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ANALYSIS

# Will Russian Agriculture Benefit from Climate Change?

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## Abstract
Climate change threatens large swaths of global agriculture. However, the global North could benefit agriculturally and economically from warming. Russia is therefore increasingly portrayed internationally as a major beneficiary of climate change. Is climate change driving today's agricultural heavyweight player to become an internationally dominant agricultural giant? In this article, I reflect on recent and important scientific studies to investigate this question.

## Russia's Path to Becoming an Agricultural Giant
Systemic change and profound social transformation in the early 1990s led Russian agriculture into a tremendous crisis. Agricultural yields and cultivated land declined, and livestock production collapsed. Around the turn of the millennium, political and farm structures stabilized, and the Russian agricultural sector entered a boom phase that continues to this day. The upswing is due less to an increase in cultivated land and more to rising productivity. While average wheat yields in the 1990s were 1.6 tons per hectare (t/ha), this metric increased to 2.0 t/ha in the 2000s and 2.4 t/ha in the 2010s (FAOSTAT, 2021). Although yields to date remain far below those of the leading grain producers, for example, in the European Union, Russia is now an agricultural heavyweight. The world's largest country supplied 23% of global wheat exports in the 2017/18 season. The Russian agricultural sector is thus not only a driving force of domestic economic growth, but also a crucial pillar for global food security. Against this background, climatic developments in Russia are being followed with great international attention (for example, Lustgarten, 2020).

## Is the Recent Agricultural Boom due to Climate Change?
Warming in the southern Black Earth region, where the main agricultural areas are located, has been well above the global increase in recent decades, with 0.4–0.5 °C warming per decade (Agafonova et al., 2017). Several scientific studies show that the large yield increases there in recent years are not due to improved climatic conditions. In contrast, a groundbreaking study indicated that Russian wheat yields would have been 15% higher between 1980 and 2008 if the climate had not changed during that period (Lobell et al., 2011). In addition, annual weather-related yield fluctuations have been high for many years and continue to rise. The number of hot summers doubled between 1980 and 2012 compared to the previous three decades. The extreme drought of 2010 resulted in yield declines (Hunt et al., 2021), prompting the Russian government to block grain exports in August 2010 to counteract domestic food inflation (Svanidze et al., 2019). Russia's export restrictions have contributed to rapid price increases and social unrest worldwide (which is particularly severe in Egypt).

## How Will Climate Change Affect Crop Production in Russia?
Russian land area is projected to warm by 2.6 to 3.4 °C by 2050, depending on trends in global greenhouse gas emissions. Warming is expected to be slightly greater in the north than in the south. It has been calculated that today's subarctic climate in northern Russia may change from a summer warm to hot continental climate by 2071–2100. Russia will then have a climate similar to the wheat belt of the United States (Beck et al., 2018). Permafrost soils will retreat far into northern Russia. Precipitation forecasts are more uncertain than temperature forecasts, but there is clear evidence of a positive trend (10–20% increase) across the largest part of Russia. Extreme weather is very likely to increase. If global warming exceeds 1.5 °C, drought events as intense and widespread as those in 2010 will be much more likely in a few decades than they are today (Templ and Calanca, 2020). Another study modeled that a weather constellation similar to 2010, in combination with lower soil moisture, would result in much more intense droughts in the future than in this extreme year (Rasmijn et al., 2018).

What do these climate prospects mean for Russian agriculture? Almost all studies suggest that climate change will negatively affect yields in the southern Black Earth region, especially in the absence of adaptation. In particular, greater heat and water stress during key developmental stages in early summer are likely to affect crops in the Black Earth region even more than today. Yield reductions are expected to be higher for spring crops than for winter crops. The highest yield declines are expected in the Volga region, where spring crops are predominantly grown. It is very likely that more frequent and intensifying extreme weather events will increase annual yield variability in the Black Earth region.

