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***Viewpoint* – Seeing Like a Farmer – How Irrigation Policies May Undermine Farmer-Led Irrigation in Sub-Saharan Africa**

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ABSTRACT: State and non-state support for farmer-led irrigation can help resource-poor farmers and mitigate adverse social and environmental impacts. However, emerging farmer-led irrigation policies are usually based on assumptions, objectives, and approaches that do not match with many farmer realities. As a result, farmer-led irrigation policies may stifle farmers’ initiatives and the distinctive strengths of these irrigation ventures. Based on two key learnings from studies on farmer-led irrigation in Kenya and Zimbabwe, this viewpoint explores how external interventions may adversely affect irrigation development. First, farmer-led irrigation is characterised by a high degree of farmer autonomy, dynamism, and flexibility. Therefore, farmer-led ventures can fail and struggle, and learning and progress are a result of this autonomy. Embedding often-informal initiatives in formal structures can smother the autonomous and/or entrepreneurial character of farmer-led irrigation. Second, farmers’ aspirations and needs do not always reflect a market-oriented and long-term engagement in irrigation. Dominant frames of commercialising farmer-led irrigation may therefore fail to accommodate the diverse needs of farming households. Interventions may be most meaningful when they recognize, build on, and support diverse aspirations of rural households, aimed at promoting their livelihoods and resilience without promoting specific technologies or pathways. This requires a shift in planning beyond technocratic irrigation discourses of market orientation and water efficiency and productivity.

KEYWORDS: Farmer-led irrigation, policy, development interventions, livelihoods, sub-Saharan Africa

INTRODUCTION

Farmer-led irrigation is appreciated for its autonomous and adaptive nature that results in a diverse and resilient form of agrarian development (Beekman et al., 2014; Woodhouse et al., 2017). Previous research and viewpoints in this journal have elaborated on issues like recognition, potential, governance constraints, and bottlenecks in the equitable and sustainable growth of this form of irrigation development (Hebinck et al., 2019; Lefore et al., 2019; Mdee and Harrison, 2019; Scoones et al., 2019). The potential contribution of farmer-led irrigation to enhancing food security and economic growth has been increasingly embraced by international donors and national governments (World Bank, 2018, 2022; Muturi et al., 2019; African Union, 2020; Government of Zimbabwe and World Bank, 2023). As a result, it is positioned as a new model for irrigation development policy in sub-Saharan Africa. The lack of recognition in policies and agricultural institutions is sometimes even seen as a problem for farmer-led irrigation in being excluded from policy and resource support (Mati, 2023). The attractiveness of public support for farmer-led irrigation lies in promoting market-oriented farming, increasing efficiency and water productivity, and accelerating development while at the same time lowering public expenditure (Izzi et al., 2021). It thereby forms a possible response to the malperformance of public irrigation schemes, which have dominated public investments and irrigation policies for long time. Yet, it is questionable whether these initiatives to support farmer-led irrigation will be successful because the underlying assumptions, objectives and approaches do not always match with farmer realities on the

ground. Interventions may negatively affect the distinct strength of farmer-led irrigation, namely its autonomous and flexible character.

In this viewpoint, recent findings from studying farmer-led irrigation in Kenya and Zimbabwe are used to highlight potential pitfalls of emerging policy support. These studies assessed individual irrigation ventures along sand rivers in Kenya and Zimbabwe, with farmer livelihoods as a starting point (Box 1). The studies analysed drivers, coping mechanisms and choices of farming families over time. Two main findings are mirrored with several assumptions, objectives and approaches that dominate emerging farmer-led irrigation policies. After discussing these in conjunction with past experiences of diverse interventions in farmer-managed or farmer-led irrigation, I present four recommendations for future support.

