1000 tons)		Production (1000 tons)		Procurement as a portion of production (%)	
Year	Cereals, total	Of which, wheat	Cereals	Of which, wheat	Cereals	Wheat
2004	1000	305	6590	1121	15	27
2005	1000	315	6090	1174.6	16	27
2006	1000	335	5685	1075.4	18	31
2007	1010	336	7014	1396.7	14	24
2008	1000	352	8712	2045	11	17
2009	1025	422	8153	1979.2	13	21
2010	990	482	6726	1739.6	15	28
2011	1025	570	7981	2132	13	27
2012	1184	640.9	8828	2554	13	25
2013	1226.9	737.5	7235	2102	17	35
2014	1182	702				

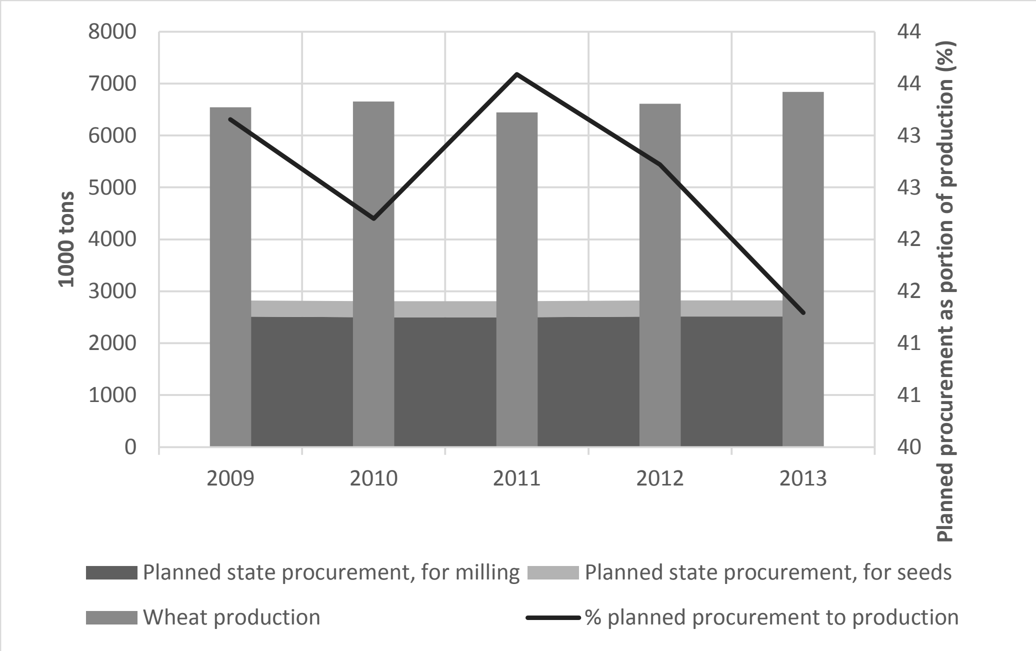
Source: Kazakevich (2014); Belarus Government Resolutions for each year.

Most importantly, the annual government procurement decrees foresee enforcement and monitoring mechanisms that hold state officials responsible for fulfillment of the procurement plan. Republican bodies of State administration and other State organizations subordinate to the Government of the Republic of Belarus, as well as regional and Minsk City Executive Committees, are instructed to conclude contracts for state needs referred to in the list. The Ministry of Economy then reviews the procurement contracts for republican state needs. The Ministry of Agriculture and Food, in agreement with the Ministry of Economy, then establishes procurement prices for agricultural products purchased for state needs. Republican bodies of State administration, other State organizations subordinate to the Government of the Republic of Belarus, regional and Minsk City Executive Committees are responsible to report each quarter on fulfillment of the procurement plan.

Uzbekistan

In Uzbekistan, the annual state order system is the operational planning system for agriculture. Wheat production in Uzbekistan is planned through the mechanism of grain purchases for state needs. Each year the government determines the amount of wheat to be procured for state needs. This volume takes the form of a state order. Farmers are contracted at the beginning of the sowing year via this state order system. A state order contract is drawn up between farmers who lease their land from the state and the local authorities. As all farmers work on leased land from the state, and the fulfillment of obligations under contracts is one of the prerequisites of extending the lease, supply of grain for public procurement is mandatory for the farmer. If the farmer fails to deliver on his state order he can lose his lease on the land. For wheat, state orders consist of approximately 40-45% of the commodity grown each year (Figure 4.3).

Figure 4.3. Uzbekistan: planned state procurement and production of wheat, 2009-2013



Source: Ministry of Agriculture and Water Resources of Uzbekistan (Yusupov 2014).

Farms may purchase inputs on concessional terms in order to meet state orders. Farmers are issued 12-month loans at 3% per annum to cover the costs of inputs for producing wheat for state needs. The “loan” (actually, an advance payment) is received in the form of a voucher granting the right to obtain fertilizer, fuel, crop protection agents and seeds at subsidized prices. The advance is paid in several tranches corresponding to the period of main agricultural activities, such as sowing, application of plant protection agents and harvesting.

The process works as follows: Before the start of the new agricultural season, the local offices of the Ministry of Agriculture and Water Resources provide information about potential wheat production in their region. Then the local offices of the State Joint Stock Company “"Udonmahsulot",” responsible for wheat procurement for state needs, collects information on local state needs for wheat in the area and the prices proposed to be paid to producers. "Udonmahsulot" also assesses the potential for wheat export in the next season. This information is sent to the Ministry of Economy, which coordinates the input supply and procurement process with other agencies. The financial resources proposed by the Ministry of Economy (including purchase price and total amount) is then agreed with the Ministry of Finance, which is the holder of the state needs procurement fund. After this, the Ministry of Economy proposes quantitative procurement targets for next year to the government.

Following Government approval of the public procurement plan for the next year and purchase prices for each class of wheat, the "Udonmahsulot" is obliged to undertake the contracting process. This involves concluding contracts with farmers for the supply of wheat for public use. Through these contractual agreements farmers learn of their individual compulsory procurement quotas and both within quota and above quota procurement prices per ton. The latter is the price offered by "Udonmahsulot" for above-quota wheat delivery.

In addition to the above state order process, agricultural inputs, such as fuel and fertilizer, are sold to farms only through state monopsonistic supply agencies. Moreover, the state as well provides subsidies from the state budget to farms in the form of loan restructuring and forgiveness, as well as providing advances for wheat production expenses.

The above state order system applies only to wheat and cotton. For other crops there are no procurement plans or price control. However, the processing sector (meat packing plants, milk processors and fruit and vegetable canneries) remains partly under the control of local state authorities. Moreover, since the state holds a monopoly on the production of alcoholic beverages, grape producers are obliged to sell their production at prices set annually by the monopsonist state joint stock company “Uzvinprom-kholding.”

Turkmenistan

As in Uzbekistan and Belarus, agricultural planning in Turkmenistan relies on the implementation of various “programs” for agricultural development. In the beginning of the 1990s a number of agricultural programs were initiated aimed at achieving “food security”—“The New Village,” “1000 days,” “Grain” and “10 Years of Stability” (subsequently renamed “10 Years of Prosperity”). In addition to these formal programs, the upper and lower houses of Parliament (Khalk maslakhaty and Mezhlis), as well as the President, issued various laws, resolutions, decrees, orders and circulars.

Table 4.4. Plan indicators in the National Program for Social-Economic Development of Turkmenistan, 2011-2030

	Years								
	2010	2011	2012	2013	2014	2015	2020	2025	2030
Irrigated land, 1000 ha	1740.3	1772.2	1794.9	1817.5	1842.3	1867.7	2000.0	2000.0	2000.0
Agricultural production (all farms, 1000 tons)									
Wheat	1600	1625.0	1639.0	1654.0	1669.1	1685.1	1810.2	1849.0	1896.2
Rice	73.0	80.4	80.6	80.8	81.0	81.2	83.0	86.5	93.0
Processed production (1000 tons)									
Flour	573,9	633,2	660,6	691,6	709,0	750,3	849,1	872,7	895,7
Groats	12,6	13,7	14,6	16,7	17,6	18,7	19,9	20,4	21,0
Pasta products, tons	8610	10850	12110	13390	14470	15310	20950	23530	28310

Source: Turkmenistan National Program 2011-2030 (2010).

Turkmenistan has the most developed planning system of the three countries considered here. The National program for social economic development of Turkmenistan, 2011-2030, outlines the following agricultural planned indicators for the period 2011-2030 (Table 4.4).

Plan fulfillment for the years 2010-2013 has been between 73% and 97% of plan (Table 4.5).

Table 4.5. Turkmenistan wheat production: plan and actual production, 2010-2013

	2010	2011	2012	2013
Plan	1600	1625	1639	1654
Actual (official)	1400	1300	1200	1600
--% of planned	88	80	73	97
Actual (USDA)	1200	1300	1200	1600
--% of planned	75	80	73	97

Source: Turkmenistan National Program 2011-2030 (2010); USDA/PSD (2014).

The current implementation mechanism for agricultural planning was created during the agricultural reforms of 1996 and 1997 which were aimed at improving the management of agriculture by removing managerial authority from the Ministry of Agriculture and the kolkhoz system, investing it in a new system of parastatal service and procurement organizations and narrowing the scope of state agriculture to only 3 crops (cotton, wheat and rice). In 2000 sugar beets were added to the list of state order crops. State orders for meat and milk were dropped, and private trade was left to develop for non-state order crops. The parastatal procurement organizations exercise a control function in the sense that they are responsible for delivering a standard package of inputs to each leaseholder in the peasant association calculated on a per hectare basis and collecting a standard expected output based on a standard yield.

As a result of the 1997 reforms the functions of the Ministry of Agriculture were severely restricted (Stanchin (2010), pp. 2, 3, 35). Its system of local offices was transferred to regional (velayat) and district (etrap) level administrations, and responsibilities for the management, financing, and servicing of farms were transferred to the new parastatal input service and procurement-based organizations. With this loss of authority and functions the staff of the Ministry was reduced to a minimum. The Ministry of Agriculture is now charged with carrying out analytic, coordination and methodological work with the main goal of implementing economic reforms in agriculture.

The essence of the centralized state planning system (goszakaz or state orders) for production of four strategic crops, cotton, wheat, rice and sugar beets, is that planning, input and service delivery, as well as procurement for the four strategic crops is carried out on the basis of Presidential Decrees and government resolutions. Neither peasant associations nor their leaseholders make decisions on production of these crops. Input and service delivery for these crops is provided by the Ministry of Water Economy, Daikhanbank and 5 parastatal service organizations for agriculture.[14] These organizations make up the so-called State Agricultural Joint Stock Company of Turkmenistan formed in 2004 by Presidential Decree (Stanchin 2010, p. 39).

[14] The current designations of the five parastatal organizations are: (1) Association Turkmengallaonumleri (for grain and bread products), (2) Association Turkmenkhimiia (fertilizer and plant protection agents), (3) Association Turkmenobahyzmat (machinery services), (4) State Concern Turkmenpagta (for cotton) and (5) Association Turkmenmallary (livestock and livestock products).

The state order system utilizes the vast majority of land resources in Turkmenistan. In 2008 it occupied 89% of total sown land in Turkmenistan with cotton and wheat occupying 92% of the total (Table 4.6).

Table 4.6. Turkmenistan: sown area of government order crops

	2005	2006	2007	2008	2009*
Total sown area, th. ha	2,002.4	2,015.5	1,588.1	1,596.6	1,705.5
Including, for government order	1,634.9	1,604,0	1,513.6	1,515.0	1,511.8
Wheat	952.7	946.5	832.9	905.6	950.0
Cotton	644.6	623.2	642.7	570.4	545.0
Rice	31.5	22.2	22.1	27.9	18.0
Sugar beets	6.1	12.5	15.9	11.1	15.0

*Turkmen government directive for 2009.
Source: Stanchin (2010), p. 5.

All aspects of the planning, production and sales process within the state order system are controlled by various government and parastatal agencies. The state leases a plot of land to the leaseholder for the express purpose of producing a commodity. Then the vertically-integrated parastatal organizations supply the leaseholder with a standard package of various inputs--seeds, mineral fertilizers, plant protection agents and water. State organizations then carry out sowing, defoliation, application of mineral fertilizers and plant protection agents, harvesting, transportation of the crop to the processor and storage.

Within this system the leaseholder has very little room for influencing the production process. He is powerless to affect the quality of seeds, the time of sowing, administration of plant protection agents, fertilizer and harvesting. On paper he receives bank credit for the purchase of inputs at the beginning of the season, but this credit is channeled to the state input providers who provide the inputs themselves according to state norms that specify the quantity of inputs necessary for fulfilling the output target. The inputs are supplied at state set prices, some at below market levels. After harvesting the output is sold at the state set procurement price which is significantly below market levels. Despite his lack of control over the production process, the leaseholder bears all the financial risks, since his net profit is based on his yield.

The state order system in Belarus, Uzbekistan and Turkmenistan

To summarize this section, about 35% of wheat in Belarus, 40-45% in Uzbekistan and 100% of wheat in Turkmenistan is subject to the state order system in the three countries considered here. The state order system involves an agreement between producers and the state whereby producers agree to deliver physical quantities of commodities at state-set prices and in return receive a package of inputs with which to raise those crops at state-set input prices. In Uzbekistan state organizations sign contracts directly with each individual producer (daikhan farms). In Turkmenistan and Belarus, the agricultural enterprise (peasant association in Turkmenistan) is the contractual organization. Obviously, the bargaining situation of individual farmers is far inferior to the monopolist state procurement organization and the monopsonist suppliers.

There are no actual money transfers between state organizations and the producer. Rather, payments are made to the state input providers who deliver their wares to the producer. This “advance” or “credit” by a bank is then an obligation assumed by the producer that needs to be repaid in kind through delivery to the state procurement organization (which transfers a payment back to the bank). An interest rate for the advance or credit is set by the state. If the producer is fortunate, he will be able to pay off the loan leaving him with a profit, against which he can then pay taxes and other fees to the state.

Support and tax policies for wheat

The system outlined above is notoriously opaque for both individual contracting farmers in Uzbekistan and Turkmenistan and for Belarusian agricultural enterprises. It is nearly impossible to tell whether the producer receives the return that he would have received in a non-controlled market with free prices. The levers of market distortion are so numerous: state-set procurement prices, state-set input prices, interest rate terms for the “advance” received by producers, state-led forgiveness of debt, penalties imposed by banks or by state input suppliers for late payment. The penalties for late payment and accumulated interest payments can easily snowball, so that an enterprise that falls behind on its payments may find itself overwhelmed with paying off previous debts with new loans.

Despite these difficulties, it is important to measure the net effect on producer income and therefore incentives of the various state policies. For this assessment we focus on the incentive effects of state support and taxation through the price system. The methodology of the estimates discussed here can be found in Box 4.1.

Agricultural finance in Belarus, Uzbekistan and Turkmenistan

Though we are particularly interested in wheat subsidies and taxes in these three countries, we should not ignore the general function of the agricultural finance system in these countries. In market economies the function of a financial system is to allocate scarce financial resources to sectors with the highest return on capital. In the case of farmers, loans are granted based on the loan servicing ability of the farm. The long term profitability of the farm is analyzed to determine its loan servicing ability.

In previous sections it was noted that in these countries bank credits and state financial assistance are dispensed according to government decrees to support planned physical production or sowing targets regardless of the loan servicing abilities of farms. This practice transforms the agricultural credit system into a quasi-fiscal system of support. However, there are very real differences in the three countries depending on whether the producer is an agricultural enterprise, as in Belarus, or an individual farmer, as in Uzbekistan, or an individual leaseholder, as in Turkmenistan.

In the case of Belarus, the incentive for cost control at the enterprise level is substantially weakened if enterprise managers know that it is not profitability but fulfillment of the physical plan that is more important. If enterprises borrow to renovate their fixed assets with limited effect of their productivity, their financial state may deteriorate. This deterioration is often seen in their decreased ability to repay their short term debts from their liquid assets.

