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Smallholder Irrigation and Rural Livelihoods in Limpopo Province of South Africa: What is the Contribution to Household Food Security and Income?

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ABSTRACT

This paper examines the contribution of smallholder irrigation farming to household income and food security of rural households in Limpopo Province of South Africa. The study compared livelihoods of irrigating and non-irrigating households. Data analysis employed semi-parametric propensity score matching methods. The respondents were mainly men older than 55-years. Irrigators grew a wider variety of crops in a year compared to non-irrigators and grew crops throughout the year. Irrigators had the highest proportion of households reporting always having enough food (29%) while home-gardener households reported not having enough food most of the time (40%). Income from farm produce constituted 39% of total household income for irrigators while non-irrigators relied on salaries and wages (59%). Irrigators had a stronger asset base compared to non-irrigators, partly explaining disparities in household income and food security. The PSM method showed that irrigation access increased household income and that irrigators were at least 57% more likely to be food secure than non-irrigators. These findings provided sufficient evidence that smallholder irrigation farming makes a significant contribution to rural livelihoods, a strong motivation for continued investment in smallholder irrigation farming. This contribution of smallholder irrigation farming to rural livelihoods can be enhanced by implementing policies that promote female participation in irrigation farming and equip farmers with entrepreneurial skills. Increasing the capital base of rural people should form part of a comprehensive strategy to empower rural households. The study contributes to the core of the African development debate on the importance of smallholder irrigation farming to rural livelihoods.

Keywords: household income, irrigation, propensity score matching, rural livelihoods, smallholder farmer

INTRODUCTION

Food insecurity and poverty are major development challenges in South Africa. It is estimated that more than 50% of the population is food insecure (Labadarios *et al*., 2009; Stats SA, 2012) and 20.2% live in extreme poverty although the numbers have dropped compared to previous years (Stats SA, 2014, Stats SA, 2017). However, the country remains in 55th position on the Global Hunger Index and the statistics gathered continue to point to a country that is facing a hunger crisis. These challenges tend to be more severe in rural areas where agriculture, and specifically irrigation agriculture, can play a major role in addressing the challenges. Irrigation farming has an important wealth-generating function, particularly in rural settings, and is considered to be an effective strategy for improved household food security and income (Department of

Agriculture, Forestry and Fisheries [DAFF], 2012). In general, access to irrigation water allows farmers to increase production and income and diversify income opportunities. This is because irrigation water makes possible the adoption and scaling up of modern farming technologies, which contributes to improved livelihoods and poverty reduction (Lipton *et al*., 2001; Hussain *et al*., 2003; Hussain & Hanjra, 2004, Nhundu & Mushunje, 2012; Kergna & Dembele, 2018).

The potential role of irrigation farming in addressing food insecurity and poverty challenges is well recognised in South Africa (Ntsonto, 2005; Phiri, 2008; Mudau, 2010; Tekana & Oladele, 2011). For example, the South African government has adopted the strategy of the National Development Plan (NDP) of reviving the rural economy through expanding irrigated farming (National Planning Commission [NPC], 2011). Whilst it is widely accepted that smallholder irrigation farming contributes to improved livelihoods and poverty reduction, little has been done to (a) quantify the contribution; and (b) examine how benefits from smallholder irrigation are distributed. It is often assumed that the benefits flowing from irrigation will be distributed evenly among the irrigators. Furthermore, previous studies have focused on farmers operating on irrigation schemes to the exclusion of independent (non-scheme) smallholder irrigation farmers.

This paper examines the contribution of smallholder irrigation farming, both scheme and independent irrigation farming, to improve rural livelihoods. In particular, the paper addresses the following question: Are household income and food security significant pathways through which smallholder irrigation farming contributes to rural livelihoods?

THEORETICAL FRAMEWORK

In South Africa, most smallholder irrigation schemes were established in the former homelands or in resource-poor areas where the incidence of poverty is higher compared to other parts of the country (May, 2000; Aliber, 2003, DAFF, 2012). In these particular socio-economic environments, smallholder irrigation farming presents an attractive opportunity for enhancing rural livelihoods. For that reason, smallholder irrigation schemes continue to attract substantial amounts of public investment (Denison & Manona, 2007). Irrigation revitalisation investment costs, in particular, ranged between R90 000 and R212 000[1] per hectare in 2012 for both capital and operation costs (DAFF, 2012).

