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Success and failure factors for increasing Sub-Saharan African smallholders' resilience to drought through water management

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ABSTRACT

This article analyses the success and failure factors underlying smallholder farmers' resilience to drought in Sub-Saharan Africa based on a literature review of the period 2007–19. The analysis is guided by transformation theory, which states that transformation requires adequate preconditions in three spheres: practical, political and personal. While significant progress has occurred in the practical sphere, only moderate change characterizes the political sphere, and the most limited progress is within the personal sphere. We argue that increasing drought resilience requires innovative solutions, including components from all transformation spheres. Interactions with local stakeholders and the empowerment of smallholder farmers are essential.

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Water management; resilience to drought; transformation; smallholder farmers; success/failure factors; Sub-Saharan Africa

Introduction

Agriculture is the world's most water-demanding activity. It accounts for approximately 70% of all freshwater withdrawals and more than 90% in most of the world's least-developed countries (Velmurugan et al., 2020). In Sub-Saharan Africa (SSA), most countries derive a significant portion of their economic output and growth from rain-fed agriculture. It plays a crucial role in providing food security for rural communities and an increasingly growing urban population (Gashu et al., 2019).

However, climate change and climate variability are challenging smallholder farming practices in various ways. For example, Africa is likely to experience a significant change in weather patterns, including more frequent droughts in many regions (Elmhagen et al., 2015). At the same time, increases in heavy precipitation that can lead to pluvial floods are forecast for most African regions. Moreover, increased aridity, hydrological, agricultural and ecological droughts, and fire weather are projected in the western part of West Africa, the western part of East Africa, North Africa and South Africa (IPCC, *in press*).

Droughts have been of increasing concern for more than a decade because they have caused asset depletion, environmental degradation, impoverishment, unemployment and migration to urban areas (Bhavani et al., 2008; Scheffran et al., 2012). The main reasons for

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this are linked to biophysical and socioeconomic limitations. These include rain patterns, soil nutrient deficits, lack of fertilizers, institutional arrangements, technological know-how, market conceptualizations, land tenure systems and international trade arrangements (Bjornlund & Bjornlund, 2019; Oya, 2012; Shiferaw et al., 2014).

Drought resilience thinking can help navigate these complex issues, contributing to development trajectories necessary for the transformation of systems (Folke, 2016; Kates et al., 2012; Mitchell & Harris, 2012; Turnbull et al., 2013). Ensuring increased resilience to drought requires that transformations in agricultural water management (AWM) are integrated with societal transformations, especially in the light of climate change, demographic growth and urbanization (Barron et al., 2015; Üllenberg et al., 2017).

Influential policymaking bodies have highlighted the need for adaptation actions for decades. One example is the global scientific report from 2007 by the International Water Management Institute (IWMI), which attempted to shed light on the importance of long-term water management in agriculture (Molden, 2007). The report presented eight policy actions (PAs) to meet the AWM challenges for a growing population in a changing climate. This was a significant report for the water scientific and practitioner community in the years that followed.

In this study, the preconditions for achieving drought resilience through improved water management in smallholder farming in SSA were analysed based on a literature review covering the period between 2007 and 2019. Inspired by analytical perspectives from transformation theory and using the IWMI policy recommendations as a baseline, the analysis addresses the following questions:

- What transformation evidence linked to selected PAs can be found in the literature?
- What enablers and barriers related to personal, political and practical transformations can be identified in the literature?
- What trends towards acknowledgements of new perspectives needed to increase smallholders' resilience to drought can be identified?

Analytical points of departure

To address the research questions, we first identified relevant PAs recommended by the IWMI (Molden, 2007) and then assessed the success and failure factors relating to changes linked to the practical, political and personal spheres of transformation.

Transformation theory

To understand the changes in outcomes in relation to success or failure factors, we used concepts from transformation theory. It builds on resilience thinking with a strong emphasis on complexity and dynamic interactions. Transformation implies that the fundamental characteristics of a system require radical changes. Furthermore, transformation requires flexibility at different levels and scales to enable sustainable development (Feola, 2015; Folke, 2016). We chose to apply this analytical framework because there is a need for fundamental, radical and rapid changes in order to ensure sustainability as opposed to predominantly short-term action, marginal and incremental change (Kates et al., 2012; Linnér & Wibeck, 2020; Salomaa & Juhola, 2020).

We adopted O'Brien's approach of applying three spheres of transformation: practical, political and personal. They focus on challenges at both the systemic and individual levels to analyse the types of changes through which elements of a system are developed at different scales (O'Brien & Sygna, 2013).

To analyse aspects related to the practical sphere of transformation, we asked whether new technical solutions, measurable strategic changes, and enhanced knowledge and expertise may have promoted innovation or improved management systems. Regarding the political sphere of transformation, we focused on rules, norms, institutions, policies and regulations where existing systems and structures have brought changes to ensure sustainability. Lastly, we identified individual beliefs, behaviour, values and views that influenced the attitudes and actions deemed important for change in the personal sphere of transformation.

Using this analytical lens, we focused on the interactions and collaboration across multilevel entities that could bring new insights into societal responses in the context of drought and water scarcity in rural smallholder communities. Finally, based on PAs evidenced in the literature, we highlighted factors linked to success and failure to change the spheres of transformation.