Essentially, this means that the farm has become less creditworthy. As agricultural enterprises become less liquid, they become more dependent on new fiscal transfers or bank loans in order to service their debt penalties and interest payments, as well as to finance purchases of inputs for production. This situation is often referred to as a “debt crisis,” but the real problem is not one of debt, but of the transformation of the credit system into a quasi-fiscal system of support in which bank credits and state subsidies are dispensed through government decrees to support planned physical production or sowing targets regardless of the loan servicing abilities of farms.

The system differs in Uzbekistan where individual farmers purchase inputs financed by banks for production of state order crops. Though profitability figures for wheat production are not published, according to press accounts, in Uzbekistan wheat and cotton production is not profitable. Raising fruits, vegetables, livestock and other high value products are the only source of profits. The lack of profitability of wheat and cotton begets a similar situation as in Belarus—mounting debt that leaves the farmer with hopeless debt service payments. The farmer remains indebted to banks for the “credit” he (or rather the input supply companies) receives at the beginning of the year to finance spring sowing, and to the various vertically integrated state input-supply companies for fertilizer, for fuel, machinery services, for transport, etc. However, still farmers in Uzbekistan enter into state order contracts in order to divert some of the land, as well as some or all of the fertilizers, fuel and plant protection agents for the raising of vegetables. In this way, at least the farmer can ensure that he has something to sell at the end of the crop year to feed his family, even while his debts accumulate (Ferghana News 2014; Peyrouse 2009).

In Turkmenistan, the situation is similar to Uzbekistan in the sense that wheat and cotton production is not profitable. However, there is a small, but important difference that makes the system in Turkmenistan more subject to abuse for the leaseholder. In Turkmenistan since 2007 the *peasant association* signs contracts for delivery of seeds, fertilizers, fuel, plant protection agents and water with the vertically integrated state input-supply companies, and then in turn signs contracts with individual leaseholders, assigning production targets and allotting inputs. Unlike in Uzbekistan, where private farms are relatively large (80 ha on average), in Turkmenistan leaseholder plots are tiny (often less than 1 ha). Moreover, the wheat crop is not harvested individually for each plot, and no record is kept of the yield of each farmer individually. Rather, as in the collective farm days, large combine harvesters gather the crop over the entire field in the presence of the local administration and the police, and take it to elevators for cleaning and weighing.

The peculiar situation in Turkmenistan leaves room for abuse from two sides. First, the vertically integrated state input supply organization can deliver fewer supplies than for which it invoices the peasant association. The interest of the peasant association in controlling the amount delivered is limited, because it passes on the bill to the leaseholders. Second, the harvesting and weighing practice whereby no record is kept of the actual yields of each individual plot means that the income of the farmer may depend less on the results of his work than on his relations with the director of the peasant association.

When agricultural enterprises, peasant farmers or leaseholders accumulate debts year in and year out regardless of performance the financial system ceases to play its role as an allocation mechanism of financial resources to the best performing farms or sectors. Rather, the financial system and debt is turned into an accounting mechanism and a tool of plan pressure on farmers. If this was not enough, the farm management as well as national and local police, tax and administrative authorities are also used to enforce plan discipline.[15]

State taxation and support for wheat production through the price system

There are a variety of means through which the state may subsidize or tax agricultural producers in the three countries covered in this study. For instance,

1. Fiscal support to the sector through long or short term development programs
2. State support or taxation through the tax system (lower tax rates for agricultural producers, for example)
3. State support or taxation of producers through the price system, i.e., through state-set commodity and input prices that differ from world market prices.
4. Financial support through the (state) banking sector
   i) Through loans advanced to agricultural enterprises at below market rates ordered by the government (interest rate subsidies)
   ii) Through state loan guarantees for loans to agricultural enterprises, thus reducing market rates for loans to producers
   iii) Through state-ordered extension or write-offs of farm debt to banks, state input supply agencies and to the government (for taxes)

The methodology used to estimate state taxation or support for wheat through the price system (item 3) is explained in Box 4.1.

Box 4.3 State taxation and support for wheat production through the price system

Three main sources of price distortion are considered: (1) state-set procurement prices, (2) state-set exchange rates and (3) state-set input prices. We estimate their net impact on producer incentives by considering the average deviation of actual prices from those that would prevail without interventions.

We use two simple measures of price distortion or "protection" based on "price gaps". The simpler of the two measures is the so-called "nominal protection coefficient" (NPC), defined as the percentage ratio between the domestic distorted price and the counterfactual (undistorted) price. For a "small country" the undistorted price is generally taken to be an international reference price adjusted for transportation and marketing costs to bring the price to either the farm gate (if the country is an exporter) or to a market (if the country is an importer). This adjusted international price is referred to as the "border price". Both domestic and border prices are measured in a common currency by using an appropriate exchange rate. Instead of NPC we can use the equivalent definition of "nominal protection rates" (NPR) defined as NPC – 1.

The (direct) NPR for wheat is calculated using the following formula:

[15] Violation of plan discipline is dealt with severely in Turkmenistan at the highest level. In 2012, after a sudden rise in the price of bread on local markets due to a forecast production shortfall, the Minister of Agriculture along with most of his staff and regional agriculture officials were dismissed for gross violations in carrying out their duties (Turkmenistan Agriculture Minister Dismissed 2012). If the threat to high officials in Turkmenistan is so high, one can imagine the pressure they bring to bear on those below them in order to ensure plan discipline.

$NPR = [P_d – rP_b]/rP_b$

where

NPR = nominal rate of protection for wheat
P_d = domestic price in units of local currency
P_b = border price in foreign currency
r = exchange rate in local currency units per unit of foreign currency
rP_b = the border price of the commodity in foreign currency converted to local currency units

If the state-set exchange rate is not a market rate, then it will typically overvalue the local currency. Thus, in converting border prices in US dollars (for example) to local currency, we need to estimate shadow (or market) exchange rates. For this calculation, we use grey market currency rates. The state exchange rates for Uzbekistan and Turkmenistan have been overvalued for certain, though not all, years.

The nominal protection rate is the most frequently used measure of protection because of its relatively limited data requirements and its ability to capture much of the market distortion effect. It can be constructed from a direct comparison of domestic and border prices (with due correction for transportation and marketing costs); it can be used as a measure of the incidence of market-price altering interventions; and it is relatively easy to understand and monitor.

The second measure of price distortion or "protection" based on "price gaps" used here is the so-called "effective protection coefficient" (EPC). The EPC is a more comprehensive measure of protection than the NPC. Whereas the NPC measures protection arising from state-set output prices, the EPC measures protection arising from both state-set output and input prices measured at the farm level.

The effective protection coefficient (EPC) for a given commodity is defined as

EPC = VA in domestic prices/VA in border prices,

where VA is value added.

Expanding, we write

$EPC = [P_d – a_jP_{jd} – a_kP_{kd} - \dots - a_KP_{Kd}]/r*[P_b – a_jP_{jb} – a_kp_{kb} - \dots - a_Kp_{Kb}]$

where

P_d = domestic price of commodity in units of local currency (e.g., 2000 rubles per ton of wheat)
a_j = units of input j per unit of output of the commodity (e.g., 0.05 tons of fertilizer per ton of wheat)
P_{jd} = domestic price of input j in units of local currency (e.g., 2000 rubles per ton of fertilizer)
a_jP_{jd} = value of input j required to manufacture one unit of the commodity (e.g., 100 rubles of fertilizer to manufacture one ton of wheat)
r = exchange rate in local currency units per unit of foreign currency (e.g., 10 rubles per dollar)
P_b = border price of commodity in foreign currency
P_{jb} = border price of input j in units of foreign currency

Source: Tsakok (1990).

Belarus

Table 4.7 shows total state budget support for agriculture (line 1) both from the Republican budget as well as from local budgets and special funds. According to calculations by the Institute of Agricultural Economics of Belarus, about 90% of fiscal support for agriculture is directed as interest rate subsidies to banks for the sector and to input suppliers to cover state-mandated discounts to agricultural producers. Thus, Table 4.7 covers subsidies to agriculture primarily for subsidized inputs. Budget transfers to agriculture reached a peak of 24% of gross agricultural output in 2007, but have remained about 15% since 2010 (line 3). We estimate fiscal support to wheat production by taking the per ha amount of support payments and multiplying by the sown area (line 4).

Table 4.7. Belarus: direct state fiscal support to agriculture, 2005-2013, bln. BYR

	Source	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Budget subsidies to agriculture, total	2415.6	3369.5	4277.4	4677.7	5680.2	4978.6	8031.9	14726.3	17280.6
2	GAO (bln BYR)	12,880	15,544	18,102	25,052	26,799	36,131	55,642	96,696	105,770
3	Support as % of GAO	19	22	24	19	21	14	14	15	16
4	Estimate of input subsidies for wheat production*	97	147	203	272	364	348	603	1,194	1,380

*Calculated by using per ha figures and applying them to wheat sown area.
Source: Ministry of Agriculture of Belarus (Kazakevich 2014).

State-set procurement prices are a second way that the state may subsidize or tax wheat producers through the price system. To gauge the implicit subsidy to agriculture from procurement prices that are higher than the world price we need to compare the average price for wheat in Belarus with the international market price. Table 4.8 illustrates the implicit subsidy to agricultural producers through the state system of procurement prices. Line 4 represents the gap between the value of production of wheat in Belarus evaluated at international and domestic prices. If domestic prices are lower than world prices for wheat then agricultural producers are assessed an implicit tax on their production, indicated by a negative "price gap" in line 4. If domestic prices are higher than world prices for wheat then agricultural producers are granted an implicit subsidy on their production, indicated by a positive "price gap" in line 4. As is visible from Table 4.8, the price gap has been positive in some years and negative in others. Likewise, the nominal protection rate, defined as the price gap tax or subsidy as a percentage of the value of output at the market price, is predominantly, though not consistently, positive.

Table 4.8. Belarus: implicit taxation of wheat producers through state procurement prices

		2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Wheat production (1000 tons)	1,175	1,075	1,397	2,045	1,979	1,739	2,132	2,554	2,102
2	Value of output in domestic prices, bln BYR	287	282	440	893	767	698	1,554	3,499	4,117
3	Value of output at international prices (bln BYR)	245	289	624	854	682	604	1,604	4,173	3,754
4	Price gap (line 2 - line 3), bln BYR	42	-7	-184	39	85	94	-50	-674	363
5	Nominal Protection Rate*	17%	-2%	-29%	5%	12%	15%	-3%	-16%	10%

*Note: NPR is the price gap in line 4 as a percent of the value of output at international market prices (line 4/line 3). Negative NPR is a tax on producers when domestic wheat prices are lower than international prices. Positive NPR is a subsidy for producers when domestic wheat prices are higher than international prices.
Source: Ministry of Agriculture of Belarus (Kazakevich 2014).

Compared to the fiscal transfers for agricultural inputs, line 4 (Table 4.8) is not very large. However, if we combine the estimated fiscal transfers for wheat and the “price gap” calculations (Table 4.9) we can see that total fiscal transfers to the wheat sector through the price system were positive each year from 2005 to 2013 and ranged between 50 and 60% of the value of wheat production in 2005-06 and 2009-2010.

Table 4.9. Belarus: fiscal transfers to wheat farmers through the price system, bln BYR

		2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Wheat production (1000 tons)	1,175	1,075	1,397	2,045	1,979	1,739	2,132	2,554	2,102
2	Value of output in domestic prices, bln BYR	287	282	440	893	767	698	1,554	3,499	4,117
3	Price gap, bln BYR	42	-7	-184	39	85	94	-50	-674	363
4	Estimate of input subsidies for wheat production, bln BYR	97	147	203	272	364	348	603	1,194	1,380
5	As percent of value of wheat production in domestic prices, bln BYR [line 3+line4)/line 2]	48	50	4	35	59	63	36	15	42

Source: Ministry of Agriculture of Belarus (Kazakevich 2014).

If fiscal transfers to agricultural enterprises for wheat were so large, and the creditworthiness of farms continues to deteriorate, it is quite probable that the costs of servicing loans, penalties and other payments are becoming a greater and greater burden on agricultural enterprises.

Uzbekistan

Previous research has found that agriculture in Uzbekistan has been heavily taxed through state procurement prices for cotton and wheat and state-controlled exchange rates. The principle method of taxation is to offer farmers state set procurement prices for wheat and cotton at less than market rates. Estimates by the Asian Development Bank indicate that 10.4% of GDP was transferred from agricultural producers to the government in indirect and direct taxes (net of subsidies) in 2003 (Djalalov, 2008). This was more than two thirds the size of the contribution of all of Uzbek industry to GDP and twice as much as construction in that year (Goskomstat respubliki Uzbekistan, 2005). The so-called “price gap transfers” from below-market prices are indicated in Table 4.10 for cotton fiber and wheat. Though agricultural producers receive subsidies for such inputs as agricultural machinery, irrigation, fuel and lubricants, electricity and fertilizers, these subsidies only partially offset the large price gap taxes that characterize the sector. In Table 4.10, net taxation of the sector is shown for the period 1996-2004 with forecasts through 2006.

For recent years we have only information on the price gap between average domestic commodity prices and international market prices, that is, the degree to which domestic commodity prices in Uzbekistan are lower than international market prices. Table 4.11 shows that the price gap has been negative since 2010, and the reason for the implicit tax on wheat producers is the overvalued exchange rate.

Table 4.10. Uzbekistan: calculated net taxation of agricultural producers, 1996-2004 and forecast for 2005 and 2006 (million $)

	Implicit tax on producers through price gap			State subsidies			Net tax on producers (1-4)
	Total	From wheat	From cotton	Total	For irrigation	Other	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1996	-841.8	-228.2	-1069.9	839.7	412	428	-230.2
1997	-785.5	-350.8	-1,136.30	505.3	283	223	-631
1998	-799.8	-377.6	-1,177.40	622.5	299	324	-554.9
1999	-1,040.80	-426.2	-1,467.00	250.9	231	20	-1,216.20
2000	-737.4	-423.1	-1,160.50	622.5	191	432	-538
2001	-399.9	-437.2	-837.1	628.7	169	460	-208.4
2002	-511.7	-631.9	-1,143.50	205.7	159.1	47	-937.8
2003	-907	-724.4	-1,631.40	207.3	193.8	14	-1,424.10
2004	-729.2	-594	-1,323.20	282.3	260.7	22	-1,040.90
2005	-549.2	-681.6	-1,230.80	200	180	20	-1030.8
2006	-431.5	-678.8	-1,110.30	180	160	20	-930.3

Note: Negative values indicate a tax, positive values a subsidy.
Source: Asian Development Bank (2005, v. II, pp. 62-63).

Table 4.11. Uzbekistan: implicit taxation of wheat producers through state procurement prices

		2010	2011	2012	2013
1	Wheat production (1000 tons)	6,657	6,445	6,612	6,841
2	Value of output in domestic prices, bln soms	2,074	3,085	3,154	3,673
3	Value of output at international prices, bln soms				
3a	---Using official exchange rate	1,596	2,920	2,722	3,745
3b	---Using market exchange rate	2,212	4,356	3,964	5,017
4	Price gap (line 2- line 3b), bln soms	-138	-1,271	-810	-1,344
5	% due to exchange rate*	446	113	153	95
6	Nominal protection rate (NPR)**	-6%	-29%	-20%	-27%

*Using market exchange rate. A value of 100% or more indicates that the reason for the price gap lies entirely with the overvalued exchange rate. **Note: For NPR, a negative value indicates a tax on producers stemming from domestic wheat prices that are lower than international prices. A positive value indicates a subsidy for producers stemming from domestic wheat prices that are higher than international prices.
Source: Ministry of Agriculture and Water Resources of Uzbekistan of Uzbekistan (Yusupov 2014).

Turkmenistan

Previous studies of the state system for input subsidies and marketing in Turkmenistan have shown that the net effect of input subsidies and low procurement prices under the state order system has been that producers receive far less net income for their commodities than they would have if they were paid world market prices and no subsidies (Lerman and Brooks, 2001; Van Rooden, 2000). The net income losses from the state order system thus defined are often known as “implicit taxes” on the agricultural producer. Lerman and Brooks (2001) showed that state procurement prices at less than market levels for cotton exacted a tax on producers ranging from 44% to 74% of the total value of their output for the period 1996-1998. For wheat, low procurement prices exacted an implicit tax of between 44% and 70% of the total value of wheat output. These initial calculations take into account only the “tax” exacted through low procurement prices without accounting for the input subsidies offered to agricultural producers.

