

Profitability and Productivity Impediments and Prospects in Small-Scale Irrigation Schemes in Zambia

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Abstract

Irrigation development in Zambia has trailed significantly behind that in other developing countries. Subsequently, economic development and food security are also trailing behind in the country. Since the late-1990's there has been a revival in the willingness to invest in irrigation farming, and Zambia has the largest potential of any other SADC region countries to benefit from it. However, to gain from new investment in irrigated farming without repeating past failures, it is critical to develop a business prototype for small-scale irrigation schemes. This article investigates the impediments that such a model needs to address to be successful and the opportunities this represents for irrigators' profitability.

Keywords: *Small-scale irrigation, Zambia, increasing productivity and profitability*

Introduction

Food security has been a perpetual problem in Zambia, and the 2014 food-price crisis elevated this issue onto the international development agenda. Even though the increase in global food production has outpaced that of population growth over the last 3 decades, food insecurity remains a major issue in Zambia, as food production and demand are not spatially balanced. Reflecting this, Jiang (in press) stresses that expanding food trade could create a more sustainable balance between food and water availability, but also argues that the projected population growth in Africa, especially Zambia, increases the concern surrounding food–water trade-offs. Hence, there remains an urgent need to increase food production in regions (provinces) in the country with food insecurity.

In the global context, irrigation accounts for 70 percent of water use, and the interconnected nature of economic and agricultural development means that local water management will have global impacts (Wada et al., 2016). Increasing the productivity of existing irrigated agricultural lands is another way of meeting future food requirement (Ministry of Agriculture, 2017 in press). In the broader natural resource's context, it is also important to recognize the increasing pressure that food demand places on soils, biodiversity and water. Agricultural development should seek to exploit, restore and have an overall positive impact on ecosystems whilst improving equity and income generation and increasing food production (Central Statistics, 2014). In developing countries like Zambia, the positive linkages between irrigation and agricultural productivity, income and food security are well established (de Fraiture & Giordano, 2014; Namara, Hope, Sarpong, & Ringler, 2014). Small-scale irrigation is recognized as a mechanism for increasing productivity and income in the rural areas of developing countries, like Zambia. However, this potential is often not realized, as many government funded irrigation systems are underperforming, run down and in serious need of maintenance and refurbishment. Examples of this are: Chapula irrigation scheme on the copper belt, Siantuinda and Buleya Malima irrigation scheme in southern province. Zambia and many other countries in the SADC region have failed to reap the potential benefits of irrigation, as its level of development is the lowest of any developing region (de Fraiture & Wichelns, 2010): only 4 percent of arable land is irrigated, compared to 47 percent in Asia and 18 percent worldwide (You et al., 2010). Hence, there is a significant potential for increasing production through investment in irrigation (Koehler, & Hellweg, 2011). While there was a growing reluctance among donors to invest in irrigation infrastructure in Zambia during the 1980s and early 1990s, a resurgence of interest took place towards the mid-2000s (World Bank, 2008). Reflecting this, the ministry of Agriculture (2010) predicted that the irrigated areas in Zambia from 2000 to 2030 will increase by 15 percent, which is 3–10 percent more than other

developing countries of the SADC region. There are also opportunities to improve the performance of existing irrigated areas (de Fraiture & Wichelns, 2010). It has been argued that closing crop-yield gaps would be a way to improve food security. However, Pardey, and Alston (2015) contend that this focus can have unintended consequences due to factors such as lack of transportation and market access. As 60 percent of Zambia's population is food-insecure (Central Statistics, 2001), small-scale public irrigation schemes have been the development focus (Ministry of Agriculture, 2001) and account for 42 percent of all irrigated land (Ministry of Agriculture, 2001). However, private irrigation is the most rapidly expanding irrigation sector in Zambia and is often considered a more viable option (Giordano, 2014). To benefit from the increased willingness to invest in irrigation without repeating the failures of the past, it is critical to develop a business model for small-scale public irrigation schemes that is both financially and environmentally sustainable and socially equitable. This article contributes to such a business model by identifying current impediments to and opportunities for improving the productivity and profitability of small-scale public irrigation schemes. It does this by first reviewing the relevant literature and then synthesizing the main findings from a study of six small-scale irrigation schemes in SSA, which are reported more fully in this issue.

Impediments to improving productivity and profitability

The efficient and productive use of water in irrigation is critical; however, it is also complicated and often misunderstood. This is described and discussed in detail by Allen, and Burt (2009), who emphasizes the importance of differentiating between beneficial and non-beneficial consumptive and non-consumptive uses. FAO (2012a) differentiates between improving

- a. Water-use efficiency, which aims at minimizing water losses by improving technical efficiency; and
- b. Water productivity and profitability, including increased yield through improvements in water, land and agronomic management practices, reduced evapotranspiration, growing high-valued crops or engaging in value-adding processes.

For comprehensive definitions of on-farm and basin-scale irrigation efficiency, including the concept of economic efficiency, see Grafton, Kirby, and Hanjra (2011). Considering economic efficiency also helps assess whether net returns are maximized; however, high economic efficiency does not always equate to irrigation being efficient overall (Qureshi et al., 2011). Increasing production of commodities for which there is no market, or for which prices are so low that the expense of irrigation and other inputs cannot be justified, makes no sense. On-farm and system efficiency need to be considered in the context of basin-scale efficiency and impacts on the environment and users downstream; efficiency at the farm scale may not result in improved basin-scale efficiency (Qureshi et al., 2011). The efficient use of water, and the complex spectrum of what this means, is an overarching issue that needs to be taken into account when overcoming barriers to productivity and profitability. The impediments to improving farm productivity and profitability in small-scale irrigation schemes are a broad and complex mix of institutional, market, infrastructure and production issues. In the following, four categories are discussed: institutional impediments; market and supply chain impediments; infrastructure and farm equipment impediments; and production and water productivity impediments.

