Editorial: **Evaluation of climate change effects on food sustainability, safety and quality**

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Climate change and food safety have become interdependent worldwide research priorities. In order to meet the EU challenge of doubling food production by 2050 (to meet population demands) while dealing with the impact of climate change on food safety, investment in research is required.

Climate change will clearly influence food safety in the short and medium future (Fig. 1). For instance, changes in temperatures and precipitations will increase chemical and microbial risks. To control or prevent these additional burdens, mitigation strategies have to be put in place and those measures need to be defined and evaluated in such a way that the sustainability of the food sector is guaranteed, otherwise, they will not be valid in the long term.

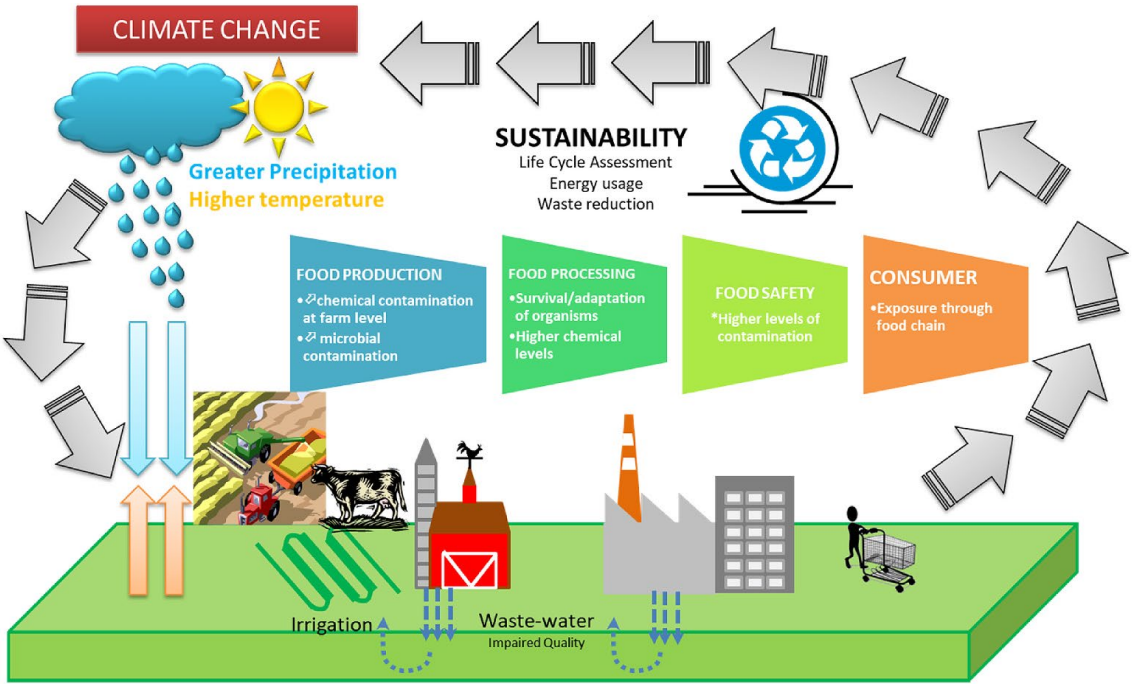


**Figure 1.** Illustration of climate change and food system interactions.

In this context, the aim of the Special Issue "Evaluation of climate change effects on food sustainability, safety and quality" is to review current trends of climate change and its impact on food safety as well as on food waste and spoilage. It also provides a set of modelling techniques, predictive and decision-support tools to assess the

effect of climate change on food safety and quality. Some illustrations are made within the dairy sector as this is a sector economically important on a global level and a good example of the farm-to-fork continuum which contributes to climate change causing greenhouse gas emissions while also suffering from climate change effects.

The first paper of this Special Issue (Katsini et al., 2021) presents the key challenges for obtaining climate projections and then underlines the potential application of predictive microbiology models. The authors highlight that the assessment of climate change impact requires a quantitative framework and a rigorous uncertainty analysis. They conclude on the need for an international effort for obtaining dedicated climate-microbial datasets.

The second paper (Chhaya, O'Brien, & Cummins, 2021) is focused on mycotoxin risks, underlying that climate change is expected to impact mycotoxin levels in animal feed and products, particularly due to an increase of mycotoxin contamination in cereals in the future. The article reviews the mycotoxin predictive models along with knowledge on risk-to-human-health from aflatoxin. The authors conclude that integration of risk assessment and predictive models are required.

In the third paper of the Special Issue, Misiou and Koutsoumanis (2021) review the potential impact of climate change on food safety and food spoilage and discuss the most important climatic-driven emerging risks. In particular, the authors highlight that climate change may promote pathogens proliferation and foodborne diseases outbreaks while risk of spoilage due to bacteria and fungi might increase as well.

In the fourth article, Roufou, et al. (2021) highlight that high nutrient values and pollutant capacity characterize dairy waste but also that environmental changes increase the risk of adverse effects on the quality of dairy waste. The authors point out that microbial survival mechanisms can be affected by environmental changes, before concluding on the need for new sustainable approaches in all sectors of the dairy industry.

The fifth article (Malliaroudaki, Watson, Ferrari, Nchari, & Gomes, 2022) provides insight on climate change effects on the dairy supply chain and impact on energy demand. It focuses on the relevance and importance of the "net-zero" carbon emissions target while identifying novel energy mitigation strategies across the dairy supply chain. The authors conclude on the importance of developing supply chain energy models (SCEM) to properly address energy mitigation in the dairy sector.

The sixth article of the Special Issue (Guzmán-Luna, Mauricio-Iglesias, Flysjö, & Hospido, 2021) revises how the climate change effects influence the dairy sector's environmental performance and how the dairy sector in turn might affect climate change, to identify the main interactions between the dairy sector and climate change. In both, the dairy farm stage is identified as the main contributor and the most vulnerable stage to climate change. They forecast that the European dairy sector will unequally experience the opportunities and threats and climate change will raise food safety risk, raw milk losses and dairy product waste.

In the seventh article, Feliciano, et al. (2022) go beyond the fact that climate change impacts pose significant challenges to food safety and human health: they highlight that ignoring the life cycle impacts when defining and implementing food safety

mitigation strategies can affect the environmental performance of a value chain and as a result, create a vicious circle. To overcome this issue, the authors review, even outside the food sector, frameworks and case studies for integrating altogether life cycle assessment (LCA) and risk assessment (RA) and suggest approaches to mitigate food safety risks while minimizing environmental impacts (win-win solution).

Finally (Talari, Cummins, McNamara, & O'Brien, 2021), close the Special Issue focusing on the fact that large volumes of data are being generated worldwide related to food safety. The authors pinpoint that big data, and data linkages between data sources, could play a better role in food safety while considering climate change. They introduce a big data analytics framework in order to support decision-makers to enhance food safety.

The Special Issue "Evaluation of climate change effects on food sustainability, safety and quality" has been prepared within the Horizon 2020 research and innovative programme PROTECT (http://www. protect-itn.eu/). The overarching aim of PROTECT is to provide high-level training in predictive modelling tools to evaluate the effects of climate change on food safety to a new generation of high achieving Early Stage Researchers (ESRs). PROTECT brings together intersectoral and multidisciplinary expertise from 11 European Countries (7 third level educational institutions, 6 industry partners, 1 United Nations agency). PROTECT (funded under the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 813329) acknowledges the opportunity offered by Trends in Food Science & Technology to have the knowledge generated by our ESRs presented in a comprehensive and coherent manner in this Special Issue.

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