

Climate Change Effects on Agriculture in Tajikistan

Parviz Khakimov, Jovidon Aliev, Timothy S. Thomas, Jarilkasin Ilyasov, Sarah Pechtl, and Shahnila Dunston

Climate change is one of the main challenges for Tajikistan's agricultural development in the medium and longer term. Tajikistan's Agri-Food System and Sustainable Development Program (ASDP) for the period up to 2030 defined climate change as one of four key challenges to the development of agriculture and food systems. Accordingly, the Program accentuates the importance climate-optimized agriculture to ensure sustainable development of the sector.

The effects of climate change on agriculture in Tajikistan was examined using IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) by simulating climate change and no climate change (baseline) scenarios between 2015 and 2050.

Key findings

- The findings of the study show that the effect of climate change on Tajikistan's agricultural sector is mostly negative.
- Climate change effects on individual crops will depend on their tolerance to heat and water availability. Winter crops in temperate climates often increase productivity in warmer temperatures, in contrast to spring crops which are more likely to experience heat stress in response to warming. Changes in seasonal rainfall patterns and severe weather events may affect planting and harvesting.
- Analysis of main crop yields shows that climate change in Tajikistan will have a negative impact on crop yields with three exceptions: cotton, potatoes, and rice. These will have either small positive gains or an almost indiscernible reduction (in the case of rice).
- Climate change ultimately affects the expansion or reduction of the area allocated for crops, impacting productivity, expected prices, competition from other crops, and land demand.

Recommended actions

- Develop and invest in strategies and measures for climate change adaptation and mitigation.
- Capacity building for farmers and rural populations on climate change resilience.
- Introduce an expand water-saving technologies, in addition to more efficient and expanded irrigation.
- Introduce crops and crop varieties that are tolerant to low moisture or drought and higher temperatures as one component of climate change adaptation strategies.
- Increase production of crops, which are less affected or benefit from climate change.

Introduction

Tajikistan is a small, landlocked, and mountainous country in Central Asia. Tajikistan's open economy has experienced prominent economic growth during the last 20 years, with the agricultural sector contributing an average of 22 percent to the GDP. The agricultural sector faces many challenges and climate change is one of the key obstacles in the sustainable development of the sector. To assess the vulnerability and resilience of agriculture and food security to climate change in Tajikistan, a study was conducted using IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT). This global partial equilibrium model integrates economic, water, and crop models and simulates national and international agricultural markets, allowing an integrated analysis of changing environmental, biophysical, and socio-economic trends. The water simulation component of

the IMPACT model estimates changes in water supply and demand for irrigation and other water-using activities. The model is designed to examine future global food supply, demand, trade, pricing, and food security. IMPACT covers 56 agricultural commodities, 159 countries, 154 water basins, and 320 food production units.¹

The main findings from a policy paper published in 2020 summarized below.²

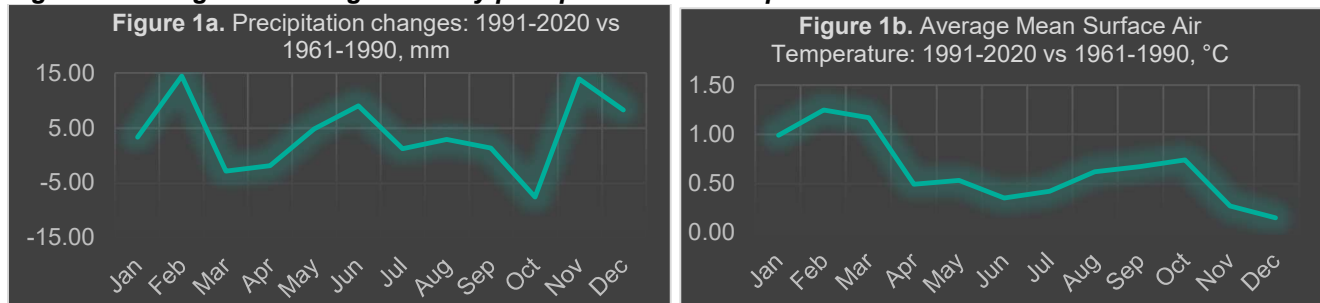
Climate Change and Recent Trends in Agricultural Development

In addition to significantly contributing to the country's total GDP, the agricultural sector employed 61 percent of the labor force. The average annual sectoral growth rates were 6.4 percent during 2010–2019, 8.8 percent in 2020, and 6.6 percent in 2021 (TAJSTAT 2021). The majority of the country's population resided in rural areas and depend on agriculture.

Water use has decreased in recent years compared to 1990, largely because of reductions in land being allocated for cotton. More than 80 percent of the country's total freshwater is used for irrigation.³ Land reform has been characterized by the reorganization of large state farms into smaller private (dehkan or peasant) farms, managed and operated mainly by individuals or family members. As of January 2023, the total number of dehkan farms reached nearly 180,000, the majority of which have small arable area, operate as subsistence farms, and have limited capacity for mitigation and adaptation to climate change effects.

