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EDITED AND REVIEWED BY
Niall Patrick Hanan,
New Mexico State University,
United States

*CORRESPONDENCE
Birhanu Biazin,
b.temesgen@cgiar.org

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Editorial: Advances in soil and water management for dryland areas

Birhanu Biazin[1]*, Giulio Castelli[2,3,4], Elena Bresci[2] and Saskia Keesstra[5,6]

[1]International Potato Center, Tamale, Ghana, [2]Department of Agriculture, Food Environment and Forestry (DAGRI), Università degli Studi di Firenze, Firenze, Italy, [3]UNESCO Chair in Hydropolitics, University of Geneva, Genève, Switzerland, [4]Environmental Governance and Territorial Development Hub (GEDT), University of Geneva, Genève, Switzerland, [5]Climate-Kic Holding B.V., Amsterdam, Netherlands, [6]Wageningen Environmental Research, Wageningen University and Research, Wageningen, Netherlands

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Editorial on the Research Topic
Advances in soil and water management for dryland areas

1 Introduction

Drylands cover about 41% of the terrestrial land being inhabited by more than a third of the global population supporting mainly grazing, crop cultivation, and natural forests. Based on precipitation and atmospheric demand of evapotranspiration, they can be divided into four categories: hyper-arid, arid, semi-arid, and dry subhumid areas (Millennium Ecosystem Assessment, 2005; UNEP-WCMC, 2007). Drylands face complex challenges due to natural and anthropogenic causes affecting sustainable livelihoods and environmental and social resilience. Recurrent drought and water scarcity are serious natural challenges that are exacerbated by climate variability and changes (Davies et al., 2015; AhmedHayat et al., 2022). Land and soil degradation caused by deforestation, loss of organic matter, and soil erosion by water and wind aggravate the rate of desertification in dryland areas (James and Reynolds, 2007). Various technological and institutional innovations in soil and water management have been put in place across the world (Marques et al., 2016; Wolka et al., 2018; Piemontese et al., 2023). Restoration of degraded drylands through area enclosures, physical and biological soil and water conservation practices, soil carbon management, and the use of deficit and supplemental irrigation have supported sustainable intensification in dryland areas (Ruiz-Sanchez et al., 2010; Stroosnijder et al., 2012; Rockström et al., 2014; Mekonnen et al., 2015). However, the available technologies and knowledge are not sufficient to tackle the complex challenges of soil and water resources management sustainably in dryland areas. Therefore, the aim of this Research Topic was to gather interdisciplinary studies focusing on innovations and new approaches for the advancement of soil and water management in dryland areas. The world cloud clearly indicated the level of importance of the different topics in this Research Topic (Figure 1).

2 Overview of the Research Topic

The contributions of this Research Topic are diverse both in spatial and disciplinary perspectives. Burka et al. evaluated the performances of different drought indices for spatiotemporal drought characterization in a dryland river basin of southern Ethiopia. The study employed four decades of daily meteorological data recorded in seven stations at different topographic features of the Bilate River basin. The drought indices include the Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), Reconnaissance Drought Index (RDI), enhanced Reconnaissance Drought Index (eRDI) with different time scale and Self-Calibrated Palmer Drought Severity Index (scPDSI). The first four indices had the highest correlation to characterize historical droughts. Ibba et al. evaluated regulated and sustained deficit irrigation strategies on olive trees in the Menara drylands of Morocco. The results revealed that regulated deficit irrigation can be a viable strategy to address the adverse effects of water stress during the sensitive growth stages of olives.

Zhou et al. clarified the process of soil desiccation in Haloxylon ammodendron plantations where over-afforestation contributes to frequent soil drying in the Alxa desert of China. The systematic analyses on soil water supply, consumption, and balance showed that the soil water storage in the top 4 m of the soil layers varied among different ages of the plantation, with the largest storage at 0–11 years old. Mao et al. examined the origin of soil water repellency in an arid area of Xinjiang province in China. Soil water repellency is one of the causes of low water infiltration in dryland soils. The results revealed that soil water repellency is positively correlated with soil organic carbon (SOC), silt content, and field capacity, while the field capacity is affected by the other two factors.

