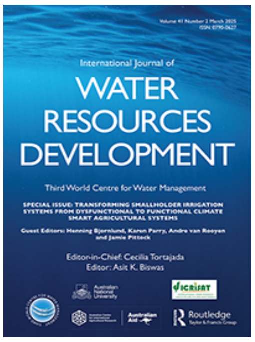

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EDITORIAL

Critical reflections on transforming smallholder irrigation systems from dysfunctional to functional climate smart agricultural systems

Smallholder irrigation schemes are complex socio-ecological systems and critical components of agri-food systems. However, they are often driven by political objectives, including the production of staple food for food security and sovereignty, and therefore contrary to individual farmers' aspirations of developing profitable farming enterprises that can adequately support scheme maintenance. This has resulted in dysfunctional schemes with rehabilitation efforts focused on infrastructure refurbishment, which neglect other critical aspects required for successful functioning such as strong market linkages and improved social dynamics. The poor performance of smallholder schemes represents a failure to enhance the livelihoods and food security of households and the development of local economies (Pittock et al., 2020). This failure creates an imperative to transform schemes using multiple interventions as leverage across the system to improve farmers' adaptive capacity and enable schemes to become climate smart agricultural systems. This imperative is made more important because of the significant investment being made by governments and donors in irrigated agriculture.

To achieve more sustainable agricultural systems, the project Transforming Irrigation in Southern Africa (TISA) applied a two-pronged approach in smallholder irrigation schemes in Tanzania, Mozambique and Zimbabwe, comprising: (1) soil moisture and nutrients monitoring tools, for improved irrigation management and (2) participatory agricultural innovation platforms (AIPs) to identify barriers to increasing productivity and profitability. The AIPs implemented a range of locally-appropriate additional interventions to overcome barriers and seize opportunities, for example: establishing market linkages; improving the quality of inputs; initiating experimental plots for new crops and farming practices; administering soil tests to improve fertilizer regimes; and undertaking participatory mapping of irrigation schemes. For a more comprehensive list see Bjornlund et al. (2024) and Ncube and Pittock (2024).

This is the third special issue of the *International Journal of Water Resources Development* presenting the learnings and results from TISA. TISA commenced in July 2013 and ended in June 2023, with the two previous open access issues reporting on baseline conditions (volume 32(5), 2017) and mid-term project outcomes (volume 36 (S1), 2020). In the final two years, there was a strong focus on assessing TISA's impact on farmers' ability to adapt to climate change and the impact of COVID-19, which is reflected throughout this special issue. However, the diversity of TISA's research team has meant that the transformations achieved through TISA can be explored from several perspectives. Each paper in this special issue provides important insights.

The special issue opens with Bjornlund's and Bjornlund's (2024) historical analysis of how the Green Revolution (GR) production system emerged and its subsequent introduction into Mexico and India. The paper provides a comprehensive understanding of the GR system – including its reliance on large-scale, input-intensive and mechanized agricultural production – and its mostly detrimental impacts in Mexico and India. The analysis highlights the critical lessons learned from Mexico and India, which were known to the Alliance for a Green Revolution in Africa (AGRA) when the new GR for Africa was introduced in 2006. The paper then documents the early impact in Africa, illustrating that the lessons were not acted upon and that the GR system has been inappropriate for African conditions and has failed Africa's many smallholders. Hence, it provides a critical understanding of the need for alternative agricultural transformation processes, such as TISA. It also highlights the need for a paradigm shift to introduce interventions that focus on smallholders, agroecology, local food production and value adding as drivers of economic development.

The next three papers discuss the impact of the TISA interventions on the pressing need to increase the adaptive capacity of smallholders and their irrigation schemes: Moyo et al. (2024) for Zimbabwe, Tafula et al. (2024) for Mozambique and Mdemu et al. (2024) for Tanzania. All three papers find that farmers improved their water productivity, yields, gross margins and household income. These, and other impacts, are analysed in the context of five key factors that are identified in the literature as influencing farmers' adaptive capacity. In doing so, the findings confirm TISA's hypothesis that the two-pronged approach would significantly improve farmers adaptive capacity and facilitate a transformation of schemes into more climate smart agricultural production systems.