For this report new estimates have been made of the value of transfers from agricultural producers to the state as a result of the state procurement system for the period 2005-20013 based on Lerman et al. (2012) and Stanchin (2014). These estimates take into account both procurement prices for commodities as well as input subsidies.

In Table 4.12 line 1 is the implicit tax on sales deriving from procurement prices that are less than international market prices, the so-called "price gap," computed in a way analogous to that demonstrated n Table 4.11. Line 2 lists annual input subsidies, calculated from data on per ha input subsidies for wheat production. The sum of lines 1 and 2 is in line 3, the net tax (or subsidy) on wheat producers through the price system in bln. manats.

Lerman et al. (2012) showed that 90% of the implicit tax on wheat producers derived from the overvalued exchange rate, which was in place through 2007. Starting in 2008, there was no difference between the official and parallel market exchange rates. Table 4.12 shows that when the two exchange rates were unified taxation of wheat farmers virtually disappeared in Turkmenistan through the price system. Instead of taxation, wheat farmers have been slightly subsidized in Turkmenistan since 2009.

Table 4.12. Turkmenistan: net tax on agricultural wheat producers through the price system

		2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Tax on sales from state set prices, mln manats	-1,233	-1,739	-870	-205	-127	-228	-140	-260	-220
2	Input subsidies, mln. manats	64	63	119	203	470	464	459	463	469
3	Net tax on agricultural producers, mln. manats	-1,169	-1,675	-751	-2	343	237	319	203	249
4	Total GAO, bln manats	4.4	5.4	6.4	7.2	8.2	9.9	10.9	11.6	13.6
5	Net tax on agricultural producers, % of GAO	-26.58	-31.24	-11.78	-0.03	4.17	2.40	2.92	1.76	1.83
6	Total GDP, bln manats	25.4	21.1	25.0	49.5	57.6	64.4	83.3	100.2	110.4
7	Net tax on agricultural producers, % of GDP	-4.61	-7.92	-3.01	0.00	0.60	0.37	0.38	0.20	0.23

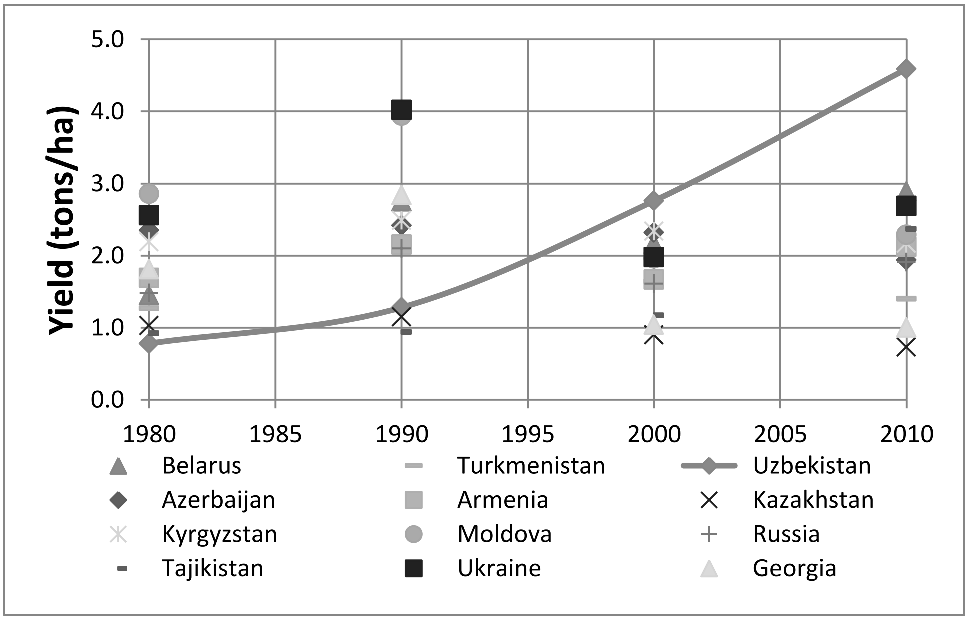
Note: For all indicators, a negative figure indicates a tax, a positive one a subsidy.
Source: Lerman et al. (2012) and Stanchin (2014).

The implications of this system for farm incentives and wheat yields

We have argued in this chapter that, though the state planning system covers only part of the wheat crop in these countries, it has an effect on the entire agricultural production system in the three countries. In Belarus, which maintained agricultural enterprises as the main source of agricultural production, wheat is only one of over ten crops subject to annual operational planning. But the introduction of planning for much of the production of agricultural enterprises affects the overall incentives of the enterprise. For planned commodities the plan is the priority, and the incentive to control costs is consequently lower. The state order system distorts the entire financial system, turning it into an accounting mechanism and plan discipline device.

In Uzbekistan wheat prices are lower than international prices. Thus, farmers are taxed. But in Turkmenistan this is no longer true. Wheat farmers there enjoy a slight subsidy. However, in both these countries we need to keep in mind the wider context. Why would farmers raise wheat and cotton if vegetables and fruits are more profitable? The answer is that without participating in the state order system farmers do not have access to land, water and inputs. So, even though wheat and cotton are not generally profitable, farmers go on raising them because this is their access to land and inputs.

Figure 4.4. Wheat yields for NIS countries, 1980-2010



Sources: CIS Interstate Statistical Committee (2013); Official statistical yearbooks for Uzbekistan (starting in 2000); USDA/PSD for Turkmenistan (starting in 1992).

With the returns to innovation so low, we can hardly expect dynamic growth of wheat yields originating at the farm level. And in fact there is little growth in wheat yields in these three countries with the exception of Uzbekistan. But in Uzbekistan yield growth did not originate at the farm level. Rather, innovation was introduced through the public research system through the introduction of new hybrid seeds (see Box 4.2).

Box 4.4 The puzzle of wheat yields in Uzbekistan

Wheat yields in Uzbekistan have shown the highest growth rate of all the NIS countries. From last place among the Soviet Republics in 1980, Uzbekistan improved wheat yields five-fold by 2010, and now has the highest average wheat yields of any NIS country (Figure 4.4). How do we explain such rapid technical change in a system where wheat production is heavily controlled by the state under the state order system and the interest of farmers in raising wheat is marginal?

Despite the uncertainties of official statistics noted in the comments on Figure 2.26, there are still reasons to believe that wheat yields have risen, though perhaps not to the extent that official statistics show. The reason for the increase lies mostly in state policies that have supported wheat production and productivity improvements through a top down process of introducing more productive and heat stress-resistant varieties. There are three important developments that have led to the increase in wheat yields. First, from a crop raised in rain fed conditions in the Soviet period wheat has been gradually shifted to irrigated land. By 2013, out of 1.5 million ha of sown area to wheat, only 13% was raised on rain fed land. This transition in itself changes the range of yields of wheat, since irrigated wheat yields are always higher than yields of wheat raised on rain fed land. Table 5.13 shows potential wheat yields according to the FAO-GAEZ database using medium inputs or high inputs. In both cases potential yields are more than double those on rain fed land.

A second factor responsible for increased yields in Uzbekistan is the change in the status of wheat from a "normal" to "strategic" crop subject to state order. This means that the set of inputs applied, including water, are "guaranteed." Wheat growers are guaranteed purchase of a package of inputs at a discounted price, and wheat fields are provided with at least 2 surge floods per season (usually 3-4), irrespective of the rainfall situation. Wheat's status as a strategic crop subject to state order also increases the attention of the government to proper crop rotation. In farms specialized in raising wheat and cotton 50% of land is sown to wheat and 50% to cotton. The next year the fields are switched, such that cotton is grown where wheat was grown the year before. Moreover, after wheat is harvested in early summer the farmer has the right to sow vegetables, maize, potatoes or feed crops in the wheat field. The growing season in Uzbekistan is long enough to allow for this second crop, which plays an important role in restoring nutrients to the soil.

A third factor responsible for higher wheat yields in Uzbekistan has been the government's attention to increasing the quality of wheat seed through a program of wheat variety development by region. All agronomic research on wheat seed breeding has been centralized under the Research Institute for Grain and Legumes on Irrigated Land (in Andijan oblast') with experimental stations in all regions of the country. The government has sought and attracted donor support on seed selection and breeding through this institute (from ADB, FAO, ICARDA, CIMMYT and bilateral donors). Initially the Uzbek Research Institute for Cereal and Legume Crops under Irrigation worked mainly with the Krasnodar Research Institute for Agriculture, and many varieties from Russia were introduced, evaluated and released. In 1999, the Institute started cooperation with international agricultural research centers such as ICARDA and CIMMYT. This collaboration has brought more than 2000 lines of grain and legume crops to the institute each year for evaluation. As of 2005, the breeders had submitted nine varieties of bread and durum wheat and three varieties of legume crops to the State Variety Testing Committee (SVTC) for official testing. Most of these new varieties were resistant to diseases, an important trait preferred by farmers (FAO, 2005).

The state also supports the introduction of new varieties into cultivation by farmers through its agents. The primary source of new seed varieties is the Research Institute for Grain and Legumes on irrigated land, which tests new varieties in its experimental stations around the country. After new seed varieties clear official testing in the State Variety Testing Committee, the state company "Uzkhleboprodukt," responsible for distribution of new seed varieties, announces a tender to raise elite and super elite seeds for the government. The farmer receives a much better price for raising these seeds, from 150 to 210% of the normal procurement price. At such prices farmers are keen to become seed breeders for government procurement. Uzkhleboprodukt then introduces new seed varieties into the packages that farmers purchase at discounted prices each year.

Source: Yusupov (2014).

The poor performance of wheat yields compared to potential is typical of the NIS countries (Table 4.13, last column). At 36% and 27% of potential yields, Belarus and Turkmenistan have shown more or less average performance for the NIS countries when measured against potential yields. Uzbekistan, however, stands out as having the best performance of all NIS countries compared to potential yields, surpassing even Australia and Turkey, two non-NIS producers with arid climates.

Table 4.13. Potential and actual wheat yields in selected countries, 1961-90, tons/ha

Country	Medium input		High input		Actual yields (ave)		Ratio (%)
	Rain fed	Irrigated	Rain fed	Irrigated	1961-90	2010-12	Actual/ Potential
Armenia	4.90	5.84	7.52	9.31	1.58	2.53	27
Australia	2.50	4.21	3.73	6.57	1.30	1.94	52
Azerbaijan	4.55	6.04	6.90	9.62	1.73	2.33	24
Belarus	**5.74**	**5.74**	**9.14**	**9.14**	**1.94**	**3.26**	**36**
China	3.37	5.31	5.30	6.86	1.80	4.86	71
France	5.68	5.76	8.89	9.11	4.46	6.74	76
Georgia	5.42	5.44	8.59	8.65	1.65	1.61	19
Germany	5.86	5.87	9.25	9.34	4.57	7.22	78
Hungary	6.37	6.74	9.72	10.72	3.53	3.81	39
Kazakhstan	1.57	4.29	2.47	7.03	0.87	1.06	43
Kyrgyzstan	3.06	5.21	4.70	8.35	1.99	2.00	24
Moldova	6.02	6.77	9.05	10.77	2.90	2.17	24
Russian Fed.	2.75	3.16	4.40	5.22	1.41	1.99	45
Tajikistan	3.53	5.53	5.43	8.81	0.84	2.61	30
Turkey	4.54	6.78	6.90	10.76	1.56	2.60	38
Turkmenistan	**1.56**	**5.13**	**2.47**	**8.18**	**1.26**	**2.19**	**27**
Ukraine	5.57	6.40	8.56	10.18	2.71	2.94	34
United States	4.18	5.78	6.48	9.19	2.13	3.06	47
Uzbekistan	**2.45**	**5.13**	**3.83**	**8.18**	**0.72**	**4.71**	**58**

Note: Ratio of actual to potential uses 2010-12 actual and hi input rain fed potential, except for countries in which arable land equipped for irrigation is 60% or higher (Armenia, Azerbaijan, China, Georgia, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), where 2010-12 actual is compared with hi input irrigated.
Source: GAEZ (2015), FAOSTAT (2014).

5. Wheat Supply Medium Term Outlook: Resource and Labor Constraints

In Chapter V we consider the main natural resource and labor constraints relevant to wheat production in Uzbekistan, Turkmenistan and Belarus and their implications for wheat production. The main concern in this chapter is with the two Central Asian countries, because wheat production there is far more constrained by such factors than in Belarus. This pertains particularly to climate, land and water resource constraints, from which Belarus does not seem to suffer, at least in the short to medium run.

However, there are two important caveats to how natural resource constraints can be expected to limit wheat production in Central Asia. The first concerns the timing and the net effects of climate change. Climate change is not anticipated to have a significant deleterious effect on water flows in Central Asia until after mid-century. Therefore, our wheat production projections to 2024 do not capture the effects of climate change. Even after mid-century, though, losses in water flow may be compensated by the carbon dioxide fertilization effect (see Table 5.3). In short, the effects of climate change, even after 2050, are considerably more ambiguous than commonly believed.

The second caveat is that natural resource constraints can be partially compensated for through policies aimed at yield growth, more robust varieties, and better incentives at the farm level. This caveat is particularly relevant to Uzbekistan, the only country of the three that has shown the capacity to produce sustainable yield growth in wheat.

At the end of Chapter V the net effect of both policy and natural resource constraints on wheat production are considered through 2024 and production projections are provided and discussed.

Climate and climate change

Turkmenistan and Uzbekistan have perhaps the most difficult climates of all countries in Eurasia over much of their territory. A substantial portion of territory of the two Central Asian countries is not suitable for wheat cultivation or very marginal, according to the FAO GAEZ database (GAEZ 2015).[16] A survey of the leading wheat producing countries shows that Turkmenistan, and Uzbekistan (as well as Kazakhstan) rank the lowest in the portion of land suitable or very suitable for cultivation of wheat under a range of cultivation regimes (Table 5.1). In these countries, essentially no land is suitable for cultivation of wheat under any cultivation regime, including on irrigated land.

Belarus, on the other hand, has a plethora of land suitable for cultivation of wheat. Over 60% of land in Belarus is potentially suitable or very suitable for growing wheat under a high or medium input regime (Table 5.1).

[16] GAEZ is an acronym for Global Agro-Ecological Zones, a data-mapping program that combines geo-referenced global climate, soil and terrain data into a land resources database. For details see GAEZ (2015).

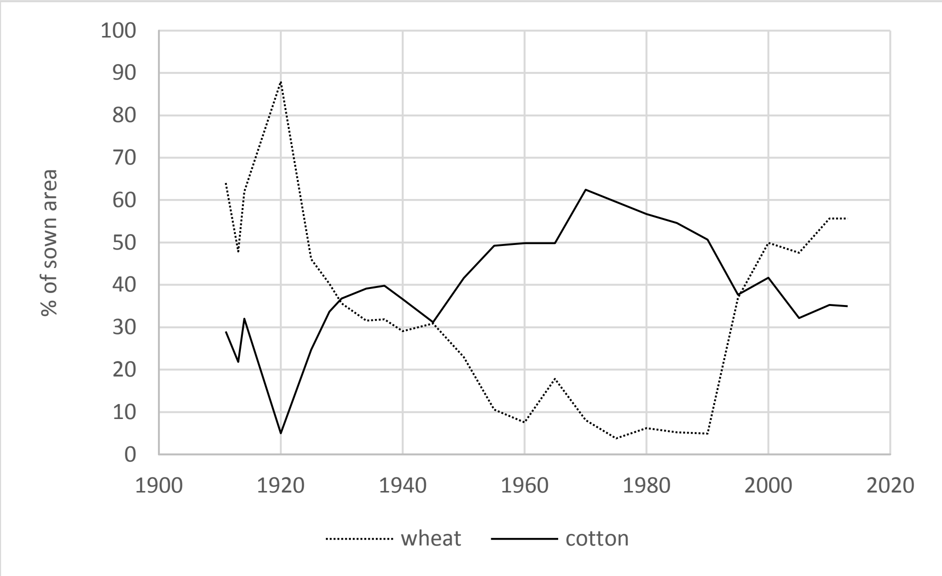
Despite the forbidding climatic conditions of Central Asia, wheat has been raised in Turkmenistan and Uzbekistan for many hundreds of years. In fact, in Turkmenistan in 1911 64% of sown land was devoted to wheat. Only during the Soviet period, when central planning guaranteed wheat imports covering 80% of domestic use, did these countries raise minimal quantities of wheat, which allowed them to raise more cotton and feed crops (Figure 5.1). Thus, with the dissolution of the Soviet Empire, Turkmenistan and Uzbekistan resumed the pattern of sowing that characterized the pre-Soviet period with 50-60% of sown area in wheat.

