International Journal of Water Resources Development

ISSN: 0790-0627 (Print) 1360-0648 (Online) Journal homepage: https://www.tandfonline.com/loi/cijw20

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To cite this article: Makarius V. Mdemu, Nuru Mziray, Henning Bjornlund & Japhet J. Kashaigili (2017) Barriers to and opportunities for improving productivity and profitability of the Kiwere and Magozi irrigation schemes in Tanzania, International Journal of Water Resources Development, 33:5, 725-739, DOI: 10.1080/07900627.2016.1188267

To link to this article: https://doi.org/10.1080/07900627.2016.1188267

INTERNATIONAL JOURNAL OF WATER RESOURCES DEVELOPMENT, 2017
VOL. 33, NO. 5, 725–739
https://doi.org/10.1080/07900627.2016.1188267

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Barriers to and opportunities for improving productivity and profitability of the Kiwere and Magozi irrigation schemes in Tanzania

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ABSTRACT

Irrigation is a key strategy for food security and poverty alleviation among small farmers in Tanzania. However, the potential of irrigation to improve food security is limited by multiple barriers. This article discusses these barriers within the Kiwere and Magozi schemes. Results indicate that water supply barriers are caused by poor irrigation infrastructure and management. Lack of finance is also a critical barrier to increasing overall productivity. Finance affects farmers' timely access to adequate supply of quality inputs and machinery and availability of transport to access inputs and profitable markets. There is evidence that these barriers have to be addressed holistically.

ARTICLE HISTORY
Received 15 September 2015
Accepted 7 May 2016

KEYWORDS
Food security; irrigation; Kiwere; Magozi; productivity barriers; Tanzania

Introduction

Irrigation development in Tanzania, as in other countries in Sub-Saharan Africa, has taken place in stages and has been associated with large challenges. In the early 1960s, Tanzania entered a phase of developing large irrigation schemes for commercial and food security purposes. The schemes were managed by state agencies, and the farmers were paid employees. Mbarali, Madibira and Dakawa are typical examples of such schemes (approximately 3000 ha). The emphasis was on large diversion infrastructures with lined main canals. These schemes performed poorly and consequently collapsed towards the end of the 1990s (Kadigi, Tesfay, Bizoza, & Zanabou, 2012). At this time, some schemes were privatized while others were handed over to small-scale farmers, thus transferring management from state agencies to farmers (Stirzaker & Pittock, 2014).

Most schemes collapsed because they were poorly managed and unprofitable and relied on government support, which made them a financial burden (Inocencio et al., 2007). Also, development costs were high, up to US$ 400,000/ha (Rosegrant & Perez, 1997), making schemes difficult to justify. Poor construction and management have resulted in negative environmental impacts (Chilundo, Brito, & Munguambe, 2004). For example, the Great Ruaha River dried out after 1994, which coincided with the opening of one of the last large

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government irrigation schemes, the 3800 ha Kapunga scheme (Mdemu & Francis, 2013). However, scientific evidence of the link between irrigation development and the drying of the river is mixed (Lankford, van Koppen, Franks, & Mahoo, 2004; Mtahiko et al., 2006).

High development and operation and maintenance costs, poor performance and negative environmental impacts became unbearable for governments and donors (Diemer & Vincent, 1992), who subsequently started to focus on farmer-managed small-scale irrigation towards the end of the 1990s. The emphasis was on modernizing the schemes by improving water intakes, institutional capacity building and community participation through national development programmes such as the river basin management and smallholder irrigation improvement projects that involved locals in maintaining the system (World Bank, 1996).

However, farmer-managed small-scale irrigation did not improve farmers' incomes (Kadigi et al., 2012). Despite being farmer-led, the irrigation department and donors continued to play a major role in design and crop production (Diemer & Vincent, 1992). Nkhoma (2011) argues that inadequate emphasis was placed on strengthening the capacity of irrigator organizations (IOs) and cooperatives; improving crop varieties and access to farm implements, inputs and output markets; and improving on-farm agronomic and water management practices. Currently, decision makers and development partners are starting to recognize the importance of addressing these barriers and other issues as opportunities to increase farmers' productivity and income. This article provides insight into how irrigation management and non-water-related issues affect productivity of farmer-managed small-scale irrigation, based on case studies of the Kiwere and Magozi irrigation schemes (hereinafter Kiwere and Magozi) and the perceptions of farmers, scheme leaders and other stakeholders regarding irrigation and food security. This is important because existing irrigation schemes will need to remove such barriers and improve water management in order to meet the challenges associated with increased water demand.

