Institute for European Environmental Policy

Increasing climate resilience

Growing potatoes using regenerative agriculture

Europeans consume an average annual of **90kg** per person (German *Kartoffelklöße*, *Belgian frites* and Spanish *patatas bravas*) and **37%** of global production are grown in the EU

Without adaptation, climate change is expected to cause **declines of 2 to 6% in global potato yields by 2055**

Mulching lowers soil temperatures and helps maintain soil water moisture in hot and dry conditions.
Intercropping has been shown to reduce pest occurrence and soil erosion

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The potato – the Germans' 'Lieblingsknolle'

Traditional German cuisine, whilst rich and diverse, is often built around two main ingredients: meat and potatoes. Indeed, none of the hearty, and rustic dishes Germans refer to as 'Hausmannskost' could exist without the Germans' 'Lieblingsknolle', or favourite tuber, the humble potato. On average, each German consumes around 56.1kg of potatoes per year (BLE 2023).

Germany is the top producer of potatoes in the EU, with a total output of 10.3 million tons of potatoes in 2022. The main potato growing areas are located in northern and western Germany as well as southeastern Germany. The most important growing regions can be found in Lower Saxony, with a share of 49.5% of the German potato cultivation area (ibid.).

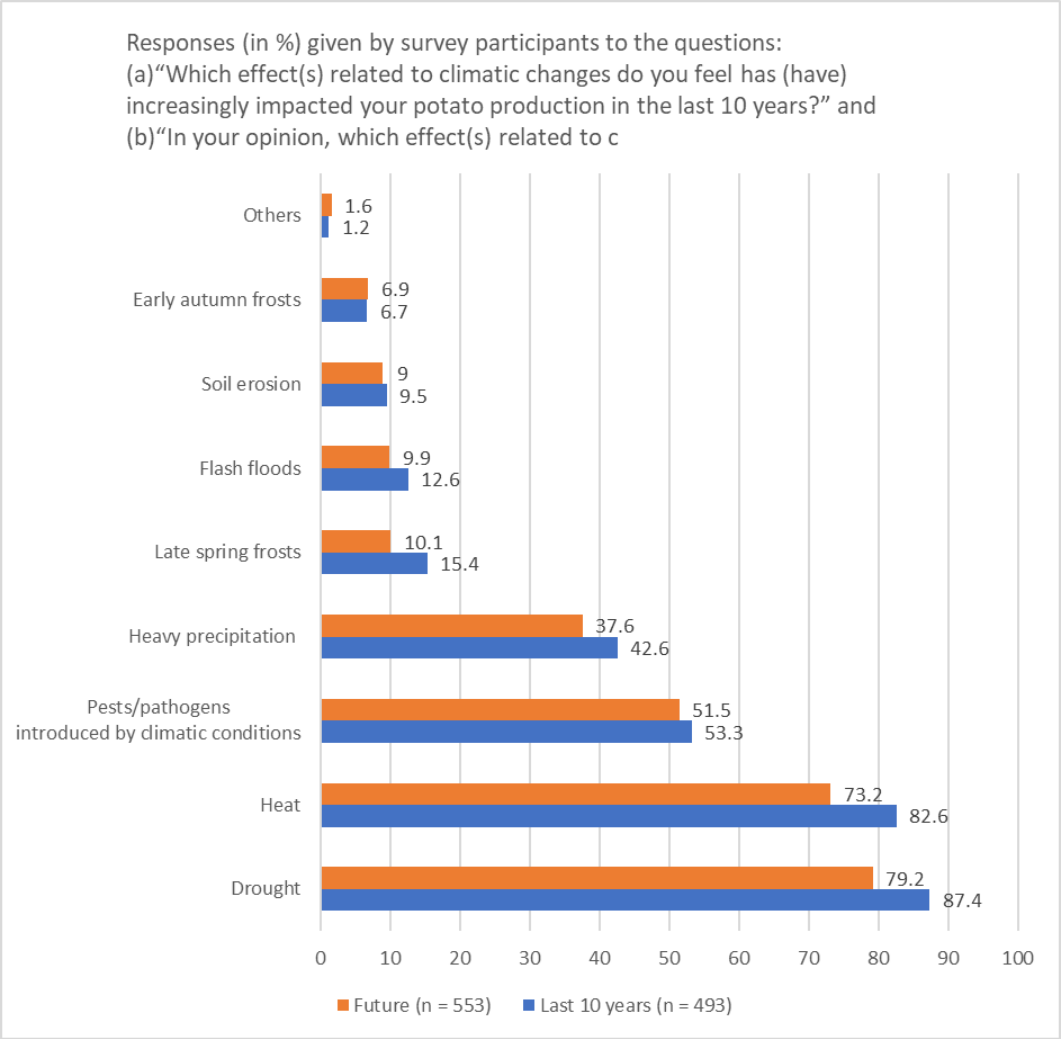
How potatoes are impacted by climate change in Germany