Box 1: Farmer-led irrigation from sand river aquifers

In the (semi-arid) lands of Kenya and Zimbabwe, ephemeral sand rivers form an annually-recharged water storage system. These rivers are increasingly accessed by farmers to produce staple and cash crops. In Kenya, along the Olkeriai river, a dynamic blend of migrant farmers, land owners and capital investors has led to a thriving irrigation sector, primarily targeting urban and export markets. In Zimbabwe, along the Shashe and Tuli rivers, farmers have invested in small-scale irrigation to overcome multiple economic, political and climatic crises. The production of staple crops and vegetables for home consumption and local sales contributes to their livelihoods in an economically harsh environment.

Most farmers in both study areas access water through small individually-owned motorised pumps and irrigate with hosepipes. Challenges in Kenya include market volatility, failing partnerships, pests and floods. In Zimbabwe, accessing fuel and continued cash flow are persistent problems, which cannot be coped with by all farmers. As a result, there are many fallow lands and production outputs and benefits fluctuate. Moreover, the studies highlight how irrigated crop production plays different roles in often diversified livelihoods (Duker et al., 2020, 2022, 2023; Karimba et al., 2022).

FARMER-LED IRRIGATION AS A NEW POLICY MODEL

Existing irrigation policies usually aim at irrigation expansion, enhancing food security, and supporting economic growth. Observed successes in farmer-led irrigation are embedded in policies to attain these already existing policy objectives, which emphasize market-oriented crop production and cost-effectiveness of farmer-led irrigation (Izzi et al., 2021; Government of Zimbabwe and World Bank, 2023). New food security and agricultural growth initiatives funded by the aforementioned agencies seek to support farmer-led irrigation by:

- Supporting investments to 'accelerate' the development of newly irrigated lands;
- Mitigating obstacles to increase the productivity and efficiency of existing irrigation initiatives;
- Addressing sustainability concerns emanating from, for example, over-abstraction of water or inequitable use of land and water resources.

Such initiatives often perceive small-holder farmers as market-oriented entrepreneurs: "Characteristically, farmers who autonomously develop irrigation are entrepreneurial innovators, targeting new markets and investing their own resources" (Izzi et al., 2021:1). It is assumed that farmers aim to expand and grow cash crops, which would require more 'advanced' and efficient farming technologies and methods. The Ugandan Ministry of Agriculture, Animal Husbandry and Fisheries expresses this in its mission to "transform subsistence farming to commercial agriculture" (Government of Uganda, 2020). Also, farmer-led irrigation is regarded as "a cost-effective and scalable water

management solution" (World Bank, 2018). These FLID attributes of cost-recovery, speedy development, and entrepreneurship mirror prominent flaws of past irrigation policies related to collective smallholder schemes.

These policy efforts take donor interests as a starting point, such as targeting specific groups of farmers (e.g.; women or market-oriented farmers), and being bankable to minimise overhead costs. Although this is understandable from an investor's point of view, this may not always align with a farmer's perspective. As a result, approaches suggested for accelerating or catalysing irrigation development require farmers to fit the moulds of donors, for example by promoting specific technologies or marketing programmes. For example, there seems to be an institutional reflex to "organise farmers" to reduce transaction costs, such as in accessing credit (World Bank, 2022).

Finally, governments and international donors express objectives of irrigation development in terms of enhancing resilience of livelihoods and food security. Strengthening livelihoods requires an understanding of the role that irrigation activities play in, often diversified and dynamic, livelihood strategies. This implies a complexity and diversity in the interests and needs of rural households that is not often explicitly recognized in irrigation policy.

The following sections present two main findings from studying farmer-led irrigation in Kenya and Zimbabwe, relate these to past experiences with diverse irrigation interventions, and the implications of these findings for the above-mentioned assumptions in farmer-led irrigation policies.