Methodology

Kiwere and Magozi were selected based on their potential to improve or address agronomic practices, institutional capacity, market barriers, farming practices and other factors, such as site accessibility, research cost, crop diversity and the district authority's willingness to collaborate.

Data were accessed from six sources: (1) a survey of 100 households from each scheme; (2) a more detailed survey of a sub-sample of 20 households; (3) a workshop with researchers and project partners; (4) site visits to schemes; (5) focus groups; and (6) meetings of the agricultural innovation platforms (van Rooyen, Ramshaw, Moyo, Stirzaker, & Bjornlund, 2017).

The survey of 100 households was undertaken in June and July 2014. Households were selected from a list of members of the IO, using a stratified sampling approach. The selection criteria included socio-economic status, based on a wealth ranking, with a preference to mix socio-economic status of potential respondents, gender and location – upstream, middle or downstream. Household surveys were conducted by trained enumerators by interviewing the household heads and other household members, who were regarded as key informants. The survey included questions related to the household, the farm and farming practices, perceptions related to water supply, perceived barriers to productivity improvements, and use of extension sources. The questionnaire was piloted prior to implementation. Hereinafter,

the term 'farmer(s)' is used rather than 'farm household', and percentages reported relate to this unit, as the terms are synonymous.

The detailed survey of 20 households was undertaken in January 2015 and explored issues emerging from the first survey, such as water supply factors limiting water productivity. The workshop that followed, in May 2015, discussed the findings of the two surveys and sought feedback from participants. Project officers undertook weekly visits from July 2013 to May 2015 to collect survey data, make observations and engage farmers and leaders in formal and informal discussions. The focus groups were held in January and July 2015 with the scheme's farmers and leaders to further validate and improve the understanding and implications of the survey results. Finally, two agriculture innovation platform meetings were held with all stakeholders along the value chain.

Survey data were analyzed to produce descriptive statistics using SPSS and Excel. Qualitative data from sources 3–6 were collected through flip charts and voice recorders and synthesized to provide a better understanding of barriers and opportunities farmers perceive related to achieving food security.

Irrigation in Tanzania

Water resources management in Tanzania is guided by the National Water Policy 2002 (United Republic of Tanzania, [URT], 2002), the Water Resources Management Act 2009 (URT, 2009a) and the Water Supply and Sanitation Act 2009 (URT, 2009b). The National Water Policy divides the country into nine river basins, each consisting of a number of catchments. The Basin Water Board is the highest planning authority, and the water user associations within each catchment are the lowest planning level. The National Water Policy allocates water to basic human needs as the highest priority. The next priority is to the ecosystems that underpin the quality of water resources, with the third priority for economic uses. The National Water Policy also introduced integrated and participatory water planning, which allows for development and management to address cross-sectoral interests. Among economic uses, irrigation is given high priority as a way of reducing poverty and enhancing food security, which is emphasized in the Second National Strategy of Growth and Reduction of Poverty (URT, 2010b) and the National Irrigation Policy 2010 (URT, 2010a). The National Irrigation Act 2013 (URT, 2013a) established the National Irrigation Commission, which has the main responsibility for development, operation and maintenance of irrigation and drainage systems. Recent government initiatives, such as the Southern Agriculture Growth Corridor (URT, 2011) and Big Results Now (URT, 2013b), place irrigation at the core of attaining each initiative's objectives. There is increasing concern over the ability of water resources to meet the expected increase in demand, and existing irrigation schemes will have to become more efficient by removing barriers to improving water management.

Demographic and scheme characteristics

Kiwere and Magozi are located in the central and north-western part of Iringa District, approximately 20 km and 60 km from Iringa, respectively (Figure 1). Farm households have a mean size of 5.47 and 6 people, respectively (Table 1), which is higher than both the national average of 4.7 and the national rural average of 5 (National Bureau of Statistics (Tanzania), 2014). The male-to-female ratio is 50.9:49.1 in Kiwere and 54.2:45.8 in Magozi, and the mean

