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The role of land- and water-use rights in smallholders' productive use of irrigation water in KwaZulu-Natal, South Africa

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ABSTRACT

This study aimed to analyse the extent to which land- and water-use rights enable/deter the productive use of irrigation water. Data was collected from 242 sampled smallholders in three study areas in KwaZulu-Natal. The findings indicate that the productive use of irrigation water is positively influenced by land- and water-use rights, with scheme committees being the first point of contact for smallholders when they need access to land and water. A provincial body of scheme committees is needed through which smallholders can capacitate each other in how they can improve access, appreciate the role of collective action and deal with challenges related to water, land and markets by applying their experiences. This body can be represented in policy formulation and aid in policy implementation. This paper shows that land and water policy alone cannot improve smallholder productivity, and that enhancing the productive use of irrigation water requires a holistic approach that considers the accessibility of input and output markets.

Key words: KwaZulu-Natal; land-use rights; productive use of irrigation water; smallholder farming; water-use rights

1. Introduction

Land and water rights, their interactions and the institutional challenges therein are at the centre of agricultural development. These elements are also linked to the global challenges of food insecurity and poverty that affect the livelihoods of 75% of rural people in the world (FAO 2011; Ma *et al*. 2017). For most developing countries, land and water policies and institutions are not sufficient to deal with the emerging land and water challenges (Binswanger-Mkhize *et al*. 2010). The increasing pressure on land and water resources has made it essential to improve the regulations that control the use of these resources (Bidogeza *et al*. 2009), especially in rural areas, where there are complex and dynamic institutions. Ostrom and Gardner (1993) criticise the development literature for focusing too much on the importance of physical technology to improve the performance of irrigation schemes instead of the institutions that govern them. The Food and Agriculture Organization of the United Nations (FAO), for example, has developed voluntary guidelines on land and water governance that developing countries can adopt to improve their policies. However, these guidelines are generic and not tailor-made for countries with unique contextual circumstances.

In order to secure water-use rights, it is important to consider the larger bundle of rights that include water-access rights, withdrawal rights, operational rights and decision-making rights (Namara *et al*.

2010). Meinzen-Dick (2014) and Hodgson (2016) argue that rights existing only on paper and not in practice are not secure, and customary law can offer greater tenure security at the local level. Securing water-use rights enhances resource allocation decisions and incentivises the formulation of collective action institutions, such as water user associations (WUAs) or scheme committees (Binswanger-Mkhize *et al*. 2010). Since the introduction in South Africa of the National Water Act in 1998, government has been pushing for the registration of WUAs in smallholder irrigation schemes in communal areas to improve water use productivity, address water scarcity and improve collective management (DWA 2014). WUAs play the important role of managing and facilitating water-use rights between farmers and the state (Hodgson 2004). However, WUAs in South Africa are not functioning well, or are often non-existent in communal rural areas (Meinzen-Dick 2014; Hodgson 2016). Most smallholders' perceptions of the lack of transparency and nepotism in cooperative governance have made them sceptical about collective-action organisations. Cooperatives were formed not because farmers understood the importance of collective-action organisations, but as a way of receiving government benefits. Even though WUAs were not apparent in the schemes, scheme committees adopted some WUA principles. For instance, smallholders elect representatives in scheme committees. Scheme committees function and take decisions autonomously without influence from government (only providing technical and infrastructure support). They collect water fees from their members and are responsible for administering the land and water. For all these reasons, scheme committees are more complex compared to WUAs. That is why this study focuses on scheme committees.

As water rights are now receiving increasing attention by researchers and policy makers, it will be useful to examine land and water rights simultaneously, as smallholders experience them (Hodgson 2004, 2016). Since a tenure type contains a bundle of rights, one may not be able to identify which institutional imperfection in this bundle leads to poor performance once it is associated with a certain tenure type, without detailed information on the exact composition of the land and water rights. Most studies have failed to address this area, as land tenure is often run as a dummy variable and the effects of water-use rights are normally not accounted for in land tenure and productivity literature (Deininger & Jin 2006; Fenske 2011). Disaggregating customary land-tenure and water-use rights into various combinations and segments will provide an opportunity to study how specific rights, instead of tenure types, affect user behaviour, decision making and productivity outcomes. A more comprehensive overview of a portfolio of land tenure arrangements and their impacts can be found in Deininger and Jin (2006) and Cousins (2007), while Hodgson (2004, 2016) has details on water tenure arrangements. While property rights can play a crucial role in building sustainable irrigation schemes, any reform to achieve this target should be based on a sound understanding of the existing property rights to land and water and their underlying institutions (Namara *et al*. 2010).

