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Abstract

This study investigates the gender differences in water access and its welfare effects using a sample of 291 irrigators from two irrigation schemes in the Msinga Local Municipality, South Africa. The data were analysed using the Blinder-Oaxaca (BO) decomposition method and the instrumental variable (IV) regression approach. The study findings highlight unequal access to irrigation water between male and female farmers, with women accessing irrigation water more frequently than women. The results also indicate a positive and significant effect of water access on incomes per capita, and that men had higher welfare than women. The results suggest that

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women would achieve higher welfare than men with the same level of water access. This implies that a deliberate policy to attain equity in access to water and other productive resources could be more effective in combating poverty compared to the status quo. The BO decomposition results reveal that 94% of the gender-based water access differential is attributable to differences in observable characteristics, while only 6% is attributable to differences in coefficients. This implies minimal inherent gender discrimination in water access. The study findings suggest that policies targeting observable characteristics (such as organising farmers into groups, registering them as water users and involving women in scheme management) would diminish the gender gap in water access in the rural areas of South Africa, and enhance the welfare of women.

Keywords: gender, water access, smallholder irrigation, household welfare, Blinder-Oaxaca decomposition

Introduction

The success of the smallholder farming sector is a critical element in the fight against food insecurity and poverty in the Sub Saharan African (SSA) region (Kilic et al. 2015). The sector is, however, underperforming in SSA, and agricultural productivity remains low, especially among the female farmers (Aguilar et al, 2015; Kilic et al, 2015). Among other reasons (such as agro-climatic factors, low adoption of modern technologies and limited use of irrigation), the low agricultural productivity is because the women, who form the majority of the smallholder farmers and contribute as much as 60% to 80% of total food production, face challenges in accessing productive resources such as land and water (Namara et al, 2010; Aguilar et al. 2015; Kilic et al, 2015).

Women's access to resources for agricultural production in SSA has been limited by the historical formulation and implementation of patrilineal laws and cultural traditions, including laws that limit women's inheritance of property (Murugani et al, 2014; Slavchevska, 2015; Sharaunga & Mudhara, 2016). The social and administrative bias against women and unequal access to education, extension, training, information and inputs worsens the plight of women (Aguilar et al, 2015; de Brauw, 2015; Oseni et al, 2015). The gender productivity gap ranges between 20% and 30% due to gender inequalities in resource and capital access in SSA (Aguilar et al, 2015; Andrews et al, 2015; Karamba & Winters, 2015; Slavchevska, 2015).

Various studies have looked at the gendered access to land and its impact on household welfare in South Africa (Thamaga-Chitja et al, 2010; Murugani et al, 2014). Few studies have, however, investigated the gender inequalities in water access among smallholder irrigators and its impact on household welfare. Anecdotal evidence (Perret, 2002; Kemerink et al, 2011) has highlighted potential water access challenges among women, reporting that the gender and social position of women in communities has limited their access to irrigation water. Ensuring access to adequate water supply is important for addressing dimensions of agricultural production, poverty and gender inequities. Thus, women's access to water for agricultural purposes should be improved, especially in view of their important role in food production.

Although South Africa's Water Act of 1998 (DWAF, 1998) is a progressive policy that seeks to achieve racial and gender equity in water access, its implementation has been slow and flawed (Movik, 2009). The reallocation of rights to water resources in South Africa to promote equitable distribution across both race and gender has progressed slowly (MacKay et al, 2003; Cullis & van Koppen, 2007; Muller et al, 2009). Consequently, greater inequalities in water access characterise the South African water sector. Cullis & van Koppen (2007) reported Gini coefficients of above 90% in the Olifants River Water Management Area. In addition, despite that South Africa enacted policies and laws that explicitly refer to gender, the provision of information and the development of the knowledge and skills that would allow women to understand the legislation has been a challenge especially in rural areas (Kemerink et al, 2011; Sharaunga & Mudhara, 2016). Given that the poor, in general, and women in particular lack knowledge and awareness of their rights, it means that they do not stand up to claim them.

This study aimed to investigate the gender differences in water access among irrigators, and the extent to which observable or unobservable characteristics can explain the gender differentials in two irrigation schemes in the Msinga Local Municipality, South Africa. The study investigated the welfare effects of the gendered differences in water access. Msinga was selected because it is one of the most rural and traditional areas in South Africa, where reports have indicated that the social discourses, structures and processes prevailing in the area are very patriarchal (Fowler, 2011; Sharaunga et al, 2015). Understanding the level of women's resource access and position in specific societies is important, as it informs policy makers in developing gender sensitive and more informed programs to enhance women's welfare (World Bank, 2011; de Brauw, 2015).