According to historical data provided by the Climate Change Knowledge Portal for Development Practitioners and Policy Makers (CCKP), average annual precipitation levels might not be significantly different between the periods of 1961–1990 and 1991–2020. However, changes in precipitation levels have taken a more seasonal pattern, which directly affects agricultural activities. While precipitation levels increased in January–February of the 1991–2020 period more than in 1961–1990, the reverse can be observed during March–May. From August onward, precipitation patterns for the two date ranges remain largely the same (Figure 1a). Contrary to precipitation data, the average monthly temperature has increased for all months during the 1991–2020 period compared to 1961–1990 (Figure 1b). Overall, the average annual temperature increased by about 0.64°C from 1991–2020 compared to 1961–1990.

Figure 1. Changes in average monthly precipitation and temperature



Source: World Bank Group. Climate Change Knowledge Portal for Development Practitioners and Policy Makers.

Simulated scenarios and results of analysis

The simulation analysis involves five scenarios, with one baseline scenario and four climate change scenarios.⁴ All four climatic scenarios predict an increase in temperature in both the Amu-Darya and Syr-Darya river basins. It appears that the largest rise in temperature will occur in July, already the warmest month. It also appears that at least for the warmest months of the year, daytime temperature is projected to rise more than night-time temperature. The baseline scenario (Sc1)⁵ allows for change in supply-and-demand factors with no climate change assumption. In this analysis, the results of the baseline scenario are compared with the average of the four climatic scenarios. Two important exogenous variables — GDP growth and population growth — are taken into consideration as they directly affect the global demand for food, which in turn indirectly affects most other economic variables in the model.

The Hadgem climatic scenario projects an increase in precipitation levels. The other three climatic models (MIROC, GFDL and IPSL) project precipitation decreases in at least some parts of the country. All four scenarios project an

¹ For more details, see Rosegrant et al. 2012.

² Parviz Khakimov, Jovidon Aliev, Timothy S. Thomas, Jarilkasin Ilyasov and Shahnila Dunston (2020). Climate change effects on agriculture and food security in Tajikistan. *Silk Road: A Journal of Eurasian Development* | 2020, <https://doi.org/10.16997/srjed.33>

³ World Bank, 2007.

⁴ 1. Model for Interdisciplinary Research on Climate (MIROC), developed at the University of Tokyo Center for Climate System Research, 2. Hadley Centre Global Environment Model (Hadgem), UK, 3. Geophysical Fluid Dynamics Laboratory (GFDL), Princeton University, 4. Institute Pierre Simon Laplace (IPSL) Global Climate Modelling Centre (France).

⁵ In scenario 1 (SC1), the terms business as usual, baseline scenario and no-climate-change scenario are used interchangeably.

increase in temperature. The effects vary in both magnitude and location. Different climate scenarios project different levels of change in precipitation in 2050 compared to the base year 2000.

The findings of the study show that the effect of climate change on Tajikistan's agricultural sector is mostly negative. We note that wheat, barley, maize, fruit, and vegetable crops seem to be particularly vulnerable to climate change, having several large negative values in the yield and supply columns. Increases in producer prices could be specifically good for export crops, because they improve the trade balance. Yet, while the effect is somewhat mixed for farmers, price increases are expected to have adverse effects for consumers, who will have to use a higher proportion of their income on food (see Table 1).

Table 1. Overall effects of climate change: climate change vs. no climate change in 2050 (percentage difference).

	<i>Yield</i>	<i>Area</i>	<i>Supply</i>	<i>Demand</i>	<i>Net Trade, 000 Mt</i>	<i>Producer Price</i>
Maize	-21,8	3,9	-18,6	-4,7	-21	41.0
Cotton	0,9	7	7,9	-1,9	23	17.0
Rice	-1,2	6,4	5,4	-4,9	12	20.5
Potato	3,9	7,7	10,7	-6,9	205	30.6
Barley	-9,6	-10	-18,2	0,2	-15	-3.1
Fruits	-10,7	-1,6	-12,2	-1,3	-71	9.7
Wheat	-14,6	-5,3	-21,1	-2,2	-110	10.1
Vegetables	-8,8	-0,6	-9,2	-2,7	-27	10.7

Source: Own compilation based on IMPACT model results.

Notes: Statistics computed for combined rain-fed and irrigated crops.

However, Table 1 only tells part of the story — namely what will probably happen compared to what could have happened without climate change. Table 2 presents a more complete story and displays what the future will look like compared to the present.

