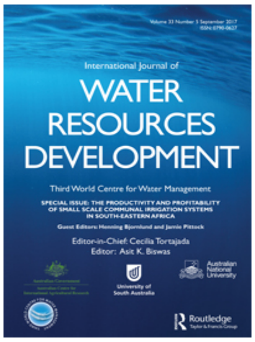

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Irrigation development in Zimbabwe: understanding productivity barriers and opportunities at Mkoba and Silalatshani irrigation schemes

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ABSTRACT

Productivity barriers and opportunities influencing smallholder irrigation sustainability in Zimbabwe were identified using case studies of the Silalatshani and Mkoba irrigation schemes. The major barriers were poor infrastructure and soil fertility, and poor access to farm inputs, farm implements, functioning markets and agricultural knowledge, which resulted in low yields, food insecurity and negative farm income. Most irrigated land remains unused, and marketing of produce is uncoordinated. Mobile technologies provide opportunities for market information dissemination. Institutions are needed to continuously encourage dialogue among agricultural value chain stakeholders to allow irrigators to align their operations to market demands and improve the viability of irrigation systems.

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Productivity barriers and opportunities; smallholder irrigation systems; sustainability; irrigation productivity; Zimbabwe

Introduction

Globally, smallholder irrigation systems are viewed as critical common property resources that are needed to increase crop water supply and sustain livelihoods in semi-arid regions (FAO and WWC, 2015). Improving agriculture and enhancing productivity through smallholder irrigation is one of the key strategies for alleviating poverty and improving the livelihoods of rural communities; the majority of the poor depend directly or indirectly on agriculture (Mutiro & Lautze, 2015). This is particularly true for Zimbabwe, where approximately 80% of agricultural land lies in arid or semi-arid regions (Jacobs, Chitima, Klooster, & Bwanali, 2013). Zimbabwe is divided into five agro-ecological regions (Figure 1), known as natural regions (NR), on the basis of the rainfall regime and number of growing days in a season (Bird, Shepherd, Scott, & Butaumocho, 2002; Vincent & Thomas, 1961). Zimbabwe's semi-arid areas are classified as NR III, IV and V. Semi-extensive (NR III and IV) and extensive (NR V) farming are recommended in these regions (Bird et al., 2002). Rainfall in the arid and semi-arid regions is too erratic and unreliable for dryland farming, making supplementary irrigation necessary for successful agriculture. Irrigation, therefore, acts as a mitigating

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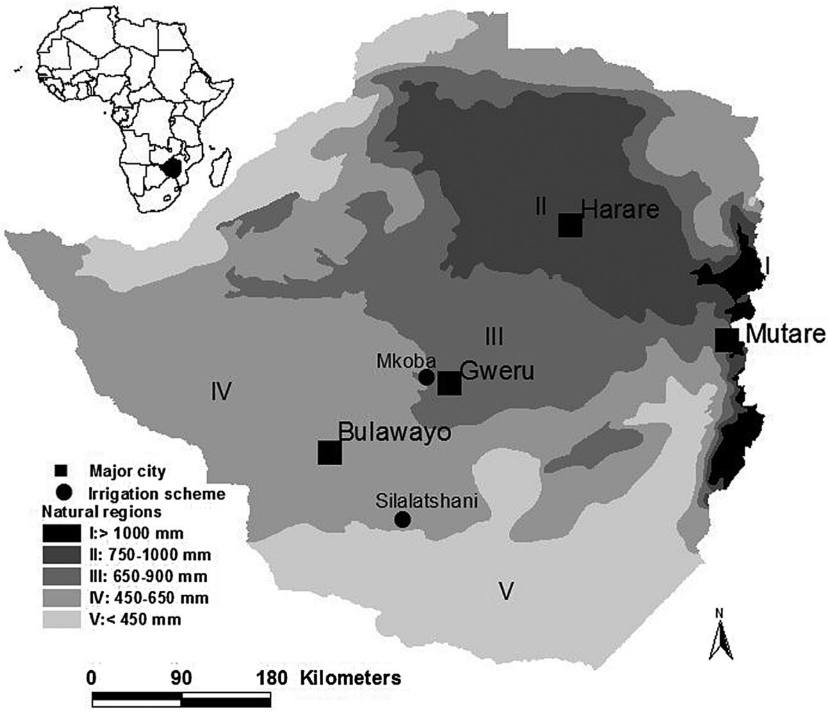

Figure 1. Location of Silalatshani and Mkoba irrigation schemes and the natural regions of Zimbabwe. Source: ICRISAT Bulawayo GIS Unit (2014).

measure against droughts and mid-season dry spells, which enables irrigators to grow crops throughout the year and intensify production. The government of Zimbabwe's objective for irrigation development is to guarantee food security through increased crop production (Chazovachii, 2012; Jacobs et al., 2013).

