UKRAINE
Building Climate Resilience in Agriculture and Forestry

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This 2021 World Bank study is the first detailed assessment of the potential impacts of climate change on Ukraine with a focus on agriculture, a key driver of the economy and jobs. Improvements in climate modeling and increased confidence in climate projections have opened the door to a better understanding of how climate change could impact Ukraine's economy and what actions could offset potential costs or tap into new opportunities.

About the Study

Supporting Ukraine in Planning for the Future

The study fills an important information gap by providing over two terabytes of highly granular data on a range of climate indicators for Ukraine using the latest available global and regional climate models. The analysis provides detailed climate projections for over 7,400 geographic points across the country, estimates the impact on key crops and forest timber species, and provides insights into how these changes would be experienced in different oblasts in the country.

The huge trove of data generated for this study is equivalent to the amount of information contained in two large libraries full of books,* and is now housed at the Ukrainian Hydrometeorological Institute in Kyiv.

Ukrainian scientific institutions can continue to update the data and are well-positioned to engage in continuous analysis. This data will also help Ukraine participate in and take advantage of the EURO-CORDEX experiment and develop highly disaggregated climate projections that could be used to estimate climate risks in different sectors of the national economy and also at the sub-national level.

The study looks at changes expected through the 21st century with climate analysis mainly focused on two scenarios:

- "Some mitigation measures to limit greenhouse gas emissions" — RCP 4.5 (global 2.4°C warming limit by 2100)
- "Business as usual" (no mitigation measures) — RCP 8.5 (global 4.3°C warming limit by 2100).
- This report is supported by four Background Technical Reports exploring Climate Projections, Impact on Agriculture, Impact on Forests, and a Distributional Analysis.

** Indiana University Information Systems Knowledge Base https://kb.iu.edu/d/ackw*

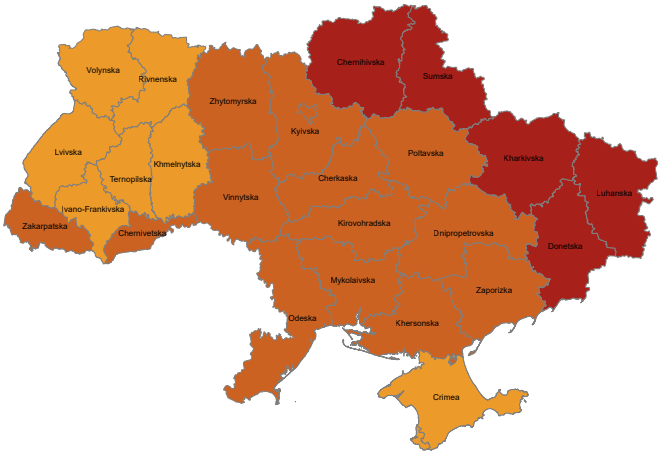
Climate change is the defining factor of global development in the 21st century.

Ukraine has recognized the importance of Climate Change to achieving its development goals and taking steps toward a green transition. The country recently affirmed its commitment to the European Green Deal and updated its Nationally Determined Contribution (NDC) in 2021. A Presidential Decree of March 23, 2021, further demonstrates that ecological security and climate change are high on the Government's agenda.

How will Ukraine's climate change during the 21st century?

Ukraine has experienced accelerating warming since the 1980s, and temperatures are projected to continue to rise.

- Without mitigation measures (RCP 8.5), temperature increases over 4°C are projected by the end of the century, with the largest effect on the east and northeast of Ukraine (Kharkivska, Luhanska, Sumska) and the smallest in the west (Ivano-Frankivska, Lvivska, Volynska).
- Annual temperature cycles are expected to change, with higher projected monthly temperature increases in summer months in warmer regions, and in winter months in colder regions. Under RCP 8.5, more than 100 tropical nights and up to 135 summer days per year are projected for the southern steppe by the end of the century.
- Rising temperatures in summer could result in heatwaves and an increase in aridity in the south and east of Ukraine.
- The number of ice days and frost nights will reduce dramatically by 22 days in the southern region even with mitigation measures (RCP 4.5).



