Water, Energy, and Agricultural Policy Linkages: The Case of Cotton in Central Asia

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Abstract

This paper examines the impacts of different irrigation scenarios on Uzbekistan's cotton sector and world cotton trade. The immediate challenges for this region's water resource management represent a test case for the long-run challenges associated with global climate change. With an eye towards this eventuality, this paper describes a variety of water policy scenarios relevant to Central Asia's agriculture and simulates their impacts on cotton markets in this region and around the world.

Keywords: water, cotton, agricultural trade, Central Asia

1 Introduction

The impact of rising demand for natural resource inputs on world agricultural production and its consequences for international trade presents a growing challenge to researchers and policy makers. And no resource is more critical, both for its obvious role in production and its increasing scarcity in the world, than water (Berrittella et al., 2007; Rosegrant et al., 2002). Raising the efficiency of water resource use, whether through improved management or the application of water-conserving technologies, promises to alleviate some of the pressure for water inputs. But water use is also subject to macro-level policy constraints, particularly in terms of water-sharing rights that cross administrative boundaries.

Following the dissolution of the Soviet Union in the last decade of the twentieth century, the five Soviet republics of Central Asia suddenly inherited levers for decision-making that were previously controlled in Moscow. One outcome of this power decentralization was the absence of a region-wide perspective towards natural resource management. During the Soviet era, water resources across the republics were managed for the purpose of maximizing cotton production, an objective that suited the Soviet Union's larger economic goals. Specifically, rivers that originated in the glaciers of the Kyrgyz Republic and Tajikistan flowed into the riparian republics of Uzbekistan and Turkmenistan where they were subsequently irrigated.

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Following independence, however, the separate republics have pursued objectives that serve their specific interests. In the case of Uzbekistan, the region's largest cotton producer, maintaining cotton production is central to its larger economic goals of export-led agriculture and foreign reserve accumulation. For neighboring Kyrgyz Republic, however, the objective is electric power self-sufficiency, for which water resources represent the primary input. As such, this competition for water between agriculture and energy represents a new twist on the familiar linkage between biofuels and petroleum and foreshadows some of the challenges related to resource use and allocation in the context of a changing climate.

Recent work by Iskandar et al. (2009) focused on the effect of different trade policy scenarios on Uzbekistan's scarce water resources. They show that trade liberalization, elimination of government production quotas, and the consequent introduction of international price signals into the Uzbek market would raise prices paid to wheat and cotton farmers and drive expansion in area under cultivation. However, given that Uzbek cotton is more competitive than Uzbek wheat, the balance of area would shift towards cotton production and disproportionately raise demand for water owing to cotton's relative thirstiness (Iskandar et al., 2009).

This paper examines the effects of competition between Central Asia's agriculture and energy sectors for this region's scarce water. Specifically, it simulates the effects of plausible water policy scenarios within the Syr Darya river basin on cotton outputs in Uzbekistan and world markets. The results from these simulations, apart from being of interest to commodity market observers, also point to this region's long-run challenges associated with global climate change. This paper begins with a background on Uzbekistan's cotton sector and regional water management and policy. Following that, we present the main water policy scenarios, provide an overview of the economic model used to simulate the simulate the scenarios, and finally report our results.

2 Cotton, Water, and Energy

Cotton provides nearly 40 percent of the world's textile fiber for clothing, home textiles, and other products. The physiology of the cotton plant means that regions with a comparative advantage in cotton production often rely on irrigation, and about 70 percent of the world cotton output depends on irrigation. As the Soviet Union industrialized during the 20th century, Uzbekistan and other Central Asian republics developed extensive irrigation networks. Soviet planners pursued fiber self-sufficiency for their expanding textile industry, and Central Asia's irrigation capacity continued to expand through the 1980s. When Uzbekistan became independent early in the 1991, its exports accounted for about 20 percent of world trade, and was typically the world's second largest exporter, trailing only the United States.

Since the dissolution of the Soviet Union, world fiber demand has expanded dramatically. Cotton has lost market share to petroleum-derived chemical fibers, but world cotton consumption still grew 36 percent between 1990 and 2009. Uzbekistan's cotton area has trended downwards during this time, and yields there have largely stagnated. The country's isolation from world price signals and the limited ability of individual producers in Uzbekistan to freely chose alternatives in production and investment have constrained development of its cotton sector. Uzbekistan remains a major cotton producer, ranking sixth worldwide, but as orther major exporters have adopted genetically-modified varieties and other yield-enhancing technologies, its role has diminished. In marketing year 2009-2010, Uzbekistan planted approximately 1.3 million hectares in cotton, yielding 893,000 metric tons of cotton. More than 90% of its output is still exported, representing 10% of total traded cotton worldwide (FAS, 2010). Although land-locked, Uzbekistan transships its cotton to markets around the world, with export receipts that totaled nearly US$1 billion in 2007 (UNCTAD, 2010; FAOSTAT, 2010).