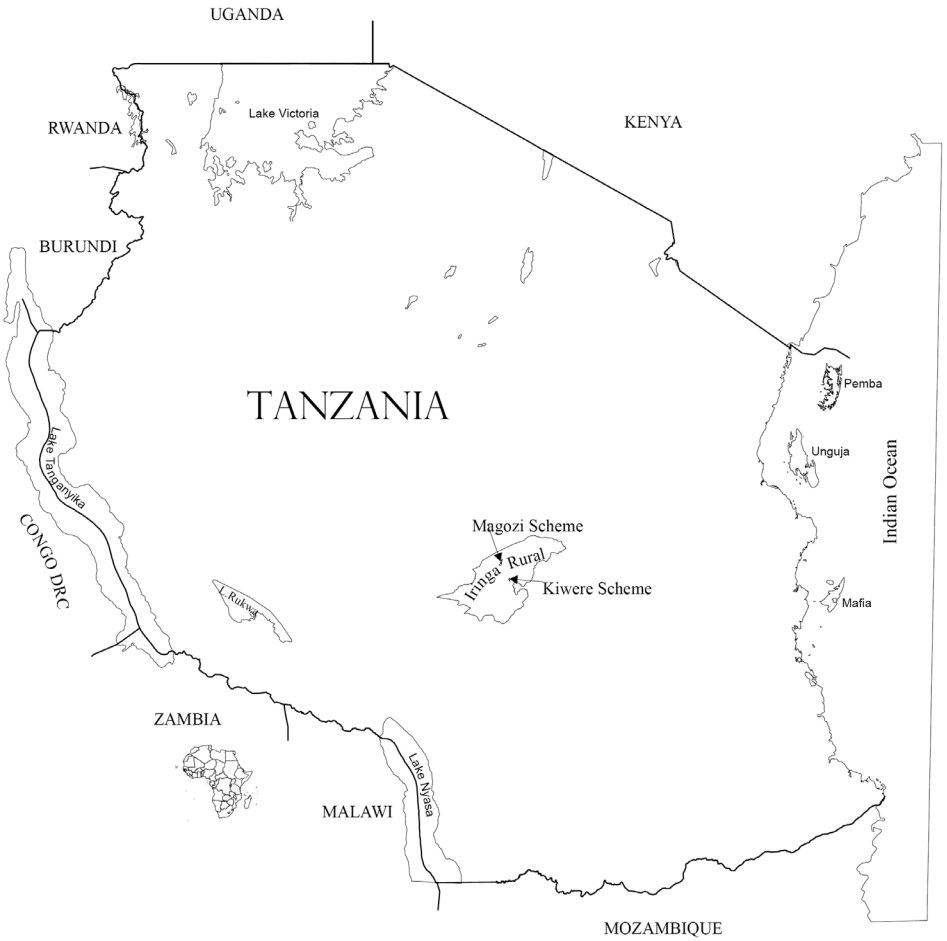


Figure 1. Location of Kiwere and Magozi irrigation schemes (©Ardhi University, 2016).

age of household heads is 46 and 43, respectively (Table 1). Agriculture, rainfed and irrigated, is the main source of income. More than a quarter of households experienced food insecurity over the last five years, while more than 90% consider themselves to be in good health.

Kiwere is managed by the TUPENDANE IO, while Magozi is managed by the Mkombilega Ilolo Mpya and Magozi IO. The IOs are responsible for governance of the schemes and operation and maintenance of irrigation infrastructure, which includes water diversion, irrigation canals and water distribution off-takes. The TUPENDANE IO has 168 members, comprising 128 males and 40 females, and draws its members from the villages of Kiwere and Mgela, which have populations of 1879 and 2639, respectively. The Mkombilenga Ilolo Mpya and Magozi IO has 503 members, comprising 383 males and 120 females, and draws its members from the villages of Mkombilenga, Ilolo Mpya and Magozi, which have populations of 1808, 1028 and 1210, respectively.

In the Mkombilenga Ilolo Mpya and Magozi IO, the membership represents 87% of the 578 registered farmers; 13% were non-members. In Kiwere, all registered farmers were members of the IO. In the July focus groups, the Magozi farmers argued that the presence of

Table 1. Demographics and characteristics of Kiwere and Magozi irrigation schemes.

	Irrigation scheme	
	Kiwere	Magozi
Demographics		
Mean household size	6.01	5.47
Age of head of household	46	43
Males in household (%)	50.9	52.2
Females in household (%)	49.1	45.8
Education level:		
Some primary education (%)	55.0	52.4
Some secondary education and above (%)	17.1	9.2
Not started or at primary school (%)	22.5	31.6
No formal schooling (%)	5.1	6.7
Scheme characteristics		
Year constructed	2005–07	2005–07
Number of members of irrigation organization	168	503
Total number of farmers	168	578
Member villages of the scheme	Kiwere, Mgera	Magozi, Mkombilenga, Ilolo Mpya
Total irrigated area (ha)	194.47	939.40
Average plot size (ha)	0.78	1.24
Range of plot sizes (ha)	0.04–8.12	0.12–16.56
Main crop 1	Tomato	Rice
Main crop 2	Onion	Tomato (pumped river)
Main crop 3	Green maize	Leaf vegetables (pumped river)
Main crop 4	Leaf vegetables/beans	
Legal structure	Registered with constitution and by-laws	Registered with constitution and by-laws
Soils	Sand clay with varying degrees of fertility	Clay soils
Annual rainfall	700 mm	600 mm
Irrigation season	Year-round	December–May
Source of irrigation water	Little Ruaha River	Little Ruaha River