Smallholder irrigation schemes in southern Africa, Zimbabwe included, have largely failed in their objective to improve rural livelihoods and sustainable crop production for food security and poverty alleviation (Mutiro & Lautze, 2015). Similarly, smallholder irrigation in Zimbabwe has numerous challenges, with more failures than successes being reported (Jacobs et al., 2013). The underperformance of smallholder irrigation schemes, in most developing countries, is largely a result of complex interrelated factors, such as low technical capacity, poor institutional arrangements and uncoordinated market linkages (Crosby, de Lange, Stimie, & van der Stoep, 2000; Jacobs et al., 2013; Mujere, Chazovachii, Chifodya, & Mushuku, 2011). Barriers to productivity in Zimbabwe include inadequate inputs; inaccessible markets; unreliable and inadequate water delivery, due to weak water governance institutions; weak market integration; significant degradation and abandonment of irrigated land, including substandard infrastructure; and government policies on land tenure that do not support a conducive environment for the successful operation of irrigation schemes (Jacobs et al., 2013; Motsi, Zirebwa, & Machingambi, 2001; Mujere, Chazovachii, Chifodya, & Mushuku, 2011).

Most research has focused on barriers or shortcomings related to the 'hardware' aspects of irrigation systems, without investigating other challenges faced by the smallholder schemes (FAO, 2000; Manzungu, 1999; Motsi et al., 2001; Senzanje, Samakande, Chidenga,

& Mugutso, 2003; Rukuni, 1984). This study fills this gap by identifying productivity barriers to and opportunities for increasing the profitability of smallholder irrigation schemes, using the Silalatshani and Mkoba irrigation schemes as case studies.

Description of the study sites

There are three broad types of smallholder irrigation schemes in Zimbabwe: government-managed, farmer-managed and jointly managed (FAO, 2000). This article focuses on two jointly managed irrigation schemes, Mkoba and Silalatshani. The schemes were selected based on their potential to improve or address agronomic practices, institutional capacity, market barriers, farming practices and factors such as site accessibility, cost-effectiveness, crop diversity and the district authority's willingness to collaborate with the research effort. In jointly managed schemes, local irrigators and the government share the financial responsibility for operation and maintenance. In both schemes, the government is responsible for the headworks, while irrigators have responsibility for the infield infrastructure.

Land is owned and administered by the government under the Communal Land Act 1982 (Rukuni & Eicher, 1994; Government of Zimbabwe, Ministry of Lands, Agriculture & Rural Resettlement, 2001; FAO, 2002), according to which rural district councils allocate land for occupancy and use. In allocating the land, the councils must consult and cooperate with the chiefs (Sithole, 2002). At both irrigation schemes, land seems to be transferred generationally through marriage; in the event of the death of the landholder, the spouse or children inherit the rights to the irrigation plot. Both Silalatshani and Mkoba are in communal areas, and the land in the schemes is subject to this system.

Mkoba and Silalatshani are in Gweru Rural District (NR III) and Insiza District (NR IV), respectively (Table 1). Mkoba is characterized by infertile sandy soils, which are deficient in nitrogen, phosphorus and sulphur and have a low cation exchange capacity owing to low clay and organic matter content. Silalatshani is characterized by infertile clay soils, which are generally acidic (pH 6.1–6.5), with a low nutrient value (Moyo, Moyo, & van Rooyen, 2015). The scheme is divided into five blocks:

Table 1. Characteristics of Mkoba and Silalatshani irrigation schemes

	Irrigation scheme	
Characteristics	Mkoba	Silalatshani
Location	19°22′0.07″ S, 29°32′13.4″ E	20°47′22″ S, 29° 17′44.59″ E
Natural region	III	IV
Year constructed	1968–69	1968–69
Number of irrigators	75	845
Irrigated area (ha)	10.1	442
Average plot size (ha)	0.11	0.41
Main crop 1	Maize	Maize
Main crop 2	Sugar beans	Wheat
Main crop 3	Leafy vegetables	Sugar beans
Main crop 4	Onions	Sweet potato
Legal structure	By-laws	By-laws
Soils	Predominantly infertile sandy soils	Predominantly clay soils
Annual rainfall (mm)	650–900	450–650
Climatic characteristics	Mid-season dry spells and high temperatures are common	Severe dry spells and seasonal droughts are very common

Source: Authors' own data.

- Landela, 109.7 ha, with 212 members
- Pelandaba North and South (North Block, 79.1 ha, with 161 members; South Block, 47.7 ha, with 84 members)
- Vukuzenzele, 66.1 ha, with 108 members
- Nonoka, 85.5 ha, with 164 members
- Mbokodo, 54.2 ha, with 116 members.