The three papers make additional, more specific contributions, providing important insights. Moyo et al. (2024) provide a detailed analysis of water productivity. They find that, in Zimbabwe, the changes to irrigation management have increased water productivity in maize production from 0.20 kg/m^3 to 1.28 kg/m^3 in 2017, before falling to 0.98 kg/m^3 in 2021/22, due to the impact of COVID-19 restrictions. Because of these changes, rainfall increased its contribution to total available crop water from 20% in 2013/14 to 75% in 2020/21. This reverts the irrigation scheme to its original intended purpose of being supplementary to rainfall. This is a crucial transformatory step in the context of increasing global demand and scarcity of water.

In Mozambique, Tafula et al. (2024) compare the management practices, yields and gross margins of farmers who received tools with farmers on the same scheme who did not receive the tools. Farmers with the tools changed their irrigation management practices and increased their yield and gross margins more quickly. Yet, farmers without the tools made similar changes, albeit at a slower pace, and over time achieved a performance close to those with the tools.

Mdemu et al. (2024) explore similar issues in Tanzania. They explore how the intervals and duration of irrigation events changed over time for farmers with tools in their fields and farmers on the neighbouring plot. They find that, while farmers with the tools initially increased the intervals between irrigation events and reduced the duration of each event more than their neighbours, the neighbours experienced the same change, but at a slower pace. By the end of TISA, all farmers within the scheme had the same frequency and duration of irrigation events. These findings provide clear evidence of farmer-to-farmer learning and illustrate that by engaging a small number of influential lead farmers in transformation processes, it is possible to impact a much larger group.

Bjornlund et al. (2024) compare the impacts of COVID-19 restrictions on farmers from schemes that experienced TISA interventions with farmers on similar schemes that were not part of TISA. The impacts of the COVID-19 restrictions were similar but varied in severity across the three countries depending on the level of restrictions imposed. The impact was experienced most severely in Zimbabwe, with the most disruptive restrictions, and least severely in Tanzania, where restrictions were quickly removed. In Tanzania, the impact was mainly due to restrictions imposed by neighbouring countries limiting the movement of produce and farm inputs across borders. The findings clearly prove that TISA farmers experienced significantly less negative impacts from the COVID-19 restrictions, suggesting that the TISA interventions have increased their capacity to adapt to changing conditions. As COVID-19 represents an unanticipated disruption on the scheme, it is an important outcome that interventions initiated to improve productivity and wellbeing have simultaneously built resilience in the farming system.

Parry et al. (2024) focus on the impact of the TISA interventions on underserved groups. Their paper explores whether TISA's interventions have reduced inequity for women, youth and tail-end farmers on smallholder irrigation schemes, focussing on access to plots, decision-making and economic wellbeing. They find evidence of equity improvements, though this was inconsistent across households and schemes, and was complicated by COVID-19 disruptions. The findings suggest that resource equity could be improved by allocating land to the person farming irrigated plots, rather than the household head, and giving some priority to new young irrigators. There is a need for further research that explores who within the broad groupings of women and youth are more or less vulnerable, and how vulnerable groups can be engaged in the co-design of transformation processes.

Parry (2024) looks at the role of youth in the local economy around an irrigation scheme in Zimbabwe and their livelihood pathways. She finds that many of them are struggling to create a livelihood, with non-farm activities particularly important to accumulate resources to engage in irrigation farming or add on other income earning activities. There is a need for more young farmers to engage in scheme irrigation. However, there are insufficient plots for all young people and there is a great need for alternative income-earning activities. Development efforts should recognize the inequality between young people and their varied capacity to contribute to developing their local economy. Those with the capacity for business development should be supported to expand or create new businesses, and those who lack capacity or prefer to work for others can capitalize on new job opportunities.

