Chapter 9

Future directions for water and agriculture in southern Africa

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The multiple and cross-disciplinary perspectives presented in the preceding chapters offer new and African insights into the challenges of increasing food production and supporting sustainable agriculture. Fresh thinking and practical guidance are needed to help address the question of how to raise domestic food production and reduce poverty while sustainably managing water resources and the environment. In this, the concluding chapter, we provide our own views as editors about the nature of the food and water security challenges in southern Africa. Based on our experiences both in and beyond Africa, we suggest possible ways forward to link food and water security.

The status of water and agriculture

An estimated one in three people in Africa goes hungry and this is the region with the largest proportion of people living in poverty. To reduce rural poverty Africa needs a productivity boost in terms of its agricultural production. One way to raise food production is with irrigation, as it can remove an important constraint and has the potential to greatly increase crop yields. Despite its potential, irrigation is underdeveloped in sub-Saharan Africa while many existing irrigation systems perform well below expectations, primarily due to technical, governance and water security challenges (Stirzaker & Pittock, this volume).

Current projections indicate that the area of land equipped for large-scale irrigation will increase rapidly in the near term, primarily through the intervention of multilateral donors. To appreciate the potential, just ten percent of the land that could be irrigated is irrigated. Not only can irrigation increase crop yields it also can assist farmers adapt to climate variability and climate change as
substantial parts of southern Africa are expected to become drier in the coming decades. Irrigation may also offer opportunities to enhance existing domestic water delivery to supply household food gardens.

At the small or micro scale, the use of small, motorised pumps to exploit shallow groundwater offers an opportunity, if practised sustainably (Stirzaker & Pittock, this volume), to raise food production. Groundwater pumping can assist farmers who traditionally grow rain-fed crops. The great benefit of sustainable groundwater extraction is that it responds much more slowly than surface waters to drought and is, therefore, a buffer against climate variability. Groundwater, in comparison with surface-water extraction, is available over a much larger spatial area, and if used sustainably provides opportunities for farmers to diversify their livelihood strategies without the social dislocation and landownership problems that frequently confront new surface-water schemes.

Policy clarity

How then should governments, donors and civil society approach these opportunities for improved food production through irrigation? The unfolding Comprehensive African Agricultural Development Plan (CAADP) process is valuable because it focuses government attention and funds on rural development. Nevertheless, transforming these aspirations into on-ground actions is a huge challenge (Sullivan & Pittock, this volume).

African governments are currently embarking on a massive expansion in irrigation without fully addressing the reasons why many previous irrigation schemes have been unsuccessful. It is essential that the mistakes of the past irrigation expansion of the 1960s to 1980s are not repeated, where low profitability did not allow the ongoing investment in infrastructure and the associated institutions that govern equitable and sustainable use (Stirzaker & Pittock, this volume). Contributors to this volume suggest that the national and Africa-wide contributions to CAADP need to be better defined and policy responses should focus on:

- irrigation and food security objectives,
- integration of agriculture and water sustainability, and
- effective capacity building and governance.

What kind of irrigation and food security?

Dryland agricultural production relies on transpiration of rainfall, known as ‘green water’. Irrigated agriculture involves the capture, storage and supply of water from aquifers, rivers and storages, referred to here as ‘blue water’ (Falkenmark & Rockstrom 2006). Waste or ‘grey’ water may also be reused in agricultural production.

Irrigation systems are varied in scale and in the application of technology, which has implications for food security and poverty reduction; Figure 9.1 illustrates this spectrum. Lankford (2009) classifies irrigation into four types of technologies:
small-scale technologically simple systems, small-scale smallholder-owned canal systems, pressurised irrigation systems built as donor or government-sponsored smallholder schemes, and rehabilitated or newly built large-scale canal systems as externally funded smallholder schemes.