Table 5.1. Portion of land suitable or very suitable for cultivation of wheat under various cultivation regimes in selected countries (%), using average 1961-1990 climate conditions

Country	**Rain Fed Wheat Cultivation**			**Irrigated Cultivation**
	Hi-input regime	**Med-input regime**	**Low-input regime**	
Uruguay	73.7	77.1	46.6	74.9
Belarus	61.4	63.9	49.7	51.8
Hungary	41.5	54.2	56.7	48.0
Germany	39.1	48.4	43.2	44.5
France	33.6	44.3	39.9	39.0
Ukraine	29.1	36.8	36.3	31.6
United States	17.9	21.8	16.6	17.7
Rep. of Moldova	4.4	20.4	37.4	18.7
Georgia	10.2	17.6	19.6	15.9
Turkey	3.8	7.2	10.8	5.6
Russian Federation	4.5	6.7	5.2	5.9
Azerbaijan	2.5	5.5	8.4	4.2
China	3.1	3.8	2.7	2.0
Australia	1.8	2.6	2.6	2.4
Canada	2.1	2.4	1.7	1.4
Tajikistan	0.5	0.7	1.2	0.5
Kyrgyzstan	0.1	0.4	0.5	0.0
Uzbekistan	0.1	0.1	0.1	0.1
Kazakhstan	0.0	0.0	0.0	0.0
Turkmenistan	0.0	0.0	0.0	0.0

Source: GAEZ (2015). The model uses a crop suitability index. The crop suitability index (SI) reflects the suitability levels and distributions within grid cells by classes based on SI values between 0 and 100.

Figure 5.1. Shares of wheat and cotton in sown area in Turkmenistan, 1911-2013, %



Source: Stanchin (2014).

According to the Intergovernmental Panel on Climate Change (IPCC), an international body for assessing the science related to climate change, the global mean temperature increased by 0.8 degree C between 1880 and 2012 (IPCC, 2013). The change in the average surface temperature of the earth has led to observable changes in climate. By 2100 the average temperature is expected to rise by 2% above the pre-industrial level across Europe and Central Asia regardless of what mitigation efforts are undertaken (World Bank, 2009) and there is a 40% chance of surface temperatures rising to 4 degrees above the pre-industrial baseline (World Bank, 2014). Analysts accordingly speak of 2-degree and 4-degree climate change scenarios.

World Bank (2014) illustrated the projected effects of temperature rises on climate by analyzing several impact studies. The results of these impact studies by warming levels are displayed in Tables 5.2 and 5.3. We can divide the effects broadly into (1) first order global-warming effects (Table 5.2) and (2) second order effects on glaciers, water availability and agriculture (Table 5.3). Table 5.2 indicates that there is a great deal of uncertainty in the first order effects of increased temperatures beyond a noticeable increase in temperature extremes across all of Europe and Central Asia. The land area subject to temperature extremes increases dramatically by 2100 as projected temperatures increase. However, surprisingly, the impact of climate change on Central Asia includes a 20% increase in precipitation under a 2-degree scenario, while a 4-degree scenario includes a decrease of 10% in western parts of Central Asia (Turkmenistan and parts of Kazakhstan) and an increase in precipitation in the east (Kyrgyzstan and parts of Kazakhstan).

Table 5.2. First-Order Impacts of Climate Change related to Turkmenistan and Uzbekistan

Risk/Impact	**Observed vulnerability or change (now)**	**Temperature increase around 2 degrees**	**Temperature increase 4 degrees and above**
Heat Extremes			
---Highly unusual heat extremes		15% of ECA land area, much of which in CA	85% of ECA land area, much of which in CA
---Unprecedented heat extremes		Nearly absent	55% of ECA land area, much of which in CA
Precipitation		20% increase	10% decrease to 10% increase in (west to east)
Drought			Uncertain
Aridity		Uncertain	Uncertain in the northern parts, up to 60% increase in the West and up to 60% decrease in aridity in the East

Source: World Bank (2014).

A more definite picture of the important effects of climate change are shown in Table 5.3, where the important issues of shrinking glaciers and their effects on runoff into rivers are described. A rise in global temperatures to 2 degrees above pre-industrial levels and more will, according to impact studies, reduce the volume of Central Asian glaciers in Tajikistan and Kyrgyzstan by 50% to 78% by 2100. This effect is very important for Turkmenistan and Uzbekistan, the two downriver countries in Central Asia. Turkmenistan and Uzbekistan receive 97% and 79% of their total water supply from surface water (FAO, 2014a and b). For both these countries, the main source of water is the Amu Darya River, which originates in the snow-covered mountains and glaciers of Tajikistan. Most of the Amu Darya flow is withdrawn by Turkmenistan and Uzbekistan along their common border (Stanchin and Lerman, 2010). Uzbekistan's main source of water, in addition to Amu Darya, is the Syr Darya River, which originates in the high mountains of Kyrgyzstan.

According to impact studies, the shrinking of Central Asian glaciers in Tajikistan and Kyrgyzstan may have one positive effect and two detrimental effects on the downriver countries of Turkmenistan and Uzbekistan. First, with increased melting of glaciers under the 2- and 4-degree scenarios, river flows in the Syr Darya and Amu Darya basins will probably increase in the medium term, by mid-century (World Bank, 2014). Second, as temperatures in the winter and spring warm up, river flow will shift from spring and summer to winter and spring (as is already observed for the Zeravshan River – see Table 5.3). This change may have detrimental effects on crops, because irrigation water is required not in winter and spring, but in summer. Third, as glaciers continue to shrink under the 2- and 4-degree scenarios, the runoff into rivers will eventually decline, leading to a net loss of water availability in downstream countries. It is estimated that reduced contribution of glacier melt could reduce flows in the Amu Darya basin by 5%-15% by 2085 and in the driest years this could be as much as 35% of current discharge. This worst-case scenario would mean that in extremely dry years it may only be possible to meet half of current demand for water (FAO, 2013). Though there is a high degree of uncertainty in these projections, responsible governments can ill afford to ignore them.

Table 5.3. Second-Order Impacts of Climate Change related to Turkmenistan and Uzbekistan

Risk/Impact	Observed vulnerability or change (now)	Temperature increase around 2 degrees	Temperature increase 4 degrees and above
Glaciers in CA	11% volume loss between 1980 and 2011, 3–14% reduction in area since 1960s. 35.5% of glacier volume loss between 1901–2000	About 50% (31–66%) of glacier volume loss, 31% mass loss in Syr Darya basin. 41% drop in annual runoff per year.	50–78% of glacial volume shrinkage
Water Availability, runoff from melting snow, ice and glaciers	Zeravshan River (major tributary of Amu Darya rising in Tajikistan): shift from summer to spring and winter.	In Syr Darya basin, shifts of 30–60 days from the current spring/early summer toward a late winter/ early spring runoff regime.	Very significant decline of runoff formation in the mountainous areas of Central Asia.
Crop Growing Areas and Food Production	Severe droughts in 2000/2001 leading to $50 million loss in Uzbekistan.	10–15% reduced runoff in the Amu Darya river, putting pressure on irrigation systems and crop production; increased degradation of soils. Water deficits during the vegetation period in the Fergana Valley.	
Yields			
---All crops		20–50% yield loss in Uzbekistan due to heat and water stress. 10–25% lower yields in Uzbekistan due to decreasing runoff in the Syr Darya River and increased water use competition.	
---Wheat		12% average wheat yield increase.* Up to 57% reduced yields in spring wheat and up to 43% reduced yields in winter wheat in Uzbekistan.**	

*Without changes in irrigation water availability, but with CO_2 fertilization effect (Sommer et al., 2013).
**Without CO_2 fertilization (Sutton et al. 2013).
Source: World Bank (2014).

The effects of climate change of the type outlined here on yields are more uncertain than one would think. The reason is that there are many competing effects on crop yields of the temperature and CO2 concentration increases. On the one hand, increases in temperature and shortages of irrigation water will cause increased heat and water stress on crops. This effect should lead to a decrease in yields unless improvements in irrigation or crop inputs are achieved. In Table 5.3 this effect is responsible for the entries under “all crop” yields. However, with an increase in the concentration of CO2 in the air certain crops are able to access this extra CO2 during photosynthesis to increase their yields. This “carbon fertilization effect” (CFE) is relevant to wheat, as it is to potatoes. In addition, if winter and spring temperatures rise, there will be less frost damage to wheat in the early spring. Thus, under the 2-degree increase scenario we find vastly different conclusions regarding the effects of climate change on wheat in Central Asia. While Sommer, et al. (2013) project increases in wheat yields throughout the region of 12%, Sutton, et al. (2013) project significantly reduced yields of spring and winter wheat in Uzbekistan. Sommer et al. (2013) argued that irrigation water demand does not necessarily increase under the influence of climate change. Instead, they believe that yield increases are a consequence of higher winter and spring temperatures, less frost damage and CO_2 fertilization. In short, the effects of climate change on wheat yields in Turkmenistan and Uzbekistan are highly uncertain.

Overall assessment of vulnerability to climate change by multiple indices establishes that, within the Europe and Central Asian region, Tajikistan, Uzbekistan and the Kyrgyz Republic are ranked as the three most vulnerable countries to climate change, while Turkmenistan is ranked no. 7 out of 28 countries (World Bank, 2009). Belarus is ranked as the seventh least vulnerable country to climate change among the 28 countries of Europe and Central Asia.

Land issues

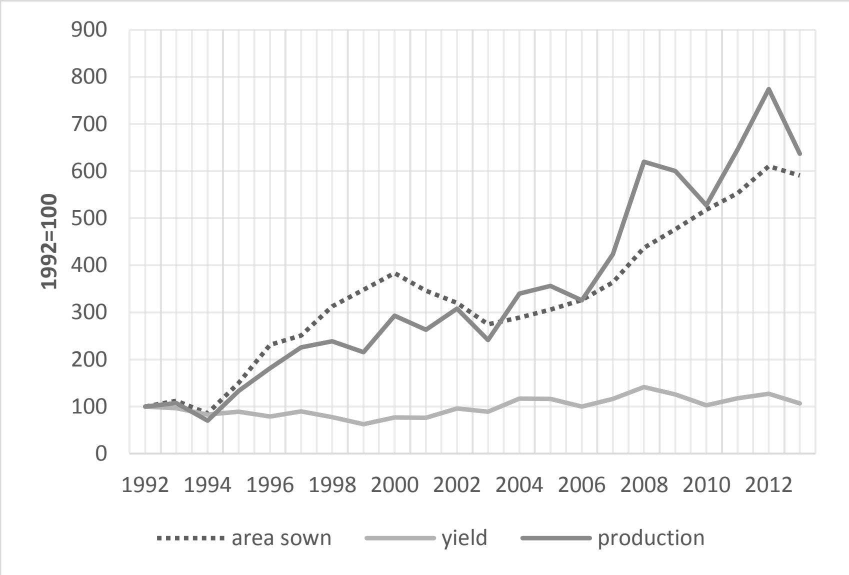
In many NIS countries, the overall quantity of land is not an important constraint on production. For instance, in Ukraine, Belarus and Russia large areas of marginal land have fallen into disuse after being abandoned. These lands may be brought back into production, if needed, albeit at a higher cost of production. However, the Central Asian countries of Turkmenistan and Uzbekistan are different. In these countries, the pressure on land resources is extremely high. This can be seen by comparing the arable land per person in rural areas in these two countries with other countries in Table 2.1. The four Central Asian countries (excluding Kazakhstan) provide only 0.5 ha or less per person, while in Belarus, Russia and Ukraine, rural residents have access to 2.1 to 3.0 ha per person. In Central Asia, arable land makes up a mere 4% (Turkmenistan) to 28% (Kyrgyzstan) of agricultural land (the rest being arid pastures), while in Belarus, Russia and Ukraine 60% to 84% of total agricultural land is arable.

However, if we focus on a single commodity, land may be a severe constraint on production, because production increases can only be achieved through increases in sown land or in yields. If yields are stagnant, land is a key constraint on production. Moreover, in the two Central Asian countries covered here the land constraint is always combined with the water constraint. All wheat must be irrigated in Uzbekistan and Turkmenistan. It is virtually not possible, and definitely not profitable, to grow wheat on non-irrigated land.

Therefore, when considering land as a constraint on wheat production, we must first look at the behavior of yields. If yields are stagnant, then any increases in production will need to come from area increases. In this case, in Central Asia it should be kept in mind that any increase in irrigated land in wheat must come out of irrigated land in another crop, such as cotton. Even Turkmenistan, which increased its total area of irrigated land up to 2004, now has stopped expanding area of irrigated land.

There is a cardinal difference in the way Belarus and Turkmenistan have achieved increases in wheat production compared to Uzbekistan. In Belarus and Turkmenistan wheat yields have remained stagnant for over twenty years, while in Uzbekistan yields have tripled over the same time (Figures 5.2, 5.3, 5.4). While the rate of wheat yield increases in Uzbekistan has slowed over time, Uzbekistan seems to have a far more viable system for yield growth than the other two countries (Box 4.2).

Figure 5.2. Belarus: Changes in wheat area, production and yield, 1992=100

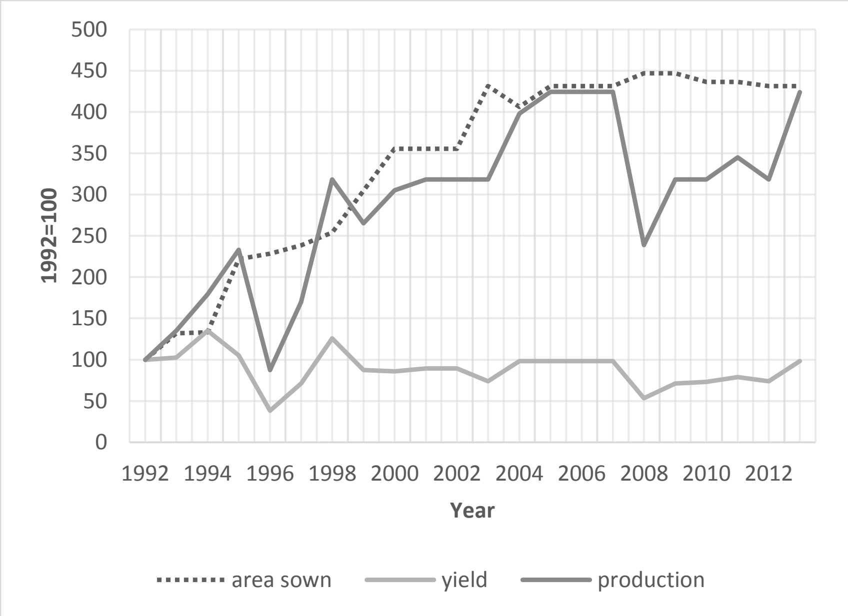


Source: Official statistical yearbooks, Belarus (various years).

Figure 5.3. Uzbekistan: Changes in wheat area, production and yield, 1992=100

Source: Official statistical yearbooks, Uzbekistan (various years).

Figure 5.4. Turkmenistan: Changes in wheat area, production and yield, 1992=100



Source: USDA/PSD (2014).