LEARNING FROM AFRICAN FARMERS 1: AUTONOMY AND FLEXIBILITY DEFINE FARMER ENDEAVOURS

Farming realities from Kenya and Zimbabwe

A strong drive to be autonomous in planning, investing and adapting crop production is a common characteristic of the farmers studied. The role of governments or NGOs has been absent or minimal in the irrigation cases analysed. For some Zimbabwean farmers, government regulation and collective action problems were the drivers to step out of public irrigation schemes and invest in their own irrigation venture (Duker et al., 2020). Farmers establish and adapt their practices on an individual basis, strongly tied within local and regional networks from which they benefit and learn. Accessing production factors such as natural resources, financial capital, labour and markets is bolstered through continuously altering relations with existing and new actors (Duker et al., 2020, 2022; Karimba et al., 2022). Also, farmers may choose to change roles in farming systems or cease farming if they so wish, to concentrate on other (non-farm) activities without affecting others as would be the case in collectively organised forms of irrigated agriculture. As a result, farmer-led irrigation is pragmatic and highly flexible. Technologies to abstract water are often mobile, replicable, easy to operate individually or can simply be transferred to other locations or owners, like portable pumps, wellpoints and shallow wells. Cropping patterns can vary each season, depending on marketability and one's personal situation (e.g. access to labour or funds), and is often informed by previous experiences. Experimenting and mutual learning within rural networks are core characteristics of farmer ventures studied in Kenya and Zimbabwe.

Lessons from past interventions and implications for future FLID policies

These examples indicate the crucial strong ownership and autonomy present in FLI, which risk decaying or even becoming 'extinct' if external agencies, like a government or NGO, directly intervene. Examples from Tanzania show how state interference has smothered entrepreneurial activities and investments by farmers (de Bont and Veldwisch, 2020). Also, there are lessons to be learned from the past and other regions in the world, particularly from farmer-managed irrigation schemes (FMIS) in Asia. Attempts to formalise FMIS in Indonesia led to the destruction of the social and institutional fabric of these schemes (Lorenzen and Lorenzen, 2008). In Nepal, recognition of the success of FMIS resulted in a drive by government agencies to assist them as they were viewed as an ideal model for irrigation development.

It is not difficult to see the parallel with the current attraction of farmer-led irrigation in SSA (Liebrand, 2019). There is a critique of the ignorance of governments and international donors of the importance of ownership and authority as grounded in local institutions (Joshi et al., 2000), although recent successes are claimed in advancing the technological attributes of FMIS in Nepal (Pradhan et al. 2023). Finally, the promotion of Water Users Associations, for example by the Asian Development Bank, was in many cases another attempt in which the farmers were expected to fit irrigation agencies' moulds and blueprints for institutional reform (Moss and Hamidov, 2016).

These interventions, either addressing individual or collective irrigation activities, are examples of how government action has not always led to advancing farmer-managed or farmer-led irrigation in the past. These experiences mirror a paradox between promoting FLID as a means to address failed irrigation policies, while applying the same rationale for and mechanisms of past policies to advance FLID (Harmon et al., 2023). Hence, it is recommended for state and multilateral agencies to be cautious in developing top-down and uniform approaches to farmer-led irrigation and avoid repeating these mistakes.

A more fundamental issue is the question as to whether farmer-led irrigation can by any means be 'established' or strengthened if a government agency takes the initiative or lead. We have known for several decades that direct investments by donors, for example by supplying watering technology or farm inputs, are likely to be counterproductive in supporting smallholder irrigation. It will not reinforce an autonomous character, but instead create a new dependency on the providing agency and its network (Coward, 1986). The impact of recent initiatives of supposedly 'demand-driven' support of farmer-led irrigation needs to be better understood in terms of farmers' dependency and autonomy. An example in Tanzania illustrates the risk of how imposing technologies or organisational formations can result in a funnel where farmers are constrained in their autonomy and flexibility to learn and adapt to new needs, risks, challenges and opportunities (de Bont and Veldwisch, 2020). Although intentions are often to accommodate for diverse bottom-up needs, support programmes risk turning rural families into beneficiaries, rather than agents of change. It remains to be studied how relatively new financing modalities such as low-interest loans or pay-as-you-go affect the autonomy of farmers and can avoid dependency creation.