Irrigation development in South Africa has been extensive since the 1920s and revitalisation of irrigation schemes intensified in the late 1990s (Bembridge, 2000; M'Marete, 2003; DAFF, 2012; Johnston *et al*., 2012). The Limpopo Province, in particular, undertook to revitalise smallholder irrigation schemes between 2001 and 2004 under the Revitalisation of Smallholder Irrigation Schemes Programme (DAFF, 2012). Over time, the number of smallholder irrigation schemes in the country increased. According to Van Averbeke *et al*. (2011), the number of smallholder irrigation schemes had risen to 302 by 2010, although about 34% were not operational. Of the 1.5 million hectares of irrigated land, smallholder irrigation schemes represent about three percent (DAFF, 2012; Department of Government Communication and Information System, 2015).

Given that this study is a livelihood-centred evaluation of the contribution of smallholder irrigation farming to rural livelihoods, the pathways framework, which extensively applies the Sustainable Livelihoods Framework (SLF) formed the basis for analysis. The framework shows the key interrelated dimensions of the relationship between access to good irrigation water and assets, eventually leading to improved household welfare. People undertake livelihood strategies using the assets they either own or to which they have access to transform their lives (Winters *et al*., 2002). These assets are key in implementing livelihood strategies, which are necessary for realisation of desired livelihood outcomes (LaFlamme & Davies, 2007; Nkala *et al*., 2011; International Fund for Agricultural Development [IFAD], 2012). Rural households have been found to construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living (Ellis, 1998).

When viewed from a livelihood perspective, smallholder irrigation farms are assets. They can be used to increase and diversify the livelihood activity of crop production, resulting in improved livelihood outcomes, either directly in the form of food or income for farming households (Asian Development Bank [ADB], 2003; Hussain *et al.*, 2003; Hussain & Hanjra, 2004; Hanjra *et al.* 2009), or indirectly by providing full or partial livelihoods to people who provide goods and services in support of irrigated farming (Van Averbeke & Mohamed, 2006). Evidence has shown that smallholder irrigation farming has the potential to contribute to growth in rural household incomes, ensures a more stable food supply for households with secure irrigation access, and reduces inequalities (Belete *et al.*, 1999; Ngqangweni, 2000; Hendriks & Lyne, 2003; Obadire, 2011). In addition, irrigation schemes have provided many rural households with a source of livelihood through casual, seasonal and permanent employment (Hope *et al.*, 2008; Tapela, 2008).

MATERIALS AND METHODS

Description of the study area

The study was conducted in Mopani district of the Greater Tzaneen municipality in Limpopo Province of South Africa as part of a Water Research Commission Project K5/2179 (WRC, 2013). Selection of the research site was guided by the need to study an operational irrigation scheme and also to include two targeted types of smallholder farmers in the sample, namely, irrigating households (both scheme and independent irrigators) and non-irrigating households (home gardeners).

For the purpose of this study, independent irrigators are defined as *smallholder farmers who have direct access to a source of irrigation water and extract, convey and apply this water using privately owned equipment*. Independent irrigation was initiated and financed by farmers individually, mostly without any support from external agencies, such as government, donors or NGOs. The origin of the term ‘independent’ as a descriptor for the categorisation of smallholder irrigators can be traced back to reports on small-scale irrigation in South Africa by De Lange (1994) and Crosby *et al*. (2000). These are farmers who were not participating in an irrigation scheme, who ‘each have a “private” water supply, such as pumping directly from a river, or an own borehole’. De Lange (1994) pointed out that having a ‘private water supply’ distinguished independent irrigation farmers from the other categories of smallholder irrigators.

On the other hand, scheme irrigators rely on a ‘communal water supply infrastructure’ for access to irrigation water. According to De Lange (1994), scheme farmers have larger plots and produce a wider range of crops than home gardeners, whose focus is reported as being almost completely on vegetables. Independent irrigators have complete control of their farms and they have complete control over irrigation scheduling, making their own decisions on how and when to irrigate and how much water to apply (Abric *et al.*, 2011). This contrasts with scheme farmers, who are dependent on each other, because they share the water distribution system and have to work collectively in order to achieve their individual objectives (Van Averbeke, Denison & Mnkeni, 2011). Home gardeners use the area of land around the family home for production of annual and perennial crops under rain-fed conditions.

The striking difference between irrigators and non-irrigators was the purpose of farming. Irrigators farm with a strong commercial orientation. In the study area, irrigators transported most produce to the Pretoria Fresh Produce market while non-irrigators practised subsistence farming. Independent irrigation farmers generally aimed at making a living out of farming, which was not always the case with farmers on schemes (De Lange, 1994; Crosby *et al*., 2000).

The size of the plots farmed by irrigators varied considerably. Julesburg irrigation scheme is particularly interesting because plot sizes are relatively large (5-10ha). Independent irrigators farmed 0.3-42 ha. According to literature, irrigators are reported the use both very small plots and fairly large commercial units, ranging between 4 and 80 ha (De Lange, 1994; Crosby *et al.*, 2000; Du Plessis & Van Der Stoep, 2001; Oosthuizen *et al*., 2005).