Iskandar et al. (2009) present a detailed description of the policy environment surrounding Uzbek cotton. Among the policies that shape the decisions and outcomes of cotton producers are land re-distribution and farm restructuring, food security initiatives focused on switching from cotton to wheat, and most relevant to this analysis, production quotas. In Uzbekistan, production quotas are partially fulfilled through mandated area plantings, often without regard for a particular area's suitability for cotton. Moreover, USDA's Global Agricultural Information Network reports that the Uzbek government exerts complete control over prices, material inputs, purchasing, and ultimately the domestic and international marketing of all cotton via state-owned trading companies (GAIN, 2010). As a result, Uzbek farmers receive about half the price offered on the world market (Iskandar et al., 2009).

Figure 1 depicts the spatial distribution of Uzbekistan's cotton production, at a resolution of five-minute grid cells (You et al., 2010). Most production occurs in Uzbekistan's eastern-most provinces along the borders of the Kyrgyz Republic and Tajikistan, as well as in its western province of Karakalpakstan, along the border of Turkmenistan. Given the country's arid climate, all cotton in Uzbekistan is cultivated under the irrigation of two major river basins, the Amu Darya and Syr Darya, the tributaries of which originate in the mountains of Tajikistan and the Kyrgyz Republic. Figure 2 depicts these two river basins and the multiple countries through which they flow. The Syr Darya river, the subject of this paper's analysis, begins at the confluence of the Naryn and Kara Darya rivers inside Uzbekistan's fertile Ferghana Valley, cuts briefly through Tajikistan, re-enters Uzbekistan and subsequently flows into Kazakhstan, stretching a total of 2,000 kilometers until it finally deposits into the Aral Sea.[1] From these two figures, it is not only clear that cotton cultivation closely depends on water availability, but also that successful water management demands significant coordination across countries.

We focus on the Syr Darya river basin due to its vulnerability to large swings in management. During the Soviet era, large dams were erected along the Naryn river in the Kyrgyz Republic, designed to ensure a consistent year-to-year supply of water for downstream irrigation purposes as well as a supplement to the region's electricity needs. The largest of these dams formed a reservoir at Toktogul, about 85 kilometers inside the Kyrgyz border. Meanwhile, to meet Kyrgyzstan's power and heating needs, coal, oil, and gas resources arrived from other republics, namely Uzbekistan and Kazakhstan(The World Bank, 2004). Since independence in 1990, however, the water-for-energy exchange that served both republics for over forty years suddenly crumbled. Economic openness permitted Uzbek natural gas to fetch a high international price which fell well-beyond the economic reach of its eastern neighbor. Consequently, in order to generate winter heat for its own population, the Kyrgyz Republic increasingly shifted its water releases from the summer to the winter. This resulted in less water reaching downstream farmers precisely when their crops needed it most. Over the period 1991-2000, the fraction of annual water released during the summer fell from three-fourths to below one-half (The World Bank, 2004).

Recently, growing public dissatisfaction in the Kyrgyz Republic, in part thanks to rolling blackouts and energy price hikes during the winter of 2009-2010, culminated in the violent replacement of President Kurmanbek Bakiyev with a new interim government. The shock of these events suggests that a stable and affordable electricity supply, particularly during the winter, will acquire even greater precedence to the Kyrgyz leadership, and efforts to achieve this will likely include stricter management of its various hydropower stations throughout the country. This is in spite of periodic attempts by Uzbekistan and Kazakhstan to reach agreements with the Kyrgyz Republic on water and energy sharing (The World Bank, 2004).