Institutional impediments

Buruchara and Nyamwaro (2013) point out that institutional impediments to improving productivity have been underestimated. Globally, there has been an increasing trend to entrust the management, ownership of and financial responsibility for irrigation systems to farmers (Turrall et al., 2010). In Zambia, this process of 'irrigation management transfer' has been an ongoing part of reform in government-run and farmer association irrigation systems since the mid-1980s. In most cases it has been a transfer of management rather than ownership, with government withdrawal from tariff collection, conflict resolution, and operation and maintenance (Merrey, de Lange, & Samad, 2002). This transfer has been driven by the underperforming public irrigation sector common in Zambia and elsewhere in Africa (de Fraiture & Giordano, 2014). The rationale was that water users would take over the tasks (Van Koppen, 2003) and that on-going maintenance costs would be met through increased productivity (Shah et al., 2002). However, productivity and profitability are not the same, and higher

yields do not always equate to financially feasible irrigation schemes. There is limited evidence that water user organizations have been successful in reducing poverty and improving equity (Bjorn Lund, 2009) or productivity. Others suggest that in Zambia and the SADC region, this process has even resulted in lower productivity (Van Koppen, 2003). In general, transition arrangements have not performed to their potential in developing countries (Shah et al., 2002). Small-scale irrigation schemes face many challenges around conflict resolution, particularly in resource use between public and private irrigation and upstream and downstream users. Resolution can be hampered by unclear mandates (de Fraiture & Giordano, 2014) or the reluctance of members to deal with issues where they have conflicts of interest. Arrayal (2010) argues that the rationale for water reform in developing countries has focused on efficiency, effectiveness and fiscal sustainability rather than equity. The literature reflects a mix of inequity issues, including non-uniform and unequal plot boundaries, how well the marginalized sectors of the community are represented during the development of associations and resource allocation, and whether this sector can effectively use the participatory 'space' (Levite & Sally, 2002; Thampratankul, & Satoh, 2008; Tankha & Fuller, 2010). In general, women in Zambia and the SADC region are not well represented in irrigator groups or associations, or as owners of irrigation equipment (Namara et al., 2014); these are indicators of marginalization. Meinzen-Dick (2014) emphasizes the importance of property rights – including land, infrastructure and water – and argues that the security and robustness of property rights has a strong influence on confidence to invest, authority to manage, incentives for maintenance and efficiency, and confidence to respond to water scarcity. The link between land tenure and food security, rural livelihoods, conflicts and environmental degradation is well known (FAO, 2012b; Deininger, 2003). More specifically, land tenure is a means to generate an income and accumulate wealth, an incentive to invest and an insurance against 'shocks', and improves access to credit (Deininger, 2003). Compared to other developing regions, parts of Africa have particularly intractable land-tenure issues. There may be no formal state recognition of land under customary tenure, and the titling process can be complex and costly (Meinzen-Dick, 2014). Some farmers in Zambia and other developing countries have been able to attain some evidence of ownership without obtaining formal property rights; this provides some tenure security but does not allow the use of land as collateral for loans (FAO, 2010).

Market and supply chain impediments

It is increasingly recognized that small-scale farmers in Zambia need to successfully participate in markets to raise agricultural income (Central Statistics, 2009). There are many impediments: supply chain complexity, food safety standards, the power of supermarkets, the need for facility upgrades, and procurement practices can all squeeze smallholders out of the market, despite their advantages of lower costs and access to family labour. Other issues are lack of information on prices and access to input and output markets and credit. In Zambia, markets can be too small to absorb supply, or farmers too scattered to effectively fill demand (Ministry of Agriculture, 1991). Inadequate transportation infrastructure and storage facilities are also critical economic impediments that impact a farmer's yield efficiency in low-income countries. Shah et al. (2002, p. 19) argue that if farmers have access to stable, reliable markets then "much else follows", as this will improve their wealth-generation potential and livelihoods, including households' nutrition, health and education.

Infrastructure and farm machinery impediments

In Zambia, if schemes had been designed with small-scale user group management in mind, they would have been built quite differently with respect to service delivery, fee collection, maintenance and self-management (Ministry of Agriculture, 1991). In Zambia, one of the reasons for small-scale irrigation schemes' underperformance is that many were designed as large-scale, single-unit systems and did not have the flexibility to accommodate small-scale operations (Central Statistics, 2004). Infrastructure impediments for small-scale irrigation schemes include dilapidated water supply systems, poor construction quality and lack of resources to maintain infrastructure (Sally, & Kabre, 2014). Whilst small-scale irrigation technologies are used by farmers, more than 70 percent of these are manual devices (Weight, & van der Blik, 2012). It is recognized that investment in small-scale equipment, such as power tillers, can bring income returns, but lack of affordability and availability present

difficulties for irrigators (Giordano & de Fraiture, 2014). As labour is not factored in, manual systems can appear to be low-cost alternatives. With women representing a significant portion of agricultural labour, the issue of balancing fieldwork with households' needs must be considered (Svendsen, & Turrall, 2007). The availability of low-cost implements for irrigation and other fieldwork would be a major improvement.