PAs of relevance for drought resilience

The IWMI report (Molden, 2007) was based on the underlying assumption that the world was witnessing a situation characterized by increasing demand for food production due to population increase, causing increasing pressure on water and other resources. The report recommended that PAs ensure poor water management. We selected five of the eight recommended PAs deemed relevant for resilience to drought among smallholder farmers:

- Policy Action 2: 'Fight poverty by improving access to agricultural water and its use'. The focus is on securing pro-poor technology solutions to store and use water for supplemental irrigation. An emphasis is also placed on access to water and water rights for poor communities and women.
- Policy Action 5: 'Upgrade rainfed systems – a little water can go a long way'. The focus is on soil moisture conservation, supplemental irrigation, land tenure integrating agroforestry, best practices, equal access to resources, functioning operational and maintenance systems, and multifunctional landscapes approach.
- Policy Action 6: 'Adapt yesterday's irrigation to tomorrow's needs'. The focus is on improving the responsiveness of stakeholders through the technological and managerial upgrading of existing systems. This includes innovative technological and managerial climate information-based approaches such as crop diversification and decision-making processes focusing on transparency.
- Policy Action 7: 'Reform the reform process – targeting state institutions'. The focus is on policy shifts involving water institutions, civil society and the private sector, which may lead to decentralized cross-cutting policies, access to micro-loans, community-managed safety net systems and off-farm employment opportunities.
- Policy Action 8: 'Deal with trade-offs and make difficult choices'. The focus is on transparent full participation and involvement in all processes seeking to improve the livelihoods and behavioural changes in communities and individuals.

Table 1. Overview of categories of policy actions (PA) with factors linked to transformation or lack of transformation.

Spheres of transformation	Category of PA	Characteristics of actions linked to transformation
Practical	Access to agricultural water and use of supplemental irrigation to meet tomorrow's needs (PA 2, 5 and 6)	• Pro-poor technologies and solutions to secure, store and use water for supplemental irrigation • Access to water and water rights for poor communities and for women • Land tenure integrating agroforestry • Soil and water conservation • Introduction of smart agriculture and equal access to seeds, credit and markets • Multifunctional landscapes approaches and functioning operational and maintenance systems • New technological and managerial climate information-based approaches such as crops diversification and decision-making processes focused on transparency
Political	Cross-sectoral institutional reforms (PA 7)	• Decentralized policies, access to micro-loans, community-managed safety net systems and off-farm employment opportunities
Personal	Trade-offs and strong collective action in communities (PA 8)	• Smallholder full participation and involvement in processes seeking to improve livelihoods and behavioural change in communities.

These PAs were analysed with a transformation theory lens, based on the assumption that the three dimensions of transformation are required to ensure long-term sustainable change. To assess evidence of systemic and individual changes regarding increasing drought resilience for smallholder farmers in SSA, we categorized the recommended PAs into the three spheres of transformation and highlighted the characteristics of actions leading to transformation (or lack of transformation). An overview of PAs recommended by the IWMI report (Molden, 2007) is categorized for each sphere of transformation (Table 1). The characteristics of actions linked to each sphere found in the literature review are also presented.

Method and empirical focus

Study area

The SSA region comprises 47 countries located south of the Sahara Desert. With a current population of approximately 1 billion, projected to double by 2050, the region is challenged by high water stress and scarcity induced by climate change (Laurance et al., 2014; Pande & Kumburu, 2018). For millions of people, variability and unpredictability of the climate is a major challenge that can critically restrict livelihood options and limit socioeconomic development (Hellmuth et al., 2007). Between 1960 and 2006, Africa was affected by nearly 400 reported drought events affecting approximately 330 million people (Gautam, 2006). SSA experiences frequent and sometimes prolonged droughts that lead to migration and famine, which, combined with inadequate socio-economic entitlements, exacerbates the vulnerabilities of households and national economies (Scheffran et al., 2012). The frequency of droughts has increased steadily in East Africa and Southern Africa but has declined in West Africa (Gautam, 2006; Shiferaw et al., 2014).

Procedures for data collection and analysis

Data were collected through web search engines such as Web of Science, Scopus, Agricola and Google Scholar, focusing on AWM in smallholder farming in SSA. The selection of the empirical material was limited to publications during the period 2007–19. The search was based on the coding of keywords as follows: ‘Agricultural water* management in Sub-Saharan Africa’, ‘smallhold* farm*’, ‘farm* water challeng*’, ‘rural communit*’, ‘drought* resilience’, ‘rainwater harvesting’, ‘transformation’ and ‘success failure factor’.

The web search was finalized in March 2020, resulting in more than 500 references. The references were narrowed down to include only the literature meeting the following criteria:

- Written in English.
- Focusing on water management in SSA.
- Addressing issues of drought resilience in rural communities through water management in smallholder farming.

The literature included scientific papers, books, working documents and grey literature, such as technical reports and policy documents with clear implications. Primary attention was given to publications in peer-reviewed journals and reports from scientific projects. For each publication, we first read the title and abstract to determine whether they met the inclusion criteria. If this were the case, we then downloaded the whole text for further reading and analysis. Literature with conceptual or theoretical significance related to resilience and transformation was also included. This process resulted in 71 publications, which were retrieved and exported into the bibliographic software Mendeley for further processing and analysis. The processed data material retrieved from the electronic database is available in the supplemental data online.