Finally, from a financial investor's point of view, benefits could be expected from efforts to organise farmers to achieve scale, for example marketing or accessing finance. Although this may work in certain contexts, such activities do not reflect farmer practices nor needs as we have studied. For example, irrigation in the Kenyan case study is thriving because of the flexibility in choosing diverse markets and financial resources, despite the high transaction costs (Karimba et al., 2022). More 'bankable' projects are likely to become uniform and rigid with limited room for adapting strategies based on renewed insights and farmer needs. This reflects a dilemma for how investments in irrigation development are shaped: a few large investments versus many small investments (see also Prasad et al., 2023).

LEARNING FROM AFRICAN FARMERS 2: LONG-TERM AND MARKET-ORIENTED FARMING ARE NOT UBIQUITOUS GOALS

Farming realities from Kenya and Zimbabwe

Our studies in Kenya and Zimbabwe show that farmers do not always pursue irrigation as a continuous or long-term commitment. Also, not all farmers aim for commercial market-oriented farming (Duker et al., 2023). In Kenya, where market-driven forms of farmer-led irrigation dominate, 39% of the studied farmers were not interested to continue irrigated agriculture. They saw irrigation as a stepping stone towards other sources of livelihood, mostly for businesses that are considered more stable sources of income such as retail outlets or restaurants. Within these diverse livelihoods, farmers frequently shifted between more subsistence and more commercial irrigation strategies or paused or stopped altogether.

Hence, farmers cannot always be categorised as subsistence or market-oriented farmers as this orientation changes in response to developments in their personal situation and network. For example, in about one third of the cases where the studied Kenyan farmers reverted from market-oriented crop production to subsistence farming, they did so out of choice; because of the associated high risks, and the availability of more stable alternative livelihood sources. Thus, even where urban and export output markets were within reach, they did not aspire to continuously produce for these markets.

On the other hand, farmers in regions where the scope for non-farm economic activities is limited, such as in southern Zimbabwe, aimed for stabilising their farm operations to provide for their families in food insecure communities. Hence, they perceived farming as the only reliable livelihood source. Being dedicated to irrigated agriculture for subsistence does not automatically imply an aspiration or compatibility for scaling to reach urban or international markets as the associated risks may compromise livelihood stability in an economically very weak and volatile system. Thus, there is a large variety in the aspirations of farmers in terms of continuity and market-orientation. This notwithstanding, there are farmers who do not manage to cope with certain challenges, or face obstacles to realise their scaling aspirations, for which support could be meaningful.

Lessons from past interventions and implications for future FLID policies

For some entrepreneurial and market-oriented farmers, indirect support in the form of subsidies or financing modalities to acquire specific technologies may be sound and welcome solutions. Nonetheless, positioning irrigation expansion and commercialisation as primary objectives of irrigation policies biases our view of farmers' needs and ignores the diversity of farming households. However, these frames of linear progression towards commercial irrigation currently dominate emerging FLI policies and support initiatives, originating from 'old' irrigation agendas (Government of Uganda, 2020; Izzi et al., 2021; International Water Management Institute, 2023). Thus, rather than centralising and promoting irrigation development as the primary source of livelihood, a focus on families' diverse strategies, needs and challenges could reach more families. This may lead to other interventions that are informed by the aspirations and needs of farmers, for example stabilising access to certain production factors instead of necessarily enhancing production growth or efficiency gains. Experiences in the past have shown too often how single-solution oriented programmes, often inspired by a specific 'improved' or 'modern' technology, have failed in meeting the needs of the myriad of farmers involved. For example, drip irrigation projects frequently result in low adoption rates where drip lines are left unused after pilot phases end, because the objectives of donor agenda's did not meet the actual farmers' interests (Wanvoeke et al., 2016).

MOVING FORWARD

Based on these two key learnings for farmer-led irrigation policies, I present four recommendations.