Eighty percent of Uzbekistan's water originates with its neighbors (Iskandar et al., 2009). Moreover, matching the information from Figures 1 and 2 reveals that about thirty-six percent of Uzbekistan's total cotton production occurs within the Syr Darya river basin. Meanwhile, the Toktogul hydropower station,

[1] The contamination and near-depletion of the Aral Sea, due to over-irrigation and overuse of chemical fertilizers and pesticides represents the worst environmental legacy of the Soviet Union, the catastrophic effects of which continue to be observed among the populations of humans and other species that inhabit the Aral Sea region. While the need for rehabilitation has been acknowledged, the primary culprit behind the Aral Sea's destruction continues to be the intensive cotton monoculture that the region has practiced over the past fifty years. While this paper does not address the environmental and economic impacts of water management on the Aral Sea region specifically, it is clear that this important region cannot be excluded from any comprehensive treatment of the topic of cotton production in Central Asia.

Kyrgyzstan's largest power plant, and four downstream stations along the Naryn river, account for nearly eighty percent of the country's electric capacity (The World Bank, 2004). In short, the Kyrgyz Republic's objective of energy security is pushing against one of the world's most important cotton exporters. The immediate impacts of water management in this region also point to the impacts of increasingly scarce water resources that stem from a warming climate. For these reasons, this paper evaluates a set of water scenarios designed to simulate Uzbek and worldwide production and trade outcomes resulting from a range of management decisions taken by the Kyrgyz Republic.

3 Commodity Trade Model

This study uses the USDA-ERS Country-Commodity Linked System (CCLS), the USDA-ERS China model, and the USDA-ERS Food and Agricultural Policy Simulator (FAPSIM) model of U.S. agriculture. Together, these models form a large-scale dynamic partial equilibrium simulation system consisting of 43 country and regional models. Each country and region is modeled to reflect domestic and trade policies and institutional behavior, such as tariffs, subsidies, and TRQs. Production, consumption, imports, and exports are endogenous and depend on domestic and world prices, which are solved within the modeling system. Macroeconomic assumptions and projections are exogenous based on USDA's 10 year agricultural projections (USDA, 2010). The system reaches simultaneous equilibrium in prices and quantities for 24 world commodity markets for each of the 10 projected years in the analysis. The 24 commodity markets include detailed coarse grains, food grains, oilseeds, meals, oils, cotton, sugar, and animal products. Primary data sources are USDA's Production, Supply, and Disappearance, (USDA, November 2009), USDA's National Agricultural Statistical Service, and the United Nations Food and Agricultural Organization's FAOStat.

The USDA-ERS Uzbekistan model is used for analyzing potential changes in water availability, its impact on Uzbek agriculture, and the ulimate effect on international cotton markets and trade. The model treats the government as the planting decision maker, insomuch as the government determines acreage to plant from year-to-year. Production, consumption, imports, exports, and ending stocks are endogenous and depend on prices. World price signals enter the domestic market through the border price. Uzbekistan directly weighs on the international market and world prices through its cotton exports. All commodities are modeled at the national level, except for cotton and wheat, which are disaggregated at the level of the Syr Darya and Amu Darya river basins.

The Uzbekistan model has a cotton sector, six livestock sectors, four grain sectors, and four oilseed sectors.

The major commodities include cotton, wheat, and beef. The individual commodities of the Uzbekistan model have five major components: prices and expected revenue equations, production, consumption, ending stocks, and trade equations. As mentioned earlier, cotton and wheat production are modeled at the river basin-level. Each basin is represented by individual area harvested and yield equations. Country-level production for both cotton and wheat are the sum of the two basins.

The cotton sector includes cotton, cottonseed, cottonseed oil, and cottonseed meal. Cotton production in both river basins is calculated from the area harvested times the yield equations. Area harvested and yields are determined by expected returns for cotton and substitute crops, namely wheat. Expected returns are determined by producer prices times an expected yield. The price transmission from the world cotton price to the government's price was estimated to be 0.85.[2] The own-price supply response of cotton's expected revenues is assumed to be 0.31. The cross-price response of cotton to wheat is assumed to be -0.15. Area harvested, consumption, and trade adjust as the model solves for world prices and reaches a new equilibrium. The own-price demand elasticity of cotton is assumed to be -0.20, and the income elasticity is set at 0.40. The Cotton exports equation is an identity which closes the model. The cottonseed sector includes production, crushed demand, feed demand, ending stocks, imports and exports. Cottonseed meal and cottonseed oil production depend on cottonseed crushed demand. Cottonseed meal and cottonseed oil are consumed domestically for feed and food, respectively.