This paper adopts the Blinder-Oaxaca (BO) decomposition method (Blinder, 1973; Oaxaca, 1973), an approach that has been used to study gender differentials in outcomes such as wages (Horrace & Oaxaca, 2001; Gardeazabal & Ugidos, 2004; Fortin, 2008), agricultural productivity (Aguilar et al, 2015; Oseni et al, 2015; Slavchevska, 2015) or smoking behaviour (Bauer et al, 2007). Using the BO decomposition, the overall mean differential in the outcome variable can be separated into a part which is due to differences in observable characteristics (the characteristics or explained effect) and a part which is due to differences in coefficients (the coefficients or unexplained effect) (Jann, 2008; Schwiebert, 2015). While the former part may provide economic justification for group differences, the latter part is often attributed to discrimination (Weichselbaumer & Winter-Ebmer, 2005; Schwiebert, 2015).

Bauer et al (2007) developed the BO decomposition approach for count data used in this study. Few studies, if any, have used this approach to investigate gender differentials in resource access among smallholder farmers. The knowledge of whether gender differences in resource access could be explained by differences in observable socio-economic characteristics or whether they are due to inherent gender discrimination is of policy interest. This knowledge may help in the design of effective policies that enhance gender equity in resource access in the rural areas. For example, if gender differences in water access is mainly due to observed characteristics such as education level, group membership or registration as water users, then policies that increase women's education level, membership in groups or registration as water users could be expected to reduce resource access differences between males and females. On the other hand, if gender differences are due to unobserved inherent gender bias, then policies that increase gender awareness such as media campaigns could be more effective.

The data used in this study were collected at the plot level, and identified the household member who manages and works on the plot, and actually makes decisions about what is to be planted, how much inputs to be used, and what is to be done with the outputs, irrespective of whether they are households heads or not. This approach, which follows studies such as Aguilar et al. (2015) and Slavchevska (2015), is an improvement to the current studies on gender relations and resource access in South Africa (e.g., Thamaga-Chitja et al, 2010; Murugani et al, 2014; Sharaunga et al, 2015), which have traditionally focused on differences between male and female-headed households. The remainder of this paper is organised into three sections. The next section presents the research methodology, briefly describing the study area and discussing the data collection approach and analytical techniques. The subsequent section presents results and their discussion, and the final section concludes the paper.

Study area description

The study was conducted in Msinga Local Municipality, which falls under the Umzinyathi District Municipality in KwaZulu-Natal (KZN) Province, South Africa (Figure 1). The population of Msinga is estimated to be 177,577 people, in an area of 2,500 km^2, implying a population density of 71 people per square kilometre (Statistics South Africa 2012). The Msinga Local Municipality is largely rural, with approximately 99% of its population residing in traditional areas. The remaining 1% live in the small towns situated mainly along the R33 road (e.g., Tugela Ferry, Pomeroy, etc.). The Ingonyama Trust holds about 70% of the land in trust administered by traditional authority in KZN (ITB 2012). The term Ingoyama denotes the Zulu king. The king is the trustee and holds the land and administers it on behalf of communities who live in the former KZN homelands. The Ingonyama Trust land covers an area of 2.8 million hectares in KZN. The remaining 30% of land is commercial farmland, all of which is located to the north of the town of Pomeroy.

Women constitute about 58% of the population in Msinga. Men are fewer because they migrate to other more urbanised areas in search of employment opportunities. About 68% of households are female-headed in the area (Statistics South Africa, 2012). Msinga has few economic resources and little economic activity and is characterised by high poverty levels (Sinyolo et al, 2014a). Moreover, the area is characterised by high unemployment rates (49.5%) leading many to be involved in smallholder farming and other informal income-generating activities (Statistics South Africa, 2012).