The review procedure applied methodological guidelines and deductive coding of texts for each selected item of literature (Fereday & Muir-Cochrane, 2006; Randolph, 2009). The selected empirical material was systematically screened with regard to authors, year of publication, geographical location, relevant PA category, determinant factors and types of spheres of transformation. We applied content analysis research methods to quantify and deductively analyse the meanings and relationships from the data to create themes and draw conclusions (Elo & Kyngäs, 2008; Krippendorff, 2018). Each of the identified factors was categorized into one dominant sphere of transformation. Additional needs for the transformation of the other two spheres were also identified.

Results

Evidence base for PAs and state of the art for transformation

Findings from the literature review show evidence of PAs related to all three spheres of transformation (Table 1). From a total of 71 publications, our findings revealed a significant proportion (65%) of publications with technical and managerial actions mainly related to the practical sphere of transformation. This category included pro-poor technologies to secure, store and use water for supplemental irrigation, ensuring access and rights to water,

land, seeds and markets (Dile et al., 2013; Mubiru et al., 2018; Rockström et al., 2010). The proportion of publications related to institutional changes with a focus on the political sphere was moderate (38%), including political and institutional approaches focusing on diversification, off-farm employment opportunities, access to micro-loans and safety nets (Adamseged et al., 2019; Davis et al., 2012; Eriksen & Lind, 2009). Finally, a limited number of publications (17%) focused on transformation in the personal sphere, with an emphasis on smallholders' participation and involvement in processes seeking to improve their livelihoods, as well as the need for behavioural changes in the communities (Mutambara et al., 2016; Shikuku et al., 2017; Tahiru et al., 2019).

Although one sphere of transformation might have a major impact on PA, the analysis shows that the three spheres of transformation are interlinked, and the success of long-term achievement of goals requires a change in all spheres. For publications highlighting actions in two or three spheres of transformation, our review shows a fair representation of publications in practical and political spheres of transformation (17 publications), followed by a few publications focusing on combined practical and personal spheres (seven publications). Only a few publications showcased actions in the political and personal spheres of transformation. In total, five publications combined actions in all three spheres of transformation.

Regarding regional distribution, our findings show a varying number of publications covering the SSA sub-regions. There are more publications related to all PAs for Eastern and Southern Africa than for Western Africa (Figure 1). Regarding publications related to political transformation, Western Africa records only one paper (PA7). For PA related to personal transformation (PA8), papers from Eastern Africa are dominant, while Southern Africa has the lowest representation.

With regard to temporal variations in the number of publications, we noticed an increasing number of publications related to PAs over time (Figure 2). It is worth noting that since 2015, publications related to PAs 7 and 8 (policy shifts and trade-offs) have increased significantly compared with the previous years when they are rarely mentioned.

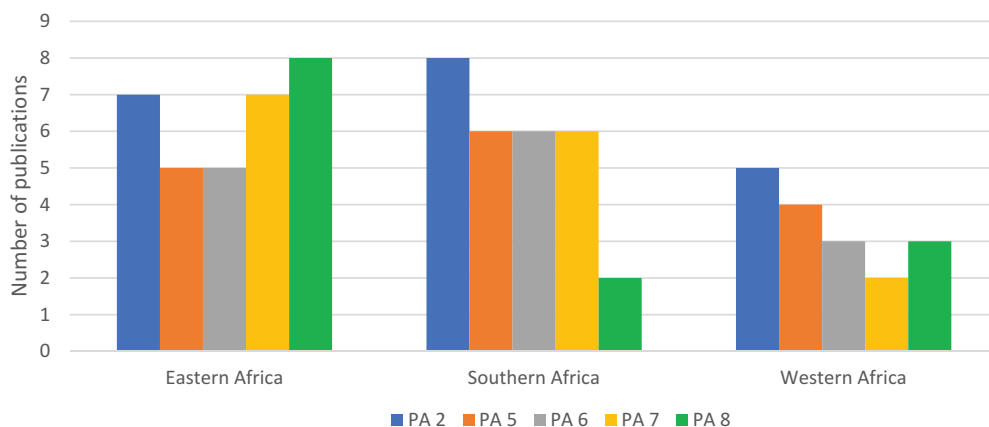


Figure 1. Regional distribution of publications covering Sub-Saharan Africa sub-regions during the period 2007–19. Policy actions (PA) 2, 5 and 6 relate to the practical, PA 7 to the political and PA8 to the personal spheres of action.