Since the chief substitute for cotton is wheat, we also introduce a river basin-level wheat sector. The wheat sector model includes border, producer and consumer prices, expected returns, production, food and feed demand, ending stocks, and trade. Domestic prices are determined by the world price, with a price transmission from the world price the producer price assumed to be 0.50. Expected returns are determined by the producer price times an expected yield. Wheat production in both river basins is calculated from the area harvested times the yield equations. Area harvested is a function of expected returns for wheat and its substitutes, cotton and cash crops. The own-price supply response of wheat's expected revenues is set at 0.40. Similar to above, wheat's cross-price elasticity with respect to cotton's expected return is -0.15. Again, area harvested and consumption adjust as the model solves for world wheat prices and reaches a new equilibrium. Wheat's own price elasticity of demand is set at -0.233, and its income elasticity is 0.08. Wheat feed demand elasticities include an own price value of -0.40 and the cross price elasticity of its nearest substitute, barley, is 0.25.Wheat import demand is an identity which closes the model.

[2]This estimate was obtained by regressing the log of the Uzbekistan's cotton lint border price on the log of the real international price of cotton, based on annual data over the past 16 years.

4 Scenario Results

Our hypothetical scenarios entail a sustained reduction in water released from the Toktogul reservoir to meet the Kyrgyz Republic's increasingly strict energy security demands beginning in year 2010. Less water is expected to translate into less area under cultivation. To capture the effect of a range of possible reductions, we negatively shock Uzbekistan's area harvested in the Syr Darya basin for cotton and its chief substitute, wheat. The shock sizes are 10%, 25%, and 50%.

In each scenario, the reduction in area harvested in the Syr Darya basin lowers cotton production and consequently reduces exports. See Figure 3 for the predicted year-to-year changes to Uzbekistan's area harvested, production, and exports.[3] Taking the 25% area reduction scenario as an example, production in 2010 is predicted to fall by about 9% relative to the baseline value, a drop of 97,000 metric tons. This is felt nearly one-to-one in exports, which fall by nearly 11% relative to the baseline, or 91,000 metric tons. Effects ten years later are only slightly dampened. See Tables 1, 2, 3 for a summary of level and percent changes for Uzbekistan's production, imports, exports, and consumption.

Wheat production in the Syr Darya basin also tumbles, again due its dependence on irrigation. Note that wheat and cotton are substitutes governed by a cross-price elasticity (discussed earlier). If the price of cotton falls relative to the price of wheat, some area can be expected to be shifted into wheat production. Wheat also requires less water per area planted, a fact which is not currently reflected in the model. For this reason, the response of wheat presented in Figure 4 is likely to be overstated.

In response to the supply shock in Uzbekistan, the international price of cotton is predicted to rise. Figure 5 shows that, relative to the baseline scenario, prices are only slightly higher. The largest shock drives prices upward only about 2% relative to the baseline. The baseline projection, morever, shows a gradual secular decline in prices that dominate any effect attributable to Uzbekistan.

Meanwhile production in other countries grows to meet the demand historically satisfied by Uzbekistan. As illustrated in Figure 6, no significant difference from the baseline scenario can be detected across the different scenarios, and any negative effect is more than swamped by the overall rise in worldwide cotton production projected by the baseline. In short, at the world-level, the effects appear small. At the country-level, as well, the responses are minimal with major exporters the United States and India registering negligible percent changes.

[3]Note that the model's baseline scenario reflects the shock and subsequent recovery from the year 2008 world agriculture crisis which affected prices, production, and exports across numerous commodities worldwide.

5 Forthcoming extensions

The model presented thus far lays a foundation for understanding the effects of water policies on Uzbekistan's most important agriculture commodity. Refinements to the model are easily imaginable, however. In terms of modeling trade, the effects of Uzbekistan's reduction of supply are likely to be felt unevenly across the world market. Currently, the one world price assumption that drives the results ignores the reality that Uzbekistan exports its cotton to a handful of countries. Imposing Armington assumptions that govern the elasticity of substitution between countries may generate more realistic country-specific results.

Furthermore, the model does not explicitly address the question of energy prices. Under their current, though shaky, arrangement, Uzbekistan and the Kyrgyz Republic exchange water for natural gas at predetermined prices and quantities. But the agreed upon quantities are periodically ignored, particularly when international prices spike upwards or when the winter cold is unpredictably extreme. In either instance, endogenizing the demand for water to world energy prices can add an extra element of realism to the model's predictions.

Additional extensions can include policy levers over the Amu Darya river basin, which falls primarily within Tajikistan. Unlike the Kyrgyz Republic, Tajikistan's hydropower resources are relatively underdeveloped, and the country has struggled to find investors in its electricity sector. The World Bank has initiated some financing towards this objective, and at least in the medium-run, additional constraints on Uzbekistan's (as well as Turkmenistan's) cotton production capacity are likely to appear.

