How climate change is reshaping potato cultivation globally

By Lukie Pieterse, editor and publisher, Potato News Today

The potato industry faces unprecedented challenges as climate change continues to alter global weather patterns. Potatoes, a staple crop for millions worldwide, are particularly vulnerable to the shifting climate. This article explores the multifaceted impact of climate change on potato cultivation and the broader potato industry, highlighting the efforts and initiatives of researchers and industry leaders to mitigate these adverse effects.

Vulnerability of potatoes

Potatoes are highly sensitive to environmental changes, with optimal growth occurring in temperate climates. Changes in temperature, precipitation patterns, and the frequency of extreme weather events have direct and indirect impacts on potato yields, quality, and disease susceptibility.

Potato is a temperate crop that thrives between 16 and 22°C; however, when the temperature exceeds 30°C for prolonged periods of time, it can cause slow tuber initiation and development and physical damage to the tubers. Higher temperatures can lead to heat stress, reducing tuber formation and increasing the risk of diseases such as late blight. Heat also accelerates the degradation of soil organic matter, affecting soil health and productivity.

Higher temperatures can disrupt the physiological processes of potato plants, leading to reduced yields and lower-quality tubers. For instance, temperatures above 30°C can impair photosynthesis and tuber development, resulting in smaller and malformed potatoes. Heat stress can also cause tubers to sprout prematurely, reducing their market value.

Increased temperatures can exacerbate the volatilisation of nitrogen fertilisers, reducing their efficiency and leading to higher input costs. Furthermore, higher temperatures can increase the respiration rate of tubers during storage, leading to greater losses and reduced shelf life.

Water stress

Altered precipitation patterns and increased frequency of droughts are major concerns. Potatoes require consistent moisture levels for optimal growth. Water stress during critical growth phases can lead to reduced yields and poor-quality tubers. Conversely, excessive rainfall can cause waterlogging, leading to root diseases and rot.

Water stress can severely impact potato yields, especially during tuber initiation and bulking stages. Drought conditions can cause tuber dehydration, reducing their size and marketability. On the other hand, excessive rainfall can lead to waterlogged soils, reducing oxygen availability to roots and promoting the development of fungal diseases such as *Phytophthora infestans*, which causes late blight.

Changing precipitation patterns also pose a challenge for irrigation management. Producers may need to invest in more efficient irrigation systems, such as drip or sprinkler irrigation, to ensure optimal water use. Additionally, the increased frequency of droughts may necessitate the development of drought-tolerant potato varieties to ensure food security in water-scarce regions.

Pest and disease pressure

Climate change can expand the range and activity period of pests and diseases. Warmer temperatures and higher humidity levels can increase the prevalence of pests such as the Colorado potato beetle and diseases such as late blight and blackleg.

The changing climate can also alter the distribution and behaviour of pests and diseases. For example, pathogens previously confined to warmer regions may expand their range to temperate areas, creating new challenges. This in turn will lead to higher pesticide use, raising environmental and health concerns.

Climate-resilient varieties

A primary research strategy is developing potato varieties that are more resilient to climate change. Researchers are focussing on breeding varieties that can withstand higher temperatures, drought, and diseases. The International Potato Centre (CIP) has been at the forefront of developing heat-tolerant and drought-resistant potato varieties.

These varieties are bred to maintain high yields and quality under adverse conditions. For instance, researchers are incorporating traits such as heat tolerance, and drought and disease resistance into new potato varieties. In addition to traditional breeding methods, modern techniques such as marker-assisted selection and genetic engineering are being employed

to accelerate the development of climate-resilient varieties.

Improved agronomic practices

Enhancing farming practices is crucial for adapting to changing climates. This includes optimising irrigation techniques, such as drip and sprinkler systems, to ensure efficient water use. Practices such as crop rotation and intercropping can also improve soil health, and reduce pest and disease pressure while helping producers maintain high yields and quality under changing climatic conditions.

By rotating crops and planting diverse species, pest and disease cycles can be broken, soil fertility improved, and biodiversity enhanced.

Integrated pest management (IPM) strategies are being promoted to manage pest and disease threats effectively. This includes using resistant varieties, biological control methods, and timely application of pesticides. Monitoring and forecasting tools are also being developed to predict pest and disease outbreaks, allowing for timely interventions.

IPM combines various approaches to manage pests and diseases in an environmentally sustainable manner. By using resistant varieties, biological control agents, and cultural practices, producers can reduce their reliance on chemical pesticides and minimise their environmental impact. Biological control methods, such as the use of natural predators and parasitoids, can also play a crucial role in IPM.

Soil health management

Maintaining soil health is vital for sustainable potato cultivation. Initiatives to improve soil organic matter through composting, cover cropping, and reduced tillage are gaining traction. These practices enhance soil structure, water retention, and nutrient availability, making crops more resilient to climatic stresses.

Composting and cover cropping can increase soil organic matter and improve soil fertility, while reduced tillage can help conserve soil moisture and reduce erosion. These practices can lead to healthier soils and more sustainable potato production systems, ensuring long-term productivity and resilience.

Climate-smart agriculture

Climate-smart agriculture or CSA integrates sustainable farming techniques with climate adaptation strategies. This includes precision farming, which uses data and technology to optimise inputs such as water, fertilisers, and pesticides.

Diversifying income sources is key aspect of CSA. By promoting alternative income-generating activities, such as agroforestry, livestock farming, and value-added processing, CSA can help reduce the economic impact of crop failures due to climate events. This can enhance the resilience of farming communities and ensure food security in the face of climate change.