Source: Mziray et al. (2015).

non-members was due to the fact that both members and non-members pay the same water charges based on acreage, while only members participate in maintenance of infrastructure. The only penalty for being a non-member is that they cannot question the organization's finances or contest for leadership. The problem of non-members may reflect weak leadership and governance of the organization, as under the National Irrigation Act 2013 farmers have to be members of the organization and it has the power to make decisions that affect all farmers (URT, 2013a). Plot size varies from 0.04 to 8.12 ha in Kiwere and from 0.12 to 16.56 ha in Magozi.

The average household income from all sources – rainfed and irrigated crops, livestock, labour, business, employment and remittances – was TZS 1,149,859 and TZS 2,998,238 for Kiwere and Magozi, respectively (USD 1 ≅ TZS 1562). The Kiwere income was 40% lower than the income in the neighbouring schemes along the Iringa–Pawaga road (Huppe, 2015), while the Magozi income was higher by 36%. Crop incomes are affected by crop production and crop prices. At Kiwere, the average tomato yield is less than half the 45,722 kg/ha potential yield of the Iringa Region. The average rice yield at Magozi is 3048 kg/ha, while the potential yield is 4064 kg/ha. Crop revenues are low, with farm gate prices of approximately TZS 325/kg for tomato and TZS 677/kg for rice, which compares to TZS 800/kg and TZS 1500/kg, respectively, in major towns (Bank of Tanzania, 2015).

Results

Barriers and opportunities for improving irrigation productivity and profitability

Farmers provided us with their thoughts about how their irrigation system operates with respect to both infrastructure and governance. They also reported barriers to improving local food production and security, some of which are directly tied to irrigation, while others have a more indirect impact.

Incomplete irrigation infrastructure

Irrigation infrastructure includes water diversion, irrigation canals and water distribution off-takes. Observations during site visits indicate that infrastructure, and the layout of irrigated plots, plays an important role in determining the efficiency of distribution and the timing of water supply. At Magozi, unlined primary and secondary canals, lack of water distribution gates, lack of silt traps, unlevelled plots and a small intake are major infrastructure barriers to efficiency. The scheme is therefore affected by siltation in the primary canal and one of the secondary canals. This causes supply problems due to the closure of the water intake when silt is removed. While sufficient water is diverted at Kiwere, unlined canals and lack of gates make it difficult to control and maintain water in the fields. Therefore, water drains back into the river before it can be effectively utilized. In both schemes, unlevelled fields cause uneven distribution of water and lack of local farm roads makes it difficult to use farm implements.

Despite these facts, the survey showed that 72% of farmers at Kiwere and 52% at Magozi were satisfied with their water supply; 10% and 5% were highly satisfied. There were significantly more dissatisfied farmers in Magozi (35%) than in Kiwere (10%) because of lack of adequate, reliable and equitable water distribution. Similarly, significantly more farmers at Magozi considered that water was not equitably distributed: 42% and 22% at Magozi and Kiwere, respectively. Our observations suggest that poor design of infrastructure and distribution of water are important productivity barriers that did not come through in our survey as they were overshadowed by farmers' perceptions of other issues, such as transport, knowledge and access to machinery and input and output markets. Poor irrigation infrastructure and management may affect productivity through interrupted water availability and result in negative consequences for crop development.

The importance of infrastructure and management was confirmed during the focus groups in January 2015. When these issues were discussed in more depth, a number of infrastructure and management issues were revealed (Table 2). For example, Magozi farmers argued that the expansion of the irrigated area over the last 10 years, and the poor design of one of the secondary canals, had caused water supply to become inadequate. An example of poor design is Kichangani's secondary canal, which has insufficient slope, resulting in reduced velocity of flow and consequently sediment accumulation and canal blockage. The canal was closed for five days during the 2014–15 season so that silt could be removed. This affected the distribution of water for 5–14 days. Consequently, crops experienced water shortages during a critical period in the growth cycle, which reduced productivity. Unreliability of water supply, especially for tail-end users, was also identified as negatively affecting productivity.