Both schemes are flood irrigated. Silalatshani's water is supplied by the Zimbabwe National Water Authority (ZINWA) from the Silalabuhwa Dam. This dam is large, has a sizeable and very productive catchment and is able to deliver the current water requirements of the scheme. The dam also supplies commercial entities – gold mines, a small town and schools – and ZINWA is strict on the collection of levies because of the commercial importance of the dam. Mkoba's water is delivered from a small dam that supplies only this scheme. This dam has siltation problems and cannot deliver the current irrigation-water requirements throughout the year. Due to these factors, ZINWA is not enforcing the collection of levies. At both schemes, water is transferred through lined main canals; the secondary and tertiary canals are predominantly lined. However, the canals at both schemes were found to be leaking and in need of repair. Water levies are paid on a per hectare basis, in principle, and water supplied according to a roster; however, currently this is not enforced at Silalatshani, so irrigators can access almost unlimited supply on demand. Irrigators have to pay the levy even if they do not utilize the land, and all irrigators on each tertiary canal are collectively responsible for payment.

Data collection and analyses

The main data source for the article is a survey of irrigator households in both schemes. In social science research, the household is identified as the most typical unit of analysis and refers to all individuals who live in the same dwelling (Bryman, 2008). The survey was conducted with the household head or the key farm decision maker, as well as any other members of the household that were regarded as key informants. When multiple respondents were relevant, the survey was conducted with all respondents at the same time. In the remainder of this article this household unit is mainly referred to as 'irrigator(s)'. The questionnaire included questions related to the demographics of the farm household, agricultural practices, perceptions of water supply and barriers to productivity, and extension sources. The survey was designed to be consistent across Tanzania, Mozambique and Zimbabwe. It was founded in the literature and contextualized based on the first meeting of the agricultural innovation platform (van Rooyen et al., 2017) and initial exploratory discussions with irrigators and their leaders.

The first author and a team of experienced bilingual enumerators carried out data collection. The team participated in a five-day training workshop to familiarize themselves with the questionnaire and to ensure consistent data collection. Subsequently, the questionnaire was field-tested, and further refined, before implementation. Interviews exceeded an hour and a half in duration. The local Department of Agricultural, Technical and Extension Services (AGRITEX) officers provided introductions to the respondents.

At Mkoba, the aim was to survey all 75 irrigators. However, 7 asked to be excused, resulting in 68 being interviewed. At Silalatshani, it was decided to interview 100 irrigators in the Landela Block, almost 50% of the total 212. The selection was undertaken using a purposeful sampling technique, informed by the resident extension personnel and local leadership, and based on age, gender, resource endowment and upstream or downstream location. We approached these households until we reached our goal of 100 completed questionnaires.

In addition to the main survey, a second survey of 20 households, from the initial sample, was conducted in each scheme in January 2015 to explore issues emerging from the first survey. Project staff also visited the sites weekly from July 2013 to May 2015 to collect data, make observations and conduct formal and informal discussions with irrigators and their leaders. To validate and improve the understanding and implications of the survey results, focus group discussions were held in each scheme in January and July 2015 with irrigators and their leaders. The analysis is also based on discussions at two agricultural innovation platform meetings with all stakeholders in the value chains and support services. The qualitative data were synthesized to provide a better understanding of barriers and opportunities and are used to support the discussion of the empirical data.

Results and discussion

This section combines the results and discussion and is organized under 10 themes, which represent the main barriers and opportunities influencing smallholder irrigation sustainability in Zimbabwe emerging from the analysis. The themes reflect the structure of the household survey, but have been amended based on the outcome of the data analysis.

Demographic and production information

The irrigators at Mkoba were predominantly female, and at Silalatshani, predominantly male (Table 2). Members of the two schemes are relatively old. Irrigators' education levels at both schemes exceeded 11 years, which might present a good opportunity for the introduction of new crops and improvement in production. Mutambara and Munodawafa (2014) note that low levels of education limit access to information and understanding of commercial farming concepts, which are both critical to sustaining high production levels. Irrigation production, especially of high-value crops, has also been shown to be knowledge-intensive, and the level of education of the irrigators could be an important variable in crop choice and production potential (Mutambara & Munodawafa, 2014).