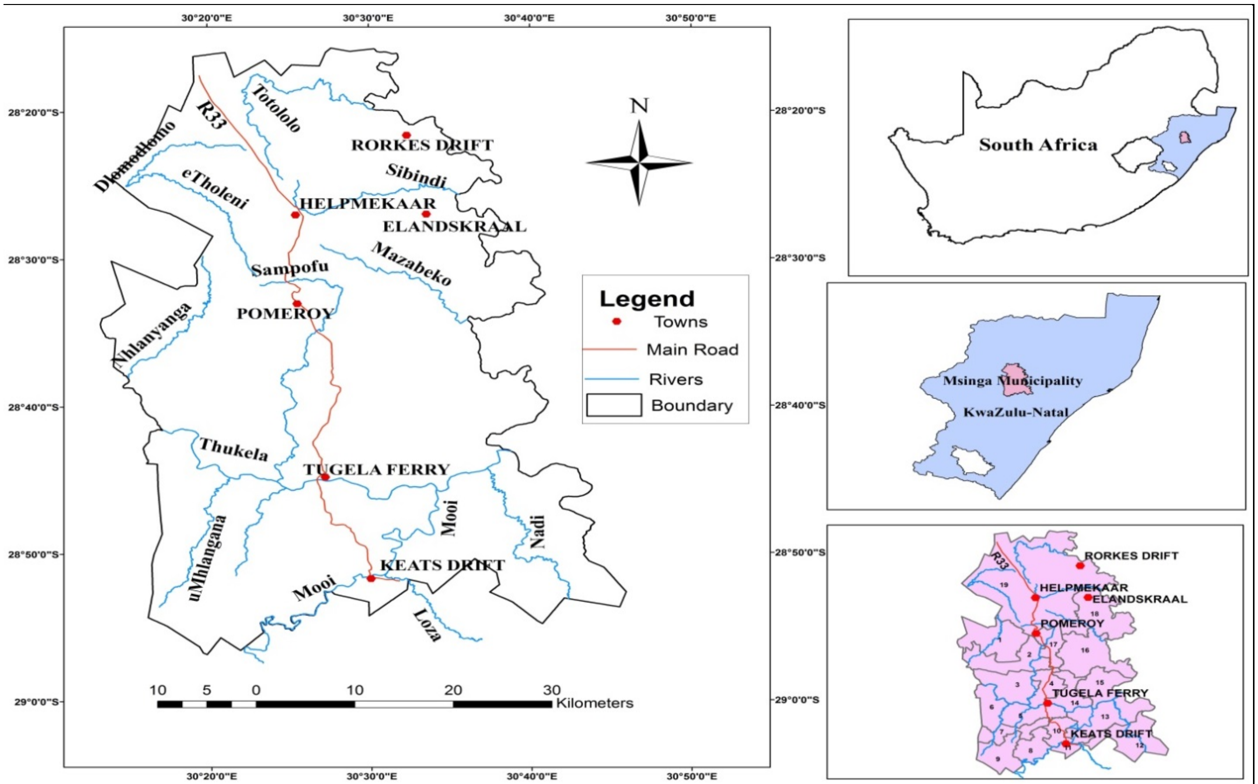

Figure 1: Location of Msinga area in KwaZulu-Natal, South Africa.

Msinga is located in a dry semi-arid zone with an average annual rainfall of 600 mm, ranging between 350-900 mm. Crop farming is practiced along the main rivers, i.e., the Tugela and Mooi. There are two dominant smallholder irrigation schemes in the Msinga Local Municipality, namely the Tugela Ferry Irrigation Scheme (TFIS), and Mooi River Irrigation Scheme (MRIS), which draw water from the Tugela and Mooi Rivers, respectively. The TFIS covers 873 ha, while the MRIS covers 600 ha (Cousins 2013; Gomo et al, 2014). There are 1500 and 824 irrigators who participate in the TFIS and MRIS irrigation schemes, respectively.

Both schemes face water shortages as well as water distribution inequities. For example, while all seven blocks in TFIS used to depend on the gravity-fed primary canal, water shortages have resulted in only three blocks located on the upper end of the canal accessing water from the canal while the other blocks now depend on motorised pumps (Sinyolo et al, 2014b). Similarly, in MRIS only 11 of the 15 blocks rely on the 20.8 km canal for water conveyed under gravity, while the last four blocks located on the lower end use a diesel pump (Gomo et al, 2014).

The farmers are supposed to irrigate in turns, at least once per week. However, monitoring mechanisms are too weak to enforce this rotation, resulting in some farmers accessing more water than others (Sharaunga & Mudhara, 2016). The fact that the irrigation takes place on a first-come-first-served basis (i.e., farmers who would have come first ought to irrigate first) compounds the situation, as the influential late-comers (often located in the advantageous upper-end plots) can still come and divert water to their plots and block water from reaching farmers located down the canal. In blocks that use motorised pumps, the irrigators pay a fee to access water. However, some farmers disregard these rules, leading to conflicts (Sinyolo et al, 2014b). The water supply and distribution in the irrigation schemes are such that it is possible for the women to be at a disadvantage due to the patriarchal culture. For example, it is culturally taboo for a woman to argue with a men (Sharaunga & Mudhara, 2016), thus, women can decline to assert their rights to water should a man infringe their rights to access water. Against such a background this paper discusses gender inequality in access to water for irrigation in Msinga.

Data

Data were collected in December 2013 using a structured questionnaire, focus group discussions (FGDs), and key informant interviews. Five FGDs were conducted with at least 10 farmers per session. FGDs were conducted before the questionnaire survey to inform the questions that could be included in the survey questionnaire. The questionnaire was pre-tested using 20 farmers, 10 from each of the two irrigations, before the main survey. Modifications to the questionnaire were made where required after the pre-testing. Pre-testing ensured that the questionnaire collected all the information required, and it helped to improve the questionnaire translation to the local isiZulu language. To triangulate the authenticity of the issues raised during FGDs and survey questionnaires, three key informant interviews were conducted. Seven trained isiZulu-speaking enumerators conducted the main survey.