In the case of rural South Africa, for example, where there is a strong presence of traditional leaders who administer most of the rural land, it is important to understand the role of local stakeholders, as they are key players in the implementation of new policies and the functioning of rural institutions. The South African Communal Land Tenure Policy (CLTP), for example, seeks to address the gross distortions in the customary systems in communal areas that were initiated by the colonialist and apartheid regimes and that have presented enormous socio-economic challenges in today's communal areas, including land scarcity and tenure insecurity (DRDLR 2013). Nonetheless, tenure problems that exist at local level cannot be fixed through policy reform alone (Cousins 2007; Place 2009), and the leaders of the various institutions need to be on board as well. The ways in which land- and water-use rights impact smallholders' incentives are not understood well. According to Wilder and Lankao (2006) and Cousins (2007), the precise combination of state, customary, collective action and individual rights depends on laws and customs, the state of economic development, technology options and stakeholders' capacities. Property rights that are secure and easily transferable have often been identified as a key element to bring about higher levels of

investment and access to credit, and to facilitate the reallocation of production factors (Deininger & Jin 2006; Sjaastad & Cousins 2008). The challenge in the smallholder sub-sector is that those rights are heterogeneous and complex and, given the diversity of actors, a 'one size fits all' approach is unlikely to work. For instance, the use of land as collateral, which is a common bank practice, was disputed by smallholders during the focus group discussions. Empirical studies by Fenske (2011) and Bellemare (2013) have shown that formal land rights have no impact on productivity, whereas informal land rights (i.e. landowners' subjective perceptions of what they can and cannot do with their plots) have a heterogeneous impact on productivity. Considering all these prevailing gaps, the objective of this study was to analyse the extent to which land- and water-use rights enable/deter the productive use of irrigation water.

2. Research methodology

2.1 Description of the study areas

The Tugela Ferry Irrigation Scheme is located in the Msinga Local Municipality in the uMzinyathi District Municipality in the KwaZulu-Natal province of South Africa. Most of the land in Msinga is owned by the Ingonyama Trust. Many smallholders operate with four plots, with an average size of 0.1 ha each, equating to a farm size of 0.4 ha. The scheme has 726 ha which is allocated to about 1 800 active smallholders. Smallholders who want to be part of this irrigation scheme first approach the scheme committee, which selects suitable smallholders whom it believes will abide by the rules of the scheme. The list of selected smallholders is then referred to the traditional authority for approval. Smallholders in this scheme do not pay for land or water, but they need to be able to pay a R200 joining fee and an annual R50 renewal fee, and they pay for electricity (R100 per plot per month) and diesel (R50 per plot per month).

The Bululwane Irrigation Scheme is located in the Nongoma Local Municipality in the Zululand District Municipality. The district consists mainly of communal land. Part of the irrigable area (62 ha) is allocated to the chief, while the remaining 122 ha is allocated to 136 smallholders, amounting to average plot sizes of 0.9 ha. The scheme committee has the power to assess and allocate land to a smallholder within the scheme after having reported to the traditional authority. Traditional authorities do not participate in the irrigation scheme, but do intervene in conflicts between the scheme beneficiaries and the surrounding community. Smallholders joining the irrigation scheme in this area need to be able to pay a R300 joining fee and an annual R100 renewal fee, but do not pay for water and land.

The Makhathini Irrigation Scheme is located in the Jozini Local Municipality in the uMkhanyakude District Municipality. The uMkhanyakude District is a presidential node, meaning that it falls under areas identified by the president as the poorest in South Africa. Traditional authorities own approximately 50% of the land in this area (MDM 2014). The scheme has 3 500 ha irrigable area allocated to about 300 active smallholders. Mjindi Farming (Pty) Ltd was established by the Provincial Department of Agriculture and Rural Development to supply water, extension, advisory and infrastructure services. It is also mandated to link small farmers to markets in Makhathini. Mjindi Farming owns a water right, issued by the Department of Water and Sanitation, which it uses to supply water to the Makhathini smallholders. These smallholders pay a fixed rate of R300 per hectare per year for water, directly to Mjindi Farming. The land is under the Ntenga Trust, consisting of smallholders as claimants.