There is also widespread scientific agreement that higher temperatures and, in particular, an extended growing season will allow for higher yields north of the Black Earth region (roughly between 54° and 60° north latitude) in the future. Even further north (roughly north of 60° latitude, i.e., north of St. Petersburg), where little grain or small amounts of forage have been produced to date, warming could produce even more dramatic changes. Numerous recent studies, some of which have received much attention, imply that the future climate in northern Canada, Scandinavia, and especially Russia will be favorable for crop production within a few decades (Hannah et al., 2020, Xu et al., 2020). According to these studies, a broad swath of northern Russia will cultivate wheat and potatoes in a few decades. The future shift of agricultural suitability toward the north is very well illustrated in Figure 3 in Di Paola et al. (2018).

## Can Future Climate Advantages Be Exploited in the North?

In the medium term (until 2050), development opportunities are most favorable for the strip north of the Black Earth region (54°–60°N). This region is well developed in terms of infrastructure and agricultural structure, and approximately half of Russia's total population lives here (although massive rural depopulation since the collapse of the Soviet Union has hit this region). Our research has shown that very large yield increases are possible in this region, especially if nutrient fertilization and crop protection are optimized (Schierhorn et al., 2014). Improved varieties, modern agricultural management, and more favorable climatic conditions could also lead to increases in terms of yield. Our research also indicates that the largest areas of abandoned agricultural land are located north of the Black Earth region (Lesiv et al., 2018). Abandoned land that has not yet stored large amounts of carbon in the soil and vegetation (some areas are already forested) could be transformed into high-yielding fields in the next few decades. In the long term (by 2100), increasing extreme weather events could, however, put a lot of pressure on cropland in this region, according to most climate predictions.

For regions north of the 60$^{th}$ parallel, agricultural potential, in my view, should be evaluated realistically and in a differentiated way. Only 4.5% of the Russian population lives in this region, and there are good reasons for this: short days in the winter months (which, of course, will not shift along with climate change), extreme weather conditions, and poor infrastructure; these features characterize northern Russia. The thawing and accompanying subsidence of permafrost poses huge challenges and investments for settlements in northern Russia (Shemetov, 2021). The Russian government is offering immigrants free land in northern Russia, but this initiative has been quite unsuccessful thus far, according to several recent newspaper articles. All in all, these are rather unfavorable conditions for positive demographic growth in this region in the medium term.

There are also arguments against exaggerated expectations with regard to agricultural suitability: Although the growing season will be longer on average, the number of warm days per year will be subject to strong annual fluctuations. Frequent late frosts and unstable summer precipitation will also affect agriculture in northern Russia for a long time. There is preliminary scientific evidence that thawing permafrost soils could flood crop fields or, due to soil erosion, have unfavorable properties for crop production (Desyatkin et al., 2021). Last but not least, ecological factors limit the agricultural potential of northern Russia. Most of the area north of 60 degrees latitude is forested, and large amounts of carbon and methane are stored in the vegetation and soil. The conversion of forests and permafrost soils to cropland is very likely to result in high greenhouse gas emissions. The draining of peatlands, which are widespread in northern Russia, is also associated with large emissions. There is also evidence that cropping leads to faster permafrost thawing than other land uses, driving climate change.

## Conclusion

To date, the Russian grain sector has been on a growth trajectory. However, the bulk of grain is produced in the fertile southern Black Earth region. There, it has already become too hot and/or too dry for primary crops, but almost all climate models predict less favorable climatic conditions for crop production. Regions north of the Black Earth region are expected to benefit from warming, and large jumps in yield are realistic there. Given the widespread abandoned croplands in this part of the country, land under cultivation could be increased. Climate change will also open up areas further north to crop production. However, many agroclimatic and socioeconomic factors will still severely limit agricultural development in northern Russia in the coming decades. Climate change poses major challenges for Russian agriculture and Russian policy. A narrative in which climate change will have only positive effects on agriculture in Russia is undifferentiated and misleading.

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