Sampling and data sources

Julesburg irrigation scheme was purposively selected, among 101 operational irrigation schemes in the area, as the anchor of the research site. Among the 48 plot holders on the scheme, 27 were actively farming. A census approach was applied where all 27 irrigators on the scheme were interviewed. The sample size for non-scheme (independent) irrigators was 35 and these were purposively selected from villages surrounding Julesburg irrigation scheme. Since there was no existing database for independent irrigators, they were identified with assistance from local extension officers and through snowballing. A census approach was then adopted, where all identified independent irrigators were interviewed. A total of 53 home gardeners (non-irrigating farmers) were randomly selected from 800 households in Rhulani village within which Julesburg irrigation scheme is located. These were interviewed as a control group of non-irrigators bearing similar contextual factors as the irrigators.

Data collection was done through face-to-face questionnaire-based interviews. Among socio-economic and agricultural data that was collected, monthly household income received by source was captured. The food security situation was assessed by asking household heads to indicate whether they had had enough food most of the time in the previous year[2].

Model specification

The analysis explored how two livelihood indicators (household income and food security) were influenced by smallholder irrigation farming. The primary livelihood outcomes, regarded as benefits of smallholder irrigation farming, are higher levels of household income and improved household food security. In this study, household income is a continuous variable while food security is a binary variable (1= improvement and 0= otherwise).

The estimation technique used is semi-parametric propensity score matching (PSM). This technique considers the possibility that (a) irrigators and non-irrigators might exhibit systematic differences in characteristics, which might make them less comparable; and (b) selection into irrigating or non-irrigating group has largely been non-random, based on certain unobservable criteria. Given the non-random selection of irrigation scheme farmers and independent irrigators, a simple comparison of household income between irrigators and non-irrigators would yield biased estimates of irrigation farming impact. The challenge is, therefore, to identify a suitable comparison group of non-irrigators whose outcomes, on average, provide an unbiased estimate of the outcomes that irrigation farmers would have had in the absence of irrigation.

Accordingly, the PSM method was used to deal with this challenge by sampling from the potential control group a smaller control group whose distribution of covariates is similar to the distribution in the treated group (Rosenbaum & Rubin, 1983; Smith & Todd, 2005). PSM gives an average treatment effect on the treated (ATT), which is considered a better indicator of whether to continue promoting interventions that target specific groups of interest, such as poor farmers, than population-wide average treatment effects given by probit models (Rosenbaum & Rubin, 1983; Heckman *et al*., 1998; Rosenbaum, 2002). Irrigation farming is the treatment and PSM is based on the assumption that it is not possible for each farmer to be both an irrigator as well as a non-irrigator. This then necessitates the creation of a counterfactual of what can be observed by matching irrigators (treatment) and non-irrigators (control). PSM, therefore, matches the two groups with similar values of $p(\mathrm{x})$ giving equation 1 to estimate:

$$E(y_1 - y_0|p(x)) = E(y|w = 1, p(x)) - E(y|w = 0, p(x)) \quad (1)$$

y_0 and y_1 are household income levels without and with irrigation farming, respectively. is a binary indicator of involvement in irrigation farming (participation =1, 0 = otherwise). p(x) is the propensity score, which is defined as the conditional probability of being in the group of irrigators conditional on x**.** The vector x contains a set of covariates considered to influence the decision to participate in smallholder irrigation farming (namely, age of household head, age of household head squared, gender of household head, distance from irrigation scheme, education of household head, membership of a farmer association, membership of a farmer cooperative, membership of a village committee and membership of a political party *)*. Selection of covariates was influenced by determinants of household welfare as documented in the literature (Mendola, 2007; Irajpoor & Latif, 2011; Tekana & Oladele, 2011). Averaging over the distribution of propensity scores in the treated population gives the average treatment effect on the treated (ATE) conditional on probability propensity scores (PPS), as shown in equation 2.

$$ATE_1^{PSM} = E[E(y|w = 1, p(x)) - E(y|w = 0, p(x))|w = 1] \quad (2)$$

Implementation of this method relies on having an estimator for the PPS. To predict the PPS for the population (the probability of being in the treatment group), a flexible probit model of participation, where independent variables and various functions of these independent variables are introduced is estimated. To get the most region of common support, a stepwise procedure was used for selection of covariates included in the probit model. Results of the probit model are used to predict the PPS, which is then used to match irrigation farmers with observationally similar non-irrigators. A number of matching methods can be used at this stage, each using a different function to conduct the matching, although the result of each is an ATT value that indicates the impact of irrigation farming on the selected livelihood indicators. In this paper, to construct the comparison group, kernel-based matching was used. This method matches a treated unit to all control units weighted in proportion to the closeness between the treated and the control unit. To check the robustness of the results from kernel matching, another matching algorithm in the calculation of the ATT, the nearest neighbour matching method was used. This method involves choosing a unit from the control or comparison group as a matching partner for a treated individual that is closest in terms of the propensity score.