**Figure 9.1** Spectrum of irrigation scale and technology versus policy objectives

<table>
<thead>
<tr>
<th>Pluses</th>
<th>Minuses</th>
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<tbody>
<tr>
<td>Reduce poverty and secure food supplies <em>in situ</em>. Simple management, Co-benefits.</td>
<td>Produce large volumes of food for national and regional security, Low cost to develop per hectare.</td>
</tr>
<tr>
<td>Micro-scale irrigation, Household or farm scale.</td>
<td>Macro-scale irrigation, Large canal-supplied systems.</td>
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<tr>
<td>High capital cost per hectare, Less suited to growing staple grains.</td>
<td>Complex management, concentrates environmental degradation, high failure rate.</td>
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**Small-scale irrigation**

At the smallest scale there is the capture and storage of water around a home for application to a household garden. A modest increase in domestic supply to water a garden is often advocated as a cost-effective first step up the ‘water ladder’ (van Koppen *et al.* 2009). At the individual farm scale, rainwater may be collected in small dams or tanks, pumped from shallow groundwater or diverted from local schemes. At these individual scales the institutional complexity in managing the water supply is low and this water access may have many co-benefits in improving social status and providing water for uses such as drinking, bathing and washing (Goldin & Owen, this volume), which are not considered in agricultural economic assessments of deployment of these technologies.

Small-scale technologies may boost water supplies where people live across the landscape and, thus, increase local food security and reduce poverty. For example, treadle pumps may assist (Lankford 2009), but a wide range of technologies is available (Kahinda & Masiyandima, this volume; Makurira, this volume). A biophysical analysis of the potential extent of conservation agriculture and rainwater harvesting for poverty reduction shows that there are extensive opportunities to reduce poverty in southern Africa by deploying these approaches and measures (Kahinda & Masiyandima, this volume).

While small-scale technologies could play key roles by improving the incomes and the resilience of livelihoods of the poor in regions subject to climatic variability and change, they are also criticised as very expensive per hectare of
irrigated land, less suited to production of staple grain crops and suboptimal steps to adoption of more effective technologies (Lankford 2009). Makurira (this volume), after surveying rainwater harvesting practices in Mozambique, South Africa and Zimbabwe, identifies knowledge of the opportunities and the high upfront capital cost as major barriers for many farmers in adopting these small-scale rainwater harvesting and irrigation technologies.

Small-scale irrigation may reduce the impacts on the environment and ecosystem services because these schemes entail lower transmission losses and, in their application across the landscape, they distribute and minimise impacts like salinity and river-flow reduction. Nonetheless, any diversion of water from ecosystems for farming can have environmental impacts, as recognised in South Africa in the regulation of stream-flow reduction activities. Pollard et al. (this volume) detail the challenges in governing irrigation water use to maximise the benefits for people and to minimise the impacts on the environment. In particular, there are trade-offs between explicit or de-facto uses of water, including between plantation forestry, canal irrigation, rainwater harvesting and biodiversity conservation. Analysis by Pollard et al. (this volume) highlights the gap between national laws and other policies versus on-ground implementation, as they argue for strengthening local water governance institutions through social learning and adaptive management.

Medium- and large-scale irrigation

At a medium scale, irrigation schemes based on pumping groundwater or village-scale surface-water systems have the advantages of modest institutional complexity and some potential for dispersal across the landscape. This has possible benefits by reducing environmental impacts while contributing to enhanced food production.

The largest commercial scales of irrigation involve large canal systems commanding thousands of hectares with water often supplied from regulated rivers. Such schemes are the cheapest per hectare to construct and can supply large volumes of food to markets, yet they often fail (Stirzaker and Pittock, this volume). Reasons for these failures include: an inability to link produce to profitable markets required to underwrite operating costs; deployment of technologies for which there is insufficient local expertise to readily maintain them; unreliable energy supplies to operate key equipment; organisational complexity and failure; and a build-up of waterlogging or salinity that is difficult to manage at these large scales. Further, such large-scale schemes are restricted to limited suitable geographic locations (You et al. 2011) and, thus, will not directly reduce poverty or increase food security in regions of a country that are physically unsuitable for such development. Finally, while opportunities to expand irrigation are suggested on the basis of general, regional statistics, there are real costs from large-scale diversions that include the loss of ecosystem services and also livelihoods.
Food security

Food security is defined by the Food and Agriculture Organization as ‘when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life’ (CWFS 2012). Elements considered in food security programs extend beyond increased production to cover such elements as nutritional quality, transport and market access, as well as purchasing capacity. While these are important, in this volume we have focused on questions of supply from irrigated agriculture.

Assessing food security in southern Africa, Bogale et al. (this volume) consider whether the challenges of high population growth and low agricultural productivity can be overcome to meet development goals for reducing hunger and poverty. Measures they assess for facilitating sustainable livelihoods among the people and nations of sub-Saharan Africa include increased investment in agriculture, sustainable land and water management processes, and drought-resistant crop varieties.