6 Conclusion

The scenarios reported above are intended to serve as a point of departure for Uzbek and international policy makers interested in weighing their response to reduced access to water in the near-term. The effects of reducing summer water releases from the Toktogul reservoir serves the interests of the Kyrgyz Republic, but the effects downstream on Uzbekistan's cotton production capacity are large. Given that Uzbekistan's primary source of foreign currency is its cotton sector, shocks to production can put vital imports even further out of reach of a population that earns about US$2,400 per capita. Investments in irrigation infrastructure and efficiency, yield enhancements, domestic water pricing schemes, and international trade agreements can potentially mitigate the effects of water scarcity driven by its neighbor's decisions. Indeed, research has shown where improvements in management can lead both countries to satisfy both their objectives (Cai et al., 2003). The results from this paper, therefore, serve to highlight the potential magnitude of the foregone productivity and foreign currency earnings that results from unexpected resource constraints. The results offer some glimpse into the greater challenges associated with climate change, when all countries begin to operate under an increasingly binding water constraint.

7 Figures and Tables

Figure 1: Grid cell-level cotton production in Uzbekistan. Note: Upper bound value, represented by the darkest shade of green, is approximately 3,000 metric tons. Source: (You et al., 2010)

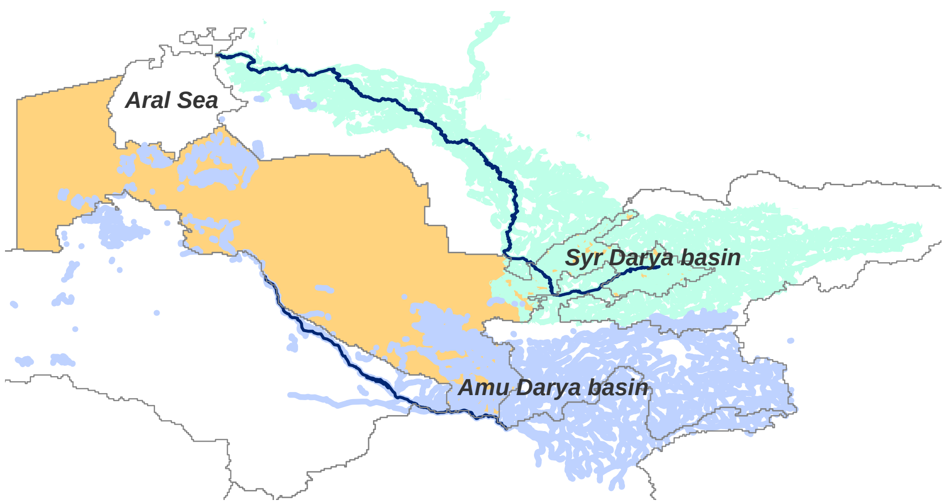
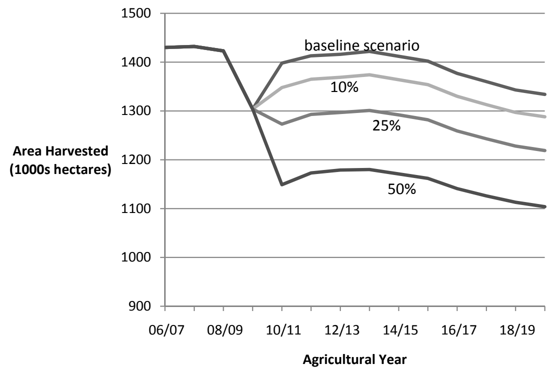
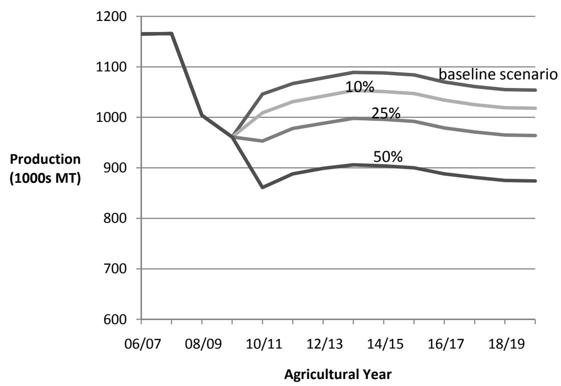