To check that the propensity score is balanced across treatment and comparison groups, the common support condition was imposed on the estimation by matching in the region of common support. If the common support condition is satisfied, there should be significant overlap in the distribution of the propensity scores of both treated and untreated groups. Furthermore, the reliability of the PSM results is explored by assessing the quality of the matching process. Since the PSM method conditions only on the propensity score, an assessment of the quality of the matching process was done by performing balancing tests that examine the standardized bias for all covariates used in the matching process. This procedure checks whether the matching procedure is able to balance the distribution of the covariates in both the irrigators and non-irrigators. In the case of a successful matching process, a two-sample *t*-test is run to investigate the significance of the post-matching differences in the covariate means for the two groups. After matching, all the variables used should not portray any statistically significant difference between irrigators and non-irrigators.

RESULTS

Socioeconomic characteristics of the sample

Disaggregation of the sample by type of household and a comparison of means for key variables used in the

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analysis is presented in Table 1. Irrigators constituted 34% of the total sample size. Overall, the *t*-tests reveal considerable significant differences in the characteristics of the different household types.

Table 1: Descriptive statistics (means) for variables by type of household

Variable	Description	Home gardeners	Scheme irrigators	Independent irrigators	t-test (p-values)	Full sample
Dependent variables						
Household food security situation	1=Food secure 0=Otherwise	0.57	0.70	0.83	0.08*	0.66
Household income level (R)[3]	Annual level of household income	56 854 (64176)	117 698 (92207)	130 645 (156022)	0.00***	80 823 (94183)
Independent variables						
Age (years)	Age of household head	56.09	62.89	60.43	0.05**	59.96
Gender	1=Male household head 0=Female	0.42	0.96	0.83	0.00***	0.61
Education	Highest level of education for household head 1= More than 7 years of schooling 0=0-7 years of schooling	0.38	0.44	0.60	0.15	0.43
Entrepreneurial attitude	Entrepreneur 1=Yes 0=Otherwise	0.64	0.72	0.76	0.00***	0.69
	Member of a farmer association 1= Member 0=Otherwise	0.00	0.63	0.31	0.00***	0.17

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Membership of associations	Member of Cooperative 1= Member 0=Otherwise	0.02	0.04	0.14	0.00***	0.04
	Member of a village committee 1= Member 0=Otherwise	0.11	0.19	0.23	0.04**	0.12
	Member of a political party 1= Member 0=Otherwise	0.28	0.33	0.46	0.17	0.31

Note: Figures in parenthesis are standard deviations

***, **, * = significant at 0.01, 0.05 and 0.1 significance levels, respectively.

A comparison of means for independent variables indicates a significant difference in the gender composition of household heads between irrigator and non-irrigator households, with more males among irrigators compared to the non-irrigator group. These results show that the smallholder farmers were typically middle-aged or old men (older than 55 years), with 61% of the household heads being male. In terms of education, about 43% of the household heads attained more than seven years of schooling. Irrigators tend to be more educated than their non-irrigating counterparts. Entrepreneurial attitude was statistically significantly different between irrigators and non-irrigators.[4] Membership of associations was also statistically significantly different between irrigators and non-irrigators, particularly with regard to farmer associations, farmer cooperatives, village committees and political parties. Since the mean values for the irrigators were consistently greater than the means for the non-irrigators, it can be concluded that irrigators joined associations significantly more than non-irrigators. However, such a result might also imply that membership of associations determined irrigation participation. This relationship constitutes further research.

Crops grown by irrigator and non-irrigator households

There was a clear distinction between the crop mixes of irrigators compared to those of non-irrigators (Moyo & Machet he, 2016). Households who irrigated grew a wider variety of crops in a year compared to non-irrigators. Smallholder irrigation farming allows farmers to diversify their crop mix. As evidenced in Tesfaye *et al.* (2008), Bacha *et al.* (2011), Oxfam (2011) and Benson (2015), access to smallholder irrigation enables farmers to grow crops more than once a year. As elsewhere in Africa, independent irrigators grew mainly horticultural crops, but those with large plots also grew field crops. Du Plessis and Van Der Stoep (2001) reported that independent irrigators in Limpopo Province primarily produced vegetables (garlic, onions, beetroot, cabbage, carrots). The prevalence of vegetable production among independent irrigators in this province was also reported by Van Averbeke (2008). Results in Table 2

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indicate that households who irrigated grew a wider variety of crops compared to non-irrigators. Scheme and independent irrigators grew on average 16 different crops during the 2012/13 season while home gardeners grew 13 crops. The *p*-values of the ANOVA indicate that there were statistically significant differences between the growing of most types of crops by irrigators and non-irrigators. There were, however, no statistically significant differences in growing onions, mustard, peas, bambara nuts, spinach, beetroot and sweet potatoes. Because of limitations in data, differences in the productivity of these crops by type of household could not be computed.