Contribution of irrigation

The mean irrigated area is 0.11 ha and 0.41 ha, which represents 9% and 23% of the total land area controlled by each household, at Mkoba and Silalatshani, respectively. Land utilization at the schemes is low, with only 20% of the irrigated land area at Silalatshani and 70%

Table 2. Demographics of irrigator households at Mkoba and Silalatshani schemes

Demographics		Mkoba (*n* = 68)	Silalatshani (*n* = 100)
Gender of household heads (%)	Male	36.8	69.0
	Female	63.2	31.0
Mean number of people per household		5.3	6.7
Mean age of household head (years)		61.5	56.3
Education level of household head (years)		13.44	11.67

Source: Authors' own data.

at Mkoba being utilized. As indicated earlier, Mkoba's supply dam has siltation problems and cannot meet the irrigation water requirements of the whole scheme. An unpublished study of the Ross Malindi Dam, which supplies Mkoba, noted that the extent of siltation of the dam was very severe and made worse by gardens within the catchment (DoIRR, Department of Irrigation, 2014). The estimated water use is 15 ML/ha per year, and the total water use is 151.5 ML/y. Silalatshani on the other hand is serviced by a large dam that has a sizeable and very productive catchment and is able to supply the current water requirements of the whole scheme. Irrigators at both schemes also have home gardens of 0.01 ha.

Farming systems at both schemes are subsistence in nature, with low crop diversity; highly water-dependent maize is the dominant crop. Other crops included groundnuts, sugar beans and wheat. These are predominantly grown for home consumption, with more than 65% of irrigators at both schemes consuming these crops. Low production levels are one of the major sustainability challenges for smallholder irrigation schemes in Zimbabwe (Mutambara & Munodawafa, 2014). Yields at Mkoba and Silalatshani reflect this; for example, maize yields are very low (300 kg/ha and 850 kg/ha, respectively), and groundnuts even lower (110 kg/ha and 200 kg/ha, respectively). Yields range between 5% and 15% of potential, which is very low considering that Jacobs et al. (2013) argue that irrigated cropping should achieve approximately 80% of yield potential. Given the small average plot size, these maize yields will provide only 33 kg and 348 kg per household, respectively. Considering that the average household requires 1000 kg of maize per year, there is little chance of producing surplus for sale. Hence, most of the households in Mkoba (75%) and Silalatshani (78%) have experienced food shortages over the last five years, most frequently between September and December. These yields are, however, consistent with other studies that argue that smallholder irrigation schemes in Zimbabwe are characterized by low production, minimal contribution to the national economy and an inability to cover development and operations costs (Manzungu & van der Zaag, 1996; Mutambara & Munodawafa, 2014). This study finds that for maize, inputs such as farmyard manure (415 kg/ha, 287 kg/ha), top-dressing fertilizer (35 kg/ha, 50 kg/ha) and basal fertilizer (26 kg/ha, 40 kg/ha) are minimally applied (figures for Mkoba and Silalatshani, respectively). The application rates of basal and top-dressing fertilizers are far below AGRITEX's recommended rate of 300–450 kg/ha (FAO, 2006).

The major obstacles to increased yields at both schemes were input shortages, primarily seed and fertilizers (84%, 89%), and lack of implements (57%, 52%). The majority of the irrigators rely on retained seed of local landraces and open pollinated seed varieties, which are low-yielding and more prone to disease than hybrid seeds. In addition, irrigators perceived low soil fertility (15%, 23%) and lack of knowledge (16%, 8%) – basic agronomy, water management and post-harvest management – as constraints to increasing productivity. Lack of knowledge is compounded by insufficient government support in terms of ongoing training of extension workers. The fact that lack of access to functional output markets was seldom mentioned as a barrier (16%, 18%) is probably a reflection of the small plot sizes and low yields of irrigators who are focused on subsistence rather than selling. (All percentages in this paragraph are for Mkoba and Silalatshani, respectively.)

Land tenure issues

In Zimbabwe, it is likely that land tenure is unclear to irrigators, especially since the state-driven land redistribution that occurred post-2000. Reflecting this, irrigators in Mkoba and

Silalatshani were unclear about whether land was owned communally or by the government. At Mkoba 42%, and at Silalatshani 44%, perceived that land is under a communal tenure system, where land is communally owned and no written title or lease is issued, while 56% at Mkoba and 49% at Silalatshani perceived that land is under government tenure. A small proportion, less than 2%, indicated that the land was privately owned. In actuality, land is owned by the government, making it difficult for farmers to secure individual loans for investing in the schemes.

Security of tenure, as perceived by farmers and potential investors and lenders, will determine the level of long-term investments (Jacobs et al., 2013). Results of this study suggest that, together, the small size of irrigated plots and the lack of secure tenure are major disincentives for irrigators to invest; therefore, they are the primary factors leading to low performance of the irrigation schemes. In other countries, it has been shown that enhanced security of land tenure improves productivity and empowers farmers, particularly women (Jacobs et al., 2013). Farmers take a long-term view of investment; they are more likely to build permanent productive structures if they have secure tenure. Improved tenure, such as the rural land certification programme in Ethiopia, has been reported to have a positive impact on soil- and water-related investments, as well as gender equality (Jacobs et al., 2013).