Production and water productivity impediments

The Ministry of Agriculture (2001) argues that crop productivity improvements should encompass irrigation technologies, field production, management practices and capacity building. Without this focus, economic growth in rural areas will not be attained even if water supply issues are being addressed. In Zambia, there is evidence of over-application of water in smallholder schemes as water is supplied on a roster basis, so if a farmer receives water on a weekly roster, they will irrigate whether water is required or not. More flexible scheduling mechanisms are needed, as is greater understanding of watering requirements and the impacts of over-watering (Ministry of Agriculture, 2001). Taigbenu and Dimes (2007) found that irrigation helped stabilize crop yield but emphasized that nutrient management was also needed, as well as knowledge to identify the critical stages in the growing cycle when water shortage most affects yield. Throughout the SADC region, smallholder farming systems suffer from negative nutrient balance for nitrogen and phosphorous, which affects crop production (Central Statistics, 2003). Stirzaker and Mbakwe (2017) further argue the case for farmer learning around soil moisture and nutrient measurements and the impact of over-irrigation on nutrient leaching. Crop choice is another important aspect of the viability of small-scale irrigation schemes. In Zambia, low-value subsistence crops are often grown by poorer farmers, and it is only when their own needs are met and their income is secure that they consider high-valued crops (Ministry of Agriculture 2001). Perceptions of risk associated with these crops are strong; hence, it is the more affluent farmers who adopt high-valued crops and realize increased income. These risks are amplified by unreliable markets and farmers' lack of understanding of consumer preferences (Central Statistics, 2001). Globally, a decline in state-funded extension services and training, and input subsidies, has created problems for farmers, and obtaining appropriate inputs has been identified as a major productivity barrier (Markelova et al., 2009). In Zambia, the adoption of new practices has been limited by a range of social and economic issues, especially in labour-deficient households such as those affected by AIDS (Central Statistics 2004).

The small plot sizes of 0.1 – 0.5 ha, so prevalent in small-scale irrigation schemes, effectively prevent farmers from producing a significant surplus; hence irrigation is only marginally profitable compared to other economic opportunities in urban centers (de Fraiture, & Acheampong, 2012). Small plot sizes mean that irrigators have to depend on several sources of income, including animal husbandry, fishing or urban work (Shah et al., 2002).

Opportunities to improve water productivity and profitability

For small-scale irrigation to be sustainable, development needs to reduce external investment as much as possible, match the economic capacity of the community and be self-supported by farmers (Sakaki & Koga, 2013). Progress is most likely to occur 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. Private schemes, such as rainwater harvesting and wells, are promoted as they

1. Require less investment and support as they are driven and financed by farmers;
2. Have improved crop yields through timely irrigation;
3. Use minimal and easier-to-manage technology;
4. Have avoided sustainability issues apparent in public systems; and
5. Allow a gradual shift to commercial farming.

In Zambia, the objective of many small public schemes is food security, as opposed to market integration, which is needed to support reinvestment in the system (Central Statistics, 2001). There are few market linkages, and hence little or no reinvestment in maintenance or infrastructure.

The focus on food security fundamentally influences profitability. Some suggest consolidation of public and private schemes, integrating modern and traditional arrangements, as a conduit for reforming small-scale irrigation institutional arrangements (McCartney, Lankford, & Mahoo, 2007). This allows the positives of local decision making and leadership to fuse with the need to manage increasingly competing uses and inequity issues associated with water allocation. Where over-allocation is a concern, some suggest that this can be resolved and successfully managed through social networks and that these locally negotiated arrangements can be more robust (Mul et al., 2011). The remainder of this section will discuss opportunities relating to farmer participation, multi-stakeholder forums, farmer capacity and livestock incorporation.

Improving farmer participation

Many opportunities are associated with facilitating more effective water user associations; however, there is no universal formula for duplication, and approaches need to be adapted to local conditions (Inocencio et al., 2007; Malik, Giordano & Sharma, 2014; Meinzen-Dick, 2014; Palerm-Viqueira, 2010; Turrall et al., 2010). Opportunities could emerge by improving farmer participation and collaboration with a broad range of stakeholders by identifying

1. Impediments to participation by individuals and user groups (Meinzen-Dick, 2014)
2. Conflict-resolution methods, giving groups the mandate to consult, mobilize and solve issues (de Fraiture et al., 2014)
3. Opportunities to regulate upstream private irrigation and capitalize on farmers' ability to effectively organize shared resources around market principles (de Fraiture et al., 2014)
4. Beneficial relationships between large commercial farms and small-scale farmers, improving access to input and output markets and equipment (Meinzen-Dick, 2014)
5. Areas where production can be adapted to global supply chains (Markelova et al., 2009; Van Koppen, 2003).
6. Transaction-cost reduction and better access to information on markets and new technologies, and how to enter high-value markets (Markelova et al., 2009)
7. Management tools for water scheduling, to support high yields and value chain participation
8. strategies to increase the revenue of associations, including fines and non-irrigation services such as supplying fertilizer and seed, equipment hire, land preparation and market organization (Shah et al., 2002).