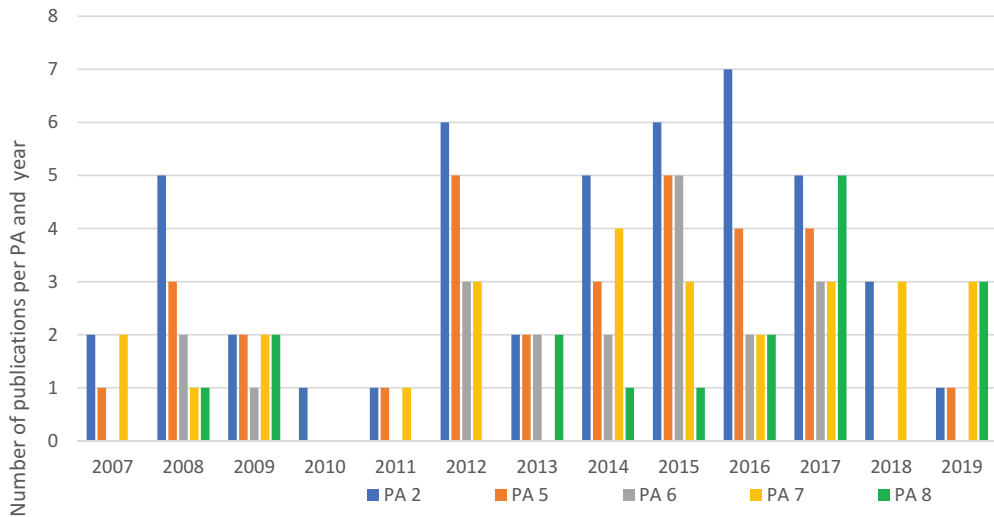


Figure 2. Increasing publications trend of selected policy actions in Sub-Saharan Africa during the period of 2007–19.

Factors linked to success and failure with regard to the three spheres of transformation

The major identified factors enabling or hampering resilience to drought for smallholder farmers are shown in Table 2.

Many authors have highlighted the importance of multidisciplinary approaches that integrate technologies, institutions and individuals. Rockström et al. (2010) argue that the focus on water management technologies should be at the farm level, but with the required policy, governance and market strategies. This management should operate at the cross-cutting scale, from the watershed to the national and regional levels. Moreover, Anley et al. (2007) noted that the undertaking of soil conservation measures is influenced by social, economic, institutional and physical factors. This point must be considered when designing appropriate strategies to achieve technical changes in the natural resource conservation process. As identified by Barron et al. (2015), improving farmers' responsiveness and engagement in adopting technical and managerial upgrades of the existing systems is dependent on the availability of natural assets, physical infrastructure, market access, social capital, financial wealth and credit options.

Changes in the practical sphere of transformation. Several of the studies in our analysis illustrate how investments in water conservation technologies, including water capture and storage for supplemental irrigation, play a significant role in enhancing food production (Erkossa et al., 2014; Rockström et al., 2010; Tesfahunegn et al., 2016). Among others, Shiferaw et al. (2014) and Welderufael et al. (2013) conclude that technological solutions should build on existing local knowledge. They should also be perceived as affordable. Farmers' willingness to invest in water conservation technologies is a prerequisite for success, and most of the time this requires substantial financial investment. This could be facilitated through political decisions (Bryan et al., 2013; Perez et al., 2015).

Table 2. Identified factors linked to success and failure in each sphere of transformation.

Sphere of transformation	Enabling factors (success)	Barriers (failure)
Practical	● Investment in water conservation and affordable supplemental irrigation technologies ● Equal access to relevant resources ● Enhanced learning and exchange on best practices ● Functioning operational and maintenance systems ● Multifunctional landscape approaches integrating agroforestry	● External technical support ● Inaccessibility to groundwater ● Inappropriate technologies and poor maintenance ● Poor watershed management ● Top-down technical interventions to the beneficiaries
Political	● Transparent farmer-centred decision-making ● Decentralized cross-cutting policies ● Micro-credits and community-managed safety net systems ● Development of infrastructure ● Agricultural weather insurance systems ● Off-farm employment opportunities	● Non-existing social safety nets ● Undeveloped road infrastructure and long distance to markets ● Top-down non-participatory approaches in policymaking
Personal	● Farmers' leadership in water-related projects ● Introducing agroforestry in existing farming systems ● Applying crop diversification ● Investments in off-farm income-generating activities ● Introduction of new agricultural practices and seasonal forecasts that incorporate traditional knowledge	● Lack of local initiatives demonstrating benefits of innovations ● Lack of willingness for farmers to invest

Although several studies have highlighted the need to avoid focusing only on technical solutions, the lack of functioning operational and maintenance systems is considered a barrier. Therefore, upgrading rainfed farming with supplementary irrigation based on water and soil conservation practices and adequate maintenance of irrigation facilities is seen as a prerequisite to meet sustainable development and ensure sufficient food production in a changing climate (Rockström et al., 2010; Shikuku et al., 2017; Wani et al., 2009).

The need for equal access to relevant resources has been highlighted in several studies. This includes secure rights to land and access to rural finance markets to provide incentives for conservation investments and sustainable intensification of agriculture. The aim is to adjust livelihoods to drought and mitigate conflicts between herders and farmers (Eriksen & Lind, 2009; Ngigi, 2009; Shiferaw et al., 2009). In addition, the provision of climate information has been advocated because it enables timely planting and the promotion of crop diversification and climate-adapted crop varieties (e.g., Carr & Onzere, 2018; Shikuku et al., 2017). Several studies have demonstrated the success of climate-adapted agriculture when combined with accessibility to seeds, credit and markets (Mubiru et al., 2018; Neubert et al., 2011; Üllenberg et al., 2017; Zougmore et al., 2018). Examples of the opposite also exist, where limited access to credit, markets, extension services, weather-related information, water resources and cropland area, high production costs, and low levels of mechanization impede effective adaptation (Amarnath et al., 2018; Boansi et al., 2017; Markelova et al., 2009; Ndamani & Watanabe, 2015; Tambo & Abdoulaye, 2013). Several studies identify that the successful introduction of new agricultural practices is limited to areas with good connections to export markets, whereas the poorest farmers often settle in remote areas with poor transport infrastructure (Bryan et al., 2009; Evans et al., 2012; Fischer & Qaim, 2012). The benefits of group-based initiatives are highlighted, such as securing formalized land

rights, access to micro-credits, off-farm job creation and upscaling of small-scale irrigation (Burney & Naylor, 2012; Cervigni & Morris, 2016; Derkyi et al., 2016; Kahinda & Masiyandima, 2014).