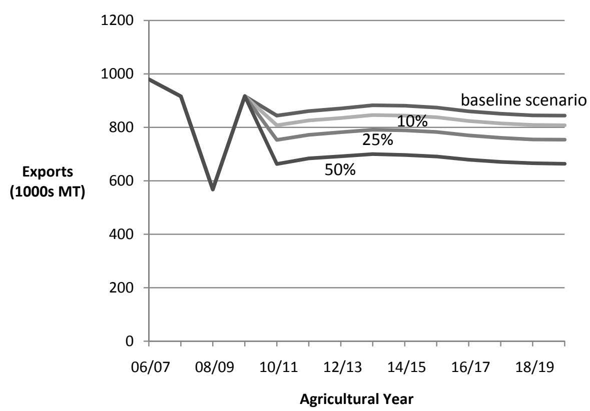
Figure 2: Amu Darya and Syr Darya rivers and basins of Central Asia. Source: (McKinney, 2005)



(a) area harvested



(b) production



(c) exports

Figure 3: Syr Darya-specific area reduction impacts on Uzbek cotton

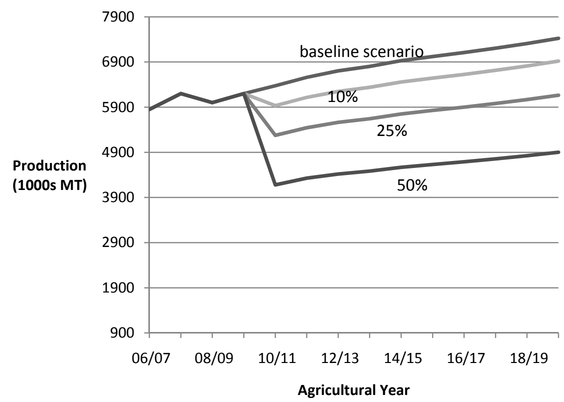


Figure 4: Syr Darya-specific area reduction impacts on Uzbek wheat production

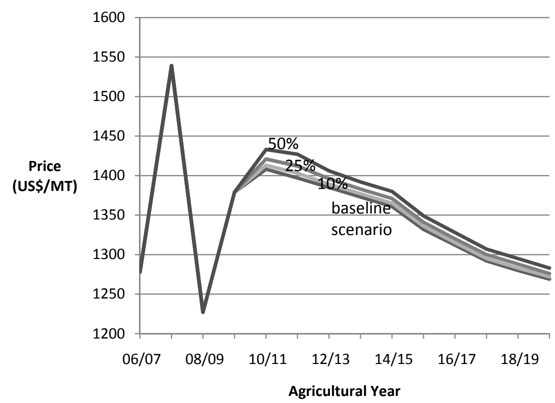


Figure 5: Syr Darya-specific area reduction impacts on world cotton prices

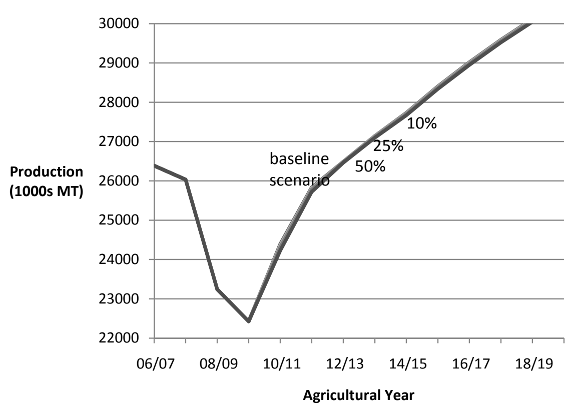


Figure 6: Syr Darya-specific area reduction impacts on world production

Table 1: Results from the 10% Area Reduction Scenario. Units are 1000s of metric tons