Agricultural innovation platforms

Approaches to improve schemes emphasize integration of a broad range of disciplines – technical, socio-economic and institutional – as well as commodity considerations (Kahinda et al., 2007). There should be a focus on problem solving rather than implementing a set of principles (Merrey, 2008), and agencies and development professionals should view themselves as participating in water users' realities (Boelens & Vos, 2014). Writing about opportunities for small-scale public and private schemes in Zambia and the SADC region, the Ministry of agriculture (2011) state that multidisciplinary stakeholder management forums should be supported to assist with the complexity of issues that both support and constrain the small-scale irrigation sector. In the context of participatory water reforms in Brazil, Tankha and Fuller (2010) discuss the value of creating access points for a broad range of stakeholders. For example, entrepreneurs are particularly useful, as they engage with opportunities when reform is slow or uncertain, and, together with capacity builders, they can act to make reform faster and more viable. Large-scale commercial farms can be engaged to act as 'model farms', to provide small-scale farmers with employment and improved access to input and output markets, logistics and processing facilities (Bjorn Lund, 2009). Agricultural innovation platforms are suggested as an option for improving water productivity and profitability. Agricultural innovation platforms are facilitated forums that bring together farmers and value-chain stakeholders. It is argued that linear technology transfer is not appropriate; rather, multi-stakeholder forums are needed to foster innovative options to overcome the complexity of barriers and stimulate change and collaboration (Adekunle et al., 2013). AIPs can also provide technical advice and address the shortage of extension officers and are comprehensively addressed in this issue (Stirzaker & Bjorn Lund, 2017).

Improving farmer capacity

Garcés-Restrepo, and Putuhena (2008) argue that while physical infrastructure, focusing on technical issues, has dominated development for decades, there is increasing emphasis on the importance of building technical and governance capacity at different levels. There is a need to put capacity building and “people rather than technology as the primary challenge and opportunity” (Pittock & Grafton, 2014, p. 197). On-farm action to improve livelihoods is required in the short term while systems, policies and distribution are being improved (Walters & Groninger, 2014). Farmers require a broad mix of agronomic, irrigation and business skills, as well as training in the selection, operation and maintenance of equipment and infrastructure (Evans, Giordano, & Clayton, 2012). As noted earlier, the shortage of extension officers is a barrier to improving farmers’ capacity, which is discussed more fully in this issue (Wheeler et al., 2017). There is a need to address the lack of understanding of crop water requirements, water-saving technologies and crop varieties (Walters & Groninger, 2014). FAO (2012a) also notes fertility and pest control as information requirements to improve yield and water productivity. Wichelns (2014, p. 164) reminds us that water productivity is not the main issue; farmers should focus on “reducing the variance in crop yields and soil moisture availability and increasing the mean values of crop yields”. The use of new monitoring technology to improve farmers’ understanding of soil moisture and nutrient management is also discussed in this issue (Stirzaker et al., 2017). Franks et al. (2008) emphasize the importance of social and experiential learning for water management in developing countries and add that facilitation should include a range of agencies: public, private, NGOs and community-based organizations. The formation of farmer groups, for demonstration and exchange between farmers, is also advocated to enhance the spread of conservation agriculture techniques (Evans et al., 2012). Overall, capacity-building opportunities are context-specific: “It is impossible to be prescriptive about capacity development needs and approaches, and to write guidelines which fit every situation” (Franks et al., 2008, p. 20). Globally, the irrigation sector is described as having missed many information technology opportunities, with agriculture being decades out of date, but access to this technology is now cheap (Turrall et al., 2010) and increasingly adopted by farmers. The enforcement of water rights and allocation is underpinned by effective monitoring, particularly of large-scale users (McCartney et al., 2007). At project scales, monitoring also underpins adaptive management and provides feedback on whether actions are having the desired effect. The expense of monitoring has been a barrier to adaptive management, but the emerging availability of simpler and more cost-effective equipment has the potential to change this (Stirzaker & Pittock, 2014).

Opportunities that assist in overcoming financial impediments to technology and crop inputs include vouchers for women, lease-to-buy options, rural credit cards, microfinance, pump rental markets, irrigation service providers and savings clubs (Central Statistics, 2001). Affordability of credit is important (Wichelns, 2014) and should be extended to dealers so they can have a varied inventory of products (Giordano & de Fraiture, 2014).

Incorporation of livestock

Incorporating livestock into the economy of small-scale irrigators has significant potential to improve profitability, as livestock provides food, income, manure, Animal draft power, social status, savings, and a buffer against risk (FAO, 2010). High mortality rates have undermined these benefits, but incorporation with irrigation has the potential to overcome some of the identified impediments, such as poor nutrition and lack of water (FAO, 2010). In the rural areas of developing countries, including Zambia, dwindling government budgets make supplying animal health services and veterinary supplies almost impossible, and existing extension services are very poorly trained in livestock management. There is a need to provide a broader range of skills and services, such as insurance, animal health services, credit and marketing, in order to reduce livestock mortality and improve profitability. However, several livestock-related problems have been identified in irrigation schemes, such as high mortality rates – caused by extreme weather events, poor nutrition or lack of water (FAO, 2010) – and unrepaired fencing (Shah et al., 2002), which allows cattle into fields, causing damage. On the other hand, conflicts can arise when fencing prevents livestock from accessing water (de Fraiture & Giordano, 2014).

A comparative discussion of the key findings from six small-scale irrigation schemes in Zambia

Irrigators in the six case-study Public schemes were asked in a baseline survey to consider the major barriers preventing them from increasing productivity and profitability. Very few mentioned issues associated with irrigation infrastructure or access to water and land, and there was also little mention of governance issues. Uniformly, farmers perceived other, ‘softer’ issues to be the major barriers, such as

1. Access to output markets;
2. Access to affordable and high-quality inputs;
3. Timely access to use of critical farm implements;
4. Knowledge about water and farm management and crop selection relative to market demand and prices; and
5. Knowledge of finance.

Access to credit and market

Lack of financing and access to financial products were particularly explored in the context of the schemes surveyed (Ministry of Agriculture, 2014), where they were found to prevent farmers from purchasing adequate inputs and having timely access to farm implements and transport to markets. This is consistent with the findings of Giordano and de Fraiture (2014). However, when markets and prices are uncertain, farmers are reluctant to take credit, and banks are reluctant to grant it; the risk of default is seen by both parties as too high. Hence, there is evidence to suggest that poor market information and lack of incorporation into the value chain are preventing farmers from accessing credit.