Table 2. Water supply and other factors limiting productivity and profitability identified in focus groups.

Water supply issue	Description of issues	
	Magozi	Kiwere
Irrigation infrastructure	• Siltation of the primary and secondary canals, where the intakes must be closed for up to five days to remove sand • Irrigation water leaks back to the river from Kichangani canal	• Constricted sections of the main canal cause spillage • Unlined sections cause water loss
Timeliness of water supply	• Upstream farmers get water on time • Downstream Mkombilenga farmers do not receive water on time	• Water available in a timely manner, except one day per week for cleaning of canal
Water distribution/allocation system	• No clear timetable for irrigation • Downstream farmers receive water once upstream farmers are satisfied	• Water allowed to flow downstream at night to be available to farmers early in the morning
Equitability of irrigation water supply	• Not equitably distributed • Farms are not levelled, and some become swampy • Swampy areas must be inundated before water can flow to the fields • Upstream farmers get more water than downstream farmers	• Water is equitably distribute; there is no favouritism with respect to access to water • Farmers decide individually when to irrigate, because there is enough water
Other important factors	• Lack of farm access roads (power tillers cannot be used to transport harvested rice; increased spending on labour to carry rice out) • Poor access to quality seed due to farmers' low income	• Tools and farm machinery (e.g. power tillers) are needed as oxen are not very effective • Pumps for spraying pesticides are also needed; pumps are rented from other farmers and may not be available at the time needed

Governance issues

Some of the management issues (Table 2) reflect governance challenges, both within and beyond the control of the IOs. Regardless of the governance structure and the mandates under the National Irrigation Act 2013, discussions with stakeholders and field observations suggest that the IOs have failed to address these governance challenges. For example, at both schemes, the water levy is below the guidelines and is too low to pay for effective operation and maintenance. Lack of enforcement of farmers' payment of water levies and the extra payment that Magozi's non-members should pay, restrictions of cattle into fields and non-compliance of IO membership have resulted in unpaid levies, poor participation in infrastructure maintenance and resource-use conflicts. Conflicts are particularly apparent at Magozi and are caused by lack of adequate, reliable and timely supply of water to tail-end farmers, which is partly due to the IO's failure to implement water schedules. However, some of the challenges, such as the high cost of obtaining land titles and enforcement of seed quality, may require attention at higher governance levels.

Farm implements

Approximately 15% at Kiwere own a tractor, compared to none at Magozi (Table 3). Lack of tractor ownership in Magozi could be due to their low utility for rice farming. Farmers reported not using tractors because the plough turns up soil and ruins levelling. Despite some tractor ownership in Kiwere, no farmers owned a disc plough, which implies that tractors are used for transportation of produce and not for ploughing. All farmers in both schemes owned hand tools. More farmers at Kiwere owned animal-driven tools than at

Table 3. Ownership of farm implements.

Implement	% of farmers	
	Kiwere	Magozi
Tractor	15.4	0
Tractor-driven tools	0	0
Hand tools	100	100
Animal-driven tools	76.9	37.5
Wheelbarrow	7.7	37.5
Ox/donkey cart	2.0	12.5
Power tiller	1.0	11.0
Disc plough	0	0
Harrow plough	0	0

Table 4. Access to farm implements and its importance for farm productivity.

	Kiwere (%)	Magozi (%)
Often need farm implements they do not have	87.1	75.0
Method used to access the equipment:		
Rent from irrigation organization	16.9	14.9
Rent from a private contractor	0	1.4
Rent from a neighbouring farmer for cash or in-kind	72.7	60.8
Borrow from a neighbour without payment	3.9	2.7
Have no ability to access	2.6	6.8
Other	3.9	13.5
Better access to farm equipment would improve productivity	96.9	96.0

Magozi, 77% and 38%, respectively. Ownership of wheelbarrows, ox/donkey carts and power tillers was more common at Magozi.

Farm implements are important for improving the effectiveness of irrigated farming. They reduce the drudgery of farm work, facilitate better timing of farm activities in terms of when water is available, and improve productivity. However, 87% at Kiwere and 75% at Magozi lack ownership of the required farm implements (Table 4). To attain access to such implements, farmers mainly rent from neighbours (73% and 61% at Kiwere and Magozi, respectively) or from the IO (17% at Kiwere and 15% at Magozi); a few farmers in each scheme rent from private contractors, or borrow from neighbours without payment.