Key: Red denotes a higher increase and gold a lower increase in mean annual temperature in the oblast through 2100 under RCP 8.5 as compared to the baseline period of 1991-2010.

These impacts will need to be further analyzed for their effect on health and the heating and cooling needs of the population, especially vulnerable groups and on urban infrastructure.

Annual precipitation is projected to increase, but inconsistently across both geography and seasons.

- Summer months will become drier and decreases in summer precipitation will become more pronounced toward the end of the century.
- Precipitation is projected to increase in the winter months for almost the entire country. Larger precipitation increases are expected in the northwest (Rivnenska, Volynska), with decreases in summer months in the south and west.
- The southern and central areas are characterized by the lowest increase in precipitation, with some decrease in warmer months.

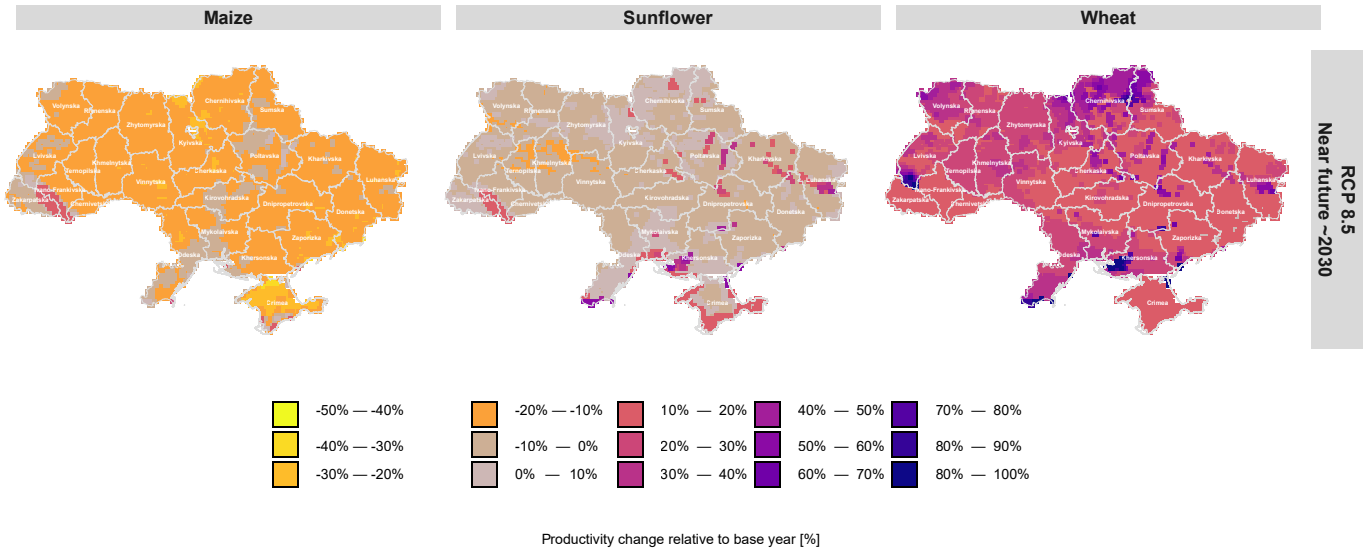
Key: Darker shades of blue indicate oblasts with higher increases in mean annual precipitation in 2100 compared to baseline 1991-2010 under RCP 8.5. Gold indicates oblasts with a decrease in mean annual precipitation.

Extreme weather and climate events, including heatwaves, thunderstorms, flooding, and droughts, are expected to rise with higher temperatures. Further analysis is needed to determine how such events will affect Ukraine over the remainder of the 21st century.

How will climate change impact agriculture in Ukraine?

Agriculture contributes about 9% to Ukraine's GDP (2019), or US$13.8 billion per year.