Irrigation for food security as part of poverty reduction through subsistence agriculture at a local scale requires an emphasis on technologies that may be applied at smaller scales in a broader range of localities where people live. Pollard et al. (this volume) point out that the status and societal value of smallholder agriculture differ by context because such farming can be viewed as a safety net for the resource poor, who are seen as low-status members of society, or as part of the solution to sustaining growth as well as delivering reasonably equitable development. In contrast, production of staples to secure food supplies and lower food prices at a national or regional scale suggests an emphasis on irrigation technologies that can be applied at key locations at a large scale.

As an example of donor-country views, the Australian International Food Security Centre observes that ‘Australia is supporting African efforts to improve food security by boosting long-term agricultural productivity and building resilience, while meeting the immediate needs of vulnerable people when humanitarian crises occur’.9 Similarly, AusAID states that:

Australia’s approach to food security is centred on increasing the availability of food through production and improving trade, while also increasing the poor’s ability to access food. Australia has prioritised three pillars to improve outcomes in food security:

- Lifting agricultural productivity through agricultural research and development
- Improving rural livelihoods by strengthening markets and market access

Governments and other organisations need to decide what scale and type of irrigation technologies need investment, which depends on the type of food security desired, and the model they favour for poverty reduction. Lankford (2009) suggests that there is not a single, correct answer, but rather deployment of a mix of irrigation technologies is desirable to meet different needs in different biophysical and societal circumstances. Nevertheless, government sponsorship of large-scale irrigation schemes appears to be the default setting. It would appear that the promotion of smaller-scale technologies is a greater challenge given the difficulty of providing government support for a larger number of scattered interventions. Further, governments struggle to combine sectoral policy interests, such as domestic water supply and sanitation, with water for agriculture in order to justify the higher capital costs of small-scale schemes. The power of the ‘hydraulic bureaucracy’ that is supportive of ‘think big’ engineering and political rewards also favours large-scale irrigation schemes (Molle et al. 2010) and is often assisted by the power of larger and more commercial operators to increase their resource access compared with subsistence farmers (Pollard et al., this volume).

In our view, the food security programs of African governments and donors would be enhanced by greater clarity on the types of security they seek so that limited resources can be focused on the types of irrigation technologies and places for their deployment that can best meet these objectives. If in-situ, small-scale irrigation and rainwater harvesting are required then governments will need to redouble their support to overcome barriers such as knowledge, capital costs and resistance from the hydraulic bureaucracy. This must be coupled with better integration of agricultural and water institutions and governance because adoption of technology is insufficient to resolve Africa’s food security challenges.

### Integration of agricultural and water institutions

Greater water productivity or ‘crop per drop’ is a priority in many regions of Africa where water is scarce or fully exploited and where there are competing users. This is illustrated by the conflicts between water for irrigation and for hydropower in the Great Ruaha River of Tanzania (Pittock, this volume). Irrigation in Africa is only one-third as productive per unit area as that of Asia and there is an order of magnitude difference between frontier and poor practices in crop production when the water supply, irrigation management and agronomy are all optimised (Stirzaker & Pittock, this volume). While there is widespread recognition that greater water productivity is required, perverse incentives abound in terms of water for conservation in southern Africa.

A number of factors contribute to inefficient water use in African agriculture. Water diversions are rarely measured and licence limits are rarely enforced. Due to the risk of power for pumps failing or other problems in scheduling there is

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every reason for African farmers to apply as much water as they can, when they can. Water fees are usually very low and as they are not proportional to the volume consumed there is no incentive to use less.

There is growing recognition internationally that tradeable water entitlements establish market-based incentives for more efficient water use, and opportunities for water to flow to higher-value uses offer the potential to increase employment and economic output without increasing environmental impacts (Grafton et al. 2011). Yet most southern African countries currently lack the requisite water accounting, entitlement laws and other institutional capacities that are the basis for such water markets, and have a cultural reluctance to consider such water market mechanisms.

We contend that irrigation schemes only work efficiently under a complex set of conditions that includes effective institutions in government and society for managing land, water and energy resources. Consequently, to enhance production sustainably there is a need for ongoing learning and adaptation of all the players and for them to ask the appropriate questions when implementing decisions and in terms of data collection and learning from past experiences (Stirzaker & Pittock, this volume).

