THE FRUIT AND VEGETABLE INDUSTRY SERIES

COLEAD

OECD

FRUIT AND VEGETABLES SCHEME

OECD-COLEAD Fruit and Vegetables Industry Series

Session 4 - Impact of climate change on production and quality of fruits and vegetables

16th May 2023 – 10:00-11:30 CET

Online (Zoom)

English-French interpretation available

1. Background

Climate change is emerging as one of the major constraints for global food security and will become more prevalent in the coming years. The Intergovernmental Panel on Climate Change (IPCC) 6th Assessment[1] outlines that changes to the climate will increase in all regions of the globe over the coming decades and that even with 1.5°C of global warming, there will be increasing heat waves, longer warm seasons, and shorter cold seasons – which will become more intense at 2°C of warming.

Climate change impacts are likely to worsen, despite progress toward mitigation, and translate into losses in key producing regions, natural resource degradation and current growing regions becoming unsuitable for production with outcomes in reduced crop yields and food shortages. One of the most pressing issues related to climate change is its impact on productivity, food security and sustainable development. As weather patterns become more unpredictable, farmers may struggle to plant crops at the right time or may see their crops destroyed by extreme weather events such as droughts, floods, and storms.
Climate change can also negatively affect food quality and safety. Rising temperatures and changing rainfall patterns can lead to the spread of pests and diseases, which can reduce the quality and safety of food crops. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Although there will be gains in some crops in some regions of the world, the overall impacts of climate change on agriculture are expected to be negative, threatening global food security.[2]
At the farm/household level, climate change impacts may reduce income level and stability through effects on productivity, production costs or prices. At the national level, exposure to climate risks can trigger shocks on agricultural production and food availability, with risks of

[1] IPCC sixth assessment report 2021-2022. https://www.ipcc.ch/assessment-report/ar6/.
[2] IFPRI. Climate change: Impact on agriculture and costs of adaptation. Gerald C. Nelson, Mark W. Rosegrant, Jawoo Koo, Richard Robertson, Timothy Sulser, Tingju Zhu, Claudia Ringler, Siwa Msangi, Amanda Palazzo, Miroslav Batka, Marilia Magalhaes, Rowena Valmonte-Santos, Mandy Ewing, and David Lee. Food Policy Report. 2009.

market disruptions, effects on supply and storage systems, as well as increases in agricultural commodity prices (food and feed), impacting accessibility and stability of food supplies for the entire population. At the global level, climatic shocks impacting areas of global importance for food supplies can have remote impacts through effects on supply flows and food price spikes, with increased market volatility; and impacts on import/export behaviour, with disruption of trade patterns.[3]
The agricultural sector also has a crucial role to play in reducing its greenhouse gas emissions.

2. Impact of climate change on the fruit and vegetable sector

Climate plays a major role in deciding perennial fruit crop's distribution, phenology, fruit quality, and pest and disease incidents. Fruit and vegetable production is expected to shift with the changing climate in different ways according to regions and products. In some regions, global warming improves production and quality of fruit and vegetables, while in others there is an inverse relationship between warming and fruit and vegetable production and quality.[4] The production and quality of fresh fruit and vegetable crops can be directly and indirectly affected by exposure to high temperatures and elevated levels of carbon dioxide and ozone. The rise in atmospheric CO_2 levels due to global climate change and horticultural practices has both direct and indirect effects on secondary metabolite synthesis in plants. Temperature increase affects photosynthesis directly, causing alterations in sugars, organic acids, flavonoid contents, firmness, and antioxidant activity. Rise in atmospheric carbon dioxide levels persistently affects post-harvest quality causing sugar content reduction in potatoes and the tuber malformation incidence of common scab. Elevated atmospheric ozone can result in the decline of the photosynthetic rate, growth, biomass accumulation, increment in vitamin C content, and potential reduction in volatile ester emissions in strawberries.[5]
Sunburn (or solar damage) is the most common temperature-induced disorder reported in fruit and vegetables, most likely because it is easily observed on the skin. There are many other temperature-sun affected disorders that damage the perceived quality of fruits and vegetables related to the visual appearance and texture of the product. In some vegetable crops, increased temperatures due to climate change could decrease the duration of their biological cycle resulting in deterioration of the perceived quality related to the appearance-size of the marketable product.[6]

