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Editorial: Agricultural production in a warmer world: challenges and sustainable development strategies

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Editorial on the Research Topic
Agricultural production in a warmer world: challenges and sustainable development strategies

Global warming is becoming more severe throughout the 21st century as greenhouse gas emissions, mainly carbon dioxide (CO_2), continue soaring. Climate change and its impacts are hitherto one of the key research hotspots. Since natural agricultural systems depend on the climate and environment, climate change has direct impacts on agricultural production. In this regard, how to achieve global food security under the effects of climate change is a primary challenge that we are encountering. Therefore, effective adaptation strategies are needed to mitigate the negative impacts of climate change on crop production and further enhance agriculture resilience. Moreover, as the impacts of climate change on crop production will likely vary substantially in space, environment-specific adaptation strategies may offer advantages. Generally, related strategies to enhance local adaptation capacity are needed to minimize climatic impacts and to maintain regional stability of food production. With this goal in mind, we have organized this Research Topic: "*Agricultural Production in a Warmer World: Challenges and Sustainable Development Strategies*". A total of seven articles were published in this Research Topic, comprising four research articles and three review articles. The specific contents of these articles are introduced as follows.

Zhao et al. predicted the maize yield in China based on historical reanalysis data from ERA5 and four future shared socioeconomic pathway scenarios (SSP) of the Coupled Model Intercomparison Project 6 (CMIP6) models. Moreover, they quantified the grid cell sensitivity of vapor pressure deficit (VPD) and root-zone soil moisture to maize yield. The article reported that maize yield was good only when the atmospheric moisture demand and soil moisture were in relative balance and would decrease under representative SSPs due to an increase in temperature. In addition, considering soil moisture in the future, the projected yield estimates reduced the overestimated yield loss by half compared to considering only atmospheric moisture requirements.

Li et al. conducted a mesocosm experiment to investigate the impact of arbuscular mycorrhizal fungi (AMF) inoculation on N_2O emissions, availabilities of carbon and nitrogen, extracellular enzyme activities, and the abundance of key N-cycling genes in degraded residue patches. This study indicated that AMF suppressed N_2O producers, particularly nirS-type denitrifiers, by slowing down the release of C and N from degraded residues, thereby leading to a cascade effect on the decrease of N_2O emissions. It also provided a promising approach to mitigate N_2O emissions by enhancing AMF in agroecosystems.

Jiang et al. adopted the bibliometric method via CiteSpace to analyze the data collected from the Web of Science (WoS) Core Research Topic and reported that the current research in climate adaptation of agricultural systems has entered a rapid development stage. Overall, conceptual studies, ecologically vulnerable areas, and climate adaptation strategies were found to be the hotspots in the field of climate adaptation of agricultural systems, while impact assessment, governance and decision-making, farming systems, and climate information services were found to be the research trends. This review is expected to help researchers quickly grasp the research situation in climate adaptation of agricultural systems and provide a reference for future research in this field.

Hasimuna et al. investigated the viability of integrated agriculture–aquaculture (IAA) as a means for small-scale producers in Zambia to boost their aquaculture output despite the numerous obstacles they face. In addition, the obstacles that could prevent small-scale farmers from adopting IAA were emphasized. This study proposed that IAA has the potential to dramatically boost small-scale aquaculture production in Zambia, but information and understanding must be improved to make it a more feasible alternative.

Khalifa and Eltahir explored the current status of sorghum production, trends, and factors controlling sorghum yield using empirical approaches. This article reported that sorghum yield seems to increase persistently despite global warming due to an improved inputs approach, offering hope that similar adaptation approaches can be fruitful, especially in sub-Saharan Africa. A combination of interventions including adequate use of fertilizers and technology adoption (e.g., tolerant cultivars), efficient management (e.g., improved irrigation), and better agronomic practices was determined to be the key to boosting sorghum yield and ensuring the sustainability of this important crop under a warmer climate.

Wu et al. reported that research is now focusing on quantifying climate impacts on crop yields and agriculture productivity while seeking effective adaptation solutions after almost 30 years. The hot keywords that have recently emerged include poverty, food security, water resource, climate service, climate-smart agriculture, sustainability, and policy. Given the uncertainty of climate change and the complexity of agriculture systems, most current studies are in the form of interdisciplinary research combining various agricultural fields with climate, environmental, and socioeconomic sciences. Future priority research should take the coupled earth system approach with the food–energy–water nexus principles to provide effective, actionable decision supports at local and regional scales to sustain national agricultural productivity and quantify climate-smart agricultural practices to mitigate global warming.

Xiao et al. explored the yield–climate relationship and its spatial variations based on experimentally observed yield (Ys) and the county-scale statistical yield (Yc) of three typical crops (i.e., maize, rice, and soybean) across Northeast China (NEC) from 1981 to 2010, as well as contemporary climate data, and noted the climate during the crop growth period had changed significantly, and this change had caused measurable impacts on crop yields. However, the impact of climate change on the yields of the three crops was far less than the actual increase in crop yields. This article indicated that other factors, mainly improved management practices, may be the main reason for the significant increase in crop yields in NEC over the past few decades.

Overall, this Research Topic aims to gather state-of-the-art original research and review articles addressing sustainable solutions for achieving global food security in a warmer world. Although these seven articles focus on different research fields, they all address agricultural sustainable development strategies under climate change, and the main research results can provide certain scientific knowledge and theoretical guidance for regional and/or global agricultural sustainable development.

Author contributions

DX: Writing–original draft. DL: Writing–review and editing. XZ: Writing–review and editing. YF: Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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