**Effective capacity building and governance**

Almost all of the contributors identify people rather than technology as the primary challenge and opportunity: the software not the hardware, institutions rather than engineering. To enhance food security in southern Africa, Bogale et al. (this volume) recommend sustainable land and water management processes as one of three key interventions. Mwenge Kahinda and Masiyandima (this volume) and also Makurira (this volume) argue that the benefits to be gained from small-scale rainwater harvesting and irrigation systems are being overlooked as government agricultural programs focus on large, commercial-scale agriculture.

From a sociological perspective, Goldin and Owen (this volume) advocate application of a ‘capability approach’ in the water sector to reinforce participation, which is a core principle of integrated water resources management (IWRM) (GWP 2000). They promote the fostering of a number of intangible goods, such as pride, self-esteem and trust, as these provide opportunities for the poor, women and other disadvantaged groups to engage and show agency in managing their water and food stress. In contrast, they say that participation is difficult where there is shame, lack of agency and trust, and social exclusion.

Pollard et al. (this volume) argue that agricultural practice cannot proceed in a vacuum, and should be referenced against important contextual factors of which three of the most important are water, land and governance. Despite the risk of capture by well-resourced commercial water users, they advocate for IWRM to support the transformation to more sustainable modes of agricultural production. Pollard et al. (this volume) also declare that the priorities for intervention are mainly in the realm of governance, with the principal improvement required not in terms of what is done, but rather the way it is done. The water and agricultural
governance measures that Pollard et al. promote, among others, include: enhanced communication between managers at every level; joint priority setting, feedback loops and reflexive learning within the relevant sectors; and a stronger focus on strategic adaptive management. In their work in the Incomati River Basin in South Africa, Pollard et al. (this volume) stress the importance of developing these capacities and institutions at the scales of catchment management areas and sub-national governments if national laws and other policies are to be well implemented.

Stirzaker and Pittock (this volume) argue that a ‘bottom-up’ technology push coupled with a ‘top-down’ organisational reform is necessary if irrigation is to be more productive, equitable and sustainable. They call for a focus on the lack of incentives for more productive use of water in agriculture to evaluate how greater investment in social learning and adaptive management can contribute to more sustainable irrigation farming. To improve production from medium to large-scale irrigation schemes, they propose the local irrigation scheme or community as the scale of intervention so as to capture the interests of the community in terms of the shared resource and infrastructure and the financial interests of farmers in terms of irrigation. They recommend enhancing local institutions to reinforce social capital and support equitable development.

Their focus is on measuring irrigation scheme performance with requisite simplicity as a catalyst for a community-based social learning and adaptive management process. In turn, the information from the monitoring and subsequent learning fosters the intermediate outcome of building capacity in local institutions and the skills of farmers. Further, they contend that most progress will be made when local communities have the agency to initiate their own reforms to improve irrigation scheme productivity, sustainability and equity because empowered communities are better able to identify and adopt appropriate technologies and demand more practical, supportive policies from government agencies and their programs.

Conclusions

The varied approaches proposed in this volume by Mwenge Kahinda and Masiyanidima, Pollard et al., Makurira, Goldin and Owen, and Stirzaker and Pittock are a challenge to business-as-usual irrigation development in southern Africa. While their views all support the need to grow more food, they argue that governments should be much more explicit in defining their food security goals and explaining how their programs will help achieve these objectives. Several authors urge support for small-scale and decentralised rainwater harvesting and irrigation because they empower the most disadvantaged people and have many livelihood co-benefits.

A key finding is the integration of governance of water and of agriculture and to make more explicit decisions on trade-offs across competing uses. We note that the ‘information deficit’ model of agricultural extension is insufficient, and stress the importance of building the capacities of local communities and governance
agencies to make their own decisions through social learning and adaptive management. The effectiveness of ‘top-down’ governance is questioned when there are no effective institutions at more local scales to ensure that there is demand for the government programs and that they are responsive to local needs.

A new approach to sustainable management of water for agricultural development and poverty reduction in Africa is required. We contend that the sole focus of many African governments and multilateral agencies on expansion of large irrigation schemes is misplaced. Greater investment in training people and establishing institutions, particularly at the community scale, is required. Successful examples and case studies presented in this volume need to be built on to achieve widespread benefits.

There are no simple solutions for increasing agricultural production, enhancing food security and sustaining fresh water, but it is clear that business as usual must change. The diverse perspectives here do not offer all the solutions. Nevertheless, they can assist and can go some way to promoting food and water security in southern Africa.

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