The available data have shown that climate change could improve some quality traits related to the primary metabolism (*e.g.* photosynthesis), such as flavour associated with carbohydrates (*e.g.* sweetness). Also, climate change could enhance biochemical pathways related to the defence mechanisms of plants, resulting in an improvement to some nutritional traits (*e.g.* antioxidants). However, the negative effects of climate change could be observed on product appearance *(e.g.* visual disorders, malformations) and nutritional value related to protein, minerals and amino acids.[7]

[3] FAO. Climate change and food security: risks and responses. 2015.
[4] Ngcebo Parton Khumalo and Wandile Ngcamphalala. Perishable Products Export Control Board (PPECB). Impact of climate change on production and quality of fruits and vegetables in South Africa. November 2022. Supported by OECD.
[5] Leonora M. Mattos, Celso L. Moretti, Sumira Jan, Steven A. Sargent, Carlos Eduardo P. Lima, Mariana R. Fontenelle, Chapter 19 - Climate Changes and Potential Impacts on Quality of Fruit and Vegetable Crops, Editor(s): Parvaiz Ahmad, Saiema Rasool, Emerging Technologies and Management of Crop Stress Tolerance, Academic Press, 2014.
[6] Christopoulos Miltiadis, Ouzounidou Georgia, « Climate Change Effects on the Perceived and Nutritional Quality of Fruit and Vegetables », *Journal of Innovation Economics & Management*, 2021/1 (n° 34), p. 79-99. DOI : 10.3917/jie.034.0079. URL : https://www.cairn.info/revue-journal-of-innovation-economics-2021-1-page-79.htm.
[7] i*bid*

Climate change has become a very serious concern for the fruit and vegetable processing sector, as several consecutive years of extreme and volatile weather has led to falling crop yields and field losses. This, in turn, has resulted in reduced and irregular deliveries of raw material to the processing factories. Areas with above-average rainfall coupled with hot temperatures see an increase in vulnerability to pests and diseases. As a result, **climate change translates into higher costs for fruit and vegetable processing businesses** who will have to make consequential investments to find solutions and adapt to this situation to still be able to offer quality and sufficient quantity of products to consumers. As such, growers and processors will have to: (i) make investments for irrigation; (ii) support farmers to continue growing vegetables despite the risks of less efficiency in factory equipment and production lines.[8]
A temperature increase of 1°C can change a major area suitable for tropical fruit. **Several fruit crop suitable areas could become marginally suitable, while new suitable areas may emerge**. Temperature rises are predicted to have a greater impact on reproductive biology of these crops. High temperatures have two major effects on crop production: they limit vegetative growth and reduce fruit set. Extreme transpiration combined with high temperatures limits fruit crops that are prone to high transpiration losses.[9]

Climate change has altered the occurrence of **pest and disease** in fruit crops. Changes in flowering time and temperature fluctuation can result in the introduction of new pests, minor pests gaining major pest status, and breaking of resistance. The lifecycle of various insect pests is directly impacted by seasonal variations, including changes in temperature and rainfall patterns. Climate change could lead to changes in geographic distribution, population growth rates, generation numbers, over wintering, developmental seasons, crop-pest phenology synchrony, increased risk of invasion by migrating pests and interspecific interactions. With the possibility of a third generation of codling moth, it would be necessary to intensify and extend protection measures (e.g. insecticides) to control this additional generation, meaning an increased risk of pesticide residual effects on fruits.[10]

Under a changing climate scenario, the systematic **degradation of plant genetic diversity** harmed the capacity to breed new cultivars for potential habitats. Horticulture crops are losing genetic diversity which is critical to the potential ability of horticulture industry to withstand disease, pest, and environmental threats. The core of any crop improvement programme is a diverse germplasm collection and research to create new or improved qualities which are resistant against abiotic/biotic stresses.