In terms of the summary of the types of water tenure systems (Hodgson 2016), the system in the Makhathini Irrigation Scheme is the agency control tenure. In the Bululwane and Tugela Ferry Irrigation Schemes, the dominating system is the customary water tenure, controlled by scheme committees. For smallholders outside of these schemes, the informal water tenure dominates.

2.2 Sampling techniques and data collection instruments

Primary data was collected by means of key informant interviews, focus group discussions and structured questionnaires. The questionnaires were administered at Msinga and Nongoma over a period of two weeks in February and March 2017 respectively, and for one week at Jozini in April 2017. The questionnaires were structured according to the information received during the focus group discussions in December 2016. Combinations of purposive and stratified random sampling methods were applied. The 242 smallholders, who were engaged in food crop farming, were selected purposively to accommodate comparisons across different study areas, while the respondents were selected by means of a stratified random sampling technique. Smallholders were categorised into four strata: scheme irrigators (69%), non-irrigators (9%), community gardeners (11%) and home gardeners (11%).

According to Birner and Resnick (2010), a promising research strategy is one that combines qualitative case studies with quantitative modelling in such a way that they inform each other. Case studies can help to discover how policy change actually occurs and to identify the factors that influence the processes of change. The emphasis in the fieldwork was mainly on the smallholders' perspectives in order to analyse, according to their explanations, what factors are involved in their decision-making processes. This approach was justified by the fact that the smallholder is the key actor in the process of smallholder development.

2.3 The empirical model

In this study, productive use of irrigation water is defined as the usage of irrigation water in crop production, and productivity refers to economic returns in terms of gross margin per hectare. To capture the economic returns, gross margin per capita was estimated for the irrigated crops. The gross margin for each irrigated crop per season was estimated as gross income minus variable costs of production. Aggregate productivity was estimated by obtaining the average yields of all the major crops grown in the study areas and their respective average market prices, adding these averages and then dividing them by the total crop area (Van Averbeke & Mohamed 2006). This method accounts for costs that vary directly with the type and level of production. This approach was adopted in this study to calculate the rand value of the total produce per hectare, instead of using physical productivity, where the productive use of irrigation water is conceptualised as the quantity produced per unit of water used. Economic productivity makes it possible to compare returns from different crops across smallholder plots.

Following Sinyolo *et al*. (2014), principal component analysis (PCA) was used to generate the water security index as a proxy for water-use rights. Similarly, the land tenure security index was generated by using PCA as a proxy for land-use rights (Brasselle *et al*. 2002). By applying the Kaiser criterion, principal components with eigenvalues greater than one were retained and used as independent variables in the univariate general linear model (GLM). The mean of the dependent variable can be modelled directly, or through a monotonic function of the mean, and the GLM relates this function of the mean to the explanatory variables through a linear prediction equation (Hair *et al*. 2010). For a detailed account of this model, see Hair *et al*. (2010). The GLMs have a very flexible structure for covariates (quantitative variables). The flexibility of the GLM makes it suitable for this study.

The GLM regression that explains the productive use of irrigation water included land tenure security and water security indices as explanatory variables, as indicated below:

$$Y_i = \alpha + \delta PC_{Li} + \partial PC_{Wi} + \beta X_i + \varepsilon_i,$$

where Y_i is the productive use of irrigation water for each smallholder i; PC_L is the land tenure security index; PC_W is the water security index; X is a vector of household characteristics; α is the intercept; δ and ∂ are impact parameters to be estimated for land and water respectively; β is a vector of coefficients to be estimated, and ε is the residual term.

According to Van Averbeke and Mohamed (2006), Molden *et al*. (2010) and Fischer and Qaim (2012), factors that influence the uptake of practices that enhance the productive use of irrigation water include markets, water and land availability, education, incentives and institutional structures. The household socio-economic factors and their means are presented in Table 1. Income differences between the groups cannot be attributed to water access alone, but also to other, varying sources such as access to land and institutional aspects (Muchara *et al*. 2014). The majority of smallholders in the selected study areas were old, and very few were young people. Smallholders mentioned that young people were more interested in finding off-farm employment, mainly due to low returns in smallholder farming. This was consistent with the findings of Mkhabela (2005) and Fischer and Qaim (2012). Similar to the findings of Ruben and Pender (2004), permanent or temporary migration of family members to other areas has led to an unbalanced population structure, characterised by a relatively large number of female-headed households that depend on social grants (main income) and farming (supplement income) for their livelihoods.