Table 2: Proportion of households cultivating different crops by type of household in 2012/13

Type of crop	Home gardeners (%) (n=46)	Scheme irrigators (%) (n=21)	Independent irrigators (%) (n=29)	ANOVA (p-values)
Tomatoes	2.2	9.5	37.9	0.00***
Onions	2.2	9.5	6.9	0.62
Sugar cane	0	4.8	20.7	0.01**
Soya beans	0	9.5	0	0.06*
Green beans	2.2	71.4	41.4	0.00***
Sugar beans	52.2	9.5	20.7	0.00***
Maize	17.4	52.4	58.6	0.01**
Okra	2.2	90.5	10.3	0.00***
Mustard	0	5.0	6.9	0.38
Green pepper	0	25.0	20.7	0.01**
Butternuts	0	0	27.6	0.00***
Cabbage	2.2	0	17.2	0.03**
Peas	0	5.0	0	0.29
Chillies	0	38.1	20.7	0.00***
Bambara nuts	2.4	5.3	4.2	0.95
Spinach	4.3	0	10.3	0.43
Paprika	0	9.5	0	0.06*
Pumpkin	30.4	0	0	0.00***
Beetroot	2.2	4.8	3.4	0.95
Peanuts	45.7	23.8	10.3	0.00***
Cowpeas	15.2	0	0	0.04**
Sweet potatoes	2.2	0	3.4	0.87

Note: ***, **, * = significant at 0.01, 0.05 and 0.1 significance levels, respectively.

4.1.2 The food security situation for irrigators and non-irrigators

Of the full sample, 66% were food secure as they reported having had enough food most of the time during the previous year. An assessment of the food security situation by type of household (Figure 1) revealed that there was a statistically significant difference in the food security situation of scheme irrigators, independent irrigators and home gardener households at 10% level of significance (*p*-value=0.08). Independent irrigators

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had the highest proportion of households reporting always having enough food (29%) followed by scheme irrigators (26%). The greatest proportion of households who reported not having enough food most of the time were among home gardeners (40%).