Several regions and organisations have implemented successful strategies to combat the effects of climate change on potato cultivation. These case studies and success stories provide valuable insights into how different parts of the world are addressing these challenges through innovation and resilience.

Peru's Andean highlands

In the Andean highlands, potato farming is a way of life, deeply intertwined with cultural traditions and local economies. However, rising temperatures and unpredictable weather patterns have threatened this heritage. The CIP has responded by developing and introducing potato varieties that can withstand higher temperatures and varying precipitation. These new varieties have not only maintained their yield but have also shown greater resistance to pests and diseases, which have become more prevalent due to the changing climate.

The success of these climate-resilient varieties has demonstrated the potential of breeding programmes to address the challenges posed by climate change. Producers in the region have reported improved crop stability and better economic returns, ensuring that their livelihoods are protected against climatic variability.

Netherlands' precision agriculture

The Netherlands, known for its innovative agricultural sector, has been a leader in implementing precision agriculture. Dutch potato producers utilise satellite imaging to monitor crop health and growth stages, allowing them to apply fertilisers and pesticides more precisely. Soil sensors provide real-time data on moisture levels, enabling efficient irrigation management. Data analytics integrate all these inputs to provide actionable insights, optimising every aspect of potato cultivation.

These technologies have not only increased yields but also reduced the environmental impact of potato farming. By using resources more efficiently, Dutch producers have decreased their carbon footprint and made their operations more sustainable. This approach has proven particularly effective in adapting to

the unpredictable weather patterns associated with climate change.

India's drought-resistant varieties

India faces significant water scarcity issues, exacerbated by climate change. To address this, researchers have focussed on developing potato varieties that require less water and can survive longer periods of drought. These drought-resistant varieties have been a game-changer for producers in arid regions such as Gujarat and Maharashtra.

Adopting these new varieties has led to substantial improvements in crop yields and quality, even under challenging conditions. Producers have reported higher incomes and greater food security, as they are now able to produce reliable potato crops despite limited water availability.

North America's IPM

In North America, IPM practices have been widely adopted to combat the increasing pest and disease pressures resulting from climate change. For instance, in the Pacific Northwest, potato producers have been dealing with increased infestations of the Colorado potato beetle and late blight due to warmer temperatures and higher humidity levels. By implementing IPM strategies, these producers have significantly reduced their reliance on chemical pesticides, thereby lowering costs and minimising environmental impacts.

Biological control methods, such as introducing natural predators of the Colorado potato beetle, have proven particularly effective. The use of disease-resistant potato varieties has also helped mitigate the impact of late blight. Monitoring and forecasting tools developed by agricultural universities and extension services provide producers with timely information on pest and disease outbreaks, allowing for prompt and effective interventions.

Kenya's climate-smart villages

In Kenya, the climate-smart villages (CSV) initiative, led by the CGIAR Research Programme on Climate Change, Agriculture and Food Security, has been instrumental in helping potato producers adapt to climate change. The CSV approach integrates various climate-smart agricultural practices to enhance resilience and productivity.

Producers in these villages receive training on practices such as water conservation, soil health management, and the use of improved, climate-resilient potato varieties. The initiative also promotes diversified farming systems, which include intercropping potatoes with other crops to improve soil fertility and reduce pest and disease pressure. The CSV initiative has led to noticeable improvements in potato yields and farmer incomes.

China's digital agriculture

China has embraced digital agriculture to combat the effects of climate change on potato farming. The use of big data, artificial intelligence (AI), and Internet of Things (IoT) technologies has revolutionised potato cultivation in several regions.

In the Inner Mongolia Autonomous Region, for example, potato producers use IoT devices to monitor soil moisture, temperature, and other critical parameters in real-time. Artificial intelligence algorithms analyse this data to provide precise recommendations for irrigation, fertilisation, and pest control. This technology-driven approach has led to significant increases in yield and reductions in input costs.

Moreover, digital platforms facilitate better market access for producers, allowing them to sell their produce at better prices.

Scotland's collaborative research

In Scotland, collaborative research initiatives between universities, research institutions, and producers are addressing the challenges of climate change on potato production. The Scottish government, through its ClimateXChange initiative, supports research on developing climate-resilient potato varieties and sustainable farming practices.

The James Hutton Institute, for example, is conducting research on breeding potato varieties that can withstand extreme weather conditions, such as heavy rainfall and frost. The institute also works on soil health management practices, including the use of cover crops and organic amendments, to improve soil structure and fertility.

Potato producers are actively involved in these research projects, providing valuable insights and feedback. This collaborative approach ensures that the research is relevant and directly applicable to real-world farming conditions. The results have been promising, with producers reporting improved crop performance and resilience to climate variability.

Australia's water-saving techniques

In Australia, where water scarcity is a significant issue, innovative water-saving techniques are being implemented to support potato cultivation. The country's potato producers are adopting advanced irrigation systems, such as subsurface drip irrigation, to optimise water use and minimise waste.

Subsurface drip irrigation delivers water directly to the root zone of the potato plants, reducing evaporation and ensuring that the plants receive the right amount of water. This technique has proven highly effective in improving water use efficiency and maintaining crop yields under drought conditions.

Australian researchers are also exploring the use of treated wastewater for irrigation, providing an alternative water source for potato production.

For more information, email the author at lukie@potatonewstoday.com or visit *www.potatonewstoday.com* for more news on potato developments abroad.

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