		Production			Imports			Exports			Consumption		
		2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
Uzbekistan	Baseline	1046	1084	1054	0	0	0	844	874	844	205	206	208
	Scenario	1009	1047	1018	0	0	0	808	838	808	205	206	208
	% Change	-3.53	-3.39	-3.42	–	–	–	-4.29	-4.20	-4.26	0	-0.04	-0.04
Top Exporters													
USA	Baseline	2991	3781	4106	2	2	2	2324	2866	3176	948	900	867
	Scenario	2991	3788	4112	2	2	2	2331	2880	3191	947	893	859
	% Change	0.00	0.18	0.16	0.00	0.00	0.00	0.30	0.47	0.46	0	-0.72	-0.93
India	Baseline	5434	6430	7254	112	97	85	1427	1536	1639	4158	4997	5725
	Scenario	5438	6439	7263	111	96	85	1436	1546	1648	4158	4996	5724
	% Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	–	–
Brazil	Baseline	1489	1788	1930	77	69	66	683	895	973	925	949	998
	Scenario	1489	1790	1932	77	69	66	690	897	975	925	949	998
	% Change	0.00	0.11	0.10	0.00	0.00	0.00	1.09	0.28	0.24	0	-0.05	-0.04
Australia	Baseline	476	572	621	0	0	0	451	577	626	9	8	8
	Scenario	476	583	621	0	0	0	451	587	626	9	8	8
	% Change	-0.02	0.04	0.03	–	–	–	0.03	0.04	0.03	0	0.00	0.00
Top Importers													
China	Baseline	7650	8830	9560	2263	2880	3241	13	11	11	10335	12072	13188
	Scenario	7650	8832	9561	2259	2878	3239	13	11	12	10333	12071	13188
	% Change	0.00	0.02	0.02	-0.15	-0.09	-0.06	0.31	0.39	0.36	0	-0.01	0.00
Bangladesh	Baseline	10	11	12	965	1200	1419	0	0	0	971	1209	1429
	Scenario	10	11	12	964	1199	1419	0	0	0	970	1209	1429
	% Change	0.05	0.09	0.08	-0.05	-0.04	-0.03	–	–	–	0	-0.04	-0.03
Turkey	Baseline	387	323	268	760	874	967	27	28	29	1119	1168	1206
	Scenario	387	323	268	760	874	967	27	28	29	1119	1167	1206
	% Change	0.00	0.00	0.00	-0.05	-0.03	-0.02	0.00	0.00	0.00	0	-0.02	-0.02
Indonesia	Baseline	6	6	6	516	520	527	4	4	4	516	522	529
	Scenario	6	6	6	516	520	527	4	4	4	516	522	528
	% Change	0.11	0.08	0.07	-0.06	-0.05	-0.04	0.00	0.00	0.00	0	-0.05	-0.04
Pakistan	Baseline	2116	2525	2634	678	785	923	50	50	50	2685	3224	3469
	Scenario	2117	2526	2635	676	783	921	50	50	50	2684	3223	3468
	% Change	0.03	0.04	0.03	-0.29	-0.23	-0.17	0.00	0.00	0.00	0	-0.03	-0.02

Table 2: Results from the 25% Area Reduction Scenario. Units are 1000s of metric tons

		Production			Imports			Exports			Consumption		
		2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
Uzbekistan	Baseline	1046	1084	1054	0	0	0	844	874	844	205	206	208
	Scenario	953	992	964	0	0	0	753	783	754	205	206	208
	% Change	-8.82	-8.48	-8.55	–	–	–	-10.74	-10.49	-10.65	0	-0.11	-0.09
Top Exporters													
USA	Baseline	2991	3781	4106	2	2	2	2324	2866	3176	948	900	867
	Scenario	2991	3799	4122	2	2	2	2341	2900	3212	945	884	847
	% Change	0.00	0.46	0.40	0.00	0.00	0.00	0.74	1.16	1.14	0	-1.79	-2.32
India	Baseline	5434	6430	7254	112	97	85	1427	1536	1639	4158	4997	5725
	Scenario	5442	6454	7277	110	95	84	1449	1561	1663	4157	4995	5722
	% Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
Brazil	Baseline	1489	1788	1930	77	69	66	683	895	973	925	949	998
	Scenario	1489	1793	1935	77	69	66	701	901	979	924	948	997
	% Change	0.00	0.27	0.24	0.00	0.00	0.00	2.72	0.70	0.61	0	-0.11	-0.10
Australia	Baseline	476	572	621	0	0	0	451	577	626	9	8	8
	Scenario	476	584	621	0	0	0	451	587	627	9	8	8
	% Change	-0.05	0.10	0.07	–	–	–	0.08	0.10	0.07	0	0.00	0.00
Top Importers													
China	Baseline	7650	8830	9560	2263	2880	3241	13	11	11	10335	12072	13188
	Scenario	7650	8835	9564	2254	2874	3236	13	11	12	10330	12070	13187
	% Change	0.01	0.05	0.05	-0.37	-0.22	-0.16	0.79	0.98	0.91	0	-0.01	-0.01
Bangladesh	Baseline	10	11	12	965	1200	1419	0	0	0	971	1209	1429
	Scenario	10	11	12	964	1198	1418	0	0	0	969	1208	1428
	% Change	0.14	0.23	0.19	-0.13	-0.09	-0.08	–	–	–	0	-0.09	-0.08
Turkey	Baseline	387	323	268	760	874	967	27	28	29	1119	1168	1206
	Scenario	387	323	268	759	873	966	27	28	29	1119	1167	1205
	% Change	0.00	0.00	-0.01	-0.13	-0.07	-0.05	0.00	0.00	0.00	0	-0.05	-0.04
Indonesia	Baseline	6	6	6	516	520	527	4	4	4	516	522	529
	Scenario	6	6	6	515	519	526	4	4	4	515	521	528
	% Change	0.27	0.20	0.17	-0.16	-0.13	-0.11	0.00	0.00	0.00	0	-0.12	-0.11
Pakistan	Baseline	2116	2525	2634	678	785	923	50	50	50	2685	3224	3469
	Scenario	2118	2527	2636	673	780	919	50	50	50	2682	3222	3467
	% Change	0.07	0.10	0.07	-0.74	-0.57	-0.44	0.00	0.00	0.00	0	-0.06	-0.06