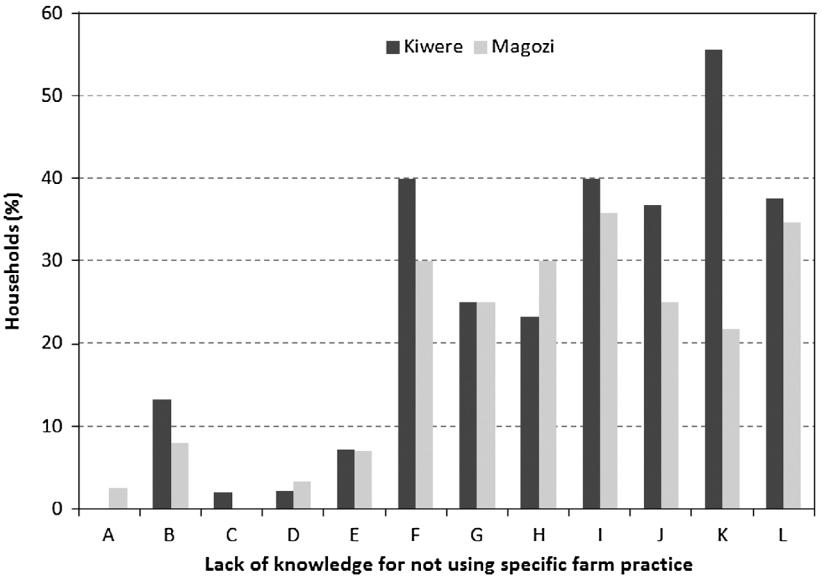
There are 18 power tillers, 1 planter and 6 combine harvesters at Magozi. Power tillers are rented for TZS 175,000/ha, while the rent for combine harvesters varies between TZS 300,000/ha and TZS 375,000/ha. The power tillers and the planter are owned by farmer groups, and the combine harvesters are owned by the IO. While only 3% and 7% at Kiwere and Magozi, respectively, report having no ability to access equipment, 97% and 96% reported that better access to equipment would improve their productivity. This suggests that dependence on rented implements means that farmers are unable to plan the timing of farming activities properly because access is determined by availability. As ownership of power tillers is low – 1% and 11% at Kiwere and Magozi, respectively – waiting times can be long, seriously delaying field operations and adversely affecting productivity, especially when irrigation water is available. Hence, the ability to access necessary implements in a timely manner could improve farm productivity and profitability. Further, our findings suggest that many critical activities are done by hand and there is an opportunity to increase productivity by improving access to farm implements.

Access to information and knowledge on crop production

Farmers use a number of sources to access information, including extension workers, district agriculture technical officers, researchers, organized training, and development initiatives. However, during the January focus groups it was revealed that accessibility varied, with the majority of farmers having little access because of the lack of information sharing among farmers. For example, farmers who did not participate in training activities did not have information on new farming technologies and practices, including those related to irrigation.

Lack of knowledge was identified as a main constraint on growing certain crops, selling produce to buyers who pay higher prices, growing cover crops, using runoff water harvesting, doing crop rotation, and in general improving the profitability of land (Figure 2). Inaccessibility of information thus affects the wise use of irrigation waters and impacts farm productivity and profitability.

The survey found that extension officers played a major role in advising farmers on which irrigated crops to plant, rainfed crops and livestock (Table 5). More farmers in Magozi obtain advice from extension officers, compared to Kiwere. This could be because the same extension officer has been in place in Magozi since 2005. In Kiwere, the extension officer has been there for less than three years. During the Kiwere focus group, the farmers reported that their decisions about fertilizer application were based on the height of the plant and information from the extension officer. For example, farmers applied fertilizer to maize when the plants reached 20 cm, while tomatoes were fertilized 7 to 14 days after transplanting.



A = Not growing maize; B = Not selling to ther buyer if not received the best possible price; C = Main constraints to improving the profitability of land;p D = Not using direct pumping from river independent of the scheme; E = Not establishing ground water pump; F = Not carrying water in buckets from local water supplyp; G = Not growing cover crops; H = Not using run-off water harvesting; I = Not dong crop rotation; J = Not accessing other natural resources; K = Not planting leguminous plants; L = Not growing less water consumptive varieties)

Figure 2. Farm practices prevented by lack of knowledge at Kiwere and Magozi. Source: Mziray et al. (2015).

Table 5. Use of extension officers.