A sample of 291 irrigators was randomly selected using a multi-stage stratified sampling method. The list of irrigators was obtained from the local Department of Agriculture located in Tugela Ferry town. The irrigators were first stratified according to their irrigation scheme (i.e., whether they belong to the TFIS or MRIS). The irrigators were then stratified according to their irrigation system, i.e., whether they used gravity or motorised pumps to divert water to their plots. The reason for stratification according to the irrigation system was to capture the differences in the distribution of water across the different systems. From these sub-strata, simple random selection was done to obtain a sample of 291 irrigators, where 210 were from TFIS, and 81 were from MRIS. The sampling was such that both TFIS and MRIS contributed 10% to the final sample, as suggested by Terre-Blanche et al (2006). Stratification was not done according to gender, meaning that both male and female irrigators had equal chances of entering the sample.

The irrigator was defined as the individual who manages and works on the plots and actually makes decisions such as what to plant, how much inputs to use and what to do with the outputs (Slavchevska, 2015). While in most cases these were household heads, there were few cases where the woman, for instance, was the farmer while the household head, the husband, was not involved in the farming decisions. The questionnaire included characteristics of the farmer (e.g., age, gender, marital status, education, etc.), the household (e.g., household size) and farm (land size, location along the canal, etc.), household wealth and asset endowment (livestock, incomes, etc.), farmer's access to institutional support services (extension, credit, farmer organisations, etc.) and agricultural production activities. Table 1 presents the variables and their descriptions.

Table 1: Description of variables

Variable name	Variable description
Water access	Number of days of farmer's access to water per month
Income per capita	Annual total income per capita ('000 Rands)
Maize yield	Maize yield (tons/ hectare)
Gender	Gender (1=Male, 0=Female)
Age	Age (Years)

Variable name	Variable description
Married	Marital status (1=Married, 0=Otherwise)
Household size	Number of members in a household
Education_0	Education level (1=No formal schooling, 0=Otherwise)
Education_1	Education level (1=Primary, 0=Otherwise)
Education_2	Education level (1=Secondary/ tertiary, 0=Otherwise)
Livestock size	Livestock size (Tropical livestock units)
Land size	Total land size (Hectares)
Extension	Number of extension visits in the past 12 months
Access to credit	Access to credit (1=Yes, 0=No)
Group membership	Membership in farmer groups (1=Yes, 0=No)
Scheme	Scheme membership (1=TFIS, 0=MRIS)
Scheme distance	Distance of farmer household from the irrigation scheme (km)
Scheme management	Scheme management member (1= Yes, 0=No)
Canal maintenance	Participate in canal maintenance regularly (1=Yes, 0=No)
Pump	Means of diverting water to plots (1=Pump, 0=Gravity)
Location_0	Geographic location of farmer plots (1=Lower-end, 0=Otherwise)
Location_1	Geographic location of farmer plots (1=Middle, 0=Otherwise)
Location_2	Geographic location of farmer plots (1=Upper-end, 0=Otherwise)
WUA member	Member of a Water User Association (WUA) (1=Yes, 0=No)

Access to water was captured as the number of days the farmers had access to water to irrigate their plots in the 30 days prior to the survey. The more the number of days irrigators access water, the better the security of access. The irrigator decides how to use the available eater depending on the nature of the crop and other factors, e.g., soil type, heat conditions, etc. The period of 30 days was considered short enough for the households to recall the days they had irrigated their plots, and thus give relatively accurate and reliable responses. On the other hand, the 30-day period was considered long enough to capture variation in water access among the irrigators. The month under study, November, is an important period for summer cropping water demand. Household welfare was captured by annual total income per capita covering the 12 months before the survey. The value of items that were produced and consumed by the household were considered part of household income. They were converted to their market values using average of local prices and included in the income amount. Ignoring own-consumption would understate the contribution of farming to household welfare for subsistence-oriented farmers, where small proportions of output is actually sold to the market.

Empirical strategy

The BO decomposition method was applied to investigate the gender differences in water access among irrigators and the extent to which the gender differentials can be explained by observable or unobservable characteristics. Since access to water was given by a count data variable, the application of the conventional BO decomposition for linear models is not appropriate (Bauer & Sinning, 2008). The study adopts the Blinder-Oaxaca decomposition method for count data models developed by Bauer et al (2007). The method was estimated in Stata 13 following Sinning et al (2008).

Consider the following linear regression model, which is estimated separately for the groups $g = m, f$:

$$W_{ig} = X_{ig}\beta_g + \varepsilon_{ig} \quad (1)$$

Where: W_{ig} represents the number of days farmer i ($i = 1, \ldots, N_g$) in group g had access to water to irrigate in a 30-day period, X_{ig} is a vector of observable characteristics, β_g denotes a vector of parameters to be estimated and ε_{ig} is a standard error term.