The following three papers focus more specifically on the two core interventions: soil moisture and nutrients monitoring tools and AIPs. Stirzaker and Driver (2024) explore the notion of requisite simplicity associated with the introduction of irrigation technology and the need to balance the amount of information generated with benefit gained by the irrigator. Their paper builds on Stirzaker et al. (2017) by providing further insight into the design and technical workings of the soil moisture and solute monitoring tools, highlighting the optimum amount of information needed for irrigators to take action and continue learning. Colour patterns of soil water, nitrate and salt data are presented to illustrate how meaning is derived from the tools and interpreted as a threshold for action. As water scarcity increases, soil moisture monitoring will remain an important technological innovation in transformation processes of irrigation systems.

Ncube and Pittock (2024) use social network analysis to explore information exchange around agricultural innovations facilitated by AIPs at three irrigation schemes in Zimbabwe. They find that most actors that held important structural positions are scheme leaders, AIP members, females, individuals older than 35 years, or long-term scheme members. In transformation processes, these actors, particularly those who can most efficiently influence the network, can be targeted for the reliable dissemination of agricultural innovation information and so influence adoption and scaling.

Ncube et al. (2024) apply the multilevel perspective and anchoring frameworks to assess the effectiveness of AIPs to embed and out-scale innovations. They argue that scaling dimensions identified during TISA can be replicated; however, scaling approaches should be designed to fit a specific context and integrated into a project's theory of change. They recommend that to sustain scaling impacts for long-term benefits, investment should be made to secure the right mix of stakeholders and an AIP membership with the collective capability to co-create, innovate, anchor and scale such that innovation is first anchored at the micro (niche) level and then institutionalized in other levels of the system.

This and previous special issues on TISA provide key messages for moving forward with further transformation of schemes and their associated communities, including:

- Governments should allow farmers to grow the most profitable crops on irrigation schemes rather than mandating production of staple grains.
- Governments and irrigation communities need to agree who owns what water infrastructure, how it will be operated and maintained, and how the relevant costs will be funded.
- Large-scale and input-intensive agricultural production systems are inappropriate for smallholder farming systems in Africa. New systems that focus on the needs of smallholders are required, which incorporate agroecological production principles and reduce reliance on expensive imported agricultural inputs.
- Transformation processes should have rural economic development at their heart and ensure the greatest benefit is derived by local communities.
- Participatory planning and innovation forums with multi-stakeholder representation are essential for transforming irrigation schemes into more profitable, sustainable and climate smart systems with enhanced adaptive capacity.
- AIP representation that includes various levels of governance is critical to support the development and implementation of locally appropriate supplementary solutions to barriers and facilitate scaling and institutionalization of innovations at other levels of the system. These forums could be explored as a space for representatives to voice the needs of the more vulnerable and highlight where there are opportunities to be more inclusive in AIP-initiated interventions.
- Dysfunctional schemes can be transformed into functional and profitable schemes. When this has been achieved irrigation schemes should become the economic driver of the surrounding dryland and livestock farming communities.

Building on these findings, van Rooyen et al. (2024) close this special issue with a paper outlining the way forward for further transformation of the schemes engaged in the TISA project. They propose to transition food systems to circularity and greater diversity, using agroecology principles and shifting mental models of development from scale to scope. They argue that integrating dryland and irrigated cropping systems and livestock systems can increase production efficiencies when aligned with local food demands and cultures. Synergies between food enterprises and their products, by-products and waste will generate further enterprises and tighten resource cycles, closing nutrient, water and energy loops, while reducing reliance on external inputs. This will generate more economic benefits per unit of land, labour and water. It will decouple local economies from natural resource use, reduce environmental impact and expand rural livelihood opportunities. This decoupling of natural resource use from socio-economic benefits is essential if the world is to feed a growing population with finite natural capital.

The Australian Centre for International Agricultural Research has acknowledged the achievement of TISA and shares the teams' vision of the way forward. Hence, it has funded a new project titled 'Circular Food Systems in Africa' (2023–2026). As a team, we are excited about being engaged in this process and are looking forward to sharing our experiences and learnings from our research in future publications. In the meantime, we are pleased to share our learning from TISA in this special issue and we hope you find plenty to stimulate your own thinking and research.