The need for a solid knowledge base and awareness at all levels has been stressed by many, including Wehn de Montalvo and Alaerts (2013). Governments and donors have made significant investments in human capital through various schemes related to enhancing learning and exchange of best practices, often directed towards women and people with a low education (e.g., De Bruin et al., 2015; Davis et al., 2012; Esterhuysen, 2012; Rockström et al., 2007). It is argued that farmers only adopt new practices and technologies when they have incentives to do so. These are often related to short-term economic gains, especially when credit markets and property rights do not permit investments with long payback periods (Davis et al., 2012; Shiferaw et al., 2009). In addition, the potential to spread successful AWM interventions by learning experiences from successful peers has been stressed (e.g., De Bruin et al., 2015).

Furthermore, multifunctional landscape approaches integrating forestry are advocated as success factors (e.g., Reij & Smaling, 2008; Tittonell, 2014). Such approaches acknowledge ecological and social dimensions, where adaptability results from individual decisions that may change the existing landscape. This demands appropriate policy and market development. Increased concerns about land degradation due to drier conditions and increasing populations have led to demands for land tenure integrating agroforestry (Akinagbe & Irohibe, 2014; Shiferaw et al., 2009). New insights related to the re-greening debate indicate the emergence of new and complex trajectories of landscape change and the production of new types of agroforestry parklands with a shift to drought-tolerant vegetation (Hänke et al., 2016).

Several publications highlighted that external technical support, inappropriate technologies and poor maintenance constitute barriers (Barron et al., 2015; Erkossa et al., 2014; Mutambara et al., 2016; Nyagumbo & Rurinda, 2012; O'Brien, 2012). Most water technologies are developed outside SSA, which can cause a dependency on external technical and financial support. Namara et al. (2011) argued that failures could be attributed to faulty designs, high water pumping costs, lack of repair of the irrigation infrastructure, farmers' lack of technical know-how, an ineffective legal framework for water abstraction and distribution, and lack of political will. Burney and Naylor (2012) showed that most dis-adoptions occurred after the first two years, corresponding to the project lifetime or handover to the beneficiaries. There is a need to merge practicality with political transformation. Tahiru et al. (2019) demonstrated that the lack of conducive policies and management strategies involving local institutions contributed to poor performance in irrigation schemes.

It is important to involve stakeholders in transparent, farmer-centred decision-making. Merging local knowledge with external expertise ensures local adaptability of the practices and involvement in trust-building and encourages a willingness to change (Amarnath et al., 2018; Dougill et al., 2017; Mutambara et al., 2016; Wilk et al., 2017). Failures often relate to the top-down interventions of beneficiaries by governments, donors or non-governmental organizations (NGOs). In these contexts, information is limited to one-way communication without local knowledge, preferences and values in the planning process. This often results in poor ownership by local communities (e.g., Dougill et al., 2017; Yami, 2016). An example of poor watershed management with

consequent erosion and siltation was provided by Mucheru-Muna et al. (2017). To ensure sustainable watershed management, behavioural transformations need to accompany technological solutions. Shiferaw et al. (2009) note that the lack of necessary insights into the major drivers, such as the environmental and socioeconomic interests of the stakeholders, has been shown to contribute to failure. Many interventions based on top-down non-participatory approaches have failed due to lack of social trust, bureaucracy, lack of ownership and inadequate institutional support (e.g., Dethier & Effenberger, 2011; Shiferaw et al., 2009).

Changes in the political sphere of transformation. Progress in water management in SSA has been accomplished across national and sectoral levels by the introduction of water regulations, policies, strategies, and institutions to govern water resources and ultimately meet the multifunctional needs and stakeholders' water demands. Innovative, transparent decision-making and decentralized implementation strategies aimed at ensuring drought resilience in communities play an important role (Barron et al., 2015; Yami, 2016). Several studies have pointed out that these achievements help to meet the continuously growing demand for food and water. These changes in institutional settings and political structures can enable positive transformations in water management (Eriksen & Lind, 2009). Identified success factors include decentralized policies that can increase farmers' resilience to drought (e.g., Mutiro & Lautze, 2015). Moreover, interconnecting water policies with agricultural development strategies have increased the resilience of farmers to weather changes. Enhanced financial capacities have facilitated access to appropriate material inputs for irrigation and supported capacity-building, raising the sense of community ownership (Mutambara et al., 2016).

Access to micro-credits and community-managed safety net systems, including the development and dissemination of rainwater-harvesting and water-saving technologies, are major determinants of successful water management (e.g., Boansi et al., 2017; Mucheru-Muna et al., 2017; Shiferaw et al., 2014). Mutual insurance and risk-sharing networks at the village level are primarily based on relatives, friends and community members. They benefit from non-agricultural services provided by external social support institutions (e.g., Tadesse et al., 2015). Low-interest credit reduces the farmers' financial burden. It can also increase their capacity to explore different climate resilience options and thereby provide complementary sources of income (Boansi et al., 2017; Shiferaw et al., 2014).