If the dependent variable was a continuous and unbounded variable, the BO decomposition would have been estimated as follows:

$$\bar{W}_m - \bar{W}_f = \Delta_{OLS} = (\bar{X}_m - \bar{X}_f)\hat{\beta}_m + \bar{X}_f(\hat{\beta}_m - \hat{\beta}_f) \quad (2)$$

Where: $\bar{W}_g = N_g^{-1}\sum_{i=1}^{N_g} W_{ig}$ and $\bar{X}_g = N_g^{-1}\sum_{i=1}^{N_g} X_{ig}$.

Given that the outcome variable is a count data variable, estimating Equation 2 using OLS may lead to biased estimates of the parameter vectors and hence misleading results of the decomposition (Bauer et al, 2007). In this case, the Poisson model was used to obtain consistent parameter estimates. Assuming that the dependent variable W_{ig}, conditional on the covariates X_{ig} is Poisson distributed, Bauer et al (2007) indicate, through several steps, that the Equation 2 can be estimated by:

$$\hat{\Delta}_P = \left[\frac{1}{N_m}\sum_{i=1}^{N_m} \exp(X_{im}\hat{\beta}_m) - \frac{1}{N_f}\sum_{i=1}^{N_f} \exp(X_{if}\hat{\beta}_m)\right] + \left[\frac{1}{N_f}\sum_{i=1}^{N_f} \exp(X_{if}\hat{\beta}_m) - \frac{1}{N_f}\sum_{i=1}^{N_f} \exp(X_{if}\hat{\beta}_f)\right] \quad (3)$$

The first term on the right-hand side of Equation 3 shows the difference in water access between men and women that is due to differences in observable characteristics, whereas the second term shows the water access differential that is due to differences in coefficient estimates. The second term exists only because society evaluates the bundle of characteristics differently if possessed by women, indicating gender discrimination. The estimated discrimination is likely understated, since some of included characteristics may also be affected by discrimination themselves (Weichselbaumer & Winter-Ebmer, 2005). For example, the male bias in land allocation may have resulted in men being allocated plots located in the upper part of the scheme where they have advantages in accessing water. Also, just like in the original BO decomposition, the results from Equation 3 may suffer from problems such as potential sensitivity of the results with respect to the choice of the reference group and the specification of the regression model (Bauer & Sinning, 2008).

The major limitation of the Poisson model is that it imposes a restrictive assumption that the conditional variance equals the conditional mean. Observed data almost always violates this equidispersion assumption, usually displaying pronounced overdispersion (i.e., the variance greater than the mean) (Chin & Quddus, 2003; Greene, 2009). However, the outcome variable in this study was not overdispersed, as the Likelihood ratio test on alpha was insignificant (p=0.500).

The Poisson model was therefore preferred over the negative binomial model since the data does not violate the equidispersion assumption and the former model makes fewer assumptions than the latter (Greene, 2009). A standard Poisson model was estimated instead of the zero-inflated Poisson model because there was no preponderance of zeros in the data (Chin & Quddus, 2003). The outcome variable does not have an excessive number of zeros, as only 3 irrigators had irrigated zero times in the 30-day period under study.

The Poisson model was estimated as follows:

$$W_{ig}|X_{ig} \sim P(W_{ig}|X_{ig}),$$

$$E(W_{ig}|X_{ig}) = \exp\left(X_{ig}\beta_g\right) = \lambda_{ig} \quad (4)$$

Where: λ_{ig} is the mean and other variables are as defined before.

Three models were estimated for Equation 4, first for the pooled data, second for women and the third for men. The pooled model included gender as one of the variables, and was used to predict the values of water access used in the instrumental variable (IV) regression. To estimate the impact of water access on household welfare, the predicted value of W from the pooled data in Equation 4 was added to a regression model estimated using ordinary least squares (OLS) regression:

$$Y_i = Z_i'\lambda + \widehat{W}_i'\theta + u_i \quad (5)$$

Where: Y_i is income per capita, $\widehat{W}_i$ is the predicted access to water; Z_i is a vector of covariates which included gender; λ and θ are parameters to be estimated and u_i is the residual term.

Using the predicted values of water access instead of the original values in Equation 5 remedies the potential omitted variable bias that may arise due to the fact that unobserved heterogeneity among farmers may influence both access to water and household welfare. For example, irrigators who are self-motivated, active and intelligent are more likely to access more water than those who are not. Also, due to the same character traits, these same farmers are more likely to have better welfare. Failure to account for this in the model, the estimated results will be biased due to omitted variables (Greene, 2003). For identification reasons, the Poisson model (Equation 4) was estimated with two additional variables that were not included in the OLS model (Equation 5). Distance to the scheme and participation in canal maintenance were used as the instruments. These two variables are expected to influence access to water but are not expected to directly influence household welfare. The validity of these instruments was tested using the falsification tests (Di Falco et al, 2011; Shiferaw et al, 2014), which indicated that the variables were jointly significant in the water access model ($\chi2$=36.51, p=0.0001) but jointly insignificant in the welfare model (F=1.66, p=0.1608).