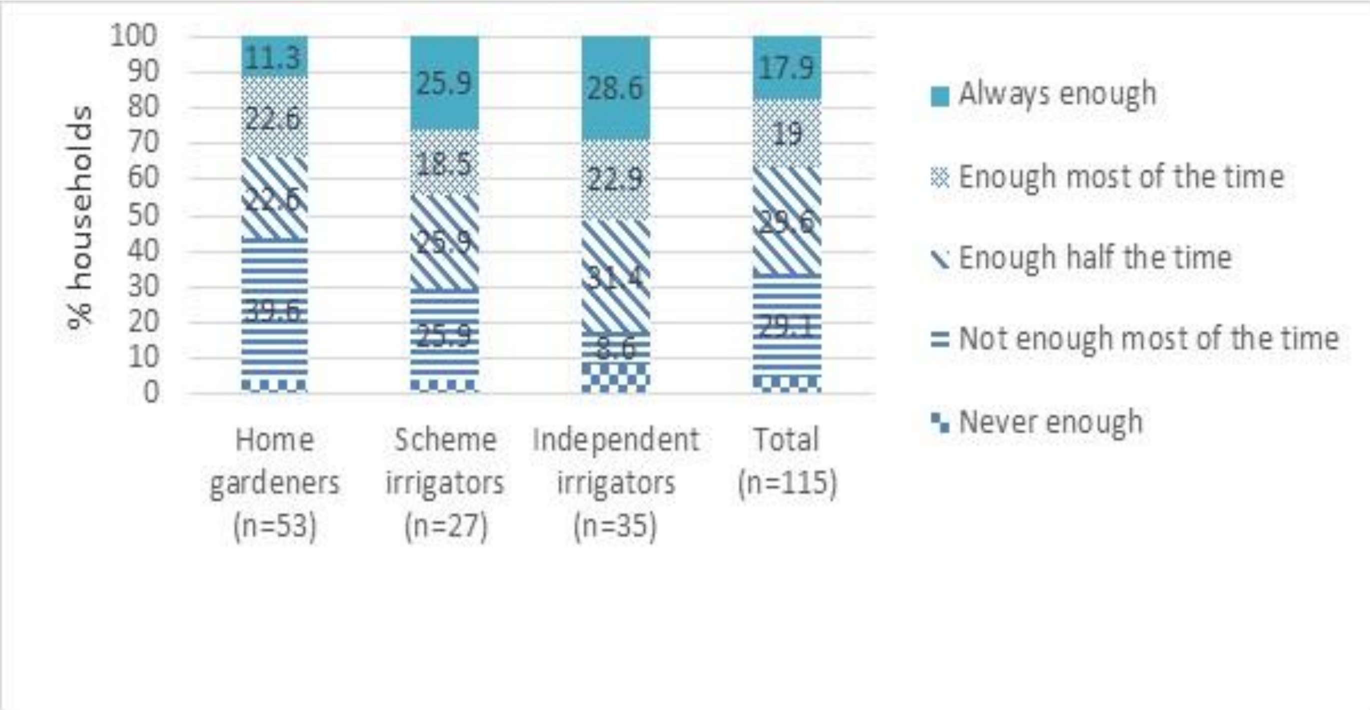

Figure 1: The food security situation by type of household

Sources of household income for irrigators and non-irrigators

Household income was statistically significantly different among the different households at 1% level of significance (*p*-value=0.00). Independent irrigators had the highest household income per annum at an average of R130 645, followed by scheme irrigators and home gardeners, with an average annual household income of R117 698 and R56 854[5], respectively. Relatively high variations in household income were found among irrigating as well as non-irrigating households as indicated by the standard deviations. The coefficient of variation among the household groups was greater than one. In addition to farming, households derived income from diverse sources. Figure 2 shows the proportional contribution of each income source to household income for irrigators (scheme and non-scheme irrigators) and non-irrigators (home gardeners). Overall, salaries and wages, farm produce and social grants were the main contributors to household income[6]. However, there were differences with regard to the extent of the contribution of each source to household income of irrigators and non-irrigators.

Among irrigators, income from farm produce contributed an annual average of R96 872 (39% of total household income). This was followed by salaries and wages, which contributed an annual average income of R95 564, constituting 38.5% of total household income. Social grants were the third most important income source contributing R36 963 per annum (14.9% of total household income)[7].

In the case of non-irrigators, income from farm produce was not the main contributor to household income. Instead, salaries and wages were the most important source of household income for non-irrigators (58.6% of total household income). Social grants were the second most important source of household income at 26.8% of total household income. These figures suggest that farming is the main source of income for irrigators while non-irrigators derive their income mainly from non-farm sources.

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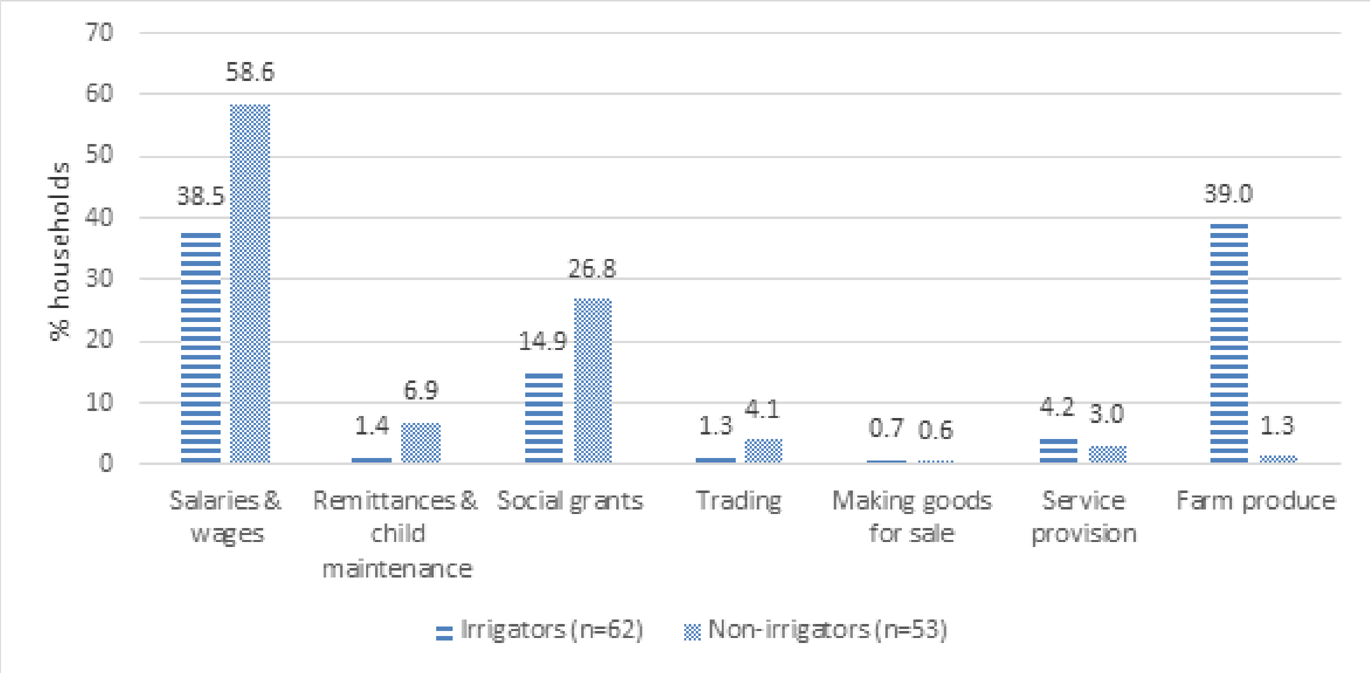