Marketing opportunities

Access to markets is a major constraint on income enhancement for farmers (FAO, 2000). This study found that irrigators in the schemes have limited access to markets, especially at Silalatshani, though they also have little need for market access due to the subsistence nature of production. However, if better market access were available it would provide incentives for irrigators to increase production. There is no coordinated marketing of produce at either scheme. The mean price of maize is relatively low; therefore, there is a need to explore lucrative cash crops such as groundnuts (USD 8.00/kg at Mkoba) and sugar beans (USD 2.00/kg at both schemes). At Silalatshani 7%, and at Mkoba 21%, indicate that there are markets available that pay better prices than those they are currently using. The majority of irrigators indicate that high transport costs prevent them from accessing better markets; there is also a lack of information on the availability of better markets. Irrigators identified a clear need for institutions helping farmers to identify the best market opportunities and the most profitable crops to produce (Table 3).

Since most irrigators indicated they have mobile phones (94% and 92% at Mkoba and Silalatshani, respectively), information and communication technologies might present a

Table 3. Reasons why irrigators do not sell their produce to alternative markets that offered a better price

Why irrigators did not sell to other buyers who offered a better price	Mkoba (%)	Silalatshani (%)
Buyers in that market only purchase in bulk	6.7	14.0
Irrigator produces a poor quality crop	7.3	43.0
High transport costs due to distant markets	57.3	43.0
The market needs reliable supplies and irrigators tend not to consistently supply the market with the desired produce	14.1	0.0
Low harvest	7.3	0.0
Lack of knowledge	7.3	0.0

Source: Authors' own data.

Table 4. Use, location and perceptions relating to irrigators' input markets

Use, location and perceptions	Mkoba (%)	Silalatshani (%)
Did the irrigator purchase any fertilizer or farm chemicals?		
Yes	67.7	87.0
If yes, where were these bought?		
Seller came to the village	8.7	16.1
Bought from a wholesale business	43.4	31.0
Bought through the irrigation management committee	0.0	8.0
Nearest local market	47.9	44.8
Do you think you can get the inputs purchased at a cheaper price elsewhere?		
Yes, there are other cheaper sellers	22.0	20.0
No, it was the best possible price	57.0	59.0
I don't know	21.0	21.0
If yes, why did you not buy from another seller?		
High transport costs	53.0	55.0
Inconsistent supply of goods by the market	9.0	5.0
Lack of time	8.0	5.0
Could not afford to purchase in bulk	30.0	35.0

Source: Authors' own data.

unique opportunity for disseminating market information. There are currently more than 13.8 million mobile phone lines in Zimbabwe, and mobile phone networks reach 76% of the country, including most rural areas. However, our results show that irrigators' use of mobile phones to access market and agricultural information is still in its infancy. Currently the Ecofarmer platform – administered by Econet, one of the largest mobile network operators – could be utilized to spread market information across Zimbabwe. EcoFarmer is described by Econet as a revolutionary way of farming using mobile technology (https://www.econet.co.zw/ecofarmer). It is Zimbabwe's first micro-insurance product, designed to insure inputs and crops against drought or excessive rainfall. In addition, the insured farmer receives daily weather information, farming tips, and information on when and where to sell and the best price for their produce.

The majority of irrigators at both schemes (87% at Silalatshani and 68% at Mkoba) purchase fertilizers and other farm inputs. Irrigators buy mainly from local or wholesale markets, with a smaller proportion, especially in Silalatshani, relying on sellers coming to the scheme (Table 4). However, 13–22% of irrigators do not purchase farm inputs, and, as indicated earlier, fertilizer application rates are very low, which reflects the subsistence nature of the majority of farmers. The FAO (2006) argues that the use of fertilizer in communal areas, especially in the semi-arid regions, is low due to a number of interacting factors, including economic, political, technical and institutional. Mapfumo and Giller (2001) suggest that the reasons for limited use of fertilizer vary from lack of knowledge of appropriate usage to cultural and traditional beliefs, such as the myth that fertilizers 'burn' the crops. This article concurs with Buresh and Giller's (1998) findings that the high costs of transport and fertilizers, as well as inconsistent supply, are major constraints on fertilizer use (Table 4).

Water access and distribution

Each scheme has a duty roster for water distribution. It is fixed at Mkoba, but more flexible at Silalatshani, where irrigators claim they can request water at any time without restriction.

This is possible because as much as 80% of the irrigable land is not utilized. At both schemes, the irrigation management committee (IMC) is in charge of water supply and makes all the decisions about when to supply to individual irrigators. Participants did not report any specific conflicts over water access, with a high proportion of irrigators indicating that they receive water when they need it. The majority of irrigators – 75% and 74% at Mkoba and Silalatshani, respectively – indicate that they are satisfied with water supply. However, whilst water availability is not a major limitation, especially in Silalatshani, there is still a need to promote water-efficient technologies (Senzanje et. al. 2003). Research findings highlight that improving water use efficiency is imperative, due to the onset of climate change and the targeted increase in irrigated lands (FAO, 2000; Jacobs et al., 2013; Senzanje et al., 2003). Findings also suggest that once irrigation becomes profitable, irrigators will start farming the currently uncultivated blocks, and demand for water will increase.