3. Empirical results and discussion

3.1 Descriptive statistics

Most smallholders have very low levels of formal education. Some of the reasons mentioned by the smallholders for not attending school or dropping out were poverty, pre-1994 political conditions, and past traditional beliefs against the schooling of women. Despite their level of experience in farming, the majority of smallholders continue to face challenges of access to input markets, output market information and extension services, all of which can be viewed as government support services. Due to limited capacity, the government is unable to reach all the smallholders in rural areas on time, and timing is critical in farming. Consistent with Chamberlin and Jayne (2013), market distance was not used in this study because most smallholders sell their produce to van traders who buy produce at the farm gate. Instead, smallholders were asked to indicate whether they had access to output market information.

Table 1: Household socio-economic factors and their means (n = 242)

Variable designation	Description of variables	Mean	Std. dev.
GM	Gross margin for all the crop produce (consumed and sold) in rand/ha	21 680.25	25 926.30
Age	Age of the household head (in years)	53.96	13.36
Sex	Gender of the household head (1 = Male)	0.22	-
Labour	Total number of persons in each household (adult equivalents)	4.87	2.41
Education	Household head education level (in years)	4.41	4.48
Experience	Number of years in farming	16.76	13.47
Input	Access to input markets (1 = Yes)	0.82	-
Omkt	Access to output market information (1 = Yes)	0.80	-
Extension	Access to extension services (1 = Yes)	0.47	-

Source: Survey data (March/April 2017)

3.2 Principal component analysis (PCA) results

A PCA was conducted on the dimensions of land-use rights and the results are presented in Table 2. Bartlett's test was statistically significant at the 1% level, and the null hypothesis that variables are not intercorrelated was therefore rejected. The Keiser-Meyer-Olkin (KMO) measure was greater

than 0.5, which indicates that the PCA could be applied to the dataset. The three extracted PCs contributed 61% of the total variation in the variables used. The PCs were named according to the dominant variables. The first component (PC_{L1}) explained 34% of the variation and was found to be closely related to the right to use land and exclude others. The second component (PC_{L2}) explained 15% of the variation and was found to be closely related to land transferability. According to Deininger and Ali (2007), transferability is a precondition for bringing land to more efficient users. The third component (PC_{L3}) explained 12% of the variation and was found to be closely related to freedom in land-use decision-making. Since most smallholders receive their inputs from government, their decisions on what to plant are limited to what government offers them. Generally, smallholders are not part of the decision on what crops or inputs government should subsidise.

Table 2: Principal component analysis on the dimensions of land-use rights

Variables	PC_{L1} – Right to use and to exclude others	PC_{L2} – Land transferability	PC_{L3} – Land-use decision-making
Belief in fair treatment by police	0.820		
Ease of approaching traditional courts	0.786		
Ease of approaching police	0.775		
Belief in fair treatment by traditional courts	0.750		
Knowledge of own legal rights and responsibilities	0.584		
Ability to exercise own rights over land (i.e. rights to use and to exclude others)	0.566		
Ability to transfer land to unrelated people if preferred		0.666	
Ability to transfer land to family members if preferred		0.646	
Ability to use own land for more than 10 years		0.517	
No threats of eviction from own land		0.399	
Freedom to choose what crops to produce			0.576
Eigenvalue	3.7	1.6	1.3
Variance explained (%)	34	15	12
Cumulative % of variance explained	**34**	**49**	**61**
Keiser-Meyer-Olkin (KMO)	**0.682**		
Measure of sampling adequacy	Bartlett test of sphericity	Chi-square	Significance
		958.05	0.000

Notes: Component loadings of less than 0.40 are not included in the table. The variables in the first column were measured using a five-point Likert scale.
Source: Survey data (March/April 2017)

The dimensions of water-use rights are presented in Table 3. The significance of Bartlett's test (1%) suggests that variables are intercorrelated. The KMO measure was greater than 0.5, which indicates that the PCA could be applied to the dataset. The three extracted PCs contribute 58% of the total variation in the variables used. The first component (PC_{W1}) explains 34% of the variation and was found to be closely related to secure access to water. According to Namara *et al*. (2010), access to agricultural water reduces poverty through its effects on the variance of output and farm income. The second component (PC_{W2}) explained 13% of the variation and was found to be closely related to the effectiveness of scheme committees. Zhang *et al*. (2013) note that the prevention of illegal abstraction of water might result in a successful collective action in irrigation water use. The third component (PC_{W3}) explained 11% of the variation and was found to be closely related to access to irrigation equipment. According to Mollinga (2016), physical access to water, i.e. the availability of equipment that brings water from the river to the field, is as important as legal and financial access to water.