Type of advice sought from extension officers	% of farmers	
	Kiwere	Magozi
What to grow:		
Rainfed crop	50.0	75.0
Irrigated crop	45.8	63.5
Livestock	48.1	79.7
Crop/livestock management:		
Rainfed crop	47.1	79.7
Irrigated crop	47.0	65.6
Livestock	50.0	77.6
Marketing of outputs:		
Rainfed crop	30.0	0
Irrigated crop	32.9	36.2
Livestock	34.5	64.9

During the focus groups, the following factors were reported as preventing farmers from accessing extension officers and the information they hold: (1) there is only one officer per scheme, whereas government standards require one per village; (2) the poor working environment of officers, which includes performing other duties; (3) visits are not routine – farmers have to call first and pay transport costs; and (4) lack of research to provide officers with adequate and current skills. These factors reflect the findings of Wheeler et al. (2017).

Despite the availability of water, and notwithstanding the problems with the irrigation systems and management, farmers indicated that barriers to improve productivity also related to the availability of farm credit, quality of seeds, farm implements and market reliability. Further, they indicated that these barriers outweighed irrigation issues, although some are linked. This finding is consistent with Torou et al. (2013), who reported that lack of access to seeds and fertilizer are problems affecting the productivity of groundwater irrigation schemes in Niger. The present findings suggest that lack of finance could be a root cause of many of these barriers. This is supported by Dittoh et al. (2013) and Villholth (2013), who found that access to inputs and new technology is affected by high costs and difficulty accessing credit. Collateral is required to obtain credit from a financial institution, and this is often required in the form of land, which farmers rarely have (Tenaw & Zahidul Islam, 2009). This makes credit inaccessible to most farmers. Though formal title within irrigation schemes is legislated in Tanzania, only about 5% of smallholder farmers have a title for their land (Business Care Services Limited & Centre for Sustainable Development Initiative (BSDL & CSDI), 2009). Discussions with the management committee in Kiwere suggest that this is due to the high cost of obtaining title. Consequently, farmers draw on their own savings, borrow from family, use remittances, go to private moneylenders, or obtain benefits from different subsidy and donation models (Table 6). However, informal loans often have unfavourable conditions, such as high interest rates or output prices fixed far below market prices. This further weakens the financial position of the farmer. Lack of finance also forces farmers to sell their output immediately after harvest, when prices are low, rather than later in the season, when prices increase, as shown in Figure 3.

Mobile phone banking offers a promising opportunity as a financial service in both schemes, while traditional savings schemes would be more beneficial at Magozi. Village community banks and savings and credit cooperatives are examples of traditional saving

Table 6. Types of financial services used by households.

Type of financial services	% of farmers	
	Kiwere	Magozi
Functional bank account	15.2	13.0
Savings account	3.0	1.0
Traditional savings schemes at local community level	12.1	20.0
Traditional burial schemes at local community level	7.1	9.0
Loan from a financial institution	6.1	3.0
Loan from an individual (e.g. uncle, neighbour, trader etc.)	9.1	12.0
Loan from other institution (e.g. church, government)	0.0	3.1
No account	25.3	32.0
Mobile phone banking	37.4	33.0

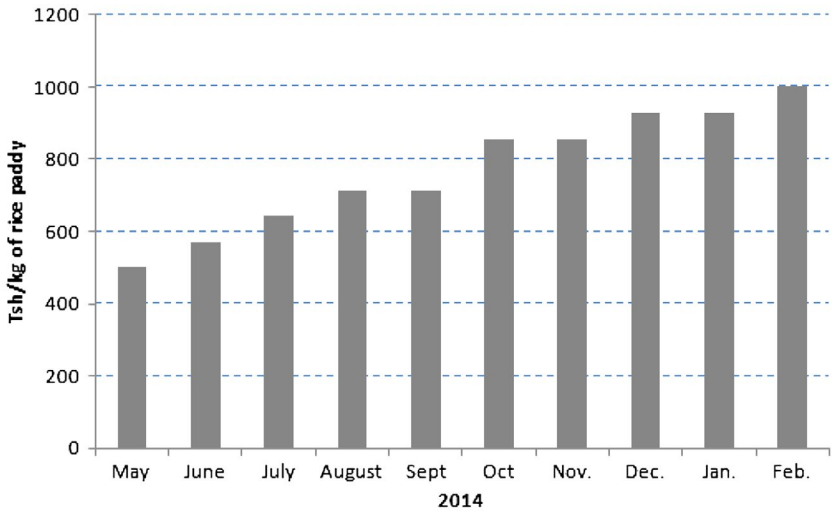


Figure 3. Rice prices at Magozi, May–June 2014 (on average, USD 1 ≅ TZS 1562 during the period). Data source: Magozi Irrigators Organisation.

schemes, which have proven to be effective microfinance institutions that offer members convenient savings accounts and access to loans (Kwai & Urassa, 2015). Currently, approximately one-third of farmers use mobile phone banking, an approach that has seen an exponential uptake in Africa in recent years (Foster et al., 2013). Phone banking provides farmers with the ability to pay for inputs or receive payments conveniently and safely over their mobile phones. Farmers reported using mobile phones to receive money from crop sales and pay for inputs, and they are willing to participate in mobile financing schemes, if established. There should be an opportunity for microfinance companies to use this system. The potential for mobile phone banking is high, as more than 75% of farmers own mobile phones.