Figure 2: Proportional contribution of each income source to total household income for irrigators and non-irrigators

Asset endowment for irrigators and non-irrigators

An assessment of asset endowment among sampled households indicated that irrigating households had a stronger asset base compared to non-irrigating households as shown in Table 2. Substantial differences existed in ownership and access to natural, physical and financial capital. These differences in asset endowment partly explain why and under what conditions irrigating households have higher household income and better food security.

Table 2: Asset endowment for irrigators and non-irrigators in Greater Tzaneen Municipality (2012-13)

Indicators	*Home gardeners (n=47)*	*Scheme irrigators (n=21)*	*Independent irrigators (n=29)*	*All (n=97)*	*Statistical significance/ LSD (p=0.05)*
Human capital indicators by type of household					
Household size	5.6_a	5.2_a	5.7_a	5.6	NSD
Number of children (<15 year old)	1.8_a	1.3_b	1.7_{ab}	1.7	NSD
Number of economically active adults (15-64 year old)	3.6_a	3.3_a	3.6_a	3.5	NSD
Number of aged adults (>64 year old)	0.3_b	0.6_a	0.5_{ab}	0.4	LSD = 0.26
Number of adult equivalents in household	4.0_a	3.9_a	4.1_a	4.0	
Number of unemployed economically active adults	1.6_a	1.2_a	1.3_a	1.4	NSD
Unemployment rate	0.46_a	0.34_b	0.33_b	0.39	NSD

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Labour participation rate	0.37_{b}	0.44_{ab}	0.45_{a}	0.41	NSD
Education participation rate	0.15_{a}	0.23_{a}	0.22_{a}	0.19	NSD
Number of household members who completed secondary education	1.3_{b}	1.7_{a}	1.3_{b}	1.4	LSD = 0.26
Number of household members who completed tertiary education	0.2_{a}	0.2_{a}	0.4_{a}	0.3	NSD
Natural capital indicators (land and water) used for crop production among households					
Home garden					
Residential area set aside for cultivation (m^2)	$1\ 041_{b}$	$2\ 756_{a}$	$1\ 958_{ab}$	1 686	LSD = 1 343
Rainfed arable land					
Total area (m^2)	4 443	5 119	4 589	4 633	LSD = 6 234
Irrigation scheme land					
Total area (m^2)	0_{b}	$59\ 190_{a}$	0_{b}	12 814	LSD = 2 729
Source of water for irrigation (%)					<0.0001
River by direct extraction	14.3	40.0	88.9	52.4	
Canal	28.6	0.0	0.0	9.5	
Dam	57.1	60.0	11.1	38.1	
Independently irrigated land					
Total area (m^2)	0_{b}	0_{b}	$61\ 605_{a}$	18 418	LSD = 11 523
Source of water for irrigation (%)					<0.0001
River by direct extraction	33.3	30.0	57.1		
Canal	11.1	10.0	14.3		
Ground by means of borehole	22.2	20.0	28.6		
Dam	33.3	40.0	0.0		

Financial capital indicators by type of household (Rand)					
Income from salaries and wages	$31\ 140_{b}$	$58\ 905_{a}$	$36\ 855_{ab}$	38 860	22 724
Income from remittances	$3\ 813_{a}$	$1\ 600_{a}$	$1\ 207_{a}$	2 555	4 413
Income from old-age grants	$7\ 277_{b}$	$14\ 263_{a}$	$7\ 771_{b}$	8 937	4 251
Income from child-support grants	$5\ 377_{a}$	$2\ 771_{b}$	$5\ 336_{a}$	4 801	2 162
Income from other grants	965_{b}	$4\ 970_{a}$	$4\ 352_{a}$	2 845	2 549
Total income from regular income flows	$48\ 572_{b}$	$82\ 509_{a}$	$55\ 521_{b}$	57 997	22 058
Physical capital indicators by type of household					
Hand hoe	95.7	100.0	100.0	97.9	0.137
Spade	85.1	95.2	86.2	87.6	0.251
Rake	63.8	47.6	58.6	58.8	0.004
Knapsack sprayer	2.1	90.5	75.9	43.3	0.000
Wheel barrow	89.4	33.3	55.2	67.0	0.000

