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Editorial: Sustainable and Climate-Smart Agriculture in the Boreal and Arctic Regions

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Editorial on the Research Topic

Sustainable and Climate-Smart Agriculture in the Boreal and Arctic Regions

Both the boreal and Arctic regions are facing substantial structural changes induced by accelerated warming. This also facilitates a rapid northward shift of the agricultural zone to historically forest dominant land cover. Expansion and intensification of agriculture into the boreal and Arctic regions, while supporting diversification of local economies through the creation of new income opportunities, create multiple challenges as they (i) threaten the fragile ecosystems, (ii) alter the carbon sink capacity of northern ecosystems, (iii) affect indigenous and non-indigenous food cultures, and (iv) require significant infrastructural changes that might also affect the local demographics and induce cultural changes. Thus, strategies aiming to support agricultural expansion and intensification in the boreal and Arctic regions must include multiple nations and cultures of the North leading to the development and implementation of tailored and context-specific standards and policies. The central challenge for supporting agricultural expansion and intensification in the boreal and Arctic regions is to achieve a sustainable balance between opportunities and risks at multiple spatial and temporal scales. Many governments already take steps to promote expansion and intensification of northern agriculture. However, accelerated warming already exceeds the adaptation capacity of numerous agricultural systems in boreal and Arctic regions (Unc et al.). This Research Topic on "*Sustainable and Climate-Smart Agriculture in the Boreal and Arctic Regions*" aimed to gather knowledge outlining the actual and potential impacts of agricultural expansion and intensification on (i) diversity of natural ecosystems and agro-ecosystems, (ii) carbon and nutrient cycles, (iii) agricultural systems, and (iv) social structures, indigenous cultures, and local economies in the boreal and Arctic regions.

Assessment of the future opportunities and challenges of developing agriculture into northern regions needs careful and systematic integration of natural, economic, infrastructural, and cultural elements. As underlined by Unc et al. it is critical to carefully address the real or perceived divergences between sustainable development of food security and food-self-sufficiency, rural development, and the mitigation of the effects of land-use change in the context of the global climate change, on carbon, nutrient and water cycles, and local biodiversity. Thus, authors underline the role of local solutions, locally relevant policies and they stress the need for the development of transdisciplinary knowledge leading to minimizing the risk to global climate.

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Increasing temperature, CO_2 levels and changes in precipitation affect crop production worldwide, including northern areas. Morel et al. employed a modeling approach to simulate the productivity of barley, forage maize, oats, and spring wheat over five seasons across a geographical gradient in Sweden. The results suggest that annual crops would benefit from the elevated temperature if the water stress was negligible supporting the overall view that climate change may favor crops production in northern regions. Moreover, the risk of crop failure is diminished as warming accelerates. However, as climate change shifts northwards invasive weeds, pathogens, and pest insects follows. Jalli et al. using a long-term experiment in southeastern Finland, found that diverse crop rotations (cereals, oilseed crops, and legumes) increase the yield and plant resilience of spring wheat. While sustainable tillage practices, such as no-till, could favor yield increases, they may affect control of weeds, pests, and pathogens. This can be only achieved if there is a targeted focus on the health factors of each crop in the rotation.

Adoption of any type of agriculture in the northern regions requires knowledge and culturally based acceptance by farmers and the local communities. Natcher et al. applied the Adoption and Diffusion Outcome Prediction Tool (ADOPT) to assess containerized agricultural systems in the northern regions of Canada. They conclude that the most constraining variables for the adoption of containerized agricultural systems includes upfront costs, expected profits, environmental impacts, and the complexity and flexibility of the technology. Additionally, Halland et al. state that educating farmers in the elements of sustainability is "a necessity in horticultural production in Arctic Norway." The complex interplay between the concept of "farm sustainability" and the natural and social contexts gives rise to a series of apparent conflicting issues that could affect the adoption of sustainable agricultural practices. After taking a wide look at integrating contextual, knowledge, motivation, and process factors, the authors conclude that farmers will require continuous assistance in their journey to sustainability supported by establishing learning platforms that integrate both knowledge and the sources of knowledge. Barriers have been revealed by Lemay et al. who performed an ethnographic study to contrast the agri-food business narrative with the agri-food industry implications narrative associated with agriculture development in the Northwest Territories, Canada. The latter narrative is more inclusive of the wider scope of the interactions of agri-food developments with the local social, environmental, and economic domains. The impact on the current food production systems of any new food systems is highlighted as a central concern. Thus, the northern, commercial agri-food industry must identify ways to fit with the broader food system to meaningfully contribute to the sustainability, security, economic development, nutrition, and poverty reduction. Keske explores in greater detail the intersection between the local food security needs and their integration in the global food systems. Evidence suggests that international trade can disrupt local food systems impeding efforts toward food sovereignty. This makes northern regions more prone to cycles of food insecurity. It is concluded that policies facilitating local access to and ownership of agriculture and food processing knowledge may foster food sovereignty and sustainability of the agri-food sector.

This Research Topic thus increases the awareness of the complexity of the impacts of policies pursuing increases in agricultural production and productivity in the northern regions. It highlights drivers and consequences and supports the need for balancing the benefits, potential risks, and challenges of expansion and intensification of agriculture into boreal and Arctic regions.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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