The integration of water management with infrastructure development is successful in building resilience (Nyagumbo & Rurinda, 2012). Adamseged et al. (2019) and Shiferaw et al. (2014) demonstrated the importance of road networks for dealers and retailers to access markets and promote off-farm jobs. They highlight the need for investments in road networks, electricity, communication facilities and market development to manage drought through diversified livelihood strategies. Undeveloped road infrastructure and long distances to markets supplying food to major cities have been identified as barriers (Bryan et al., 2009; Enfors, 2013). Consequently, the introduction of techniques such as rainwater harvesting and conservation agriculture will only be efficient if access to markets is ensured (Rurinda et al., 2014).

On the one hand, without social safety nets, poor rural households may suffer during drought as food and livelihood security are threatened (Boansi et al., 2017; Perez et al., 2015; Rurinda et al., 2014; Shiferaw et al., 2014). On the other, social safety nets need to be

accompanied by proactive measures for recovery strategies, which may include climate information to inform timely planting, promote crop diversification and introduce drought-resistant crop varieties (Shikuku et al., 2017).

Changes in the personal sphere of transformation. Changes in farmers' individual and collective choices make a difference in communities and highlight the need for new technologies and policies or institutional reforms to go hand in hand with behavioural changes to improve community resilience (e.g., Adger et al., 2013; Nyagumbo & Rurinda, 2012; Shiferaw et al., 2009). Success factors include farmers' leadership, which is portrayed as key to the adoption of new technologies and the uptake of new water strategies. Local capacity-building embedded in a strong local leadership can create a spirit of innovation and willingness to learn and take on new challenges among individuals, as well as within farmer cooperatives (McGinnis & Ostrom, 2014; Subijanto et al., 2013). On the other hand, local initiatives require local champions with strong leadership to ensure long-term changes through learning from peers in the community. Barron et al. (2008) argue that the lack of local initiatives demonstrating the benefits of innovations is a major hindrance to personal transformation in terms of both investing in technology and self-confidence in embarking on new innovations. Weak participation in decision-making due to a lack of enabling institutional mechanisms contributes to capital loss and lack of responsibility for operation and maintenance (Mutambara et al., 2016).

In general, farmers do not have the resources to make large investments to reduce their vulnerability to drought and climate change (Bryan et al., 2013). The introduction of agroforestry has been shown to be successful as long as it does not compete with crops for water resources (Akinagbe & Irohibe, 2014). Agroforestry provides additional sources of income in times of harvest failure, as well as reducing erosion. In addition, it often provides access to additional social networks and extension services by introducing crop diversification, including drought-tolerant crop varieties. Climate variability appears to encourage farmers to change their attitudes and take action (Barrow, 2016; Bedeke et al., 2019; Rosegrant et al., 2014). Agricultural techniques and information are transferred from generation to generation, which implies that the introduction of new agricultural practices, agroforestry or seasonal forecasts should incorporate traditional knowledge to be perceived as transparent and accountable (Bohensky & Maru, 2011; Shikuku et al., 2017; Wilk et al., 2017).

Investments in off-farm income-generators are a success factor because these activities generally attract young people who would otherwise move to towns for employment. For the youth, rural farming is often considered unproductive and old-fashioned (Erkossa et al., 2014). Hence, they prefer to move to the suburbs, work in peri-urban agriculture and send home remittances. Nevertheless, a lack of willingness to invest has been found in large farming households with a high dependency ratio, who meet the subsistence needs of members instead of investing resources in increased agricultural productivity (Shikuku et al., 2017). This seems to be particularly true for farmers who are situated a long way from existing markets (Belay & Beyene, 2013; Shikuku et al., 2017).

Discussion

Acknowledging new perspectives in AWM

Building on the IWMI report (Molden, 2007), our findings show that much focus has been placed on investing in smallholder farming with pro-poor technologies along with access to agricultural extension services to meet food security, reduce poverty and conserve ecosystems. However, although the report focused less on other dimensions, several authors highlighted the need for appropriate policy frameworks, institutional structures and the need for actions to enhance human capacities. Our results also reveal a trend in actions focusing on the practical sphere (Figure 2). These were mainly related to rainwater harvesting technologies and soil and water conservation approaches, often linked to the need for adaptation to climate change. However, few publications have focused on institutional and financial aspects, and very few studies have investigated how transformations at personal levels can be triggered. This situation may be due to lack of meaningful institutional reforms in the water and agriculture sectors coupled with lack of financial policies which integrate poor rural farmers into the formal economy with access to lending and savings at village levels (Mutambara et al., 2016).

Moreover, from 2015 onwards, there has been an increase in publications focusing on institutional and personal changes as well as highlighting linkages to the United Nations' Sustainable Development Goals (SDGs) and Agenda 2030. An increasing number of studies have acknowledged both adaptation and mitigation, suggesting a shift from irrigation pumping technologies based on fossil fuel systems towards the use of renewable energy sources, such as solar-driven pumps (Kamwamba-Mtethiwa et al., 2016; Melesse et al., 2014). An integrated approach is also exemplified by the reuse of wastewater in agriculture to supplement water for irrigation (Alam, 2015; Kamwamba-Mtethiwa et al., 2016; Tran et al., 2017).