At Mkoba, 49% of irrigators report that water charges are fair, and 21% are indifferent; at Silalatshani, 50% report that charges are expensive. Irrigators at Mkoba pay USD 2.90/ha per month, and at Silalatshani, USD 14/ha per month. Water allocation and price are based on area. This is regardless of how much water is available at Mkoba, or how much is extracted at Silalatshani. The reason for the price difference between the two schemes is embedded in Zimbabwean policy and outside the scope of this article. The findings suggest that irrigators' perceptions of price have little to do with reality. Irrigators at Silalatshani feel hard done by, as ZINWA demands that water bills be paid at critical stages of crop growth, when crops are sensitive to water supply, and threatens to shut off supply if payment is not made. Closure would render irrigators' efforts useless and put them in a difficult financial position, as they would be saddled with water bills but no crop production.

The majority (over 75%) of irrigators at both schemes do not believe that there are ways to improve irrigation water productivity, although there are some who believe irrigation could be improved through better technologies, such as drip systems and dam rehabilitation. Farmers at both schemes generally lack the capacity to fully maintain the infrastructure, with some of the canals unlined and leaking. Field visits indicate that the Silalatshani scheme may be losing up to 50% of the water during conveyance. The water canals are leaking, and the night storage dam valves are not functional, leading to water losses. Senzanje et al. (2003) and Jacobs et al. (2013) suggest that there is a need to improve on-farm irrigation efficiencies in smallholder irrigation systems, and they propose the introduction of better technologies, such as drip and micro-sprinkler irrigation systems. Neither of these were operational at the two schemes.

Infrastructure ownership and scheme management

Ownership of infrastructure in smallholder irrigation schemes has been described as "a complicated issue", as infrastructure comprises various parts: headworks, conveyance and infield structures (Jacobs et al., 2013). In our study, the respective roles of government and irrigators in the management of infrastructure are not well defined or understood by the irrigators, which leads to confusion over management. According to the FAO (2000), traditionally it was the government's role, with no input from irrigators; however, infrastructure management has recently become a joint responsibility of government and irrigators. At both schemes, the government is responsible for the headworks, while irrigators have responsibility for the infield infrastructure. However, in both locations the irrigation systems are not

Table 5. Other activities that irrigators have to do besides paying the water levy

Activities	Mkoba (%)	Silalatshani (%)
Apart from paying the water levy, do you have to do work maintaining the irrigation system?		
Yes	61.5	63.0
No	38.5	37.0
If yes, what do you have to do?		
Maintain the canals	21.6	13.0
Maintain the fence	13.5	27.0
Agroforestry activities	5.4	0.0
Cut grass	2.7	5.0
Pay the general-purpose levy for maintenance	54.1	38.0
Train other irrigators	2.7	0.0
Maintain roads	0.0	7.0
Provide security at the scheme	0.0	10.0

Source: Authors' own data.

well maintained, mainly due to the low productivity of the schemes and the lack of secure tenure, which is a major disincentive for irrigators to invest.

The confusion over management responsibilities is clearly reflected in the survey results. Only 60% of irrigators believe they have to contribute to maintenance, in addition to paying the water levy. There also seems to be confusion about what the water levy is for. At Silalatshani, while irrigators have to pay a monthly maintenance fee of USD 1 per 0.5 ha (in addition to the water levy), only 38% report paying it. At Mkoba, no such levy exists; however, 54% report paying it (Table 5). This suggests that irrigators at Mkoba think that the water levy also covers maintenance.

Confusion over maintenance responsibilities and what the money collected as levies is for, as well as the disenfranchisement of irrigators, has caused lack of commitment among both irrigators and the IMC. This has resulted in dilapidated infrastructure, such as fences, which has led to problems with stray livestock invading the scheme and destroying crops; and leaking canals, resulting in large conveyance losses between the dams and the fields; it has also resulted in the widespread and silently accepted illegal abstraction of water from the main canal. Ultimately, these results lead to losses for irrigators.

Each scheme has an IMC; however, they seem to be ineffective, as their legality and authority remain unclear. The IMCs were established with the help of AGRITEX, and their main objectives are to enhance irrigators' participation in management and decision making at the scheme level, to introduce a system of discipline among the irrigators and to control infield water distribution (Svubure & Zawe, 2010). The findings of this study suggest that uncertainty surrounding the IMC's authority has created a lack of capacity or willingness to enforce critical rules, such as those reported in this section, and resulted in reduced productivity and limited system maintenance.

