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EDITORIAL

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Water resource management in agriculture for achieving food and water security in Asia

Introduction

Agriculture is one of the largest users of water in the world. According to the Food and Agriculture Organization (FAO, 2011), 90% of freshwater resources are used for agriculture in the Asia Pacific region, considerably more than the global average of 75%. As is widely known, climate change is exacerbating water scarcity, which, together with increased demand from competing sectors, is limiting the agriculture sector's capacity to contribute to food security unless issues related to improved water management are addressed.

Globally, irrigated agriculture represents 20% of the total cultivated land, contributing almost 40% of the total global food production (World Bank, 2022). In the People's Republic of China (PRC), irrigated agriculture contributes almost 75% of the global grain production (National Bureau of Statistics of China, 2021), indicating the critical role of improved water management in agriculture to ensure national food security as well as the stability of the world grain market. In contrast, many other Asian countries have low irrigation water use efficiency. For example, despite being a large agricultural producer, India´s irrigation water use efficiency is as low as 38% (Jain et al., 2019). Against this backdrop, there are increasing worries about whether existing policies, practices and technology are appropriate, or even sufficient, to address the challenges associated with agricultural water management to adequately support future food demand.

With this special issue, we aim to broaden the understanding of the prevailing challenges related to water resource management in agriculture and their repercussions on food security in the context of climate change. Simultaneously, we discuss alternative water management practices that are particularly relevant for both water-scarce and water-abundant agricultural settings. Finally, the outcomes provide policy alternatives required to address the institutional, socio-economic and financial constraints that limit agricultural water management.

In preparation for the special issue, an online international meeting was organized by the Asian Development Bank Institute (ADBI) on 26–27 October 2022, where the authors discussed their main research findings. The papers were improved based on the comments received during this meeting and later submitted to the journal for peer review.

The special issue contains ten papers. The first paper by Datta et al. (2023) examines the impact of climate-change-induced water-related threats on food security in the Indian Sundarbans and develops a management option to address the problem. Their findings indicate that climate change has lowered agricultural output, endangered traditional livelihoods and threatened food security through its impact on water availability. To properly address these issues, there is a need to integrate local-level adaptation measures with national and global-level mitigation initiatives. Considering the variations in rainfall and evapotranspiration across seasons, the paper by Mohapatra et al. (2023) investigates the effects of seasonal weather variables and

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extremes on the mean yield and yield variability of rice, *bajra*, chickpea, groundnut and sugarcane in India using data from 1990 to 2015. They showed that changes in rainfall and evapotranspiration across seasons largely affect mean yields for most crops, including *bajra*, chickpea and groundnut. High summer rainfall and low monsoon evapotranspiration reduce groundnut and chickpea yield variability. In an investigation of the effects of mechanization in land preparation on irrigation water productivity in the PRC, Li et al. (2023) found that it helped increase water productivity substantially, and more importantly, that water productivity does not differ across the different methods of accessing the machine for land preparation. In the context of the increasing use of groundwater for irrigation and domestic use and climate change, Shiferaw et al. (2023) examined the governance aspects of groundwater in India. They showed that it is complicated because of externalities associated with its attributes that create problems of rivalry and exclusion. Their study concluded that balancing and integrating demand- and supply-side approaches are critical to improving groundwater governance. According to the study by Zheng et al. (2023), the adoption of integrated water management technology highly correlates with farmers' perceptions regarding its impact on farm workload, input use efficiency, operational easiness and income generation. Using data from northeast Thailand and central Vietnam, Do and Nguyen (2023) showed a positive role of year-round irrigation facilities in coping with weather shocks and its positive contribution to increasing farm households' income and lowering poverty. The study conducted by Srinidhi et al. (2023) highlighted the importance of integrating water management interventions into broader agricultural productivity enhancement strategies, thereby reinforcing climate resilience. Taking an example from the Mekong Delta in Vietnam, Tran and Cook (2023) indicated how the emerging climate change and development processes jeopardize water supply in the Global South. Disrupted water flows driven by climate change and hydropower development have caused water scarcity, threatening agricultural systems in both upstream and coastal areas. Considering these issues, they suggested adopting grey (engineered) solutions in addressing water scarcity and in securing water sustainability (water retention) for agricultural resilience and recommended integrated 'grey–green' (engineered-nature-based) solutions. The study by Behera et al. (2023) provided evidence that the number of rainwater-harvesting structures, annual average rainfall, forest cover and net sown area improve groundwater levels. They also found evidence that tube well irrigation and rice cultivation can adversely affect groundwater levels. They advocated for the effective utilization and management of both surface and groundwater for the long-term sustainability of water resources. The study in Uzbekistan by Babadjanova et al. (2024) found evidence that rising summer temperatures and soil salinity considerably reduce food supply. The study recommended progress in water and soil management practices to safeguard the future of agricultural activities, promoting resilience and ensuring food security in the region.

Conclusions and key policy implications

Comprising ten papers addressing various aspects of climate change and water-related challenges, this special issue discusses in-depth water management policies in Asian agriculture by offering practical insights at various levels. Securing water and food security in the face of escalating climate change necessitates collaborative efforts among individuals, local governments, non-governmental organizations (NGOs), international organizations, the private sector, academia and diverse stakeholders. Based on key findings of the articles featured in this special issue, we summarize policy implications as follows:

(i) *Integration of measures at multiple levels*: In order to achieve water and food security amid increasing climate change, local-level adaptation measures need to be combined with global-level mitigation initiatives (Datta et al., 2023). A promising example of this is the initiative that can be taken to improve irrigation at the local level and link such initiatives with national and international investment in agricultural development. Integrating water management approaches in the overall agricultural development approach can help reduce the severity of seasonal climate impacts on crop production (Mohapatra et al., 2023).

(ii) *Technological development and agricultural mechanization*: An adequate level of mechanization of agricultural activities such as land preparation can help increase irrigation water productivity, thereby addressing water shortages in the future (Li et al., 2023). This is also in line with some past studies on mechanization and water use efficiency, such as by Aryal et al. (2015).

(iii) *Provision of irrigation facilities*: Proper provision of year-round irrigation facilities contributes to farm income and lowers farm poverty (Do & Nguyen, 2023). Poor irrigation facilities hinder the potential of farm households to diversify crops and also reduce water productivity. Thus, investment in better irrigation facilities falls under the major policy implications for sustainable water management in agriculture and contributes to reducing rural poverty.

(iv) *Improved water governance*: Water governance in the agriculture sector has remained a crucial issue for a long time. Studies included in this analysis have focused on the need to use both demand- and supply-side approaches to improve groundwater governance (Behera et al., 2023; Shiferaw et al., 2023; Tran & Cook, 2023). The overall water governance should also examine the need for grey solutions in some sectors while giving due consideration to grey–green solutions in the governance of water resources in the agricultural sector (Tran & Cook, 2023). Governance plays a crucial role in improving agricultural intervention's impact as it contributes immensely to embedding monitoring, evaluation and learning components while designing interventions required for sustainable water management in agriculture (Srinidhi et al., 2023).

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