Innovative pathways to transformation

This paper's theoretical point of departure is that the practical, political and personal spheres of transformation are interlinked and need to be addressed simultaneously for a sustainable change to be catalysed. Our study of publications from the last decade illustrates that, despite significant developments in the practical sphere of increasing smallholder resilience to drought, there are still significant limitations when it comes to addressing the political and personal spheres. The need for agricultural development requires an urgent acceleration in the uptake of best practices to meet climate change, food security and economic growth challenges (Barron et al., 2015). Water conservation calls for investments in pro-poor technologies, including rainwater harvesting facilities, supplemental irrigation and diversification of crop varieties. Still, the empirical material shows that other factors such as access to micro-credit schemes, markets, social safety nets, agricultural weather insurance and off-farm employment need to be in place to trigger resilience to drought.

We find that, at the institutional level, a visionary political leadership, based on policies integrating 'drought relevant' sectors with a landscape approach, including agriculture, water, energy and tourism, is needed to ensure integrated water management by recognizing conflicting demands and enhancing collaboration across sectors and geographically within a watershed. In addition, flexible institutions combining top-down and

bottom-up approaches, with accessible funding schemes that consider contingency and recovery, need to be an integral part of budget planning to ensure proactive drought management (Brüntrup & Tsegai, 2017).

Furthermore, based on our analysis, systemic changes in water management for irrigation in rural areas need to be accompanied by strong political will and legal instruments that support long-term maintenance, conflict management and capacity development. As Mutambara et al. (2016) noted, there is a need for a changed mindset towards acknowledging the importance of personal contribution to change. For this to occur, farmers' full participation and involvement in strategic planning for community use and the appropriation of new technologies is a prerequisite. External subsidies and foreign donor support should only be supplied if a clearly formulated community demand expresses the need to lay the foundation for local mobilization, leading to the acquisition of new skills and the adoption of new approaches.

Building on these findings, we suggest two different visualizations highlighting enablers to success (Figure 3) and barriers to be avoided (Figure 4). Success depends on actions related to two or three spheres of transformation, which together facilitate increased capacities among small-scale farmers, recognizing the need for flexibility to cope with local realities. With this framework, we suggest a combination of political and personal transformations to increase cooperation and empowerment among farmers. This requires leadership at both community and national institutional levels that encourages collective responsibility, collaboration between stakeholders and diversification of resources, all of which are important building blocks in resilience thinking (Folke, 2016). For example, policy changes can trigger communities' self-organization by building up water user associations. This process can, in turn, facilitate knowledge-building through social learning, diversification of capital, addressing contingencies, enforcing accountability and fast track cost recovery for diverse investments (Bjornlund et al., 2020a).

Moreover, changes related to the introduction and implementation of new technological solutions require both innovative institutions and behavioural changes in communities to promote technical skills' learning, which strengthens empowerment at the individual level. Institutions play a vital role in introducing innovative and affordable technologies based on local leadership needs. Building capacity enables transformation and opens up spaces for new profitable options and opportunities for rural communities.

However, barriers to long-term transformations are related to factors likely to lead to failure. Our analysis shows that actions focusing on only one sphere of transformation often lead to a status quo as there tends to be no change. For instance, failure can be related to inappropriate technologies and solutions transferred to local communities without prior assessment of community demands that meet natural, physical, human, financial and social needs (Davis et al., 2012; Shiferaw et al., 2009; Tittonell, 2014). In line with our analysis, Bjornlund et al. (2020b) maintain that water and agricultural research in SSA has been mostly driven by commercial interest since colonial times. Therefore, it has mainly focused on increased agricultural production to export and supply food to urban settlements instead of addressing local needs. High investment costs and technical skill dependence on foreign technologies for operation and maintenance have excluded smallholder farmers from using irrigation technologies at small-scale levels. In many

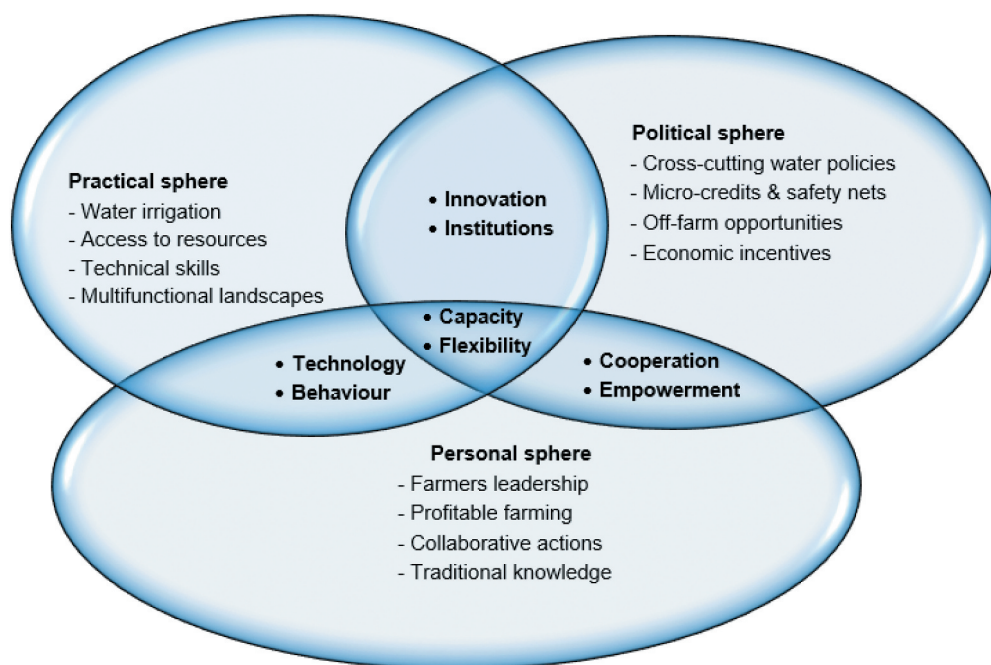


Figure 3. Enablers that can trigger transformation in the practical, political and personal spheres.