3. Adopting a set of adaptation and mitigation actions

The responses to climate change impacts are multiple and context specific. A holistic approach, rather than a single approach, is essential to overcome the impact of climate change on vegetable crops. Some examples include:

- Enhancing carbon sequestration in soil via soil moisture and temperature manipulation, restoring soil carbon on depleted lands and reserving excess agricultural land can all help to reduce CO_2 emissions from agriculture.
- Manuring, minimum tillage, residue incorporation, mulching, micro aggregation and improving soil biodiversity can all help to sequester carbon in soil.

[8] European Association of Fruit and Vegetable Processors (PROFEL). 23 October 2019 CLIMATE CHANGE IMPACT ON FRUIT AND VEGETABLES FOR PROCESSING. 2019.
[9] Panchaal Bhattacharjee, Omkar Warang, Susmita Das and Shubranil Das. Impact of Climate Change on Fruit Crops- A Review. Department of Horticulture, Anand Agricultural University, Gujarat, India. 2 Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Jammu and Kashmir, India. 3 Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India. 2022.
[10] Skendžić S, Zovko M, Živković IP, Lešić V, Lemić D. The Impact of Climate Change on Agricultural Insect Pests. Insects. 2021 May 12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8150874/.

- **Developing climate-resilient fruit and vegetables and improved varieties** for adaptation to increasing temperature, drought, and pest and disease incidence becomes a priority.[11]
- Various management practices have the potential to raise the yield of vegetable crops grown under hot conditions such as **adjusting fertiliser application, direct and precise delivery of water to root zone, grafting to increase disease tolerance, and use of soil amendments**.
- Means for adaption and mitigation may include **improving vegetable production systems, better exploitation of biodiversity, applying biotechnology and genomic approaches, genetically engineering different stress tolerance crops and ultimately developing climate-resilient vegetables**.[12]
- **Shifts in planting date, adjustments in crop mix, adoption of more efficient irrigation technologies, adoption of early warning systems and insurance mechanisms**.
- **Cultivar selection for a particular area and climate**.
- Moving crops into new production regions will be another coping mechanism.
- **The use of shade netting** to protect crops against adverse environmental effects, such as hail, wind, and extreme radiation causing sunburn on fruit.
- **Precision farming/climate smart agriculture** that allows farmers to withstand the adverse effects of climate change and remain viable.
- **Degreening of citrus fruit** can be employed to enhance fruit colour and make fruits more appealing.

4. Way forward

Undoubtedly, climate change is a major concern to the agricultural sector, which must remain viable amid unfavourable temperature and rainfall trends. It is therefore important for the industry to adapt.
The effect of climate change on the quality of fruit and vegetables could undermine or reverse progress, unravelling many of the developmental gains of recent decades. It could threaten the livelihoods, health and wellbeing of millions of people worldwide, and of the poorest and most vulnerable groups. Implementation of innovative actions and measures in technological, agricultural management practices and in the socio-economic system could be a solution for the risk mitigation of hazardous climate events.[13]

The key strategies for addressing this challenge will be the development of new horticultural crop varieties that are resistant to high temperatures, are resistant to pests and diseases, and produce high yields under stress conditions, as well as the use of high-tech horticulture and prudent natural resource management (i.e. water efficiency).[14]
Increased availability of data on the effects of pests and diseases and the quantification of plant diversity loss and area sustainability are needed to measure the future of fruit productivity and fruit quality.