Credit access and financial products

Access to credit through formal institutions is nonexistent in the two schemes, and only 13% at Mkoba currently have access to loans from individuals (Table 6). This could be closely associated with the lack of formal tenure and an inability to provide collateral for loans. This results in irrigators' not having the credit needed to finance inputs and land improvement, which could be a contributing factor to the low level of utilization of irrigable land, a scenario

Table 6. Irrigators' financial arrangements

Financial arrangements	Mkoba (%)	Silalatshani (%)
Functional bank account	11.8	5.0
Savings account	13.2	10.0
Traditional savings scheme at local community level	20.6	36.0
Burial scheme at local community level	11.8	9.0
Loan from an individual	13.2	3.0
No account	47.1	48.0
Mobile phone banking (EcoCash, Telecash, One Wallet)	32.4	13.0

Source: Authors' own data.

also noted by Mutambara and Munodawafa (2014) in the south-eastern Lowveld of Zimbabwe. Lack of access to credit also affects the choice of crops grown. Private loans might leave the irrigator dependent on the lender, which might influence farming decisions and the sale price of produce. At both schemes, some irrigators have a range of financial products: a bank account; traditional communal saving and burial schemes; loans from an individual; or mobile phone banking. However, almost half the irrigators have no form of financial account, which emphasizes the subsistence nature of many of these farm households.

There are three mobile phone banking platforms in Zimbabwe: EcoCash, Telecash and One Wallet. EcoCash is described as an innovative mobile payment solution that enables Econet customers to complete simple financial transactions, such as sending money to other people and paying for goods and services (https://www.econet.co.zw/ecocash/). Telecash is a service offered by a mobile company, Telecel Zimbabwe, whereby mobile phone users deposit money (physical cash) through an agent, bank, or Telecel shop into a Telecash account. This money then becomes electronic money (e-money), which customers can transfer electronically to other mobile phone users without visiting any bank (http://telecel.co.zw/telecash). Lastly, One Wallet is a service offered by a mobile company, NetOne (a private company wholly owned by the government of Zimbabwe). One Wallet is described as a convenient and secure mobile money service which allows one to send and receive money, purchase airtime and pay bills the mobile way (http://www.netone.co.zw/).

Extension services

Decisions on where to seek advice are generally made by the head of household, or as a combined husband-and-wife decision. The extension officers are the most important source of advice; this is mainly provided by the Department of Irrigation and AGRITEX, which are both parts of the Ministry of Agriculture. The Department of Irrigation is primarily responsible for advice related to water management, and AGRITEX is used for agronomic advice. Irrigators trust and believe in the local AGRITEX extension officers but also, to a lesser extent, seek advice from local farmer groups. There is also evidence that a very small proportion at Silalatshani seek advice on crop choice from the IMC. The fact that irrigators seek advice from the IMC suggests that this could be a good entry point for the encouragement and promotion of group production and marketing for improved incomes and enhanced viability of the schemes. Irrigators do not currently seek advice from buyers and sellers. This is a weakness in the extension system, as without producer–market linkages the irrigators may continue with 'business as usual' and produce what the market does not really need.

Smallholder irrigators did not show any awareness of the Agricultural Marketing Authority, a statutory body with a broad mandate to regulate participation in production, buying and processing of agricultural products in Zimbabwe. The authority's duties include the promotion of agricultural production of strategic crops (tobacco, cotton, sugar, soya beans, barley); crops for the provision of food security (maize, wheat, sorghum); livestock (beef, dairy, piggery, poultry, small stock); borrowing and lending for agricultural production and marketing; promoting contract farming through encouraging private-sector participation; promoting marketing and fair pricing of agricultural commodities; and coordinating the operations of statutory bodies charged with regulating and marketing of agricultural products (Agricultural Marketing Authority of Zimbabwe, AMA, 2015).

The transformation of the agricultural landscape in Zimbabwe requires a pluralistic extension system (Jacobs et al., 2013). Such a system would allow irrigators to access information from a complex range of sources. This would be a significant improvement, as it is not reasonable to expect AGRITEX officers to have the skills and knowledge to meet all the needs of irrigators. Private-sector players, such as sellers of farm inputs and buyers of farm produce, could also play a significant role in providing extension advice. The Agricultural Marketing Authority's presence and work also need to greatly improve, as they are currently not fulfilling their mandate within the smallholder irrigation systems.