The differences in yield performance have critical consequences for wheat production projections. In the absence of changes in the farming system in Belarus and Turkmenistan, any increases in wheat production are likely to come from increased sown area, rather than from yield increases. In Belarus this is not so much a problem, because suitable land is plentiful. About 35% of sown land in Belarus is planted with non-wheat cereals and legumes, which can be switched to wheat cultivation if necessary (Table 2.3). Rye and oats cultivation in Belarus, though traditional, probably bring lower returns than wheat (Figure 2.25). Therefore, there may be good reasons for increasing area in wheat. In Turkmenistan, however, it is far more costly to increase land in wheat for the simple reason that there are currently only two main sources for additional irrigated land—either take it out of cotton or high-value crop cultivation or expand the area of irrigated land (Figure 2.15). Both of these alternatives are quite expensive.[17] In Uzbekistan any slowing of wheat yield growth can be compensated by slight increases in sown area. Thus, the prospects for wheat production growth in Uzbekistan seem much better than in Turkmenistan.

Water resources and irrigation

Water resources are not a serious constraint on Belarusian agriculture, but they are an important constraint in Central Asia. While Belarus uses a mere 3% of its annual total actual renewable water resources, Turkmenistan uses 111% and Uzbekistan 101% (Table 5.4, line 3a). This implies a tremendous stress on water resources in the two Central Asian countries.

[17] A rough calculation of the gross returns from cotton lint production at international prices per ha. in 2013 was $1156 per ha (= international price of cotton lint per ton*lint yield in Turkmenistan from one ha.) (=$1993/MT*0.58 MT/ha.). The gross return to (soft) wheat per ha. at international prices was only $456 per ha. (=$268/MT*1.7 MT/ha.). The cotton price is from IMF (2014a), the wheat price from USDA/ERS (2014), while yields are from USDA/PSD (2014).

Agriculture is directly responsible for this stress, since it uses 94% of water in Turkmenistan and 90% in Uzbekistan (Table 5.4, line 2a).

Table 5.4. Annual water resources and withdrawal in Belarus, Turkmenistan, and Uzbekistan, cubic km

		Turkmenistan	Uzbekistan	Belarus
1	**Renewable water resources (total actual)**	24.765	48.87	58.0
a	--from ground water*	0.405	6.8	0
b	--from surface water	24.36	42.07	58.0
c	----of which, from internal sources	1.0	9.54	37.2
d	----of which, from external sources	23.36	32.53	20.8
2	**Withdrawal**	27.958	56.0	2.7
a	--Agriculture	26.364	50.4	0.567
b	--Municipal	0.755	4.1	0.972
c	--Industry	0.839	1.5	1.161
3	**Note: Surface and groundwater withdrawal**	27.542	49.160	2.7**
a	% of total actual renewable water resources	111	101	5

*Net of groundwater drained by surface water network; **total withdrawal.
Source: FAO Aquastat Country Profile (1997, 2014a, 2014b).

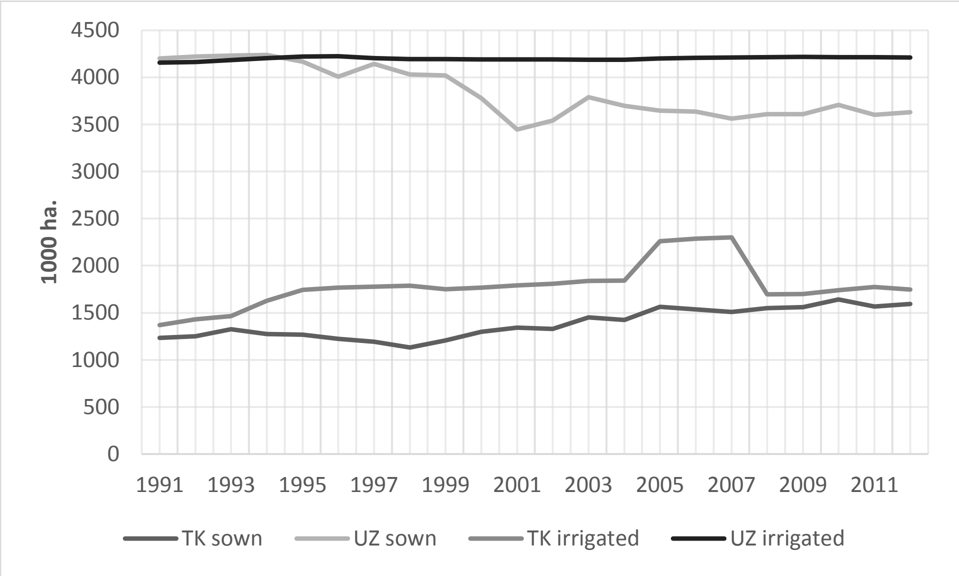
Another key characteristic of water use in Turkmenistan and Uzbekistan is that, being downriver countries, their dependence on river water flow from other countries is very high. Fully 94% of water use in Turkmenistan is drained from rivers that originate abroad, the largest of which is the Amu Darya River from Tajikistan (Table 5.4, line 1d/line 1). Uzbekistan receives 67% of its renewable water resources from abroad, primarily through the Amu Darya and Syr Darya rivers from Tajikistan (through Turkmenistan) and Kyrgyzstan (Table 5.4, line 1d/1).

There are a number of formal agreements between upstream and downstream countries that allot water flow along the rivers of Central Asia (FAO, 2014a, 2014b). The main agreement was signed in 1992 between all five Central Asian states in Almaty, where it was agreed to keep the water use quotas from the Soviet era in place. The 1995 Nukus Conference Resolution, signed by the five Central Asian countries, ratified these Soviet-era water allocations. By and large these agreements have worked reasonably well to avoid conflict in the region over water allocation.

Irrigation in Uzbekistan and Turkmenistan

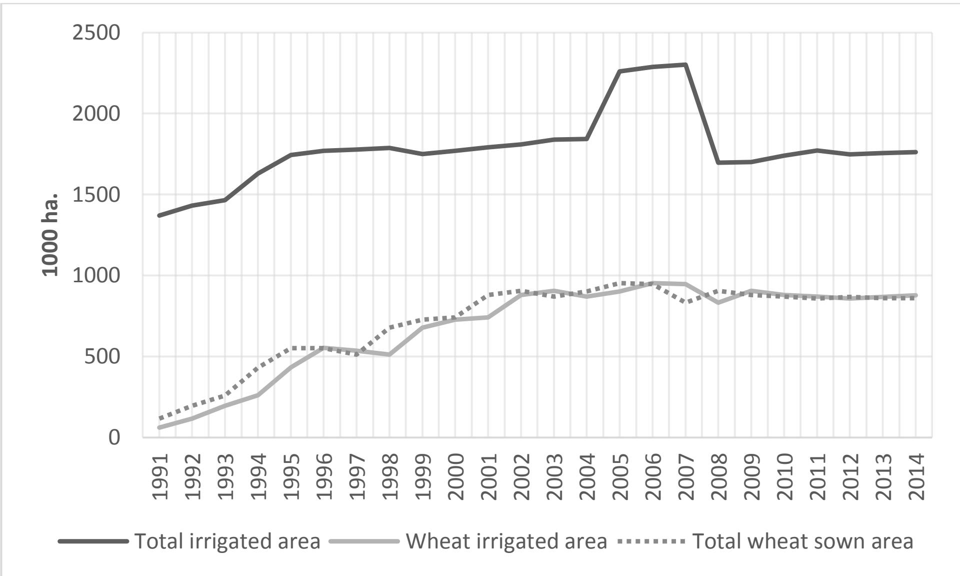
Most cultivation is irrigated in Uzbekistan and Turkmenistan, and, given the difference in yields that irrigation affords, the irrigation system in working order is most likely used to its fullest extent. However, not all areas equipped for irrigation are always utilized for lack of water resources. That is, the area equipped for irrigation generally exceeds the total area of crops sown (Figure 5.5). In Uzbekistan, for example, irrigation water no longer is able to reach the smaller tributaries of the irrigation system. Therefore, in 2005 only 88% of the area equipped for irrigation in Uzbekistan was actually irrigated (FAO, 2013). In Turkmenistan all area sown to wheat is irrigated (Figure 5.6), while in Uzbekistan over 80% of wheat area is irrigated (Yusupov, 2014).

Figure 5.5. Uzbekistan (UZ) and Turkmenistan (TK): Area equipped for irrigation and total sown area, 1000 ha.



Source: Official statistical yearbooks; Turkmenistan sown area from USDA/PSD (2014). The irrigated area hump in Turkmenistan is probably a result of the “wheat inflation” statistics issue of that period. The “wheat inflation” is taken out of the sown area series in Turkmenistan.

Figure 5.6. Turkmenistan: Total irrigated area and wheat, 1000 ha.



Source: Official statistical yearbooks; wheat sown area from USDA/PSD (2014). The irrigated area hump in Turkmenistan is probably a result of the “wheat inflation” statistical issue of that period. The “wheat inflation” is taken out of the sown area series in Turkmenistan.

Both supply and demand for irrigation water are causes for concern for they both may raise threats to crop production in the future. On the supply side, we have already noted in the section on climate change (Table 5.3) that in the second half of the twenty first century the supply of renewable surface water may diminish by 5% to 15% in the Amu Darya (FAO, 2013) due to glacier melt. Another issue of supply is the risk to downstream countries of relying on water supplies sourced from other countries (Table 5.4). To address this issue Uzbekistan has constructed over 20 water reservoirs since independence. Whereas in 1991 Uzbekistan had 47 water reservoirs, it now has 70. While most of these reservoirs are small to medium sized, they are still large enough to store an amount of water equal to the annual inflow from the Amu Darya and the Syr Darya into the Aral Sea. The reason why Uzbekistan has pursued this policy of stockpiling water is a fear that the construction of hydroelectric dams in Tajikistan (Rogun) and Kyrgyzstan (Kambaratin) will lead to a loss of water flow for irrigation (Yusupov, 2014).

A third supply issue is the large capital outlays required for maintenance of the current off-farm and on-farm irrigation system. Irrigation in Uzbekistan and Turkmenistan relies on a system of pumps and canals, which is among the most complex in the world. In Uzbekistan in 1994, about 1500 electric pumps lifted water to irrigate 1.17 million ha. The total length of the irrigation network in Uzbekistan is about 196,000 km. The main canals and inter-farm network extend for about 28,000 km, of which only 33% is lined. The on-farm network is about 168,000 km. In Turkmenistan, 79% of canals are unlined earthen canals, 19% are made of concrete and 2% use pipes. The total length of inter-farm irrigation canals is more than 8,000 km, out of which around 94% are earthen canals and about 6% concrete-lined canals. The total length of on-farm canals is more than 34,000 km, of which around 83% are earthen canals (FAO, 2013).

However, these supply issues are arguably less important than the key issue of water demand. The irrigation delivery systems of Central Asia are immensely inefficient (Lerman, Garcia-Garcia and Wichelns, 1996). Estimates of water losses from the source to the field range to 50% and more. Much of this occurs in the main, inter-farm and intra-farm canals on the way to the fields, since most are made of bare dirt and sand without plastic liners or concrete (see above). But most water losses apparently occur in the on-farm delivery networks. Water use and farm management surveys indicate an average of 21% and up to 37% of the total water supplied to farm is wasted in the fields (UN, 2004).

To understand this figure it is important to understand the flood irrigation method used on nearly 100% of irrigated land in Turkmenistan and Uzbekistan (FAO, 2013). In flood irrigation, water is pumped to the fields and allowed to flow along the ground in furrows among the crops. This method is simple and cheap, but about one-half of the water used ends up not getting to the crops. Water loss occurs through a variety of causes, such as evaporation from the water surface, deep percolation to soil layers underneath unlined canals, seepage through, overtopping or breaking through the canal bunds (the small hills of dirt that surround the flooded area), runoff into the drain and runoff through rat holes in the bund. According to a water use and farm management survey for irrigation in Central Asian from 1999, a major reason for water loss is failure to level the furrows, so that water flows too fast through the crops without seeping into the soil (Tacis, 1999).

Though governments in Central Asia have committed themselves to addressing the demand side issues of irrigation water use, 20 years after independence 100% of irrigation in Uzbekistan and Turkmenistan uses the same wasteful methods as under the Soviet system. If the (distant and uncertain) risks of climate change promise a possible diminished river flow of between 5% to 15% and perhaps 35% per year after 2085, the field irrigation techniques currently in use in Turkmenistan and Uzbekistan waste up to 50% of irrigation water right now. Merely leveling the fields could save much of this water, and the installation of drip irrigation lines could reduce water loss by up to 25% compared to flooded furrow irrigation.

Soil damage from irrigation: salinization and waterlogging

A byproduct of extensive use of flood furrow irrigation is soil salinization. Salinization refers to a build-up of salts in soil, eventually reaching toxic levels for plants. Salinization decreases the osmotic potential of the soil so that plants are unable to absorb water from it. Soil salinization is a result of the application of large quantities of water to the soil, as in cases of irrigation, and the evaporation of water from the soil surface, leaving the salts behind. Salinization is particularly common on arid, irrigated land where there is little rainfall, because rainwater tends to “flush out” the salts from the soil. Salinization is especially likely to become a problem on poorly drained soils when the groundwater is within 3 meters or less of the surface (depending on the soil type). In such cases, water rises to the surface by capillary action, rather than percolating down through the entire soil profile, and then evaporates from the soil surface. The accumulation of salt degrades the soil, inhibiting and finally stopping crop growth (FAO, 2013). Figures on area of soil salinization as a result of irrigation are available for the five countries of Central Asia (Table 5.5).

Table 5.5. Soil salinization in Central Asia

Country	Year	Area equipped for irrigation (ha)	Area salinized by irrigation (ha)	% salinization
Kazakhstan	2010	2,065,900	404,300	20
Kyrgyzstan	2005	1,021,400	49,503	5
Tajikistan	2009	742,051	23,235	3
Turkmenistan	2002	1,990,800	1,353,744	68
Uzbekistan	1994	4,198,000	2,141,000	51

Source: FAO (2013).

Another problem associated with excessive irrigation on poorly drained soils is waterlogging. This occurs in poorly drained soils where water is unable to penetrate deeply or on land areas that are poorly drained topographically. Irrigation water (and/or seepage from unlined canals) eventually raises the water table in the ground from beneath. The raised water table results in the soils becoming waterlogged. When soils are waterlogged, air spaces in the soil are filled with water, and plant roots essentially suffocate.

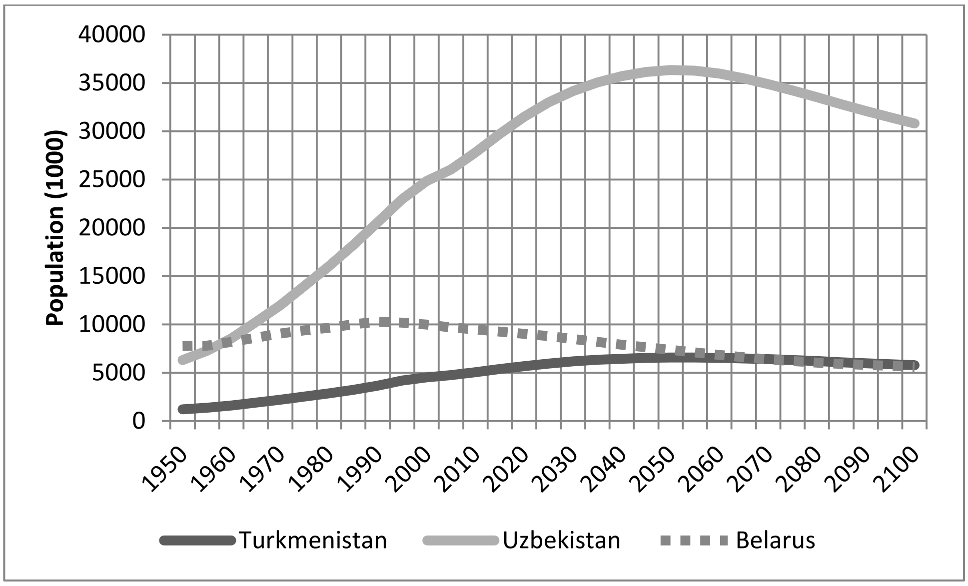
The rehabilitation of land following salinization requires flushing the soil with lots of water. However, this results in salinization of the river and groundwater where the flush water goes. The Amu Darya in Turkmenistan is highly salinized for this reason. The intensity of irrigation in Central Asia, particularly in Turkmenistan and Uzbekistan, requires artificial drainage to carry away the salinized water and, ideally, to filter out the salt content before returning the water to the surface. However, the drainage system in place is entirely insufficient to achieve this goal. Currently there are about 5.35 million ha of land with drainage in Central Asia, of which about 59.6% is surface, 26.2% subsurface and 14.2% vertical drainage (tube-wells).