Although lack of access to functional markets was mentioned as one of the main constraints on improving productivity and profitability by only 5% at Kiwere and 17% at Magozi, it might actually be the most important constraint. Market access is more problematic at Magozi because it is further from Iringa, which is the main market for irrigated produce and farm inputs. Jägerskog and Jønch Clausen (2012) identified market inefficiency such as poorly developed supply chains, high taxes and transaction costs as a constraint that requires

Table 7. Main market channel used by farmers for different crop types.

	% of farmers				
Type of crop	Farm gate	Village market	Regular trader	Wholesale	Other
Kiwere					
Green maize	41.3		29.3	19.6	
Rice	31.3		50.0	18.8	
Tomato	31.7		30.0	26.7	
Magozi					
Rice	30.6		48.0	12.2	
Harvested maize	28.0		64.0		28.0
Sorghum	20.0	20.0	60.0		

Table 8. Reasons for not selling to buyers that are perceived to offer a better price.

	% of farmers	
Reasons	Kiwere	Magozi
Poor quality of crop produced	0	41
High transport costs	47	76
Market requires consistent supply	20	19
Lack of knowledge	13	8
Buyers offering good prices only buy small quantities	20	0

immediate public and private action. They also found that addressing information and power asymmetries in output markets would increase the return to many farmers. In a European Union–funded project in Zimbabwe, where farmers were convinced to invest in inputs to obtain higher yields, a 265% increase in farm income was achieved due to the provision of an assured market by NGO-established grower associations and reliable groundwater supplies (Villholth, 2013). While assured markets are very important, it is equally essential to ensure that farmers can reliably supply the market so that buyers have confidence they will obtain the required produce. Unfortunately, both Kiwere and Magozi sell to local markets that deal in unprocessed and non-value-added products, for which lower prices are paid (Table 7). Consequently, more than half the farmers perceive that their current buyers are not the best possible and that a better price could be obtained elsewhere (Table 8).

The findings of this study also suggest that it is possible to improve profitability by creating opportunities to add value to current products, which has been pursued by the agriculture innovation platforms established as part of this project. At Magozi, a rice mill and storage facility is planned, as well as introduction of branding and labelling of the rice, supported by the Iringa District and Ministry of Agriculture and with input from the farmers. The storage facility will be linked to the existing warehouse receipt system, which ensures that farmers can access credit and sell their rice when prices are highest. For Kiwere, the tomato processing factory currently being established will offer reliable markets for tomatoes and other vegetables. Ongoing work by the agriculture innovation platform aims to create opportunities to build farmers' knowledge of inputs, on-farm production and output markets, and includes linking them with stakeholders dealing with markets (van Rooyen et al., 2017).

Conclusions

Non-water-related factors such as access to inputs, farm equipment, transportation, value-adding opportunities and functional markets, which impede the ability to increase production and farm profitability, are foremost on irrigators' minds. Lack of finance might be a root cause of many of these factors, as it prevents farmers from securing (1) timely and adequate supply of high-quality seeds, when irrigation systems are operating, and appropriate fertilizer and chemicals to obtain high yields; (2) timely and adequate access to implements, to ensure that farm operations are carried out at the optimal time and are not limited by availability; (3) transport, to access inputs from the best sources and sell output to the most profitable buyer; and (4) the storage of outputs until prices are optimal. However, the current level of market risk makes farmers reluctant to take out loans and banks reluctant to lend to farmers. It is thus necessary to address the issues holistically, as part of a complex system, and agriculture innovation platforms seem to be a promising means of achieving this approach (van Rooyen et al., 2017). We also find strong evidence that water supply issues are negatively influencing productivity. Water issues will come into focus when the non-water-related issues have been resolved, when irrigation has proven to be profitable and when demand for water increases.

Funding

This research was part of the project Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through On-Farm Monitoring, Adaptive Management and Agricultural Innovation Platforms, funded by the Australian International Food Security Research Centre of the Australian Centre for International Agricultural Research and participating organizations [grant number FSC-2013-006].

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