Descriptive statistics

Table 2 presents the descriptive summary of 290 irrigators according to gender. One household was dropped from analysis due to missing data on important variables. The majority (68%) of the sampled irrigators were women, with only 32% being men. This is expected since women dominate the smallholder farming sector as well as smallholder irrigation schemes in South

Africa, as has been reported by other studies (Sinyolo et al, 2014b; Sharaunga & Mudhara, 2016). Table 2 indicates that more than a third of the farmers had no schooling, and that there is gender variation in terms of education levels of the sampled farmers. The results suggest that men were more likely to have attended school and to have reached higher grades compared to females. Only 48% of the men had no schooling compared to 67% of women. On the other hand, whereas 13% of women had at least matric, about 20% of the men had achieved a minimum of a matric qualification. The explanation is that, historically, school attendance was mostly for boys while girls remained at home to perform household chores. The girls were also more likely to drop out of school and get married after puberty than boys. Culturally, back then it was believed that there was little point in educating a girl who, one day, would leave the household and go to her new home. However, farmers highlighted that this belief is no longer widely held.

The results also indicate that men had more contact with agricultural extension officers than women, implying that there is gender bias in access to extension services. The extension officers, most of whom are men, find it easier to visit men than women. The results indicate a significant relationship between mode of water diversion and gender, showing that a higher proportion of women relied on gravity than men. Use of motorised pumps for water conveyance is more costly than gravity, such that men, who have more resources, can afford motorised pumps than women.

Table 2: Summary statistics of sample irrigators according to gender

Variables	**Pooled sample (n=290)**		**Females (n=198)**		**Males (n=92)**		**t-test (χ^2 test)**
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	
Water access	4.29	3.23	3.82	2.10	5.30	4.70	-3.70***
Incomes per capita	5.72	4.10	4.93	3.82	7.43	4.16	-5.06***
Maize yield[a]	1.91	1.83	1.74	1.78	2.29	1.88	-2.29**
Age	57.33	13.24	57.52	13.56	56.90	12.57	0.37
Education_0	0.61	-	0.67	-	0.48	-	10.08***
Education_1	0.23	-	0.20	-	0.30	-	3.04*
Education_2	0.16	-	0.13	-	0.22	-	4.98**
Married	0.25	-	0.29	-	0.18	-	3.43*
Household size	6.52	4.66	6.43	5.34	6.72	2.66	-0.48
Land size	0.42	0.52	0.38	0.38	0.52	0.72	-2.19**
Livestock size	3.92	9.59	3.40	10.18	5.04	8.09	-1.35
Credit access	0.26	-	0.25	-	0.30	-	1.09
Extension	2.95	1.99	2.67	1.88	3.54	2.09	-3.56***
Group membership	0.39	-	0.38	-	0.40	-	0.11
Scheme	0.72	-	0.70	-	0.76	-	1.03
Scheme distance	8.49	10.63	8.21	10.33	9.10	11.29	-0.67
Pump	0.62	-	0.66	-	0.51	-	6.18***
Scheme management	0.26	-	0.18	-	0.31	-	4.75**
Location_0	0.52	-	0.52	-	0.50	-	0.13
Location_1	0.23	-	0.26	-	0.16	-	3.43*
Location_2	0.30	-	0.26	-	0.40	-	6.35**

WUA member	0.18	-	0.13	-	0.28	-	9.90***
Canal maintenance	0.58	-	0.54	-	0.67	-	4.46**

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively. [a] Refers to a total of 268 (Women=186, Men=82) farmers who had planted maize last season.

Table 2 shows that men were more likely to be in scheme management committees than women. This result is expected, as it is part of the culture and traditional beliefs in the area that women should not be community leaders (Sharaunga & Mudhara, 2016). Discussions with the farmers indicated that groups involving only women would invite one or two men to their groups so that the men would represent them at the scheme level. Men were more likely to own plots in the upper end than women. This also demonstrates the gender bias that favours men in land allocation, as it suggests that those who demarcated the plots gave preferential treatment to men, allocating them upper plots before allocating lower plots to women. The upper plots are advantageous for water access, as the water reaches these plots before it gets to those located in the tail-end of the scheme.

Table 2 indicates that most of the men participated in canal maintenance compared to women. According to the farmers, canal maintenance activities such as canal cleaning (removing logs, stones or sand) and fixing canal leaks are physically demanding and more masculine, and women have to send a male representative in their place. The results show that 18% of the irrigators were registered as water users (i.e., members of water user associations (WUAs)), and that more men than women were registered water users. The small proportion of members of WUAs implies that there is a long way to meeting the policy target of ensuring that all water users join WUAs as stipulated in the Water Act of 1998 (DWAF, 1998).

Table 2 demonstrates that women had less welfare and access to resources than men. The incomes per capita were over 50% significantly higher for males than for females. Women had 40% less land and owned less livestock (although this is not statistically significant). Table 2 indicates that the sampled farmers achieved average maize yields of less than 2 tons ha^{-1}. Men were 30% more productive in maize production than women. The fact that men are more productive per unit area than women has been reported by other studies such as Aguilar et al (2015) and Karamba & Winters (2015).