Government extension

Government extension services were reported as important sources of information and advice for irrigators in all the six public schemes surveyed. However, resource constraints in the irrigation schemes have limited the availability of extension services, as found by Department of Agriculture (2004). There is little extension presence in the irrigation schemes because public-sector pay and working conditions are very poor and the most qualified staff seek private-sector work. Hence, there is a shortage of extension officers, and once recruited they do not stay long (Ministry of Agriculture 2010). The number of extension officers is below government guidelines, and due to resource constraints, the officers are also given other responsibilities, such as serving both irrigated and dry land (Rain fed Farming) farmers and serving as business development officers. Hence, extension officers do not pay routine visits to schemes; farmers have to book a time and also pay transport costs. Further, there are inadequate resources to secure on-going and up-to-date training of the officers, and irrigators consider their advice outdated (Ministry of Agriculture al., 2014) found that better educated farmers in Zambia were less likely to use extension services, possibly because they believe they can obtain better advice elsewhere, say Zambia Farmers union. There is evidence that irrigators in the irrigation schemes surveyed, in the absence of extension officers, seek more advice from other sources, like the Zambia Farmers Union; while in Buleya Malima Irrigation Scheme it was identified that a pluralistic extension system is required, as it is unreasonable to expect one extension officer to provide high-quality advice on irrigated and dry land cropping as well as livestock and markets.

Livestock issues

In Zambia, livestock mortality rates are unacceptably high, with more animals dying each year than the numbers of eaten and sold. This is disappointing, considering that livestock are widely owned in some schemes like Buleya Malima, Siatwinda and Mkandabwe, and could make significant contributions to household income and food security, as well as providing a buffer when crops fail or excess floods the market. This is consistent with findings from other developing countries (FAO, 2010). There seems to be a serious lack of advice on livestock management and marketing, as well as veterinary services; national policies are reported as giving “scarce attention” to this sector (FAO, 2010). In Zambia and Some other SADC Countries, the training of extension officers is clearly focused on cropping, and there is little emphasis on managing the incorporation of cropping and animal production (Moyo et al., 2017). Most farmers in all the schemes have a combination of irrigated and dry land.

Hence, there is a substantial opportunity to incorporate the management of irrigated and dry land with animal production and improve productivity, as is reflected in the literature (Herrero et al., 2010).

Infrastructure

The focus on these softer issues does not mean that infrastructure, water, land and governance issues are not important, real and tangible ways to improve farmers' productivity and profitability, but it does support the argument of Wichelns (2014) and Meinzen-Dick (2014) that by itself fixing technical issues will not make small-scale irrigation schemes productive and profitable, and it accords with Adekunle et al. (2013), who suggests that the most critical issues to address are the softer issues addressed above. Once productive and profitable schemes have evolved, the issues of access to and control of water, land and infrastructure and the associated institutional arrangements will come to the fore. Hence, it is important to address both the softer and the technical Impediments in an integrated and holistic way, consistent with the findings of Walters and Groninger (2014). It could be argued that engineers, together with western donors, have been somewhat successful in constructing and refurbishing irrigation schemes. Designing canals and slopes and mixing concrete are relatively well-known processes. However, organizing people and resolving governance and softer issues is far more complex and requires a very different and far less tested skillset. Hence, in very few cases have small-scale irrigators been successfully integrated into the market and the broader economy such that they become profitable, have adequate food and have sufficient surplus to secure their children's education and their family's health. Only then will farmers be willing to pay water levies adequate to cover the full cost of scheme maintenance and to contribute sufficient labour to properly maintain the infrastructure. Further, the government of the republic of Zambia and donors will be much more comfortable and willing to fund new schemes and refurbish existing schemes if they can see the small-scale irrigators in public schemes following a business model that leaves them profitable, capable and willing to maintain the irrigation systems. While issues associated with infrastructure, land and water access, and governance were not mentioned by irrigators in the baseline survey, they were apparent in field observations and were raised in focus groups with farmers and discussions with stakeholders at Agricultural innovation platforms meetings.

Governance

There is significant confusion about who controls the public schemes in the country (Zambia) and who is responsible for irrigation infrastructure (Ministry of Agriculture, 2004). Traditionally, this was the sole responsibility of the Zambian government, but more recently it has become a joint responsibility. Further, the schemes (Chapula, Buleya Malima, Siatwinda, Nongoma etc.) were designed and constructed in a centralized and top-down manner without any input from the irrigators or their team leaders, which has resulted in members being disenfranchised. Reflecting this confusion and disenfranchisement, only about half the irrigators consider that they have to do any maintenance work in addition to paying their water levy. While farmers at the Chapula Irrigation scheme, now Chapula Horticultural center owe a maintenance levy in addition to their water levy, only 3 percent reported paying it. On the other hand, at the Buleya Malima Irrigation scheme, irrigators do not have to pay such a levy, yet 5 percent reported paying it. Therefore, Buleya Malima farmers must believe that the water levy is for maintenance. There is clearly confusion. Among the leaders in the Irrigation Management Committees there is uncertainty over their legality and authority, which contributes to lack of capacity and willingness to enforce critical rules. All of these factors have resulted in low participation in maintenance works and conflict over payment of water and maintenance levies. This has led to degraded infrastructure and significant water losses; widespread, blatant and silently accepted theft of water from the main canal; and unmaintained fences that allow stray cattle to damage field infrastructure and cause production losses, consistent with Ministry of Agriculture (2002). In other Public schemes that were considered in the base survey, similar issues have resulted in a lack of enforcement of basic rules such as membership in irrigation organizations, water levies set far below what is prescribed and needed for maintenance, stray cattle found in the fields, upstream-versus-downstream water distribution issues, water thefts, and lack of participation in maintenance Ministry of Agriculture, 2004).