Gholami et al. applied a new approach, the graph convolutional networks (GCNs), to analyze wind erosion susceptibility in the Semnan Province of Iran which has an arid climate with high vulnerability to dust storms and climate change. The model revealed that the GCN approach can be recommended for spatial analyses of susceptibility to wind erosion hazards in other arid environments around the globe. Gao et al. revealed higher soil fertility and a healthy ecosystem from the combined chemical and organic fertilizer due to the increased beneficial microorganisms. However, chemical fertilizers tended to increase the risk of crop infection with soil-borne diseases.

A study by Ni et al. revealed that treating cotton with NaCl can improve its drought resistance. After NaCl pretreatment, both drought resistance and germination rate of cotton were improved by controlling the expression of some plant hormones and regulating genes related to the carotenoid and abscisic acid downstream synthesis pathways.

3 Reflection

Overall, the papers presented in this Research Topic conveyed new knowledge and strategies for the advancement of soil and water management in dryland areas. The key Research Topic addressed included the characterization of meteorological droughts using different indices; the link between soil desiccation and dryland afforestation; the control of deficit irrigation applications adjusting to the sensitive growing stages of the crops; the effect of inherent soil properties on soil water repellency; and the long-term use of integrated soil fertility management on soil properties.

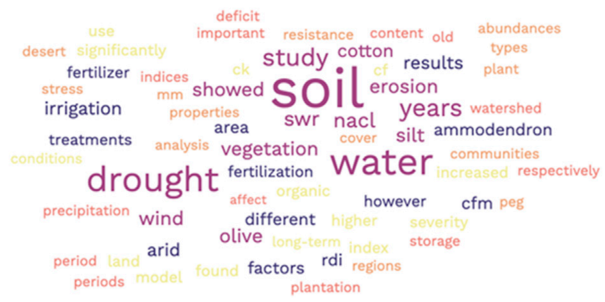

FIGURE 1
Word cloud generated with the abstracts of the Research Topic.

The findings about the relationship between the vegetation carrying capacity of soil moisture and afforestation in desert areas implied the need to identify the appropriate ages of thinning and harvesting of plantation forests for reduced soil desiccation, thus balancing between the outflux through evapotranspiration from the plantation and influx from natural precipitation. While sustained deficit irrigation techniques were previously studied, the benefits of regulated deficit irrigation for improved performances of olive orchards in drylands were presented in this Research Topic. Hence, the results implied that regulated deficit irrigation focusing on sensitive growth stages of the dryland crops can be contextualized according to the types of crops and local environmental conditions. Tackling the crop water stress through soil water conservation by integrated use of organic and chemical fertilizers was also explored. The results implied that the combined application of organic and chemical fertilizers was superior to the application of sole chemical fertilizers in maintaining soil fertility and ecosystem functions, while the latter caused microbial infestation of dryland crops. Moreover, the use of NaCl treatment on cotton enabled to increase the crop drought resistance.

These contributions implied the role of context-based and integrated soil and water management innovations as there is no silver bullet to address the challenges across the dryland areas. Overall, the studies implied that sustainable and improved soil and water management in dryland areas can be achieved through integrated and contextualized soil-water-vegetation management strategies.

Other innovations such as water harvesting have been found to be effective for sustainable crop production and agroecosystems restoration in dryland areas (Biazin et al., 2012; Rockström et al., 2014; Piemontese et al., 2021; Wang et al., 2022). In this sense, further research can assess how local-scale experiences could be transferred and adapted in similar contexts elsewhere in the world and, more in general, it can explore the future impacts of climate change on drylands at the local scale.

Author contributions

BB: Writing–original draft, Writing–review and editing. GC: Formal Analysis, Methodology, Writing–review and editing. EB: Writing–review and editing. SK: Writing–review and editing.

Conflict of interest

Author SK was employed by Climate-Kic Holding B.V.

The remaining 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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