Table 3: Principal component analysis on the dimensions of water-use rights

Variables	PC_{W1} – Secure access to water	PC_{W2} – Effective scheme committees	PC_{W3} – Access to irrigation equipment
Secure right or claim to water	0.782		
Water accessibility	0.745		
Maintenance of the canal	0.725		
Water quality	0.690		
Overall scheme management	0.620		
Involvement in the decision-making process	0.552		
Effective conflict-resolution mechanisms	0.540		
Reliable water source (never dries up)	0.427		
Effectiveness of existing committees in ensuring compliance with scheme rules		0.751	
Adequate access to water equipment			0.703
Frequency of failure to receive water on allocated irrigation day			0.560
Eigenvalue	3.7	1.4	1.2
Variance explained (%)	34	13	11
Cumulative % of variance explained	**34**	**47**	**58**
Keiser-Meyer-Olkin (KMO)	**0.795**		
Measure of sampling adequacy	Bartlett test of sphericity	Chi- square	Significance
		475.85	0.000

Notes: Component loadings less than 0.40 are not included in the table. The variables in the first column were measured using a five-point Likert scale.
Source: Survey data (March/April 2017)

3.3 Results of general linear model (GLM)

Table 4 presents the results of the factors that influence the productive use of irrigation water. The use of the Type III sums-of-squares option tests the unique contribution of each independent variable by removing the effects of all other independent variables (no multicollinearity). The Type III sums of squares of the GLM also ensure that both continuous and categorical variables from either balanced or unbalanced samples are not problematic, hence its adoption in this analysis. Moreover, the condition index (CI) is 20.9 (less than 30), indicating that there is no severe multicollinearity problem. The variance inflation factors (VIF) of 1.13 to 1.72 also indicate that multicollinearity is not an issue in this analysis. Partial eta squared was used to determine how big the effect of an independent variable is, controlling for all the other independent variables. Partial eta squared values are preferable, since they represent the variation attributable to an effect after correcting for any other effects in the model.

Levene's test of homogeneity of variance, which is less dependent on the assumption of normality than most tests, was employed to test the assumption of homogenous variance. The p-value of Levene's test was greater than 0.05, suggesting that the variances are homogenous. The independent variables included in the GLM model explained R^2 = 17% of the variability in gross margin per hectare, which is low but generally acceptable for cross-section data (Wooldridge 2013). The corrected model was statistically significant at the 5% significance level, with a p-value of 0.019 (F = 2.13). According to Wooldridge (2013), dropping variables is important when they substantially alter the magnitudes and/or significance of the coefficients of interest. In this analysis, secure access to water was correlated with access to irrigation equipment (0.5), and dropping access to water made access to irrigation equipment statistically significant. Essentially, having secure access to water depends on access to irrigation equipment.

Table 4: Factors that influence the productive use of irrigation water

Parameter	B	Std. error	Partial eta squared	VIF
Intercept	42 250.85	12 699.62	0.076	
Input	**10 249.05***	**5 927.25**	**0.022**	**1.23**
Omrkt	288.83	5 431.61	0.000	1.13
Extension	-1 416.24	4 449.59	0.001	1.20
Sex	-4 100.01	5 291.39	0.004	1.18
Age	-303.82	200.01	0.017	1.72
Experience	222.35	177.17	0.012	1.37
Education	**-1 156.16****	**582.48**	**0.029**	**1.64**
Labour	-740.56	938.32	0.005	1.23
Right to use and to exclude others from land use (PC_{L1})	-1 177.18	2 244.82	0.002	1.47
Land transferability (PC_{L2})	**4 137.63****	**2 085.35**	**0.029**	**1.16**
Land-use decision-making (PC_{L3})	-1 547.96	2 239.07	0.004	1.14
Effective scheme committees (PC_{W2})	**6 200.21****	**2 450.91**	**0.046**	**1.38**
Access to irrigation equipment (PC_{W3})	**3 956.11***	**2 176.33**	**0.024**	**1.19**
R squared = 0.17 (Adjusted R squared = 0.09)				
Corrected model	df = 13	F = 2.13**	0.17	Mean
Levene's test	df1 = 13 df2 = 134	F = 0.84	**CI** = 20.9	**VIF** = 1.42