1. Centre-stage farmers instead of irrigation

Policy engagement and learning that respects bottom-up initiatives can result in more promising results, different from many of the currently top-down articulated irrigation policies. Hence, it is preferable that agencies adjust to the farmers' realities, instead of moulding the farmers to the agencies' needs. I therefore recommend incorporation of the diverse roles that farmer-led irrigation plays in livelihoods, as an outcome of balanced decision-making within a diversified livelihood portfolio. Development programmes should recognize and embrace this context, including the aspirations, options, hurdles and needs that may go beyond the irrigated plot alone. This demands more intensive assessment phases, and collaboration with different disciplines that perceive rural families in their dynamic multiple identities. Key to successful projects is the assurance that control over farming activities remains with the farmer,

for them to remain agents of change. Farmer-centred action research could contribute to meaningful 'farmer-led support', to include a diversity of activities and objectives.

2. Adjust policy objectives

Following from the first recommendation, I recommend that policies aimed at supporting farmer-led irrigation recognise alternative avenues for agrarian development other than the commonly framed objectives based on modernist technologies and market-driven irrigation development. They could better respond to differentiated needs, aspirations and challenges of farming families. Such an integrated and tailored approach could result in smaller, yet more targeted and meaningful project activities and outcomes. This change in policy formulation and articulation can be facilitated by an interactive process of policymakers, scientists, development experts and farmers. Mutual learning is key in such a process, whereby the starting point is a problem and not a preferred (technological) solution. Such approaches are likely costlier and more difficult to scale but could turn out to be more effective in the long run.

3. Revisit government and donor roles

Policymakers should be cautious in adopting planned farmer-led irrigation as a policy outcome and development model for agrarian change. Instead of leading and investing themselves, they can focus on facilitating financial and knowledge solutions to reach those who cannot afford to invest, and in addressing adverse environmental or social impacts of farmer-led irrigation at a larger scale. Hence, it is recommended that governments and donors be modest in assigning their own roles, while focusing on addressing those issues that go beyond the individual farmers' sphere of influence. Moreover, such a facilitating role can more reasonably fit the pragmatic, adaptive and multiple realities present within water governance (Clever, 2015).

4. Revise financial modalities for more adaptive rural development

More farmer-centred approaches demand acceptance of uncertain, unplanned and diversified programme activities and results. This would require a radical revision of project budgeting based on predefined targets and outputs. New financing modalities could accommodate flexibility and adaptation of activities along the way, which is, for example, reflected in the proposed concept of Adaptive Investment Pathways (Prasad et al., 2023). This approach advocates for small step-wise investments at landscape level, instead of rigid lumpsum investments that create systemic lock-ins. I recommend testing such approaches, coupled with emerging financing modalities like pay-as-you-go or cash transfers to learn about their feasibility in practice.

CONCLUSION

In conclusion, policymakers are encouraged to ask themselves how farmer objectives can become more central in developing interventions, and what their own role in supporting these farmers can be, while avoiding the perversion of farmer-led irrigation to becoming just another example of state-led irrigation.

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REFERENCES

African Union. 2020. Framework for irrigation development and agricultural water management in Africa, https://au.int/sites/default/files/documents/38632-doc-framework_for_irrigation_development_english.pdf