The potato plant is a temperate climate crop. Although it is grown all over the world in a range of climatic conditions, it is quite sensitive to heat and droughts. Temperatures above 30°C and water scarcity during growing season can reduce the number and size of potatoes developing. Physical defects such as hollow heart, tuber cracking, and skin russeting are more likely (Dahal et al, 2019). A survey of 553 potato farmers[1] carried out in 2021 by the ADAPT project[2] effectively demonstrates climate

[1] The majority of replies were received from farmers from Austria, the Netherlands, Germany, France, Switzerland, Slovenia, Belgium, Poland, Spain and the United Kingdom.
[2] https://adapt.univie.ac.at/

change's effect on potato production in Europe: 89% of respondents confirmed that changing climatic conditions have impacted them in the last ten years. The top three threats identified by farmers as impacting on both past and future production are droughts, heat and pests and pathogens. (von Gehren et al, 2023).

Figure 1. Climate change-related difficulties for European potato farmers



(Compiled from von Gehren et al, 2023)

Records show that the average temperature in Germany rose by 1.6°C between 1881 and 2021. The years 2018, 2020 and 2022 were the country's warmest since recordings began. The average number of 'hot days', i.e. days where temperatures reach at least above 30°C, has increased from three days in 1950 to nine in 2021. In contrast, the number of days where average temperatures fall below 0°C has markedly decreased from 28 to 19 over the same period. Changes in precipitation show a large seasonal and regional variation. While the average rainfall in summer remained largely unchanged, it has significantly increased in winter in winter. The number of consecutive

dry days has increased, especially in summer. According to recent climate change projections for Germany, these trends are set to continue[3].

(Image by Richard Webb)

In Germany, potato yields are relatively stable, even with low rainfall, due to the high proportion of irrigated potato areas. However, variations are becoming increasingly common: in 2018, yields per hectare reached a historical low at 353.8 dt/ha due to the extremely dry weather throughout the entire growing season; they were only slightly higher in 2019 at 390 dt/ha (Nimmrichter, 2021). On top of hotter, dryer summers, farmers face increasing pesticide and fungicide resistance to pathogens and disease carriers. Many soils have a soil organic matter content of less than 1% following years of intensive cultivation – only 4% of potatoes grown in Germany were cultivated using organic farming methods in 2020[4] - negatively impacting the water retention capacity and nutrient supply of plants (Nimmrichter et al, 2020).

Growing potatoes using regenerative agriculture practices

There are a number of strategies that could potentially increase resilience to the direct and indirect climate change hazards threatening potato production. Switching from rainfed to irrigated cultivation, and ideally high-efficiency irrigation, is one measure to increase the drought resilience of potato cultivation (Reay, 2019). However, irrigation development is contingent on available water sources, and farmers will also need to invest in new infrastructure (Lynn, 2022). A recent assessment of the potential of reducing potato yield losses in Northeast Lower Saxony (Germany) shows that irrigation only has limited capacity to minimize yield losses. First, the higher the irrigation levels, the lower its effectiveness in preventing yield losses as irrigation levels and yield losses rise in parallel. Second, as water availability decreases under climate change conditions, requirements by other sectors will limit the amount that can be allocated to agricultural uses (Egerer et al, 2023).