In all six schemes significant hard issues were also identified, such as lined canals, control gates, broken down reservoirs, flood-damaged pumps and broken pipes and unlined and temporary canals, insufficient off-take size and lack of siltation traps at pump stations (Ministry of Agriculture, 2004). All these issues cause water losses, supply disruptions, production losses, and reduced overall irrigation efficiency. Uncertainty of mandate, ownership and responsibility, as factors that affect irrigation-scheme productivity, have been widely reported in the literature (de Fraiture & Giordano, 2014).

Land tenure

Land tenure and security of tenure were also mentioned as productivity Impediments in the all six schemes, as were the small plot sizes and the policy focus on subsistence farming. In Zambia, these factors seem to have resulted in only 5 percent of land being utilized and, as farmers have little to sell, comparatively little concern over market access. The concepts of subsistence farming and irrigation are not well matched. For irrigation to be successful, enough surplus income is required to pay for the maintenance and management of infrastructure. Where families need their crops for their own consumption this is not possible. It has often been pointed out that lack of secure tenure provides a disincentive for farmers to invest and makes it difficult to obtain financing, as farmers do not have land to mortgage (Deininger, 2003; Meinzen-Dick, 2014). In all schemes, irrigators cannot obtain formal title as land belongs to government. Land tenure in Zambia continues to be classified as in colonial times, with three categories: State land, reserves and trust land. Because of the high level of abuse, the government introduced radical land reform in 1975, eliminating private property, closing down the estate agents and placing all land under the control of the President. This reform was well received at the time, but the government is now considering a different type of reform based on private ownership. Customary tenure continues to govern access to reserves and trust land. While the debate on reform to facilitate the private ownership of reserves and trust land continues, care needs to be taken to prevent better-educated and better-connected urban speculators from abusing the situation at the expense of the rural population.

Concepts of customary and private land tenure in Zambia

Customary law

Most Zambians conduct their activities in accordance with and subject to customary law (Hansungule and Mwansa, 1993), but the term is used to cover a host of tribal laws existing in different ethnic groups. Since the colonial era, customary law has been recognized only after it has been found not to conflict with written law. Two contending views are held on customary land tenure in customary law. One view suggests that land and land rights are not individual but commonly shared. The other, increasingly held view recognizes individualism in land relations and tenure (Mvunga, 1977). Both views are valid because they arise from the dynamism of customary tenure, which has evolved from commonly shared land rights to individualization of croplands with continued commonly shared rights to grazing land, forests and fisheries. Individualization of croplands is a result of agricultural intensification, increase in population pressure and commercialization of agriculture. At present, cultivation rights of individual families are recognized on land where other families are excluded, but communal use rights may also be recognized (Hansungule and Mwansa, 1993).

Statutory law and private property

The Conversion of Titles Act of 1975 stresses two features: first, the distinction of improvements on the land versus the land itself; and second, the right of inheritance of land. The act does not distinguish trees from land, so trees are included in the concept of land. The introduction of a 100-year lease as the only form of ownership of State land marked the cornerstone of the reform process. Freeholds and other types of estates were abolished.

The statute appropriated all economic value of land except for improvements. An important impediment to rights in leaseholds is the restriction on tenants' dealings in their land: all dealings in land must follow Presidential consent. Another impediment is the requirement for planning permission before any development is attempted.

Comparison of the two systems

Zambia has had the experience of both freehold and leasehold tenure. Supporters of leasehold tenure argue that it allows State intervention if the tenant fails to utilize the land or damages it by mismanagement. They find the unrestricted ownership of land offered by freehold tenure undesirable because it may also result in speculation, fragmentation, underutilization or damage to the land by irresponsible farming practices. On the other hand, opponents of leasehold tenure argue that it does not convey absolute ownership which the occupier needs for assurance of the security of long-term investments. A leasehold is essentially a qualified right to occupy land for a fixed term which may or may not be renewed. The leaseholder is essentially a tenant of the State, to which rent is paid. The argument in support of freehold tenure is that it conveys absolute ownership to the occupier. The owner is free to develop the land as desired or to sell part or all of it at any time. No rent is payable. Ownership and security are virtually unrestricted. Occupants can invest without fear of dispossession. They can pass on the property to their designated heirs without any restriction. Customary tenure has by and large been more successful than leasehold tenure in meeting the needs of the people. The administrative procedures are simple and easily implemented. Land issues are dealt with efficiently and decisively. The problem, however, is that the land rights are never registered, although their recognition is guaranteed. No attempt has been made to reform customary tenure. However, the obtainment of title deeds to customary land must be facilitated by a simplified government machinery for land delivery.

Comparative evaluation of customary and leasehold tenure

This section presents an evaluation of the strengths and weaknesses of the land tenure systems with respect to a number of variables including employment creation, income generation, agricultural productivity, social justice, social cohesion and group solidarity, environmental considerations and general welfare. The evaluation is supported by a case study of 52 farmers in Mazabuka district carried out by the authors in 1993. Half of the farmers (26) were from communal areas and the other 26 were from a government settlement scheme on State land. Most of the farmers in the latter group came from communal areas where there was a land shortage. The settlement scheme started in 1975, but to date none of the 26 farmers interviewed have title deeds to their land.