Table 3 shows the Foster, Greer and Thorbecke (FGT) (Foster et al, 1984) poverty indices of the sampled farmers according to gender. The poverty line used was R5939 per capita per year, a figure that was determined by adjusting the lower-bound poverty line of R5316 suggested by NPC (2012) in 2011 prices by the consumer prices index (CPI) to 2013 prices (Statistics South Africa, 2014). Table 4 indicates high poverty levels among the sampled households, especially among the women. The results indicate that poverty incidence, severity and depth were more prevalent among women than among men.

Table 3: FGT poverty indices according to gender

FGT index	**Pooled sample**	**Women**	**Men**
Poverty headcount index	0.63	0.72	0.41
Poverty gap index	0.26	0.33	0.10
Poverty severity index	0.15	0.20	0.04

Is access to water gendered?

Table 4 presents the results of the Poisson models estimated to investigate the differences in the water access between men and women. Three models were estimated, first for the pooled data, second for women and the third for men. The pooled model results indicate that gender is a significant determinant of water access, showing that men accessed water more frequently than women. The results also show that married farmers accessed water less frequently than unmarried ones. A plausible explanation is that married farmers, especially women, may have less time to dedicate to farming activities due to additional responsibilities of taking care of their families.

The pooled results indicate that farmers with bigger plots access water more frequently than those with smaller plots. The size of land one has determines water access, as has been reported by studies such as Molden (2007), Thamaga-Chitja et al (2010) and Namara et al. (2010). Table 3 shows that group membership was positively correlated with water access. This is because members of groups collectively lobby for better access to water and may have better access to information about who to approach in order to gain more access to water. The results show that irrigators in TFIS had less access to water than those from MRIS. As expected, distance to the scheme was negatively associated with access to water. Given that water is accessed on a first-come-first-served basis, those located near the scheme are more likely to arrive earlier than those located far from the scheme. Also, location near the scheme is associated with less time and transport costs.

Table 4: Determinants of water access, Poisson model results

Variables	**Pooled sample**		**Women**		**Men**	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Gender	0.117**	0.059	-		-	
Age†	-0.161	0.111	-0.121	0.109	-0.271	0.245
Married	-0.077*	0.042	-0.075*	0.045	-0.112	0.107
Household size†	-0.016	0.057	-0.058	0.055	0.165	0.134
Educat_0	-0.021	0.061	-0.085	0.067	0.023	0.097
Educat_2	0.103	0.086	-0.033	0.092	0.278*	0.144
Livestock size	0.003	0.002	0.001	0.003	0.009*	0.006
Land size†	0.207***	0.043	0.172***	0.044	0.240***	0.075
Credit	-0.090	0.079	-0.095	0.078	-0.073	0.161
Extension	0.020	0.019	-0.041***	0.015	0.080**	0.036
Group membership	0.146**	0.063	0.010	0.054	0.330**	0.107
Scheme	-0.281***	0.085	-0.121	0.079	-0.545***	0.217
Scheme distance†	-0.055**	0.025	-0.057**	0.024	0.038	0.041
Pump	-0.241***	0.065	-0.248***	0.055	-0.133	0.165
Scheme management	0.250***	0.060	0.240***	0.062	0.367***	0.122
Canal maintenance	0.072*	0.041	0.048*	0.029	0.001	0.147
Location_0	-0.105*	0.059	-0.342***	0.109	-0.018	0.069
Location_2	0.365***	0.073	0.265***	0.077	0.361**	0.146
WUA member	0.239***	0.087	0.255***	0.088	0.244	0.142
_Constant	1.976***	0.530	2.171***	0.498	1.363	1.042

N	290	198	92
Wald χ^2	677.43***	519.71***	508.95***
Pseudo R^2	0.16	0.09	0.27

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively. † means the values were logged

The separate model results for women and men, presented in Table 4, show that there are fundamental differences in the factors that influence access to water between men and women. The results demonstrate that while married women accessed water less frequently than the unmarried women, marital status does not seem to matter for men. The explanation here is that it is usually married women who have additional household responsibilities compared to married men. Table 4 indicates that education level is positively correlated with access to water for men. The men with at least secondary education accessed water more frequently than those with primary education. However, education level does not appear to be important for accessing water for women. Table 4 shows that increased contact with extension officers is negatively correlated with water access for women, but positively correlated for men. This result, which perhaps need further study, suggests that women who contact extension officers frequently are those with less access to water, possibly in an attempt to get the extension officers to address their water challenges. It could also be indicative of the ineffectiveness of extension support for addressing women's access to irrigation water.