Notes: ** and * mean statistically significant at the 5% and 10% level respectively
Source: Survey data (March/April 2017)

Smallholders with access to input markets were found to have a higher productive use of irrigation water compared to those who did not have it, *ceteris paribus*. This was an expected finding, as the major crops planted by smallholders (maize, cabbage and tomatoes) require fertilisers and chemicals to yield meaningful produce and income. For example, most smallholders lose a lot of produce as a result of pests in cabbages and maize and diseases in tomatoes. This result reinforces the complementarity of irrigation and inputs, i.e. an exclusive focus on irrigation without considering access to inputs will not result in the envisaged outcomes. Conventional production is characterised by high input costs, which most poor households cannot afford, thus strengthening the case for indigenous and low-input technologies is of key importance (Baiphethi & Jacobs 2009). A study by Mkhabela (2005) found that most smallholders reported that, if the government would provide inputs at a subsidised cost, they would use more of them. This is an idea that smallholders in this study welcomed during the focus group discussions, because free inputs are not tailored to their fields and weather conditions. This therefore calls for new ways that smallholders can use in order to control their access to inputs, either as suppliers or producers of inputs, because it can help reduce the transaction costs of accessing inputs and, in turn, ensure that irrigation water is used more productively. How this can be done in the presence of big corporations that dominate the input markets needs further investigation.

Increasing the level of formal education decreases the productive use of irrigation water, *ceteris paribus*. This finding was unexpected, as having formal education should mean that smallholders would be more likely to make use of extension advice and adopt new technologies that can improve the productive use of irrigation water. However, as smallholders become more educated, they seem likely to spend more time looking for and utilising off-farm job opportunities than on-farm opportunities (Mkhabela 2005). Drought and crop diseases that affected smallholder farming activities and income can also be an explanation for such behaviour, because it encourages a diversification of income sources. This then leads to smallholders reducing the effort and time spent on farming. For most smallholders, farming is currently an economic activity meant to supplement their income; it is not their main source of livelihood. As a result, they have less interest in adopting new technologies that will require more commitment. Therefore, more lucrative agribusiness opportunities need to be opened up for smallholders so that the opportunity cost for leaving the sector becomes high, especially for those who are educated, so as to prevent them from exiting the

sector. Moreover, based on the focus group discussions, emphasis should be on promoting indigenous knowledge and informal education for smallholders who are old and have low literacy levels.

Out of three components of land-use rights, only land transferability was found to be statistically significant. As expected, improving land transferability increases the productive use of irrigation water, *ceteris paribus.* The results are consistent with the findings of Brasselle *et al*. (2002) and Deininger and Jin (2006). Even without considering the potential benefits from the actual reallocation of land to more productive producers (land market effect), well-defined and enforceable rules for transferring land are important to smallholders' investment decisions (Deininger & Jin 2006; Ma *et al*. 2017). According to Deininger *et al*. (2014), land registration or registry operation is economically desirable only if the cost of establishing and maintaining these institutions is matched by the benefits in terms of higher investment and productivity increase via land transfers. Therefore, it is expected that the formalisation of this process will not have that much of an economic impact, since smallholders are already enjoying the benefits of transferring land to relatives or others within the family (Cousins 2007). Smallholders' investment decisions depend not only on their land rights, but also on the expected economic return (Bainville 2017). Transferability rights have a huge impact on the next generation's livelihood opportunities. Hence, customary tenure acts neither as an obstacle to investment and increased productivity, nor as an absolute safety net for the poor (Hodgson 2004; Cousins 2007; Fort 2008; Bainville 2017).