Employment creation

During colonialism, reserves and trust land became the major source of labour for the industries on Crown land. The resulting exodus of young people left behind mainly old people, women and school-leavers. To ensure continued labour availability, the colonial administration did not develop any rural industries or capacity for entrepreneurship. These trends have continued in post-independence Zambia. Opportunities for wage employment continue to be limited on reserves and trust land because of small farm size, low capital investment, limited incentives, limited entrepreneurship, poor infrastructure and limited availability of services. However, customary tenure makes it possible for all rural people to have work - in the sense of labour - through access to land.

After independence, settlers who chose to leave the country sold their farms to the Africans. Some of the settlers chose to stay and are still farming today. Some of the farms left by the settlers were demarcated into smallholdings and given to Zambians for small-scale intensive farming. Because of this history, State land is characterized by large farms of 200 to 5 000 ha and smallholdings of 2 to 25 ha. Almost all commercial farms employ workers. In short, employment opportunities for wage labour are much greater on State land than on reserves and trust land, largely because of the differences in the scale of operations and level of investment.

Income generation

Low incomes are generally associated with customary tenure, but they cannot be attributed entirely to the tenure system. They are rather the result of a host of socio-economic, political and historical factors, including the colonial bias against rural areas in the development of infrastructure, industries and essential services, and much slower economic growth on reserves and trust land than on Crown land. Because of the long tradition of rural-urban labour migration, the majority of rural households have historically suffered from labour shortages which constrained their production. Limited access to

markets and technology, and controlled prices, especially for maize, further restricted income growth. At present, money transactions account for about 25 percent of all economic activity in reserve and trust land areas, the remainder consisting of subsistence production.

Agricultural productivity

Customary tenure has historically been associated with subsistence farming. The colonial regime did little to change this because it saw the urban and mining economies as the basis of the territory's economic development, with agriculture fulfilling a supporting role by providing a cheap supply of food and labour. Commercialization was not sought for African farmers for fear of reducing the volume of labour migration, but this view was modified in the 1940s when the territory lost its self-sufficiency in maize for more than a decade and was dependent on imports. Colonial policy favoured the establishment of large-scale commercial farms on Crown land. Only such units were seen as capable of producing regular surpluses for sale and providing the level of efficiency and responsiveness to market needs that the country's administrators regarded as necessary. The bulk of the resources spent on agriculture went to European producers on Crown land (Wood and Vokes, 1990). The land reserved for them had the best soils, had access to the road and railway networks and was close to the areas with high food demand. At independence in 1964, the government moved in quickly to redress the imbalance caused by this dualistic approach to agricultural development by reforming services for the communal areas. The measures included the creation of lending institutions, expansion of extension services, development of cooperatives and provision of subsidies on inputs.

Social justice

The cornerstone of customary land tenure is communal ownership of land resources. Individuals have no right to sell land assigned to them. People have equal access to the resources that nature has provided. Cropland is equitably distributed. Farmers therefore feel secure in the customary tenure system because they enjoy long-term rights to land without fear of dispossession of these rights.

There is a well-founded fear that proposed land reforms will make it easier for outsiders to get title deeds to land on reserves and trust land at the expense of the local people. When titling is introduced, wealthier and better-informed individuals may use their information advantages to claim land over which other, less informed individuals have customary rights. Binswanger, Deininger and Feeder (1995) observed that even when there are no information advantages, titling based on the on-demand principle involves high costs that put the rural poor at a disadvantage. Thus, titling has equity-reducing impacts. Bruce (1988) noted that during titling programmes, land grabbing by influential individuals who are able to use the rules in their favour does more to facilitate land concentration than transactions in the land market following the issuance of title.

Social cohesion and group solidarity

Customary land tenure is consistent with the African traditional way of life which hinges on strong family ties and lineage control over land. The primary landholding unit under customary law is the family, whose members hold land collectively. On communally owned land, all members of the community are entitled to use a fair share of available resources. Any attempt to replace customary tenure with individualized tenure could disrupt some of the basis of social cohesion.

Customary land tenure has a number of disadvantages, however, which limit the benefits derived from communal ownership of land discussed above. At independence, the tenure institutions left by colonialism continued, except that Zambians were allowed to settle on State land. Communities are less cohesive and social interactions are less strong on State land than on reserves and trust land. Landowners confine their activities within the boundaries of their own holdings.

Environmental considerations

From the onset of colonialism, the British South Africa Company expressed concern over the dangers of shifting cultivation, especially the chitemene system of northern Zambia practised for centuries. The chitemene system involves the lopping and sometimes felling of indigenous trees and the burning of the cut wood to generate mineral ash for incorporation into the soil.

The resulting gardens are cultivated for about six years, during which the soil is leached of its nutrients by the relatively high rainfall of northern Zambia. The gardens are then abandoned for another area of new woodland. Woodland can then regenerate in the vacated areas. In 1909, the colonial administration restricted chitemene practices to areas close to villages. The concentration of gardens close to villages led to a rapid depletion of soil fertility because of continuous cultivation without allowance of sufficient time for fallowing. Throughout the colonial period, African farmers were restricted to the reserves and trust land where soils were marginal.

The combination of restricted land access and agricultural practices resulted in excessive erosion. In a bid to curb the erosion hazard, the colonial administration developed compulsory conservation measures. While temporarily successful, these measures provoked hostility and resistance on the part of farmers. After independence, the compulsory conservation regulations were abandoned. Currently, the major causes of land degradation on reserves and trust land are deforestation, poor cattle management and uncontrolled fires.