Table 4 demonstrates that being a member of a group results in increased water access for men, but has no impact on women's access to water. This suggests that women are not benefitting much from the groups, which in most cases are led by men. While staying far from scheme disadvantages women in accessing water, it is not significant for men. Also, using pumps results in decreasing water access for women, but does not matter for men. The women enhance their access to water through participating in canal maintenance. However, this does not matter for men. Location in the lower end of the canal disadvantages women in water access, but not men. Registration as water user increases water access to women as it gives them some legitimacy to their rights. However, it does not matter for men.

The BO decomposition results presented in Table 5 indicate that most of the differences in the water access between men and women is due to differences in observable characteristics than differences in the estimated coefficients. Table 5 shows that 94% of the water access differential could be explained by differences in observable characteristics and only 6% by different coefficients. This indicates that minimal differences in water access between men and women would emerge when they have the same socio-economic characteristics. This suggest that women have disadvantages in observable characteristics, and that there is minimal inherent gender bias against women with regards to access to water in the irrigation schemes.

Table 5: BO decomposition results

	Coefficient	**Standard error**	**% of $\hat{\Delta}$**
$\hat{\Delta}$	0.616***	0.219	100
Explained part	0.577**	0.287	94
Unexplained part	0.038	0.193	6

Notes: Standard errors were bootstrapped (250 replications). *** and ** means significant at 1% and 5% levels, respectively.

Impact of gendered water access on household welfare

Table 6 shows the OLS results on the impact of gendered access to water on household incomes per capita. The results indicate that increasing water access is associated with increasing incomes per capita. The explanation of this result is that increased water access leads to increased agricultural production and/or productivity, which results in improved farm incomes. Farmers with more access to water face less risk of crop failure and, therefore, have better incentives to invest in improved inputs and technologies such as fertilisers that improve crop productivity. The results also indicate that men have higher welfare than women. This result is also in line with a number of studies (Kerr, 2005; Li et al, 2008; Mallick & Rafi, 2010; Murugani et al, 2014) that reported women to be more likely to have less welfare than men in settings of unequal resource access such as rural areas. The advantages that men have in capital and resource access results in them achieving higher welfare than females.

Table 6 indicates that an additional day of access to water increases men’s welfare less than it does to women. This suggest that women are more efficient compared to men in using water resources to improve household welfare. This finding suggests that equitable allocation of productive resources such as water between men to women would have a bigger impact on rural poverty. Farmers located in the upper-end of the canal achieved higher welfare than those located in the middle and tail-ends. This is in line with the location externalities argument (Mbatha & Antrobus, 2008; Sinyolo et al, 2014b). Farmers located in the upper-end have better chances of accessing water than those in the lower sections, and these certainties regarding water availability among these upper-end farmers lead to production decision certainties, economic efficiencies and higher production levels. The results also show expected signs for the other variables.

Table 6: Impact of gendered water access on household welfare, OLS results

Variables	**Coef.**	**Std. Err.**
Water access	0.278***	0.073
Gender	0.647***	0.136
Gender*Water Access	-0.134**	0.066
Age	0.007	0.164
Married	-0.277**	0.117
Household size	-0.383***	0.082
Educat_0	-0.047***	0.013
Educat_2	0.126**	0.062
Livestock size	0.007**	0.004
Land size	0.060**	0.027
Credit	0.060*	0.001
Extension	0.018	0.020
Group membership	0.420***	0.078
Scheme	0.638***	0.189
Pump	-0.193**	0.095
Scheme management	0.033	0.095
Location_0	0.118	0.118
Location_2	0.291***	0.110
WUA member	0.099	0.087

Variables	Coef.	Std. Err.
_Constant	7.818***	0.737
N	290	
F(19, 271)	11.19***	
R^2	0.4313	

Notes: ***, **, and * means significant at 1%, 5%, and 10% levels, respectively

Conclusions and policy implications

This study aimed to investigate the gender differences in water access among irrigators, and the extent to which the gender differentials can be explained by observable or unobservable characteristics. The study findings highlighted unequal access to irrigation water between men and women, with men accessing irrigation water more frequently than women. The results indicate a positive and significant effect of water access on household welfare, and that men had higher welfare than women. The results suggest that women would achieve higher welfare than men at the same level of water access. This implies that a deliberate policy to attain equity in access to water and other productive resources could be more effective in combating poverty compared to the status quo.

The BO results reveal that the explained portion of the gender gap is bigger than the unexplained portion, implying that there is minimal inherent gender discrimination in water access in Msinga. The study findings suggest that policies targeting observable characteristics can improve access to water. The results indicate that women would benefit more from being registered as water users, relying on gravity instead of pumps as well participating in canal maintenance activities. The study recommends that women be empowered to assume leadership positions in scheme management as well as in groups to improve their influence and close the gender gap in access to productive resources such as water. Involving women in leadership positions, however, would require a change in the patriarchal attitudes prevailing in rural South Africa, which can be achieved by increased awareness and appreciation of women as equal players in society.

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