Improving the effectiveness of scheme committees increases the productive use of irrigation water, *ceteris paribus*. If scheme committees ensure compliance with rules and have strong conflict resolution mechanisms, smallholders can be more productive, as they are able to get water on their irrigation days (Ostrom 2002). Similar to the findings of Wilder and Lankao (2006), the major problem facing scheme committees is the lack of resources, which was caused by the government withdrawing its support for irrigation projects, and the requirement that full operation and maintenance costs have become the responsibility of irrigation scheme communities. The fact of the matter is that most irrigation projects were established by government as development programmes, with the main objective to increase food security (selling coming only after meeting household consumption), and not to build sustainable farming businesses. At the moment, scheme committees are left to operate on their own, while they are not ready to do so. They are not capacitated to own, manage and maintain the schemes after the government withdraws. This unpreparedness leaves them vulnerable, and their effectiveness is threatened by challenges they cannot solve by themselves, like dealing with theft and critical technical issues relating to burst pipes and defaulting engines. As noted by Ostrom and Gardner (1993), the common institutional challenges that the scheme committees have to deal with are that people use water on days not allocated to them, and that they fail to maintain broken pumps/pipes collectively. Therefore, it is not clear how strengthening the legal status of individual water entitlements to explicit water rights can do much to make water distribution less unequal. The challenge is mainly relating to the lack of technical expertise and resources to respond to technical issues. This conclusion is in line with that drawn by Mollinga (2016). Therefore, government development initiatives must involve leaders or owners of the projects – from the conceptualisation stages all the way to the transfer of ownership/management of the schemes. A community-based development approach, and not a project-based approach, is needed to ensure the sustainability of rural development projects. A community-based development approach would focus on the capacity of the community members to own and manage their own development.

Access to irrigation equipment increases the productive use of irrigation water, *ceteris paribus*. As expected, access to irrigation equipment enables smallholders to irrigate their produce faster and allows them more time to look for customers for their produce. Access to irrigation equipment also provides smallholders with opportunities to grow higher value market-oriented produce. For most

smallholders, poor access to irrigation equipment often leads to water insecurity, resulting in poor water productivity, which, in turn, leads to poor livelihood outcomes. For example, when pumps or engines break down during the production season, smallholders have no access to water, since rivers are too far for them to collect water manually. This finding is consistent with that of Meinzen-Dick (2014). In as much as government continues to invest in irrigation system infrastructure to allow smallholders access to irrigation equipment, the focus must not be exclusively on physical infrastructure, but other services should also be included in the development plan. Smallholders have to be trained in how they can repair their irrigation systems and must be able to find spare equipment locally at reasonable prices. Without these essential services to enable small farmers to own and manage the schemes, irrigation schemes cannot be sustainable by expecting government to intervene whenever there is any technical or social (e.g. conflict) issue.

4. Conclusions and recommendations

This paper has analysed the extent to which land- and water-use rights enable/deter the productive use of irrigation water. This was done by using a bundle of rights approach that combines both land- and water-use rights in the same model. The empirical results indicate that the existing land- and water-use rights improved the productive use of irrigation water. More specifically, the important bundles are the ability to transfer land-use rights, access to irrigation equipment or technical assistance, and access to effective irrigation scheme committees or institutions. This finding suggests that current tenure systems generally play a positive role in the development of smallholders. In this study, the customary tenure system was found to be favourable, as it is inclusive and ensures sustainability and accountability of leadership. Moreover, the CLTP was found to be consistent with what is happening at the local level. Based on the findings of this study, it is not clear what benefits the privatisation of individual land title would bring to improve productivity or investment in land when commons are governed collectively and are inclusive of gender. This also goes for water-use rights, which are managed by the same scheme committees in consultation with traditional leaders.

Going forward, scheme committees should be empowered with knowledge of their rights and be urged to encourage young people to participate in farming. The roles and responsibilities of scheme committees should be reflected in the CLTP and NWA policies, as bodies that manage land and water within schemes. Scheme committees should be consulted in policy formulation, as they are the first point of contact for scheme irrigators. This paper recommends a provincial body of scheme committees so that smallholders can capacitate each other based on challenges related to water, land and markets. This body needs to be represented in policy formulation legislature, and can aid in policy implementation. Hence, this paper recommends that government take a bundle-of-rights approach when addressing land and water policy issues, since smallholders use different tenure systems. Moreover, land and water policy alone cannot improve smallholder productivity – other integrated interventions are required to simultaneously support smallholders in accessing input and output markets.

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