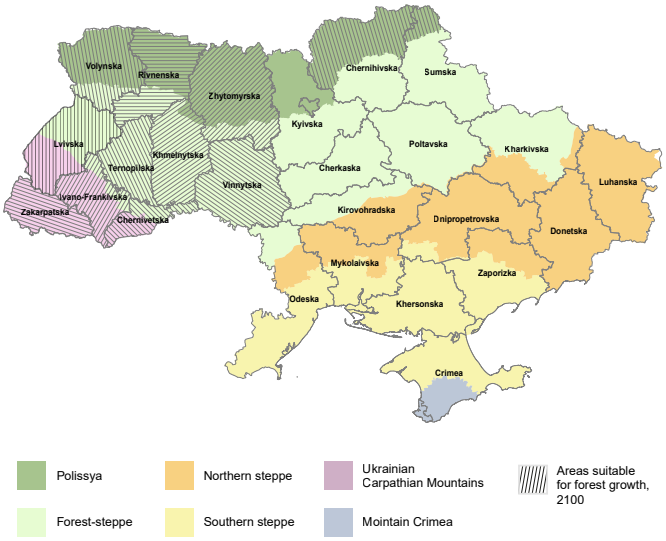
- Agricultural yields for all crops may fluctuate significantly and in any given year, and the risk of lower-than-expected yields is large.
- Sowing and harvest seasons will likely need to shift to accommodate changes in temperature and precipitation:
  - Winter crops will need to be sowed later (October–November), and spring crops sowed earlier.
  - Crops will need to be harvested before the dry weather of late summer, especially in the south of Ukraine.
- Yields of barley, maize, and sunflower could decrease by 10-30% in 2030 and 2050 as compared to 2010.
- Winter wheat yields are projected to increase by 20–40% in north and northwestern Ukraine by 2050 as compared to 2010, The main drivers of winter wheat yield are the changes in precipitation (autumn, winter), increased CO2 concentration, and the decrease in the number of frost nights.
- With climate-smart water management interventions, the productivity of maize, sunflower, and barley could also benefit from changes in temperature and rainfall patterns by mid-century. Climate-smart strategies for water management, and shifts in sowing dates, could increase yields up to 80% for maize and by 40–80% for sunflower.



How will climate change impact forests?

Forests currently cover about 9.6 million hectares or about 15.9% of Ukraine's territory.

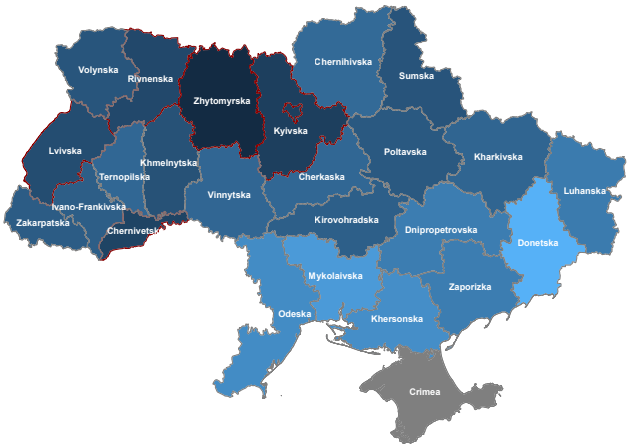
- A significant reduction is expected in the area suitable for the growth of spruce, beech, pine and oak. Without climate mitigation measures, less than 3% of the country's forest areas would have optimal conditions for Norway spruce, Scots pine and beech and just 8% would have optimal conditions for English oak, and only the Carpathians are projected to remain a suitable zone for Norway spruce.
- Forests are likely to face increasing threats from wildfires and insects.



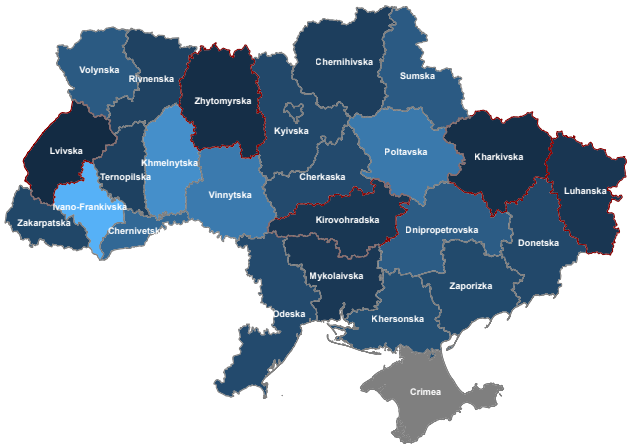
Impact of Climate Change on Agriculture and Inequality

Without climate adaptation measures, increased warming and agricultural losses are projected to result in significant loss of household incomes and increases in poverty and inequality, with impacts varying across oblasts.