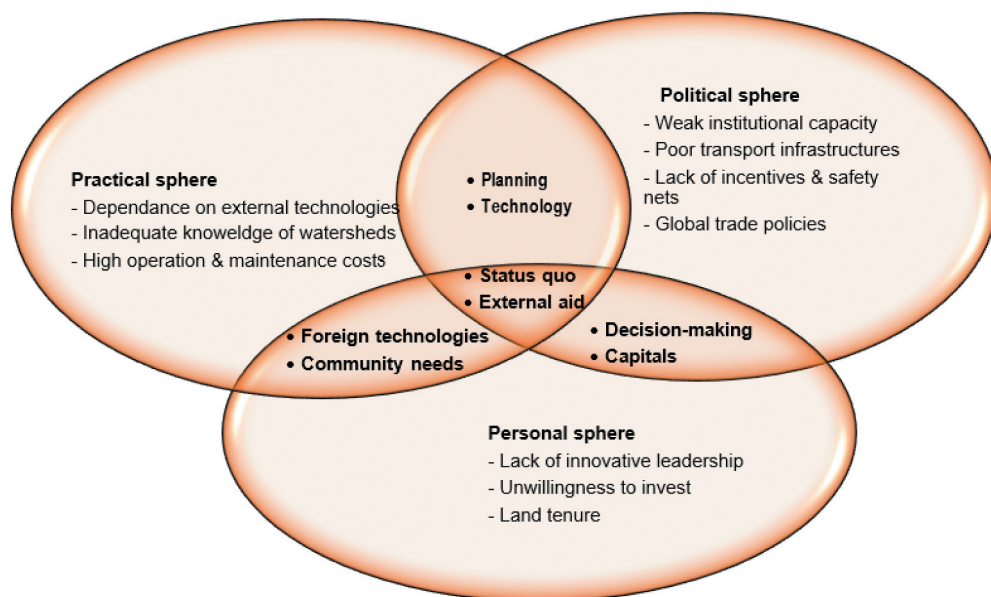


Figure 4. Barriers that can hamper transformation in the practical, political and personal spheres.

cases, policies are indirectly influenced by global trade framework arrangements dating back to the colonial era, which have then been kept in place by post-independence governments (Bjornlund et al., 2020a).

Addressing water scarcity and increasing drought resilience for smallholder farmers requires enhancing human capacity, adaptive institutions, finance and governance (Figure 4). However, weak institutional capacities, combined with a lack of participatory planning and community involvement in the decision-making process, lead to poor planning and implementation.

A shortage of capital linked to lack of land ownership and tenure, social safety nets or community cooperatives make farmers more vulnerable to drought. Limited involvement of local organizations, such as water users' associations, in decision-making has often resulted in limited community behavioural changes. Where there is dependence on external assistance, there is a reluctance to cover maintenance costs. At the personal level, the poverty trap, lack of innovative leadership and hands-on learning from local peers such as farmer field schools are often shown to be the cause behind a short-term perspective, leading to conflicts between water users and ultimately contributing to failure.

Conclusions

Our literature review of the period 2007–19 revealed evidence of implementation of the PAs identified by the IWMI report (Molden, 2007) in SSA. In general, the PAs recommended by Molden (2007) were highlighted in the literature published during the 12 years after the report (2007–19). Consequently, implementation and further assessment of how to increase resilience to drought among smallholder farmers are slowly progressing along the paths suggested in 2007.

The identified barriers to implementation were found to be linked to the lack of preconditions for political and personal transformation. Thus, there are still obstacles to transformation in the political and (not least) in the personal spheres, although increased recognition of the need for solutions integrating practical, political and personal aspects was observed.

Consequently, while there has been much research and development of technical methods during the last decade, there is still relatively little new published knowledge related to the transformation of political and personal spheres, which in this empirical context corresponds to the identification of drivers of institutional and behavioural change.

Thus, there is a need to encourage initiatives with components from all three spheres of transformation, for which knowledge exchange with local stakeholders is essential for success.

Potential new drivers for transformation include the implementation of the Agenda 2030 SDGs and the associated indivisibility discourse. Another driver for transformation is the increased focus on climate change, including both mitigation and adaptation approaches, such as the use of renewable energy and wastewater reuse to supplement agricultural irrigation.

We encourage future research and the development of strategies to cope with drought in SSA, which is likely to become increasingly critical due to climate change. Moreover, these strategies should be based on integrated approaches that acknowledge all three spheres of transformation. It will be important to increase smallholders' resilience to drought by moving towards innovative solutions recognizing the need for

political and personal transformations. This process will require actions that empower smallholder farmers, encourage cooperation and enable diversification in relation to local conditions and needs. To succeed, resilience to drought among small-scale farmers should be put in a broader context of sustainable rural development. Such actions take considerable time to implement but are a prerequisite for increased, sustainable resilience to drought among small-scale farmers in SSA.

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