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[11] Khalid E. Abd El-Hamed Ibrahim. Climate Change Impact on Vegetable Crops and Potential for Adaptation: A Review. Department of Horticulture, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. 2021.
[12] *ibid*
[13] Christopoulos Miltiadis, Ouzounidou Georgia, « Climate Change Effects on the Perceived and Nutritional Quality of Fruit and Vegetables », *Journal of Innovation Economics & Management*, 2021/1 (n° 34), p. 79-99. DOI : 10.3917/jie.034.0079. URL : https://www.cairn.info/revue-journal-of-innovation-economics-2021-1-page-79.htm.
[14] Panchaal Bhattacharjee, Omkar Warang, Susmita Das and Shubranil Das. Impact of Climate Change on Fruit Crops- A Review. Department of Horticulture, Anand Agricultural University, Gujarat, India. 2 Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Jammu and Kashmir, India. 3 Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India. 2022.

A holistic approach, which includes adaptation and mitigation, is essential to overcome climate change impacts on fruit and vegetable crops.

5. Promoting increased knowledge about the fruit and vegetable industry

Launched in the context of the United Nations (UN) 2021 International Year of Fruits and Vegetables, the COLEAD[15] through its FFM SPS and FFM Plus programmes (funded by the European Union and OACPS) and the OECD Fruit and Vegetables Scheme[16] of the Trade and Agriculture Directorate launched an online series highlighting the significance of the fruit and vegetable sector and its various dimensions.

The main objectives of the series are:

- Sharing knowledge of markets and operators working in local and export fruit and vegetable markets
- Understanding the fruit and vegetable sector contribution to sustainable production and consumption
- Promoting fruit and vegetable contribution to healthy and nutritious diets
- Showcasing successes and innovations of private sector operators across the European Union and Southern countries and lessons learned

The fourth session to be held on 16th May 2023 will discuss the impact of climate change on production and quality of fruit and vegetables. Of significant importance is for producers and exporters of fruit and vegetables from African, Caribbean and Pacific (ACP) countries to raise awareness about the challenges they face and to share best practices amongst themselves.

[15] As a private sector (not-for-profit) organisation, COLEAD's purpose is to support activities that aim to increase the agricultural sector's contribution to achieving the Sustainable Development Goal. https://www.colead.link/

[16] OECD Fruit and Vegetables Scheme promotes international trade through the harmonisation of implementation and interpretation of marketing standards. https://www.oecd.org/agriculture/fruit-vegetables/

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PROGRAMME

Moderator: *Marie Russel, Senior Programme Officer, Trade and Agriculture Directorate, Agricultural Codes and Schemes,* OECD

10:00-10:10 Welcome and introduction

- *Jeremy Knops, Délégué Général, COLEAD*

10:10-10:40 Impact of climate change on production and quality of fruit and vegetables

This panel will share some findings of recent research on the impact of climate change in the fruit and vegetable sector

- Policies to foster climate change adaptation and resilience in agriculture
  Kelly Cobourn, Agricultural Policy Analyst, Trade and Agriculture Directorate, OECD
- Impact of climate change on production and quality of fruits and vegetables produced in South Africa
  Ngcebo Parton Khumalo and Wandile Ngcamphalala, PPECB Research and Development, South Africa

Q&A session

10:40-11:20 Views from the operators

This panel will feature experiences from operators in the fruit and vegetable industry who implement innovations to cope with climate change effects

- *Gert-Jan Lieffering, Quality & Sustainability Manager, Eosta BV / Nature & More, the Netherlands*
- *Maik Blaser, Leader Production Units, HPW Fresh & Dry, Ghana & Côte d'Ivoire*

Q&A session

11:20-11:30 Conclusion and way forward

- *Isolina Boto, Head of Networks and Alliances, COLEAD*

The OECD-COLEAD Fruits and Vegetables Industry Series focuses on market access conditions and opportunities for the fruit and vegetable sector, especially for fruit and vegetables producers and exporters from ACP-countries. This activity is supported by the Fit For Market Plus programme, implemented by COLEAD within the Framework of Development Cooperation between the Organisation of African, Caribbean and Pacific States (OACPS) and the European Union.