Farm implement ownership

The majority of irrigators own rudimentary farm implements to cultivate their land (Table 7). Although the majority of the irrigators report owning some farm implements, 75% and 67% (at Mkoba and Silalatshani, respectively) report frequently needing other farm implements that they do not own; the majority secure access from neighbours, with or without payment. Only 7% and 1% (at Mkoba and Silalatshani, respectively) report having no access to implements. However, more than half believe that not having ready access to farm implements is the second-most important constraint on improving farm productivity. Farm implements owned include hand tools, animal-driven tools, wheelbarrows, and ox or donkey carts. Ownership of farm implements such as tractors, ploughs and wheelbarrows is important for poverty reduction and for securing livelihoods, as irrigators who own or have access to these implements have a better chance of coping with the negative impacts of climate change (Roncoli, Ingram, & Kirshen, 2001). Irrigators with enough farm implements and draught animals are able to perform land preparation in a timely way; hence, their ability to attain reasonable yields is higher than irrigators without these implements.

Table 7. Irrigators' ownership of farm implements

Farm asset	Mkoba (%)	Silalatshani (%)
Hand tools	91.2	39.5
Animal-driven tools	52.9	31.0
Wheelbarrow	89.7	48.0
Ox/donkey cart	47.1	34.8
Borehole/water pump	48.5	6.0
Mobile phone	94.1	92.0

Source: Authors' own data.

Table 8. Irrigators' livestock ownership and use of draught animals

	Number of irrigators owning livestock		Mean number of livestock owned/used	
Ownership and use	Mkoba	Silalatshani	Mkoba	Silalatshani
Class of livestock owned				
Cattle	37	76	6.8	7.4
Donkeys	5	60	3.6	4.5
Sheep	3	84	4.3	3.9
Goats	29	84	5.1	6.8
Chickens	61	89	11.0	12.0
Class of livestock used as draught animals				
Cattle	27	53	2.4	2.4
Donkeys	5	60	0.8	3.1

Source: Authors' own data.

The role of livestock

Livestock provide flexibility to irrigators, as they can be sold to offset losses in crop production, provide a food source during critical periods and are a form of saving (Rohrbach, van Rooyen, & Hargreaves, 2004). Livestock play an important role in Zimbabwe, where crops and livestock are integrated to improve food security and livelihoods; livestock are a means of diversification of income and a way of reducing vulnerability and income risk. Cash income and draught services are the most important reasons for keeping cattle. Manure is also an important input for crop production. Four main categories of livestock are owned by irrigators at the two schemes: cattle, donkeys, goats and chickens (Table 8). At Mkoba 54%, and at Silalatshani 76%, of the irrigators own cattle; 73% and 70%, respectively, use some of them as draught animals.

Livestock mortality is high; an average of 1.5 cattle per household per year are lost at both schemes. The consumption and sale of livestock are infrequent. Goats are locally consumed, and cattle are sold. The number of livestock sold is less than half the number of livestock deaths. Seventy per cent of irrigators report seeking advice from extension officers; however, the officers' training is biased towards crop production, and they are not fully qualified to provide livestock advice. Most irrigators are dependent on natural rangelands for feeding their cattle, donkeys and goats. A notable benefit of irrigation is the supply of quality crop residues as animal feed, with many irrigators using it to feed their livestock. There is evidence of irrigators' growing forage crops on rainfed fields. This suggests that there might be an opportunity to invest more widely in fodder production to provide food security, through increased quality and quantity of livestock production and livestock sales to generate cash income.

Conclusions

This study of the Silalatshani and Mkoba irrigation schemes in Zimbabwe provides evidence that land utilization is low. The supply dam for Mkoba has siltation problems and cannot meet the irrigation-water requirements of the whole scheme. Irrigation conveyance channels at both schemes are not fully functional; water canals are leaking, and the night storage dam valves are not functional, leading to water losses. This is of particular concern in a region where water supply is affected by climate change and variability of supply; promotion of water-efficient technologies is therefore pertinent. Socio-economic issues such as very small plot sizes, land tenure and infrastructure ownership, weak input and output markets, poor infrastructure, high transport costs and poor policies present the main productivity barriers in the schemes. Cultivation of low-value crops, such as maize and wheat, mainly for subsistence affects the viability of the schemes; production of higher-value crops, integrated into functional value chains, is fundamental for improving the livelihoods of the irrigators. Coordinated efforts to integrate missing value chain players through continuous dialogue among the stakeholders, taking advantage of opportunities such as high mobile phone ownership to utilize mobile phone technologies, are required. Agricultural innovation platforms offer a forum for continuous dialogue among relevant stakeholders (van Rooyen et al., 2017). Policy and institutional support is fundamental to allow the irrigators to tap into innovations developed in other sectors, such as mobile technology. Finally, for these schemes to be sustainable, there is a need to review organizational structures and provide a better definition of the roles and responsibilities of current institutions, particularly the irrigators, IMCs, ZINWA, the Department of Irrigation and AGRITEX. Policies that govern water supply need to be improved, coupled with education of irrigators and a pluralistic extension system; all these are needed if the productivity of smallholder irrigation schemes is to be improved.

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