- Beekman, W.; Veldwisch, G.J. and Bolding, A. 2014. Identifying the potential for irrigation development in Mozambique: Capitalizing on the drivers behind farmer-led irrigation expansion. *Physics and Chemistry of the Earth* 76-78: 54-63, <https://doi.org/https://doi.org/10.1016/j.pce.2014.10.002>
- de Bont, C. and Veldwisch, G.J. 2020. State engagement with farmer-led irrigation development: Symbolic irrigation modernisation and disturbed development trajectories in Tanzania. *The Journal of Development Studies* 56(12): 2154-2168, <https://doi.org/10.1080/00220388.2020.1746278>
- Cleaver, F. 2015. In pursuit of arrangements that work: Bricolage practical norms and everyday water governance. In de Herdt, T. and de Sardan, O.J.-P. (Eds), *Real governance and practical norms in Sub-Saharan Africa. The game of the rules*, pp. 207-227. Routledge.
- Coward, E.W. 1986. Direct or indirect alternatives for irrigation investment and the creation of property. In Easter, K.W. (Ed), *Irrigation investment, technology, and management strategies for development*, pp. 225-244. Boulder, USA: Westview Press.
- Duker, A.E.C.; Karimba, B.M.; Wani, G.E.; Prasad, P.; van der Zaag, P. and de Fraiture, C. 2022. Security in flexibility: Accessing land and water for irrigation in Kenya's changing rural environment. *Cahiers Agricultures* 31(7), <https://doi.org/10.1051/cagri/2022003>
- Duker, A.E.C.; Maseko, S.; Moyo, M.A.; Karimba, B.M.; Bolding, A.; Prasad, P.; de Fraiture, C. and van der Zaag, P. 2023. The changing faces of farmer-led irrigation: Lessons from dynamic irrigation trajectories in Kenya and Zimbabwe. *The Journal of Development Studies* 0(0): 1-20, <https://doi.org/https://doi.org/10.1080/00220388.2023.2204176>
- Duker, A.E.C.; Mawoyo, T.A.; Bolding, A.; de Fraiture, C. and van der Zaag, P. 2020. Shifting or drifting? The crisis-driven advancement and failure of private smallholder irrigation from sand river aquifers in southern arid Zimbabwe. *Agricultural Water Management* 241(2020), <https://doi.org/10.1016/j.agwat.2020.106342>
- Government of Uganda. 2020. UgiFT Micro-scale irrigation programme: A guide for the private sector, <https://www.agriculture.go.ug/wp-content/uploads/2020/11/UgiFT-MicroScaleIrrigation-Program-Private-Sector-Actors-Brochure.pdf>
- Government of Zimbabwe and World Bank. 2023. Farmer-led Irrigation Development in Zimbabwe. Position Paper. Harare, Zimbabwe.
- Harmon, G.; Jepson, W. and Lefore, N. 2023. Farmer-led irrigation development in sub-Saharan Africa. *WIREs Water* 1-13, <https://doi.org/10.1002/wat2.1631>
- Hebinck, P.; Bosma, L. and Veldwisch, G.J. 2019. Petrol pumps and the making of modernity along the shores of Lake Victoria, Kenya. *Water Alternatives* 12(1): 13-29, <https://www.wateralternatives.org/index.php/alldoc/articles/volume-12/v12issue1/476-a12-1-2/file>
- International Water Management Institute (IWMI). 2023. Scaling best-fit irrigation bundles in Mali: A pathway for improved development outcomes. Adaptive Innovation Scaling – Pathways from Small-scale Irrigation to Sustainable Development. Water Issue Brief 23. Colombo, Sri Lanka, www.iwmi.cgiar.org/Publications/Water_Issue_Briefs/PDF/water_issue_brief_23.pdf
- Izzi, G.; Denison, J. and Veldwisch, G. 2021. *The farmer-led irrigation development guide: A what, why and how-to for intervention design*. World Bank, Washington, DC.
- Joshi, N.N.; Ostrom, E.; Shivakoti, G.P. and Lam, W.F. 2000. Institutional opportunities and constraints in the performance of farmer-managed irrigation systems in Nepal. *Asia-Pacific Journal of Rural Development* 10(2): 67-92, <https://doi.org/10.1177/1018529120000205>
- Karimba, B.M.; Duker, A.E.C.; Prasad, P.; de Fraiture, C. and van der Zaag, P. 2022. Irrigation on the move: How transient farming partnerships facilitate booming smallholder irrigation along ephemeral rivers in dryland areas of Kenya. *Agricultural Water Management* 265(2022), <https://doi.org/10.1016/j.agwat.2022.107526>
- Lefore, N.; Giordano, M.; Ringler, C. and Barron, J. 2019. Sustainable and equitable growth in farmer-led irrigation in Sub-Saharan Africa: What will it take? *Water Alternatives* 12(1): 156-168, <https://www.wateralternatives.org/index.php/alldoc/articles/volume-12/v12issue1/484-a12-1-10/file>
- Liebrand, J. 2019. The politics of research on farmer-managed irrigation systems in Asia: Some reflections for Africa. *Water Alternatives* 12(1): 129-145, <https://www.water-alternatives.org/index.php/alldoc/articles/vol12/v12issue1/482-a12-1-8/file>