Uzbekistan has the highest area of artificially drained land, approximately 1 million ha (FAO, 2013). Deep subsurface drainage canals are believed essential to control waterlogging and salinity. However, the construction of drainage canals has lagged far behind construction of new irrigation facilities in Turkmenistan (Stanchin and Lerman, 2010). For these reasons salinization of soils continues. Stanchin and Lerman (2010) reported that, in 2004, 73% of land in Turkmenistan was salinized.

Rural population and agricultural employment

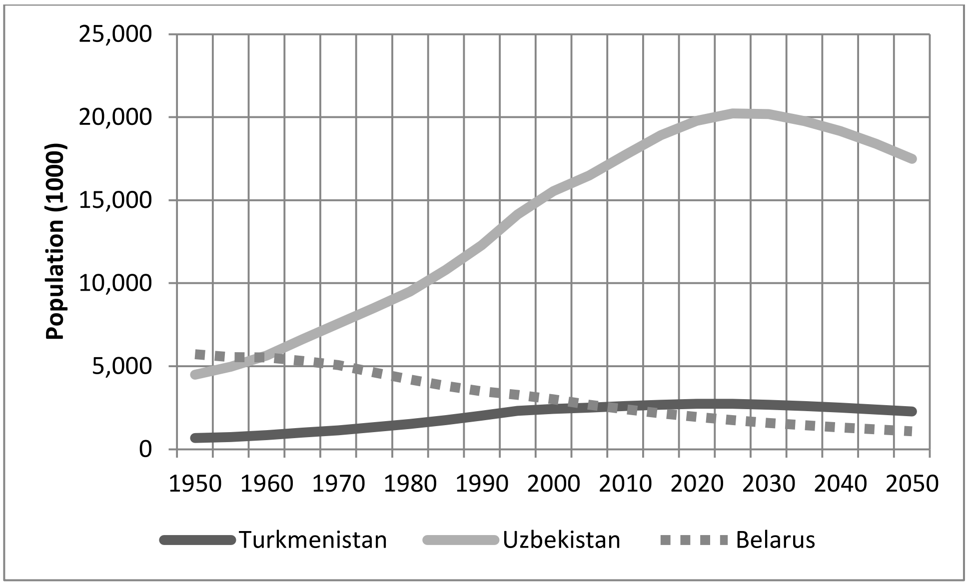
Population trends in Belarus and Central Asian countries are very different. The total population of Belarus peaked in 1990 and both the total and the rural population have been declining at a rate of 0.4% and 1.8% per year since then (1990-2010). Both are projected to continue this decline through the end of the century (Figure 5.7). Population in Turkmenistan and Uzbekistan is projected to grow through 2050, declining gradually thereafter to the end of the century. Rural population in these two Central Asian countries is projected to grow through 2025 (Figure 5.8). The combination of overall and rural population trends means that by 2050 Turkmenistan will be the most urbanized country in Central Asia with 65.5% of the total population living in urban areas. Only 52% of the Uzbek population will live in urban areas by 2050, while in Belarus over 85% of the population will live there.

Figure 5.7. Turkmenistan, Uzbekistan and Belarus: total population trends, 1950-2100



Source: UN Population Division (2013).

Figure 5.8. Turkmenistan, Uzbekistan and Belarus: rural population trends, 1950-2050



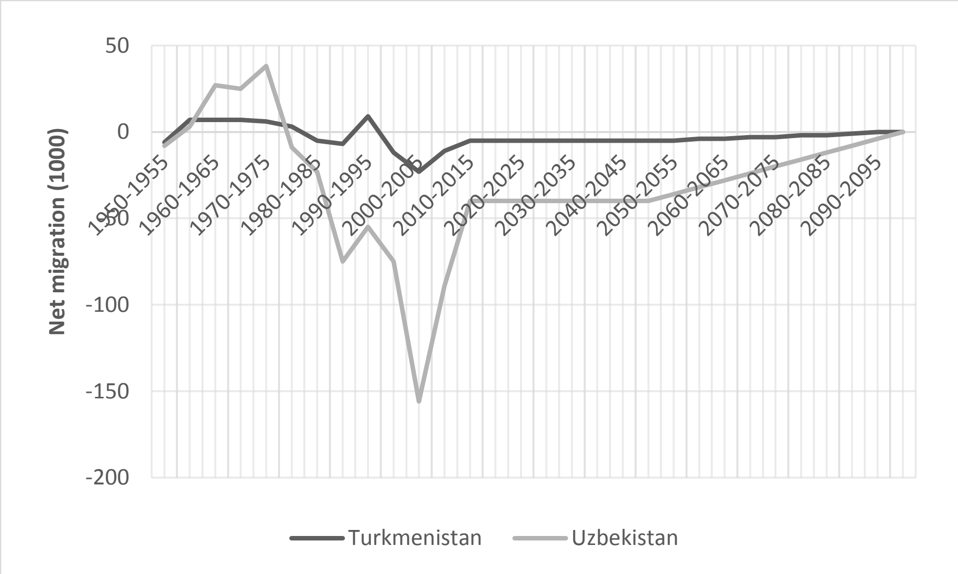
Source: UN Population Division (2014).

Falling population in Belarus is unlikely to constrain production of wheat, since wheat and most other crops are raised in large mechanized corporate farms requiring very little labor. Likewise, growing population can hardly be considered a constraint on growth on wheat production in Central Asia.

The greater possible problem from growing population is the stress it exerts on land and water in the region. Figures 5.7 and 5.8 indicate that there will be no diminishment in population pressure on land and water in the Central Asian states through 2050. Indeed, the populations of Turkmenistan and Uzbekistan are currently growing at between 1.2% and 1.4% per year and will continue growing at over 1% per year through 2020. Because these countries have explicit policies of wheat self-sufficiency, the pressure on wheat production will continue as well, though with increasing incomes the mix of wheat demand changes over time from predominantly wheat for food consumption to more wheat raised for animal feed (Figures 3.10, 3.11 and 3.12).

The continued pressure of high population growth on land, water and the economies in Central Asian countries has led to significant net outmigration (Figure 5.9). Outmigration is projected to continue through 2050, slowing only after population growth slows. Some 150 thousand people emigrated from Uzbekistan between 2000 and 2005, mostly to Russia. This outmigration is projected to continue, slowing only with the end of population growth in 2050.

Figure 5.9. Net migration from Turkmenistan and Uzbekistan, 1950-2100



Source: UN Population Division (2013).

Still, outmigration from Uzbekistan and Turkmenistan are the lowest of the Central Asian countries save Kazakhstan, and only a fraction of net outmigration from Kyrgyzstan and Moldova, the two leaders in terms of the rate of migration per 1,000 population (Table 5.6). Moreover, the size of remittances in Turkmenistan is tiny compared to those received in Tajikistan, Kyrgyzstan and Moldova, where remittances were equal to 25%-42% of GDP in 2013 (Table 5.7).

Table 5.6. Net migration rate (per 1,000 population) from selected NIS countries, 1990-2050

Year	Belarus	Kazakhstan	Kyrgyzstan	Moldova	Tajikistan	Turkmenistan	Uzbekistan
1990-1995	-1.2	-19.1	-12.1	-6.1	-10.4	2.2	-2.5
1995-2000	1.1	-17.6	-1.4	-11.8	-10.9	-2.8	-3.1
2000-2005	-0.1	0.6	-9.7	-16.1	-3	-5	-6.1
2005-2010	0.9	-0.1	-4.9	-9.3	-1.7	-2.3	-3.3
2010-2015	-0.2	0	-6.3	-5.9	-2.5	-1	-1.4
2015-2020	-0.2	0	-2.5	-3.7	-2.2	-0.9	-1.3
2020-2025	-0.2	0	-2.4	-2.5	-2	-0.9	-1.2
2025-2030	-0.2	0	-2.2	-2.6	-1.8	-0.8	-1.2
2030-2035	-0.2	0	-2.1	-2.7	-1.7	-0.8	-1.2
2035-2040	-0.2	0	-2.1	-2.8	-1.6	-0.8	-1.1
2040-2045	-0.3	0	-2	-3	-1.5	-0.8	-1.1
2045-2050	-0.3	0	-1.9	-3.1	-1.4	-0.8	-1.1

Source: UN Population Division (2013).

Rural labor in these three countries is perhaps a less important constraint than other inputs. In particular, water and land in the Central Asian countries seem to constrain wheat production considerably more than labor.

Table 5.7. Remittances as a portion of GDP in the NIS, 2013 (%)

Country	Percent of GDP
Tajikistan	42.1
Kyrgyzstan	31.5
Moldova	24.9
Armenia	21
Georgia	12.1
Uzbekistan	11.7
Ukraine	5.4
Azerbaijan	2.4
Belarus	1.6
Kazakhstan	0.1
Turkmenistan	0.1

Source: World Bank Migration and Remittances Data (2013).

Assessment: Evaluation of natural resource constraints for wheat production

Four main points of relevance for wheat cultivation in these three countries seem to stand out from this analysis of natural resource constraints in this chapter. First, Belarus enjoys an excellent climate for wheat cultivation, exceeding that in France and Germany, and bettered only by climatic conditions in Uruguay, Hungary under low input conditions (Table 5.1), and parts of Ukraine and Russia. Turkmenistan and Uzbekistan, on the other hand, have perhaps the most forbidding climate for wheat cultivation of all NIS countries. A mere 4% of land in Turkmenistan is arable, while 24% of land is arable in Uzbekistan (Table 2.1). While the effects of climate change in Belarus are not likely to be severe, impact analyses indicate that after 2080 surface warming is likely to lead to diminished water flows of 5% to 15%, and ranging up to 35%, in the Amu Darya River, leading to possible water shortages in Central Asia. Despite this uncertain prospect, the direct effects of climate change on wheat yields under a scenario of 2 degrees above pre-industrial levels are uncertain. Some studies indicate yield losses of up to 57% (Sutton, et al., 2013), while others indicate that the higher levels of carbon dioxide in the air (Sommer, et al., 2013) will actually increase wheat yields so as to more than offset the negative effects of heat stress (Table 5.3).

Relatively clear conclusions can be drawn on land issues. The historical record shows that the system of wheat variety improvement in Uzbekistan, relying on centralized state research supported by international research institutions, is quite capable of raising wheat yields. Uzbek wheat yields tripled between 1992 and 2013, while those in Belarus and Turkmenistan stagnated over this 21-year period. It is likely, then, that any future increase in wheat production in Turkmenistan and Belarus will need to come from increased sown area, and not from yield increases. In Uzbekistan, however, the historical record suggests that further increases in yields are possible, thus lessening the need for expanded area. This is a key fact to be taken account of in projecting wheat production.

Water issues provide one of the clearest examples of unsustainable resource use in the world today. Experts refer to the water stress situation in Central Asia as “critical” (Bruinsma, 2012). Turkmenistan uses 111% and Uzbekistan 101% of its annual renewable water resources each year (Table 5.4, line 3a). Agriculture is directly responsible for this stress, since it uses 94% of water in Turkmenistan and 90% in Uzbekistan (Table 5.4, line 2a). The irrigation delivery systems of Central Asia are immensely inefficient. Estimates of water losses from the source to the field range to 50% and more. Much of this occurs in the main, inter-farm and intra-farm canals on the way to the fields, since most are made of bare dirt and sand without plastic liners or concrete. But most water losses apparently occur in the on-farm delivery networks. Water use and farm management surveys indicate an average of 21% and up to 37% of the total water supplied to farms is wasted in the fields (UN, 2004).

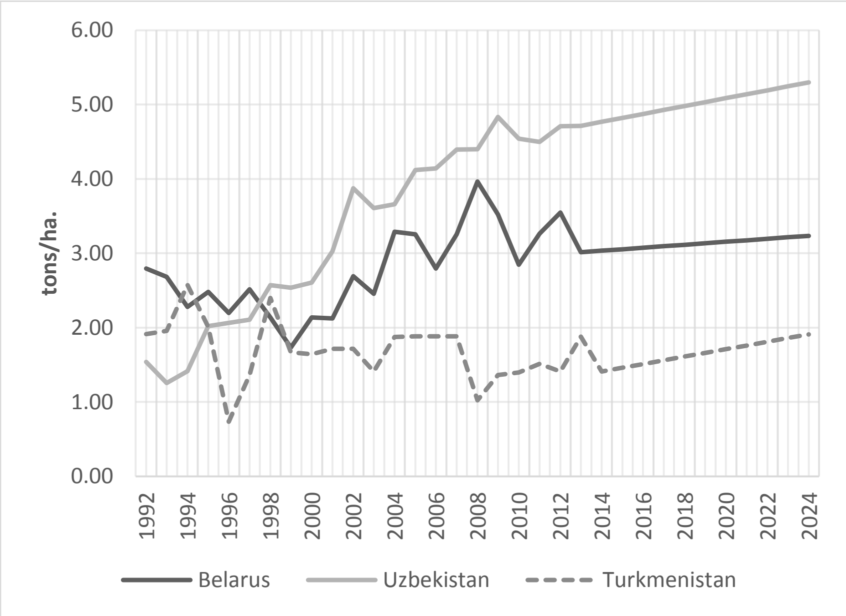
In addition to the wasteful use of water in Central Asia, irrigation is responsible for ecological damage to the soils on a scale rarely seen. Estimates of soil salinization for Turkmenistan and Uzbekistan from 10 or more years ago ranged from 50% to 70% (FAO, 2013; Stanchin and Lerman, 2006). It is likely that salinization has reached 80% to 90% of all sown areas by now. While salinized soils are still cultivatable, yields on these soils suffer. In Turkmenistan, for example, cotton yields have undergone a steep decline since 1995. Though the main reason for this decline seems to be the halting of alfalfa-cotton crop rotation (another unsustainable agro-ecological practice), increasing salinization of soils has been a contributing factor as well. The culmination of the wasteful and unsustainable use of irrigation water in Central Asia is the drying up of the Aral Sea, an ecological disaster caused by the reduction of water flow due to irrigation from the Amu Darya and Syr Darya rivers.

The above are important factors that constrain growth of wheat production in Turkmenistan and Uzbekistan. But they must be balanced off against food security policies aimed at wheat self-sufficiency. These two countries have allowed cultivation of other crops, such as cotton, vegetables and feed, to fall while continuing to increase production of wheat. Though the challenges of raising wheat in Central Asia are many, the regimes there apparently see wheat as the key crop, and will likely continue to pursue the policy of self-sufficiency in the future.

Wheat yield, area and production forecasts for Belarus, Uzbekistan and Turkmenistan

The analysis of chapters IV and V form the basis for the forecasts of wheat yields, area and production from 2013 to 2024 presented in Figures 5.10, 5.11 and 5.12. The forecasts assume that policies and natural resource constraints remain unchanged over the projection period. In keeping with the generally stagnant wheat yields seen in Turkmenistan and Belarus for the past 20 years, the yield forecasts in those two countries are very modest with growth rates ranging from 0.77% per year in Turkmenistan to 0.95% per year in Belarus over the projection period. Uzbek yields grow at a more respectable rate of 1.07% each year for 11 years (Table 5.8).