Table 3: Results from the 50% Area Reduction Scenario. Units are 1000s of metric tons

		Production			Imports			Exports			Consumption		
		2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
Uzbekistan	Baseline	1046	1084	1054	0	0	0	844	874	844	205	206	208
	Scenario	861	900	874	0	0	0	663	691	664	204	206	208
	% Change	-17.66	-16.96	-17.08	–	–	–	-21.49	-20.98	-21.29	0	-0.22	-0.19
Top Exporters													
USA	Baseline	2991	3781	4106	2	2	2	2324	2866	3176	948	900	867
	Scenario	2991	3816	4138	2	2	2	2358	2933	3248	941	868	827
	% Change	0.00	0.92	0.79	0.00	0.00	0.00	1.48	2.32	2.27	-1	-3.58	-4.63
India	Baseline	5434	6430	7254	112	97	85	1427	1536	1639	4158	4997	5725
	Scenario	5451	6479	7300	109	94	83	1470	1587	1687	4155	4993	5720
	% Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
Brazil	Baseline	1489	1788	1930	77	69	66	683	895	973	925	949	998
	Scenario	1489	1798	1939	77	69	66	720	907	985	923	947	996
	% Change	0.00	0.55	0.48	0.00	0.00	0.00	5.44	1.40	1.22	0	-0.23	-0.20
Australia	Baseline	476	572	621	0	0	0	451	577	626	9	8	8
	Scenario	476	584	621	0	0	0	451	588	627	9	8	8
	% Change	-0.11	0.20	0.14	–	–	–	0.17	0.19	0.13	0	0.00	0.00
Top Importers													
China	Baseline	7650	8830	9560	2263	2880	3241	13	11	11	10335	12072	13188
	Scenario	7651	8839	9568	2246	2867	3230	13	11	12	10325	12068	13186
	% Change	0.01	0.10	0.09	-0.74	-0.44	-0.32	1.58	1.95	1.81	0	-0.03	-0.02
Bangladesh	Baseline	10	11	12	965	1200	1419	0	0	0	971	1209	1429
	Scenario	10	11	12	962	1197	1417	0	0	0	968	1207	1427
	% Change	0.27	0.46	0.38	-0.27	-0.19	-0.16	–	–	–	0	-0.18	-0.16
Turkey	Baseline	387	323	268	760	874	967	27	28	29	1119	1168	1206
	Scenario	387	323	268	758	873	966	27	28	29	1118	1167	1205
	% Change	0.00	-0.01	-0.02	-0.26	-0.13	-0.10	0.00	0.00	0.00	0	-0.10	-0.09
Indonesia	Baseline	6	6	6	516	520	527	4	4	4	516	522	529
	Scenario	7	6	6	514	519	526	4	4	4	515	521	527
	% Change	0.54	0.40	0.34	-0.33	-0.25	-0.22	0.00	0.00	0.00	0	-0.24	-0.22
Pakistan	Baseline	2116	2525	2634	678	785	923	50	50	50	2685	3224	3469
	Scenario	2119	2529	2638	668	776	915	50	50	50	2679	3220	3465
	% Change	0.14	0.19	0.15	-1.48	-1.15	-0.87	0.00	0.00	0.00	0	-0.13	-0.12

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