- The five oblasts with the highest impact on agriculture in absolute terms by 2030 are Cherkaska, Khersonska, Kirovohradska, Poltavska, Vinnytska. Kirovohradska oblast has the highest agricultural GDP Ukraine. In Kyivska and Zhytomyrska oblast with reduction in precipitation in spring and summer, potential losses in agriculture could reach 40-60 % by 2050 if no adaptation measures are taken. With a consistent rise in dry and hot conditions, Chernivetska and Kyivska oblasts will be exposed to extremely high temperatures that may result in an increase in extreme weather events.
- The five oblasts with the highest increase in poverty and inequality due to lower agricultural production values are Kharkivska, Kirovohradska, Luhanska, Lvivska, and Zhytomyrska. These blasts would be most susceptible to the rise in food prices and reduction of income from agricultural production caused by the warming climate. Lvivska and Zhytomyrska oblasts could lose a significant proportion of their agricultural revenue by 2030.



Key: Darker shades denote a higher negative impact on agricultural production and its value in the oblast.



Key: Darker shades denote a higher impact on poverty headcount, poverty gap, and severity of poverty in the oblast.

A Way Forward for Ukraine

With timely adaptation, Ukraine can reduce the economic risk to agriculture and forests and enhance opportunities in these sectors.

Empowered with data and analysis, Ukraine can take action to adapt to meet the projected risks of temperature increases, shifts in seasons, and changes in precipitation patterns.

With proactive planning, policy and investment, Ukraine may be able to turn changing weather patterns to its advantage for certain crops in the most affectedareas of the country. Recommended adaptation actions for Ukraine, based on the country context and international good practice, are outlined below.

Recommendations

Based on the analysis presented in the report, as well as global best practice, actions are recommended along three broad streams:

- Strengthen Institutions, Policy and Planning
- Increase Scientific Capacity and Research
- Promote Transition to Climate-Smart Agriculture and Forestry

Strengthen Institutions, Policy and Planning

- **Establish a national-level institutional mechanism to coordinate climate change policy and actions across all line ministries**. This will enable fiscal risk assessment of climate actions, policy and planning, and climate budget tagging to prepare critical sectors— including energy, infrastructure, health, and agriculture—for climate impacts.
- **Establish a mechanism to integrate climate change action within the Ministry of Agriculture Policy and Food (MAPF).** Strengthened climate expertise and functions will equip MAPF with the technical capabilities to support effective and coherent climate policies and programs for farmers. It will also be important for MAPF to regularly carry out climate vulnerability assessments for the agriculture sector and develop action plans (every five years).
- **Integrate climate change risk in oblast development planning.** More comprehensive oblast-level impact assessments need to be conducted to identify specific climate risk considerations for development planning, and tailoring action to the sectors in the oblast facing the highest risk.

Increase Scientific Capacity and Research

Enhance institutional capacity for collecting, maintaining, analyzing, and disseminating climate data through a National Climate Resource Center. Strengthen the *Ukraine Hydrometeorological Institute (UHMI) and the Ukrainian Hydrometeorological Center (UHMC) as a National Climate Resource Center (NCRC),* which can ensure systematic research on hydrometeorology, agrometeorology, and climate science.