Table 2: Change in agriculture between 2015 and 2050 under climate change (percentage difference)

	<i>Yield</i>	<i>Area</i>	<i>Supply</i>	<i>Producer price</i>
Wheat	-7.5	-9.4	-16.1	27.9
Cotton	18.6	21.0	45.2	36.9
Fruit	-2.2	27.8	25.0	27.8
Barley	6.9	-9.9	-3.6	9.8
Maize	-8.6	29.2	17.9	75.3
Potatoes	16.1	27.3	48.4	41.3
Vegetables	2.5	19.4	22.4	47.2
Rice	38.7	19.5	66.2	42.4

Source: Own compilation based on IMPACT model results.

Notes: Statistics computed for combined rain-fed and irrigated crops.

Table 2 elucidates that although both wheat and maize yields are projected to decline in absolute terms between 2015 and 2050, the land area to grow wheat will decline while the land area to grow maize will expand. This can be explained by wheat prices being expected to rise by only 28 percent while maize prices are estimated to rise by 75 percent. Cotton yields are expected to improve over time—not primarily as a result of climate change, but due to continued improvements in technology and management. Given the projected rise in cotton prices, this is also expected to lead to an increase in the area cultivated. Rice yields are expected to grow as well, and more than any of the other major crops in Tajikistan. Nonetheless, its share of all cultivated land is quite small. By 2050, this share will still be significantly smaller than that of wheat, cotton, and fruits. Like wheat, the area used to grow barley is projected to decrease. This appears not to be driven by climate change as much as by meagre projected price increases. If those projections for future prices turn out to be overly pessimistic, the land area for barley may not shrink at all, but may even increase.

It is important to note that while IMPACT is useful for predicting future climate impacts, it does not account for all adaptation options. For example, it does not consider spring wheat and winter wheat as separate crops but labels them as just 'wheat'. However, using crop modelling, we observed that climate change is expected to improve winter wheat yield by roughly 5 percent in Tajikistan, while lowering spring wheat yields by around 15 percent. This suggests that Tajikistan might not need to reduce wheat cultivation and might not even lose wheat productivity if it is able to discover how to help farmers shift to winter wheat cultivation.

Some limitations of the approach used in this study should be discussed. The current version of the IMPACT model does not reveal the effects of climate change on livestock. Also, with the model being partial, though global, it does not show the effects of climate change in other sectors of the economy. An analysis of climate change effects on livestock and the implications of the computable general equilibrium model that allow for revealing the effects of climate change in other sectors of the economy should be subject to further studies. Moreover, future analyses should examine the effects of climate change on the agricultural sector by agro-climatic zones.

Looking ahead

An analysis of main crop yields shows that climate change will have a negative impact on crop yields with three exceptions—cotton, potatoes, and rice—which will have either small positive gains or an almost indiscernible reduction in the case of rice.

The objectives; tested hypothesis; socio-economic, demographic, agricultural and climate change analysis; as well as the main findings of the study lay the basis for some policy recommendations.

First, the development of climate change mitigation strategies and capacity building for farmers and rural populations in knowledge related to climate change, including mitigation and adaptation strategies, should be defined as a strategic priority of the country.

Second, in light of the limitations on available resources to invest in climate change adaptation, cooperation in research and development to minimize the cost of climate-change-related activities would be beneficial for each country in the Central Asia region.

Third, it is necessary to introduce and expand water-saving technologies, in addition to more efficient and expanded irrigation.

Fourth, the introduction of crops and crop varieties tolerant to low moisture or drought and tolerant to higher temperatures should be integrated as one component of climate-change adaptation strategies.

Fifth, considering the limited land resources in Tajikistan, the restoration of abandoned land will allow for increased agricultural activity and will increase domestic supply of agricultural products.

Sixth, increased cotton yields, in addition to its gain in the climate change scenario, will lead to an increase in domestic supply and the development of the textile and sewing industries, which may help increase competitiveness of the sector in the domestic and global market.

Finally, expanding winter wheat cultivation should be explored as a means to maintain or even increase wheat production. Land allocated for potato production should be expanded to allow for the satisfaction of domestic demand, the development of a processing industry, and increased potato exports.

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ABOUT THE AUTHORS

Parviz Khakimov (p.khakimov@cgiar.org), Country Program Leader / Senior Research Fellow, Development Strategy and Governance (DSG) Unit of IFPRI based in Dushanbe, Tajikistan

Jovidon Aliev (j.aliev@cgiar.org), Senior Research Analyst, DSG Unit of IFPRI based in Dushanbe, Tajikistan.

Sarah Pechtl (s.pechtl-nsf@cgiar.org) is a Mickey Leland International Hunger Fellow in the Development Strategy and Governance Division of IFPRI based in Dushanbe, Tajikistan.

Timothy S. Thomas (tim.thomas@cgiar.org), Senior Research Fellow, Foresight and Policy Modelling (FPM) Unit, IFPRI, Washington, DC, USA

Shahnila Dunston (s.dunston@cgiar.org), Senior Research Analyst, FPM Unit, IFPRI, Washington, DC, USA