[3]Deutscher Wetterdienst (2024) Klimawandel – ein Überblick, https://www.dwd.de/DE/klimaumwelt/klimawandel/klimawandel_node.html;jsessionid=88EEF1F0369148310EB068AA489B640B.live21064, accessed 16.04.24

[4] Klim (2024) Kartoffeln anbauen: Regenerative Methoden für Ertrag und Bodengesundheit, https://farms.klim.eco/article/regenerativer-kartoffelanbau-0ca61c80-df1f-47cf-afe4-62e6d858c6f8, accessed 25.03.24.

Adopting better-adapted or improved crop varieties can be another important adaptation strategy for potato growers. Efforts to breed more resilient varieties are ongoing but will require time[5]. Against this background, several cropping practices may increase the climate change resilience of potato cultivation in the short and medium term by maintaining soil moisture levels, lowering soil temperatures, and reducing the occurrence of pests and diseases.

Practices such as mulching and mixed or intercropping are already being successfully applied in mostly organic potato cultivations. For instance, mulching, i.e. covering soil with organic materials, such as grass, weed cuttings or wheat straw, can help regulate soil temperatures. Findings from experiments around Europe demonstrate that mulching can reduce the heating of the soil during the day and protect it from cooling down too much during the night (Adamchuk et al, 2016). Several studies concluded that mulch applications might positively impact the soil moisture content of potato fields (Döring et al, 2005; Adamchuk et al., 2016; Kral et al., 2019). Research suggests that a sufficient layer of mulch can inhibit the emergence of weeds and pests (Adamchuk et al, 2016; Dvořák et al, 2013.

In light of changing climatic conditions and an increase in extreme events, some farmers are turning to the concept of regenerative agriculture. Regenerative agriculture describes an approach that focuses on soil and crop health to increase yield whilst also benefiting carbon and water cycles and biodiversity. Healthy soils are considered the key prerequisite for productive agriculture, with the three core principles being: (1) no-tillage, (2) permanent ground cover with plants or plant residues and (3) promotion of biological diversity (Kurth et al, 2023). The practices associated with these principles are already widespread in cereal farming systems but are not yet common practice in potato cultivation, at least not in Europe. For instance, conservation tillage and cover crops are commonly used in the US and Canada in rotation with potatoes and have been shown to improve soil characteristics and suppress soil-borne potato diseases (Larkin et al. 2010; Larkin and Halloran 2015). Hence, experiences with regenerative agriculture are limited but some practices have

[5] See e.g., the Horizon 2020 project ADAPT – Accelerated Development of multiple-stress tolerant Potato, https://adapt.univie.ac.at/

proven to be beneficial as reported by three farmers from Germany and Austria (Nimmrichter, 2021):

- A conventional farmer cultivating potatoes on 15ha of his land in Bavaria (southern Germany) uses cover crops, conservation tillage, compost tea[6] and no glyphosate reports higher organic matter content, and a better soil structure overall. The farmer observed that, during heavy rainfall events (80mm of rain in 20 minutes), the dams remain stable.
- A conventional farmer who, for the past three years, has been applying regenerative farming principles to grow potatoes on 35ha of his conventional farm in Lower Saxony (northern Germany) reports a significantly lower level of weed emergence. Fertiliser use could be reduced, and the soil has a very good structure. The farmer uses conservation tillage, a cover crop that is integrated into the soil, under sowing, no glyphosate and transfer mulch.
- A third farmer from neighbouring Austria has been working according to regenerative agriculture principles for the past ten years, using mulch and compost tea to cultivate potatoes organically. The farmer acknowledges that these farming methods are more labour-intensive than conventional practices but highlights that the additional effort is offset by higher yields and better, healthier tubers; there are no problems with the Colorado Potato Beetle.

The evidence and practical experiences suggest that different practices might have positive effects on those soil and water parameters, which could make potato cultivation more resilient to climate change hazards without necessarily reducing yields. Of course, whether these benefits can be realised will depend on a wide variety of factors, such as environmental conditions and soil types, and the selection of the 'right' cropping practices. Hence, experimenting with different practices and sharing practical insights with farmers is a crucial step towards identifying the most appropriate practice for different conditions.

[6] "[…} Compost teas […] are organic liquid products that come from the mixture of mature compost with tap water in 1:5 or 1:10 (v/v) ratios for a specific period of incubation" (Gonzalez-Hernandez et al, 2021, p.2.

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