Promote Transition to Climate-Smart Agriculture and Forestry

- **Promote climate-smart agriculture, including agroforestry (planting combinations of trees and crops), drought-resistant varieties of key crops, and cover crops.** Expand landscape diversity and connectivity to increase the ability of ecosystems to adapt to changing climate conditions and stresses.
- **Give incentives to farmers through agro-tourism and eco-tourism programs to manage non-arable lands, maintaining biodiversity and natural habitats.** These approaches have been shown to protect agriculture from environmental and climate stresses.
- **Promote Farmer Information Systems and Precision Agriculture Technologies.** Provide farmers with reliable and accessible knowledge about climate-smart agriculture and enhance their capacity for adaptation. An information system for farmers through mobile, online, and in-person extension services will be key to raising awareness and initiating action on the ground. Promoting the use of precision agriculture, including Variable Rate Technology (VRT)—remote sensing and drones—would help Ukraine reduce waste of water and other resources. Ukraine can leverage its significant capacity and large talent pool in information technologies to develop and maintain such systems.
- **Improve targeting of subsidy programs and develop insurance products for climate risks.** In addition to improving targeting of subsidies to small-scale farmers, agricultural programs and loans could be linked to the adoption of climate-smart technologies and specialized insurance can be offered to farmers to cover residual risks of climate change not addressed by adaptation actions.
- **Engage in long-range climate risk planning for the forest sector:** include climate risk management in the forthcoming Forest Strategy 2030 and associated plans for reforestation/afforestation in the country and maintain a regularly updated national forest inventory.

Climate-Smart Agriculture

Soil fertility and water availability have been enhanced, and water runoff and soil erosion reduced, through adaptation measures implemented in many locations around the world to strengthen the resilience of agricultural systems. For example:

Climate-Smart Soil Management

- contour ploughing or contour tillage on sloping land
- contour bunding
- conservation tillage
- surface mulching
- revegetation and reforestation of areas around farmland (i.e., shelter belts)

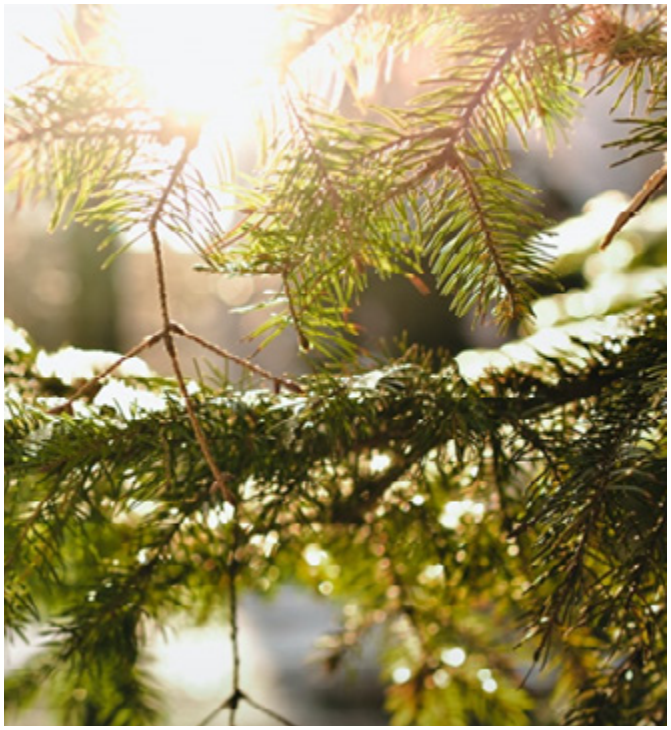
Climate-Smart Water Management

- bio mulching (using biodegradable mulch on fields)
- conservation farming practices (direct seeding and covering crops with different tillage systems: no-till, mini-till, strip-till, etc.)
- precision agriculture to minimize water and material inputs
- planting drought-tolerant species with long growing periods

Forestry and Agroforestry Practices

- Incorporating trees in farming systems has been shown to improve soil quality ensuring higher and more stable crop yields.
- Agroforestry practices increase the soil's moisture absorptive capacity and reduce evapotranspiration.
- Tree canopy covers help reduce soil temperature for crops planted beneath and decrease runoff and soil erosion from heavy rainfall.

Source: Adapted from CGIAR Research Program on Climate Change (2021).



The analysis for this study focused on climate projections and their impact on agriculture, modeled by projecting the yield of key crops—wheat, soybean, sunflower, maize, and barley—through the middle and end of the century. The study did not project frequency or intensity of extreme events such as floods and storms. The assessment's impact on agriculture was modeled on yield projections alone. Detailed assessments, including those at the oblast level, would be needed to prepare actionable adaptation plans for different sectors.

For more details, please see the full report: Ukraine: Building Climate Resilience in Agriculture and Forestry. This study is based on the analysis in four Background Technical Reports covering: Climate Projections, Impact on Agriculture, Impact on Forests, and Distributional Analysis.

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