- Lorenzen, S. and Lorenzen, R.P. 2008. Institutionalizing the informal: Irrigation and government intervention in Bali. *Development* 51(1): 77-82, <https://doi.org/10.1057/palgrave.development.1100441>
- Mati, B. 2023. Farmer-led irrigation development in Kenya: Characteristics and opportunities. *Agricultural Water Management* 277(108105), <https://doi.org/10.1016/j.agwat.2022.108105>
- Mdee, A. and Harrison, E. 2019. Critical governance problems for farmer-led irrigation: Isomorphic mimicry and capability traps. *Water Alternatives* 12(1): 30-45.
- Moss, T. and Hamidov, A. 2016. Where water meets agriculture: The ambivalent role of water user associations. In Hüttl, R.F.; Bens, O.; Bismuth, C. and Hoehstetter, S. (Eds), *Water-society-technology, a critical appraisal of major water engineering works*, pp. 149-167. Springer Open, <https://doi.org/DOI 10.1007/978-3-319-18971-0>
- Muturi, J.S.O.; van Veldhuizen, L.; Mehari, A. and Veldwisch, G.-J. 2019. *Accelerating farmer-led irrigation development: Theory and practice of the smart water for agriculture in Kenya project*. SWA Kenya, SNV Netherlands Development Organisation, Nairobi, Kenya.
- Pradhan, P.; Yoder, R.; Meinzen-Dick, R. and Merrey, D.J. 2023. Adaptation to change in six farmer-managed irrigation systems in Nepal: Forty years of observations. *London Journal of Research in Humanities and Social Sciences* 23(5).
- Prasad, P.; Duker, A.; de Fraiture, C. and van der Zaag, P. 2023. Irrigation development under uncertainty: A call for adaptive investment pathways. *Environmental Science and Policy* 140(2023): 104-110, <https://doi.org/10.1016/j.envsci.2022.11.017>
- Scoones, I.; Murimbarimba, F. and Mahenehene, J. 2019. Irrigating Zimbabwe after land reform: The potential of farmer-led systems. *Water Alternatives* 12(1): 88-106.
- Wanvoeke, J.; Venot, J.-P.; de Fraiture, C. and Zwarteveen, M. 2016. Smallholder drip irrigation in Burkina Faso: The role of development brokers. *Journal of Development Studies* 52(7): 1019-1033, <https://doi.org/10.1080/00220388.2015.1107048>
- Woodhouse, P.; Veldwisch, G.-J.; Venot, J.-P.; Brockington, D.; Komakech, H. and Manjichi, Â. 2017. African farmer-led irrigation development: Re-framing agricultural policy and investment? *Journal of Peasant Studies* 44(1): 213-233, <https://doi.org/https://doi.org/10.1080/03066150.2016.1219719>
- World Bank. 2018. Innovation, entrepreneurship, positive change. join the farmer-led irrigation revolution. <https://www.worldbank.org/en/news/feature/2018/09/05/innovation-entrepreneurship-positive-change-join-the-farmer-led-irrigation-revolution>
- World Bank. 2022. *From concept to operationalization: Reflections on Farmer-led Irrigation Development (FLID) across Africa*. Washington, DC.

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