General welfare at country level

The reserves and trust land comprised areas that were undesirable to the white settler community during the colonial era. They have therefore less potential than State land. Development of infrastructure was much slower than on State land. The majority of the people in trust and reserve areas are still as poor as they were at independence. Whether customary tenure is to blame for this condition is debatable. Customary land tenure is not compatible with business approaches to farming. Farming is taken as an ordinary way of life and not as a business.

Little is done to conserve the soils because when their productivity declines, the farmer simply moves to another village and starts again. Despite the constraints, customary land tenure has continued to survive because it is a product of the peoples' culture and values and is consistent with the African way of life. From the onset of colonialism to the present day, State land has had the advantages of better soil resources, better infrastructure and high investments by both government and individuals and consequently has offered a much better quality of life for the people. This explains the high population drift from agricultural to mining and industrial areas.

Conclusion

There are two main types of impediments to increasing the productivity and profitability of small-scale irrigation systems in Zambia: those associated with the technical characteristics of irrigation infrastructure and those associated with softer issues such as access to markets, knowledge, farm implements and financing, as well as governance and land tenure system of Zambia. Both are reflected in the literature and the case-study findings. This and other articles in this special issue argue that while much research, policy and donor focus is centered on the technical impediments, it is the softer barriers that are foremost on irrigators' minds. They see these issues as the day-to-day struggle that prevents them from increasing their productivity and profitability. In the six schemes that were considered in the base survey this article also identified a number of technical issues that seriously affect productivity in the irrigation schemes.

However, even if all the technical issues are resolved it could improve productivity without improving profitability. It does not help to increase the production of products for which there are no markets, or for which markets are already flooded or the roads to the markets are impassable. Collectively, this results in either no profit and/or very low prices. Increased productivity and profitability are determined by many of the softer barriers, such as timely access to knowledge, high-quality inputs (hybrid seeds and modern fertilizers) and critical machinery and implements. To turn increased output into increased profitability, small-scale irrigators need to be linked to appropriate market channels and the value chain.

In conclusion, this article suggests that a new business model for small-scale irrigation is needed in Zambia that addresses both the technical and the softer barriers, including governance and land tenure issues, in a holistic and integrated manner; a promising opportunity is AIPs, which allow better coordination of the actors in the total value chain.

References

- [1]. Araral, E. (2010). Reform of water institutions: Review of evidences and international experiences. *Water Policy*, 1, 8–22.10.2166/wp.2010.011 [Cross ref], [Web of Science], [Google Scholar].
- [2]. Beddow, J. M., Hurley, T. M., Pardey, P. G., & Alston, J. M. (2015). Rethinking yield gaps. Staff Paper Series P15-04. University of Minnesota: College of Food, Agricultural and Natural Resource Sciences. [Google Scholar].
- [3]. Bjorn Lund, H. (2009). Is water and land redistribution a driver of economic growth and poverty reduction? Lessons from Zimbabwe. *Water International*, 34, 217–229. [Taylor & Francis Online], [Web of Science ®], [Google Scholar].
- [4]. Boelens, R., & Vos, J. (2014). Legal pluralism, hydraulic property creation and sustainability: The materialized nature of water rights in user-managed systems. *Environmental Sustainability*, 11, 55–62. [Web of Science] [Google Scholar].
- [5]. CGIAR Research Program on Water, Land and Ecosystems (WLE). (2014). Ecosystem services and resilience framework. Colombo, Sri Lanka: International Water Management Institute (IWMI). doi:10.5337/2014.229 [Cross ref], [Google Scholar].
- [6]. De Sousa, W., Ducrot, R., Munguambe, P., Bjorn Lund, H., Cheveia, E., & Faduco, J. (2017). Irrigation and crop diversification at 25 de Setembro irrigation scheme in Boane district. *International Journal of Water Resources Development*, 33 (5), 705–724. doi:10.1080/07900627.2016.1262246 [Taylor & Francis Online].
- [7]. Food and Agriculture Organization of the United Nations (FAO). (2010). Livestock sector policies and programmes in developing countries – A menu for practitioners. Rome: FAO. [Google Scholar].
- [8]. Food and Agriculture Organization of the United Nations (FAO). (2012a). coping with water scarcity: An action framework for agriculture and food security (Water Report No. 38). Rome: FAO.
- [9]. Inocencio, A., Kikuchi, M., Tonosaki, M., Maruyama, A., Merrey, D., Sally, H., & de Jong, I. (2007). Costs and performance of irrigation projects: A comparison of sub-Saharan Africa and other developing regions (Research Report 100). Colombo, Sri Lanka: International Water Management Institute. [Google Scholar].
- [10]. Kahinda, J. -M., Rockström, J., Taigbenu, A. E., & Dimes, J. (2007). Rainwater harvesting to enhance water productivity of rain fed agriculture in the semi-arid Zimbabwe. *Physics and Chemistry of the Earth, Parts A/B/C*, 32, 1068–1073.10.1016/j.pce.2007.07.011 [Cross ref], [Web of Science ®], [Google Scholar].
- [11]. World Bank. (2008). Investment in agricultural water for poverty reduction and economic growth in Sub-Saharan Africa. Washington, DC: World Bank. [Google Scholar].
- [12]. Lie, H., You, L., Wielgosz, B., & Ringler, C. (2014). Estimating the potential for expanding smallholder irrigation in Sub-Saharan Africa. *Agricultural Water Management*, 131, 183–193.10.1016/j.agwat.2013.08.011 [Cross ref], [Web of Science], [Google Scholar].
- [13]. You, L., Ringler, C., Nelson, G., Wood-Sichra, U., Robertson, R., Wood, S., & Sun, Y. (2010). What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach. Washington, DC: International Food Policy Research Institute. [Google Scholar].