Figure 5.10. Belarus, Uzbekistan and Turkmenistan: Wheat yield history and forecasts, 1992-2024



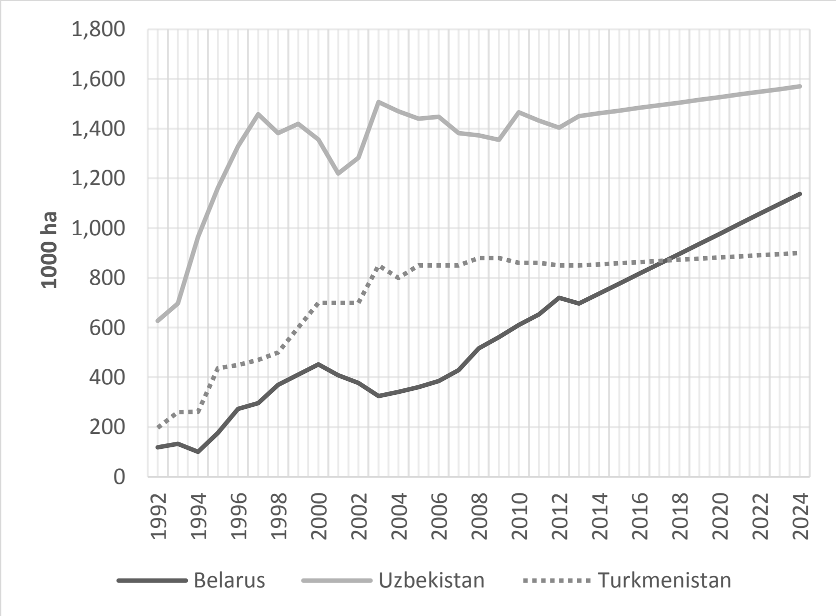
Source: Official statistical yearbooks (various years), USDA/PSD (2014) and model projections.

Turkmenistan yields reach a mere 2.1 tons per ha in 2024, while Belarus yields rise quite modestly to 3.34 tons per ha in 2024. Uzbekistan continues to increase wheat yields through improving varieties, as it has done for the past 20 years. In 2024 wheat yields there will reach 5.3 tons per ha. Yield growth over the projection period in Uzbekistan (1.07%) is a bit more modest than that of the past 6 years (1.17%, Table 5.8), and quite a bit more modest than the rate for the past 11 years (1.8%). Thus, the projections carry forward the slowdown observed in Uzbek yield growth over the past 11 years.

Area sown growth over the projection period is also very modest in Turkmenistan and Uzbekistan. This reflects the analysis of this chapter that showed area under irrigation in these two countries as essentially flat. Thus, any expansion of wheat area would need to come at the expense of cotton. While such a change would reduce water demand (wheat uses about half the water that cotton does per ha) it is very expensive. Returns to cotton in international prices far exceed those to wheat (see the discussion earlier in this chapter under “Land Issues”).

Area under wheat in Belarus, however, expands at a rapid rate in the projections period, though this is also more modest than recent trends. In the past 11 years (2002-2013) wheat area in Belarus has expanded by 84%. In the projections period (2013-2024) area will expand by 63%.

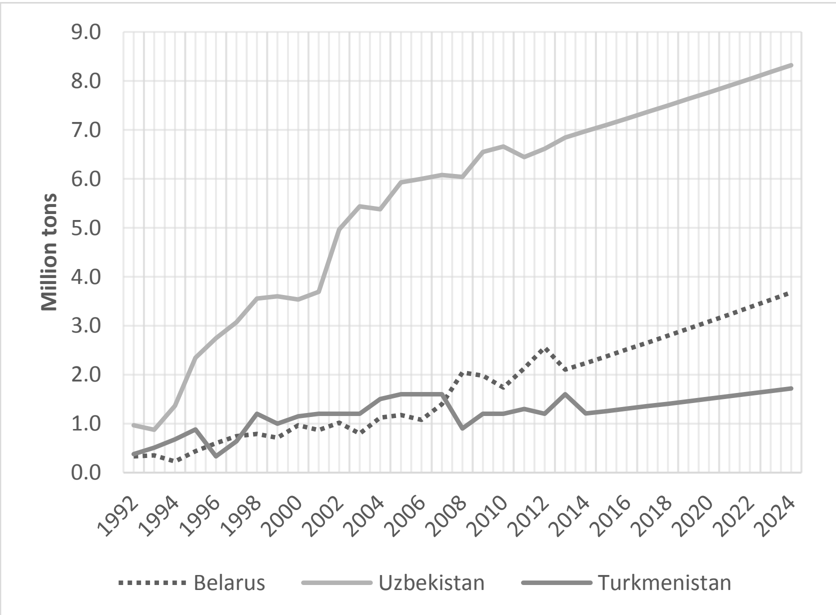
Figure 5.11. Belarus, Uzbekistan and Turkmenistan: Wheat sown area history and forecasts, 1992-2024



Source: Official statistical yearbooks (various years), USDA/PSD (2014) and model projections.

The resulting production forecasts for Belarus, Uzbekistan and Turkmenistan are shown in Figure 5.12. Production expands in Belarus at a rapid rate nearly exclusively due to area increases. Uzbekistan wheat production expands by nearly 2% per year, driven mostly by increases in yields. Turkmenistan production growth is quite modest, a mere 1.08% per year.

Figure 5.12. Belarus, Uzbekistan and Turkmenistan: Wheat production history and forecasts, 1992-2024



Source: Official statistical yearbooks (various years), USDA/PSD (2014) and model projections.

Comparing the forecasts with recent history, we can see that the projections generally capture an observed trend of ever-slower growth, compared with the last 11 and 6 years. Production in the forecast period expands a bit less robustly in Uzbekistan and Belarus than it has for the past 6 and 11 years. Turkmenistan is projected to halt the fall in sown area, though yield growth is very slow. The resulting production growth is better than the past 6 years, but worse than the past 11 years (Table 5.8).

Table 5.8. Belarus, Uzbekistan and Turkmenistan: Annual growth rates of wheat yield, area and production in recent historical and forecast periods (% per year).

	Belarus	Uzbekistan	Turkmenistan
Forecast period: 2013-2024			
Yield	0.95	1.07	0.14
Area	4.55	0.72	0.52
Production	5.54	1.79	0.67
Past 6 years: 2007-2013			
Yield	-1.28	1.17	0.00
Area	8.42	0.81	0.00
Production	7.04	1.99	0.00
Past 11 years: 2002-2013			
Yield	1.04	1.80	0.84
Area	5.72	1.13	1.78
Production	6.82	2.95	2.64

Source: Official statistical yearbooks (various years), USDA/PSD (2014) and model projections.

6. Conclusions: Wheat Demand, Supply and Trade Forecasts to 2024 and Beyond

The main purpose of this study has been to analyze the wheat outlook for Belarus, Uzbekistan and Turkmenistan to ascertain whether these countries are likely to take a larger role in future wheat exports in the region. The answer to this query has important implications for the food security of the importers in the region. If Belarus, Uzbekistan or Turkmenistan were to significantly expand exports this would mean that the wheat importers in the region would have a more diverse choice of sources of wheat imports rather than just the big three—Russia, Ukraine and Kazakhstan. It would also mean that the big three would likely export more wheat outside of the region.

In 2013 the main wheat importers in the NIS region, as well as Moldova (a moderate exporter), are shown below (Table 6.1). The largest net wheat importer in the entire region in 2013 was Uzbekistan, followed by Azerbaijan, Tajikistan, Georgia, Kyrgyzstan and Armenia.

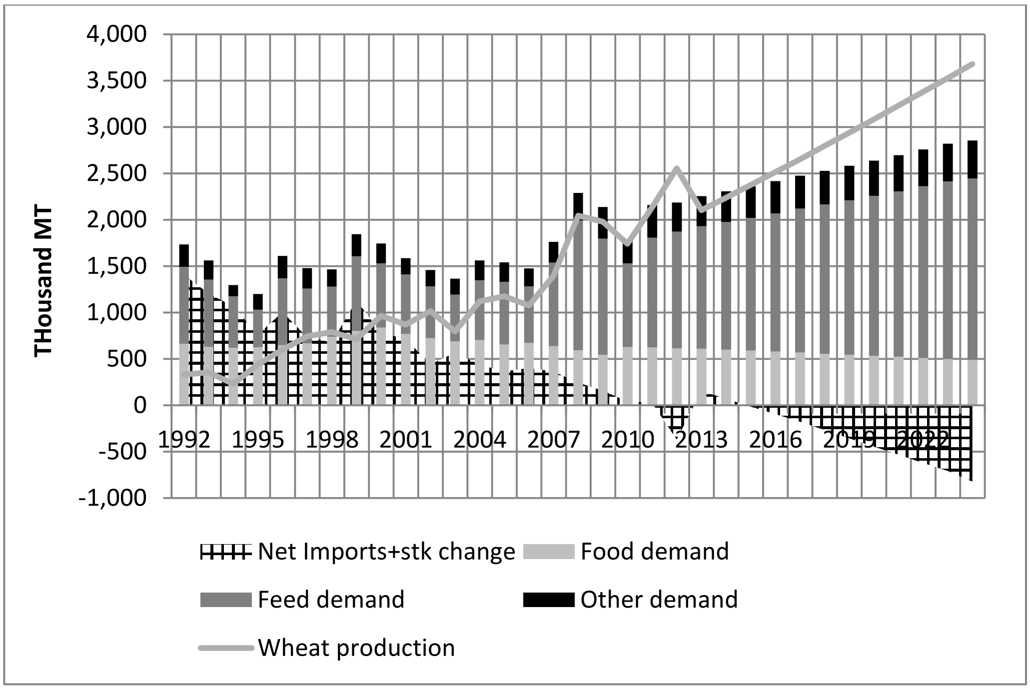
Table 6.1. Main NIS wheat importers and Moldova, 2013

2013	Area (1000 ha)	Yield (t/ha)	Production (1000 t)	Net imports (1000 t)
Uzbekistan	1,451	4.71	6,841	2,159
Azerbaijan	689	2.75	1,898	1,893
Tajikistan	300	3.00	900	1,031
Georgia	44	1.84	81	627
Kyrgyzstan	335	2.61	875	546
Armenia	105	2.86	300	332
Belarus	697	3.01	2,101	152
Turkmenistan	850	1.88	1,600	112
Moldova	366	2.75	1,007	-196

Source: USDA/PSD (2014).

Table 6.1 suggests that it is unlikely that Uzbekistan would change from being the largest wheat importer in the region into a wheat exporter. However, Belarus and Turkmenistan are quite small importers, and with the right policies they could probably become regional wheat exporters.

Figure 6.1. Belarus: Wheat demand, production and net trade, 1992-2024

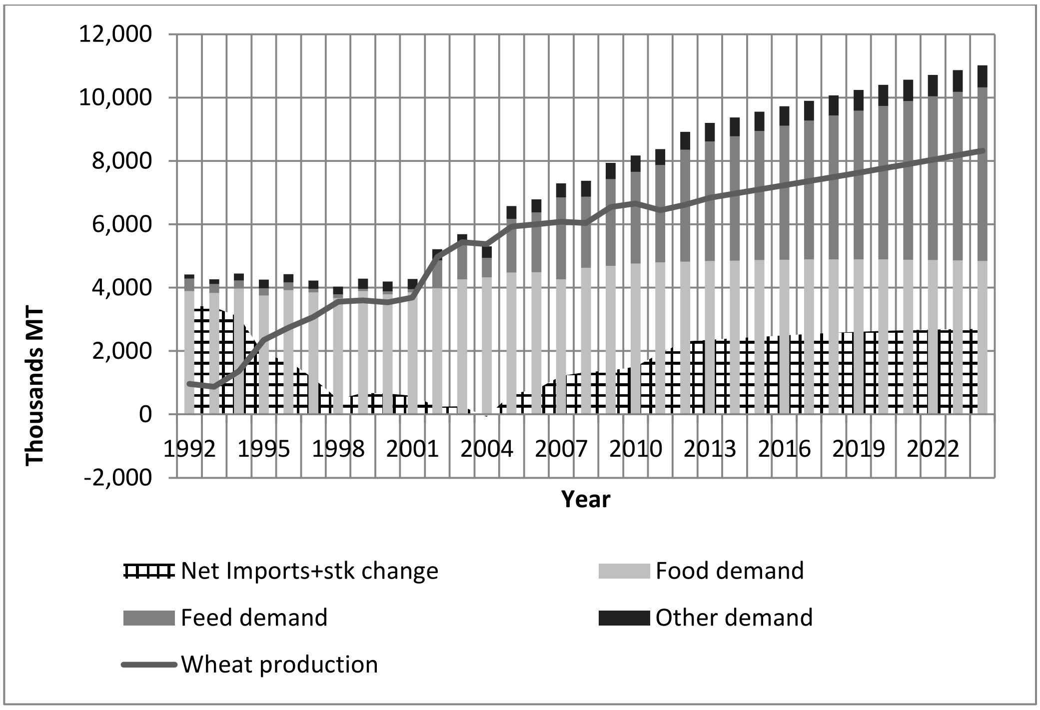


Source: Official statistical yearbooks, Belarus (various years) and model projections.

In fact, our forecasts show that Belarus will most likely become a moderate wheat exporter in the next few years, and by 2024 it will be exporting nearly 1 million tons of wheat each year. This rapid change from being a small importer of wheat to being an exporter is caused by a combination of slowly growing wheat demand and a rapid expansion of wheat production. The slowly growing wheat demand is primarily a consequence of declining population and growing incomes. Declining population limits both feed and food demand for wheat, while improving incomes leads to higher demand for meat. While higher demand for meat increases feed demand for grains, Belarus feeds a variety of grains, wheat being on 20% of total grains fed. Rapidly growing wheat production is nearly exclusively a consequence of expansion of wheat area.

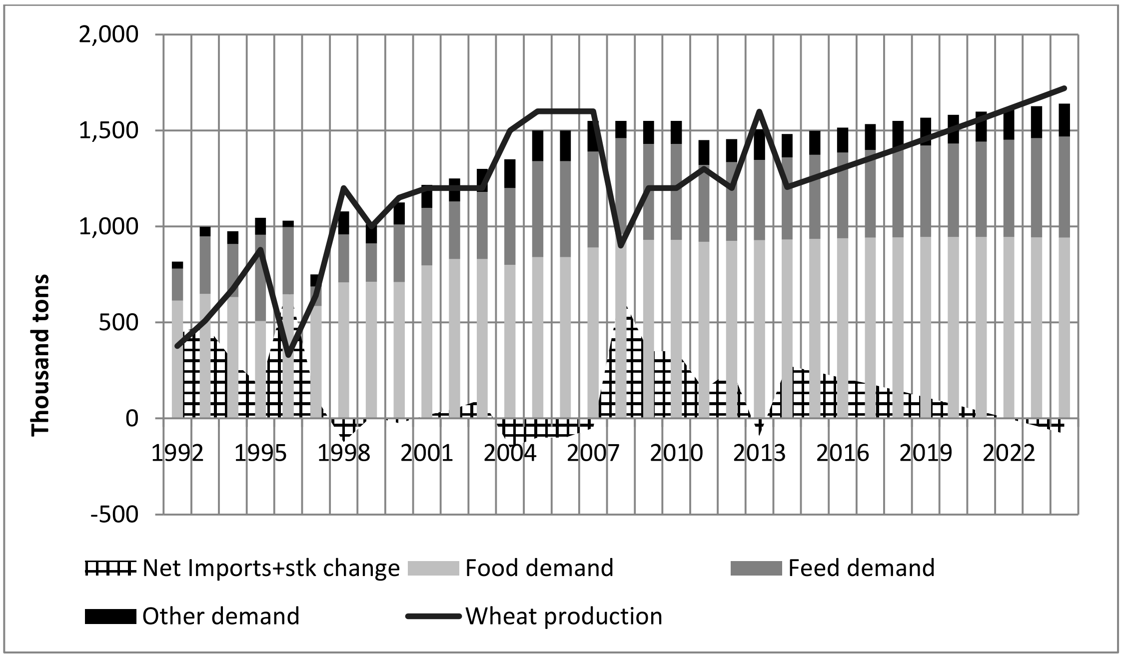
Forecasts of Uzbek demand, production and trade show that production lags slightly behind demand, implying that net imports expand slowly (Figure 6.2). By 2024 Uzbekistan should be importing about 2.6 million tons of wheat in the form of wheat and flour, up from about 2.3 million tons in 2013. Uzbekistan's wheat outlook is shaped by the difficulties of expanding area under wheat and a rapidly growing population. On the positive side, Uzbekistan has the highest growth in wheat yields of any of the three countries considered here.