References

Bjornlund, H., Parry, K., Kissoly, L., Dube, T., Mujeyi, A., de Sousa, W., & Bjornlund, V. (2024). The impact of COVID-19 and how to improve the resilience and adaptive capacity of farmers in small-scale irrigation schemes in sub-Saharan Africa. *International Journal of Water Resources Development*, *41*(2), 350–373. https://doi.org/10.1080/07900627.2024.2421565

Bjornlund, V., & Bjornlund, H. (2024). Reviewing the Green Revolution strategy in view of lessons from Mexico and India – Africa. *International Journal of Water Resources Development*, *41*(2), 229–273. https://doi.org/10.1080/07900627.2024.2363954

Mdemu, M., Kissoly, L., Kimaro, E., Bjornlund, H., Ramshaw, P., Pittock, J., Wellington, M., & Bongole, S. (2024). Climate change adaptation benefits from rejuvenated irrigation systems at Kiwere and Magozi schemes in Tanzania. *International Journal of Water Resources Development*, *41*(2), 325–349. https://doi.org/10.1080/07900627.2024.2397400

Moyo, M., Dube, T., Bjornlund, H., van Rooyen, A., Pittock, J., Wellington, M., & Ramshaw, P. (2024). Adapting smallholder irrigation systems to extreme events: A case of the Transforming Irrigation in Southern Africa (TISA) project in Zimbabwe. *International Journal of Water Resources Development*, *41*(2), 274–297. https://doi.org/10.1080/07900627.2024.2423733

Ncube, X., & Pittock, J. (2024). Application of social network analysis in determining innovation information exchange at irrigation schemes in Zimbabwe. *International Journal of Water Resources Development*, *41*(2), 447–465. https://doi.org/10.1080/07900627.2024.2443765

Ncube, X., Pittock, J., Bjornlund, H., & van Rooyen, A. (2024). Agricultural innovation platforms for scaling innovations – Insights from the Transforming Irrigation in Southern Africa project. *International Journal of Water Resources Development*, *41*(2), 466–488. https://doi.org/10.1080/07900627.2024.2345913

Parry, K. (2024). Youth living around irrigation schemes in Zimbabwe: Their livelihoods and role in the local economy. *International Journal of Water Resources Development*, *41*(2), 402–427. https://doi.org/10.1080/07900627.2024.2423738

Parry, K., Bjornlund, H., Mdemu, M., Dube, T., & Tafula, M. (2024). Women, youth, and tail-end users: Improving the livelihoods of disadvantaged irrigators in Southern Africa. *International Journal of Water Resources Development*, *41*(2), 374–401. https://doi.org/10.1080/07900627.2024.2435988

Pittock, J., Bjornlund, H., & van Rooyen, A. (2020). Transforming failing smallholder irrigation schemes in Africa: A theory of change. *International Journal of Water Resources Development*, *36*(sup1), S1–S19. https://doi.org/10.1080/07900627.2020.1819776

Stirzaker, R., & Driver, M. (2024). Soil water sensors that display colours as thresholds for action. *International Journal of Water Resources Development*, *41*(2), 428–446. https://doi.org/10.1080/07900627.2024.2322153

Stirzaker, R., Mbakwe, I., & Mziray, N. (2017). A soil water and solute learning system for small-scale irrigators in Africa. *International Journal of Water Resources Development*, *33*(5), 788–803. https://doi.org/10.1080/07900627.2017.1320981

Tafula, M., Chilundo, M., de Sousa, W., Bjornlund, H., Pittock, J., Ramshaw, P., & Wellington, M. (2024). Climate change adaptation benefits from rejuvenated irrigation farming systems in Mozambique. *International Journal of Water Resources Development*, *41*(2), 298–324. https://doi.org/10.1080/07900627.2024.2436601

van Rooyen, A. F., Bjornlund, H., Moyo, M. P., Pittock, J., Parry, K., & Mujeyi, A. (2024). Agroecology and circular food systems: Decoupling natural resource use from rural economic development in sub-Saharan Africa? *International Journal of Water Resources Development*, *41*(2), 489–511. https://doi.org/10.1080/07900627.2024.2449224

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