Figure 6.2. Uzbekistan: Wheat demand, production and net trade, 1992-2024



Source: Official statistical yearbooks, Uzbekistan (various years) and model projections.

Figure 6.3. Turkmenistan: Wheat demand, production and net trade, 1992-2024



Source: Official statistical yearbooks, Turkmenistan (various years), USDA/PSD (2014), and model projections.

In Turkmenistan wheat production growth is slow, but wheat demand expands at an even slower rate, leading to a decrease in wheat imports, so that by 2024 Turkmenistan will be a small exporter.

Table 6.2. Comparison of wheat indicators for leading NIS wheat producers, 2013, 2023

2013	**Area (1000 ha)**	**Yield (t/ha)**	**Production (1000 t)**	**Net exports (1000 t)**
Russia	23,520	2.3	54,100	13,850
Ukraine	6,776	3.17	21,500	9,495
Kazakhstan	13,000	1.25	16,300	7,500
Belarus	697	3.01	2,101	-154
Uzbekistan	1,451	4.71	6,841	-2,345
Turkmenistan	850	1.88	1,600	-112
2023	**Area (1000 ha)**	**Yield (t/ha)**	**Production (1000 t)**	**Net exports (1000 t)**
Russia	25,940	2.63	68,191	21,999
Ukraine	7,716	3.1	23,932	9,736
Kazakhstan	14,825	1.21	17,972	8,650
Belarus	1,097	3.21	3,526	706
Uzbekistan	1,559	5.24	8,178	-2,582
Turkmenistan	895	1.86	1,666	40
% change	**Area**	**Yield**	**Production**	**Net exports**
Russia	10	14	26	59
Ukraine	14	-2	11	3
Kazakhstan	14	-3	10	15
Belarus	57	7	68	-558
Uzbekistan	7	11	20	10
Turkmenistan	5	-1	4	-135

Sources: OECD-FAO (2014), official statistical yearbooks (various years), USDA/PSD (2014), and model projections.

A comparison of indicators for leading NIS wheat producers in 2013 and 2023, using OECD-FAO wheat projections for Russia, Ukraine and Kazakhstan, shows the following key differences between Russia, Ukraine and Kazakhstan and the lesser producers of Belarus, Uzbekistan and Turkmenistan. First, the expansion of wheat area in Belarus, though from a small base, outstrips all area changes in the NIS countries in terms of growth. This leads to quite high growth of production in Belarus in comparison to all NIS countries. Second, yield growth in Turkmenistan and Belarus is quite modest, while Uzbekistan and Russia have good growth performance. While Belarus compensates for mediocre yield performance with area increases, the Central Asian countries can not expand wheat area very much.

In general, prospects for the leading wheat producers of the NIS region will show relatively little change over the next 10 years. Belarus will likely emerge as a new exporter, while Uzbekistan will import a bit more. Turkmenistan production will most likely recover to pre-2007 levels and the country will be a small exporter by 2023. These developments do not change the food security situation of the wheat importers in the region substantially.

Annex 1. Legislation on land reform and farm restructuring in Turkmenistan

1990 October	Land Code of the Turkmen SSR (amended May 1991) [sweeping prohibition on all transactions in land]; Law on Leasing and Lease Relations
1991 April	President’s letter to local councils of People’s Deputies and heads of ministries and authorities “On augmentation of areas for household plots and collective gardens from inefficiently utilized lands”
1991 May	Amendment of the Land Code reflecting the program for augmentation of household plots
1992 May	Constitution of Turkmenistan (article 9: private ownership of land)
1993 February	Presidential decree “On right of ownership and use of land in Turkmenistan”; Regulations on Allocation of Land Use in Private Ownership and Long-Term Leasing to Citizens of Turkmenistan [land may be allocated in private ownership to household plots and private (daikhan) farms]
1993 May	Presidential decree “On increasing economic motivation for increased production and improved quality of agricultural products” [sets maximum deductions for lease payments as a percentage of leasehold production]
1993 October	Law on Ownership [land may be privately owned by individuals subject to the provisions of the Land Code]
1994 March	Presidential decree “On restructuring of kolkhozes, sovkhozes, and other agricultural enterprises in Turkmenistan”; Law on Peasant (Daikhan) Farms
1994 May	Presidential decree “On implementation of reforms in agriculture of Turkmenistan” [directs competent authorities to start implementation; sets producer subsidies]
1995 June	Presidential decree “On creation of peasant associations (daikhan birleshikleri)”; Law on Peasant Associations
1995 September	Standard regulations on peasant association
1995 December	President’s program “On deepening of market reforms and socio-economic development of Turkmenistan in 1996“; Presidential decree “On additional measures for reforming peasant associations in 1996” [directives for implementation of June 1995 reforms]
1996 June	Presidential decree “On additional measures for stimulating agricultural production” [daikhan farmers exempted from state orders]
1996 December	Law on Allocation of Land in Ownership to Citizens for Commercial Farming Presidential decree “On additional measures for implementation of economic reforms in agriculture” [leasehold converted to private ownership after 2-year probation; establishment of specialized farm-service providers]
1997 January	Presidential decree “On increasing economic incentives for agricultural production” [lease payment set at 20% of contracted production; sweeping tax exemption for agricultural producers]
1997 July	Directive on normative allotment of leased land per worker (varying by commodity)
1998 March	Presidential decree on subsidized credit to producers delivering on state orders
1998 July	Civil Code
1998 August	Presidential decree on subsidized rates of mechanical field works [50% cost subsidy to cotton and wheat production on state orders]
1999 January	Presidential decree “On privatization of agricultural, agro-industrial, and construction enterprises in the agro-industrial complex”
1999 February	Presidential decree “On improvement of lease relations in agriculture”

2000 August	Presidential decree “On some measures regularizing land relations in Turkmenistan” [new organizational responsibilities for allotment of land]
2000 September	Presidential decree “On creation of Land Resource Service in the Ministry of Agriculture” [responsible for land monitoring, cadastre, registration, titling]
2001 August-December	Presidential decrees on the sowing of wheat, cotton, and rice in 2002 [state orders made optional for leaseholders; entitlement to subsidies conditional on acceptance of state orders]
2002 April	Presidential decree “On improving the mechanism of income distribution from cotton production” [ginning byproducts belong to producers]
2004 November	Water Code
2004 November	Land Code [incorporates private land ownership without any transfer rights, subleasing of state land by peasant associations but not by daikhan farms]
2005 January	Presidential decree “On measures for implementation of the Land Code”
2005 January	Presidential decrees (7040 and 7082) on transformation of three leading daikhan associations into joint-stock companies in response to leaseholders’ request [increased operating independence and improved incentives]
2007 March	Law on Daikhan Associations
2007 March	Law on Daikhan Farm
2007 April	Presidential decrees (8496 and 8553) on development of a state program to ensure a high level of social and living conditions of rural and urban population [legislation with rural development impacts]
2008 January	Presidential decree on streamlining of market transactions and establishment of “Ak altyn” as an organization for procurement and sale of cotton

Source: Stanchin (2014).

Annex 2. Legislation on land reform and farm restructuring in Uzbekistan

Pre-Independence (Uzbek SSR)	
1989 Aug.	On Allocation of Land to Subsidiary Household Plots (Resolution of Central Committee of the Communist Party, Presidium of Supreme Council, and Council of Ministers of Uzbek SSR)
1989 Dec.	Regulations on Leasing in the Uzbek SSR (Resolution of the Presidium of Supreme Council implementing the Basic Law of the Soviet Union and Union Republics on Leasing)
1990 May	On Sale of Young Animals and Feed by Collective and State Farms to Subsidiary Household Plots (Resolution of Council of Ministers of Uzbek SSR)
1990 June	Land Law (amended July 1993)
1990 Oct.	Law of Property (amended July 1992, May 1994)
1991 Jan.	On Measures for Development of Subsidiary Household Plots of Collective Farm Members, State Farm Employees, and Other Rural Residents (Presidential Decree)
1991	Measures to support private livestock production, including allocation of 200,000 ha of irrigated land for lease by livestock producers
1991 Feb.	Law of Enterprise (amended Nov. 1991, July 1993)
1991 Feb.	Law of Entrepreneurship
1991 June	Law of Cooperatives (amended Dec. 1993)
Post-Independence (Republic of Uzbekistan)	
1991 Nov.	Law of Destatization and Privatization
1991 Nov.	Law of Leasing
1991 Nov.	On Further Strengthening of Peasant Farms and State Support for Entrepreneurial Activity in Uzbekistan (Presidential Decree)
1992 July	Law of Peasant Farms
1992 Dec.	Law of Economic Associations, Partnerships, and Companies
1992 Dec.	Constitution of the Republic of Uzbekistan (article 53: private property; article 55: state ownership of land)
1993 March	On Measures for Deepening of Economic Reforms in the Livestock Sector (Government Resolution No. 137)
1993 May	Land Tax Law
1994 Jan	On Approval of Standard Statute of Collective Farms (Presidential Decree)
1994 Jan.	On Further Deepening of Economic Reforms, Protection of Private Property, and Development of Entrepreneurship (Presidential Decree)
1994 Feb.	On Improvement of Reforms in Livestock Farming and Protection of Interests of Peasant Farms and Privatized Farm Enterprises (Government Resolution No. 87)
1994 Feb.	On Additional Measures for Implementing Economic Reforms in Agriculture (Government Resolution No. 88)
1994 Mar,	On Priority Directions for Further Development of the Process of Destatization and Privatization (Presidential Decree)
1994 May	Bankruptcy Law
1994 June	Temporary Regulations for Privatization and Creation of Various Forms of Ownership in Agriculture
1994 July	Regulations on Sale into Private Ownership of Trade and Service Facilities Together with the Land Plots On Which They are Located (Government Resolution)
1994 Aug.	On Results of Implementation of Economic Reforms in the First Half of 1994 and Measures for Further Improvement of Their Effectiveness (Government Resolution)
1994 Aug.	On Measures for Economic Encouragement of the Development of Agriculture (Presidential Decree)

1998	Package of laws intended to promote market relations in agriculture: Land Code (introducing private land use, leaseholding, land tax) Law on Agricultural Cooperatives (Shirkats) Law on Peasant Farms Law on Dekhkan Farms Law on State Cadastre
2003	Conception for the development of peasant farms in Uzbekistan (enterprise restructuring to be completed by 2007, peasant farms shifted to use leased land)
2006	Presidential Decree No. 308 "On measures to stimulate the livestock headcount in household plots, dekhkan farms, and peasant farms" Program to stimulate the growth of livestock headcount, and primarily cattle headcount, in household plots, dekhkan farms, and peasant farms during 2006-2010
2007 Oct.	Presidential Decree "On measures for radical improvement of the land amelioration system"
2007 Nov.	Presidential Decree "On support of peasant farms producing crops for state needs on low-yield land"
2008 Apr.	Presidential Decree "On additional measures for enhanced stimulation of increasing the livestock headcount in household plots, dekhkan farms, and peasant farms and expansion of livestock production"
2008 Oct.	Presidential Decree "On measures for optimization of sown areas and increased production of food crops"
2009 Jan.	Presidential Decree "On state program for rural development and welfare"
2010 Mar.	"Outcomes of land size optimization for peasant farms"
2010 Nov.	"On further improvements of livestock selection and extension services in livestock production"
2011 Apr.	Presidential Decree "On measures to enforce legality during reorganization and optimization of land in peasant farms"
2011 Oct.	Presidential Decree "On measures for further improvement of management and development of food industry in 2012-2015"
2012 May	Presidential Decree "On program for further modernization and technological upgrading of agricultural production in 2012-2016"
2012 Aug.	"On additional measures for improvement of processing of agricultural raw materials, expansion of production volumes, and increased variety of food products in 2012-2015"
2013 Jan.	Instruction "On the procedure for land size optimization and liquidation of peasant farms"
2013 Mar.	Instruction "On the procedure of water use and water consumption in Uzbekistan"
2013 May	"On measures for the purchase of chain tractors for agriculture"
2013 June	"On measures for efficient organization of introduction and financing of drip irrigation systems and other water-efficient irrigation technologies"
2014 Jan.	"On improvement of the procedure for state registration of rights in immovable property"

Source: Yusupov (2014).

Annex 3. Legislation on land reform and farm restructuring in Belarus

1990 Dec.	Land Code of Belarus SSR (December 11, 1990, amended January 4, 1999 – superseded by the Code of the Republic of Belarus on Land, July 30, 2008)
1990 Dec.	Resolution of the Supreme Soviet of Belarus SSR “On Land Reform” (December 11, 1990)
1991 Feb.	Law of Belarus SSR “On Peasant Farms” (February 18, 1991)
1991 July	Resolution of the Council of Ministers of Belarus SSR No. 277 “Major Principles of Land Use in Belarus SSR” (July 15, 1991)
1991 Dec.	Law of Belarus SSR “On Payments for Land” (December 18, 1991)
1993 June	Law of the Republic of Belarus “On Land Ownership” (June 16, 1993, amended January 4, 1999 – superseded by the Code of the Republic of Belarus on Land (July 30, 2008)
1993 Aug.	Resolution of the Council of Ministers of the Republic of Belarus No. 539 “On the Amount of Payment for the Land Title” (August 12, 1993)
1993 Oct.	Resolution of the Council of Ministers of the Republic of Belarus No.679 “On Normative Land Prices” (October 7, 1993)
1995 Feb.	Law of the Republic of Belarus “On Amendments to the Law of the Republic of Belarus ‘On Land Ownership’” (February 21, 1995, amended January 4, 1999)
1997 Dec.	Law of the Republic of Belarus “On Amendments to the Law of the Republic of Belarus ‘On Land Ownership’” (December 21, 1997, amended January 4, 1999)
1997 Dec.	Law of the Republic of Belarus “On Amendments, Changes and Additions to Some Laws of the Republic of Belarus Regulating Land Tenure” (December 31, 1997, amended January 4, 1999)
1998 Mar.	Presidential Decree No. 95 “On Measures of Development of Peasant Farms and their Government Support (March 3, 1998)
1998 Mar.	Presidential Decree No. 97 “On Financial Support and Reorganization of Non-Profitable Agricultural Enterprises” (March 3, 1998)
1998 Apr.	Presidential Decree No. 193 “On Measures to Improve Government Regulation of Peasant Farms” (April 1, 1998)
1998 Dec.	Civil Code of the Republic of Belarus (December 7, 1998)
2006 Jan.	Presidential Decree No. 27 “On Debt Restructuring and Some Other Measures of Financial Recovery of Agricultural Enterprises and Attraction of Investments for Agricultural Production” (January 13, 2006)
1999 Jan.	Land Code of the Republic of Belarus (January 4, 1999 – superseded by the Code of the Republic of Belarus on Land, July 20, 2008)
1999 Jan.	Presidential Decree No. 29 “On Government Support of Industrial and Farm Input Supply Enterprises that Decided to Merge with Non-Profitable Agricultural Enterprises” (January 15, 1999)
2004 Mar.	Presidential Decree No. 138 “On some measures for financial recovery of agricultural organizations and attraction of investments for agricultural production (March 19, 2004)
2008 Feb.	Presidential Decree No. 113 “On procedure and conditions for the sale to legal bodies of enterprises as property portfolios of loss-making state organizations” (February 25, 2008, updated in 2999-2010)
2008 June	Presidential Decree No. 350 “On attracting investments for agricultural production” (June 24, 2008, updated 2009, 2010, 2012)
2008 July	Code of the Republic of Belarus on Land (July 30, 2008)
2010 Mar.	Presidential Decrees Nos. 92, 34 “On some issues of agricultural organizations” (March 1, 2010, January 24, 2011)
2011 June	Presidential Decree No. 256 “On additional measures for implementation of state programs for agriculture” (June 20, 2011)

2011 Aug.	Presidential Decree No. 342 “On State Program for sustainable rural development” (August 1, 2011)

Source: Kazakevich (2014).

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Regional Office for Europe and Central Asia

Food and Agriculture Organization of the United Nations

34 Benczur utca

1068 Budapest, Hungary

Telephone: +36 1 461 2000

Fax: +36 1 351 7029

http://www.fao.org//europe/