Cattle	10.6	28.6	37.9	22.7	0.000
Donkeys	0.0	4.8	10.3	4.1	0.000
Animal-drawn plough	2.1	4.8	6.9	4.1	0.111
Tractor	0.0	14.3	24.1	10.3	0.000
Tractor-drawn plough	0.0	9.5	20.7	8.2	0.000
Animal-drawn cart	0.0	4.8	3.4	2.1	0.284
Bakkie or truck	6.4	23.8	27.6	16.5	0.000
Water pump	0.0	28.6	37.9	17.5	0.000
Irrigation pipes	8.5	61.9	69.0	38.1	0.000
Water storage facility	10.6	4.8	10.3	9.3	0.003
Farm shed	0.0	23.8	20.7	11.3	0.000
Grain storage facility	4.3	4.8	13.8	7.2	0.007
Grain mill	2.1	9.5	3.4	4.1	0.005
Social capital indicators by type of household					
Farmer association/cooperative	2.1	71.4	41.4	28.9	p<0.0001
Water user association	0.0	28.6	10.3	9.3	p<0.0001
Trade union	2.1	4.8	6.9	4.1	p = 0.003
Village committee	12.8	14.3	27.6	17.5	p<0.0001
Religious group	85.1	90.5	82.8	85.6	p = 0.015
Political party	29.8	33.3	44.8	35.1	p = 0.001
Cultural association	8.5	4.8	20.7	11.3	p = 0.056
Burial society	83.0	90.5	72.4	81.4	p<0.0001
Credit/savings group	29.8	42.9	27.6	32.0	p<0.0001
Non-governmental/civic organisation	8.5	4.8	6.9	7.2	p<0.0001

Propensity scores predicted through probit model estimation

The propensity score was estimated using a probit model of irrigation given a set of covariates. Table 3 presents results from the first-stage probit estimation of smallholder irrigation farming. These results give an indication of the socio-economic factors that affect the probability of a household participating in irrigation farming.

Table 3: Probit estimates for factors affecting the probability of participating in irrigation farming

Variable	Coefficient	Std. error	p-value
Age	0.071	0.096	0.459
Age squared	-0.0006	0.0008	0.499
Gender	1.749	0.594	0.003***
Distance from irrigation scheme	0.726	0.150	0.000***
Education of household head	-0.580	0.415	0.162
Member of farmer association	2.654	0.530	0.000***
Member of farmer cooperative	3.529	1.121	0.002***
Member of village committee	0.848	0.468	0.070*
Member of political party	-0.013	0.393	0.975

Constant	-5. 666	2.840	0.046
Log likelihood	-34.74		
Likelihood ratio test:$c^2(9)$	162.35		
Correct predictions (%)	70		
Observations	115		

Note: ∗∗∗, ∗∗, ∗ =significant at 0.01, 0.05 and 0.1 significance levels, respectively.

Gender of the household head was a significant determinant of participation in smallholder irrigation farming at 1% level of significance. Male-headed households were more likely to irrigate compared to their female-headed counterparts. This result is consistent with the finding of Tekana & Oladele (2011) that male-headed households experienced significant improvements to their household welfare through irrigation farming.

Distance from the irrigation scheme, which was represented by the village in which a household is located, had a positive relationship with irrigation farming and was significant at 1% level of significance in explaining participation in irrigation farming. Households located closer to the irrigation scheme tended to participate more in irrigation farming.

Participation in smallholder irrigation farming tended to be for those who were members of a farmer association, farmer cooperative and village committee. This suggests that smallholder farmers who joined farmer associations and farmer cooperatives were more likely to participate in irrigation farming at 1% level of significance. Membership to a village committee was significant at 10% level of significance in explaining participation in irrigation farming. Membership of associations could have been as a result of participation in irrigation farming or the other way around.

However, contrary to expectation, the highest level of education attained by the household head had a negative relationship to irrigation farming and was not significant in explaining participation in smallholder irrigation farming. Various specifications of the probit model were attempted until the most complete and robust specification that satisfied the balancing tests and establishment of the common support region was obtained.

Treatment effects from the propensity score matching method

Propensity scores from the first-stage probit model estimation presented in Table 3 were used to generate samples of matched irrigators and non-irrigators using the kernel and nearest neighbour matching methods. However, to check that the propensity score is balanced across treatment and comparison groups, the common support condition was imposed on the estimation by matching in the region of common support. Results indicated that the common support condition is satisfied as there is significant overlap in the distribution of the propensity scores of both treated and untreated groups. PSM results are presented in Table 4. Only observations within common support are used, that is, observations for which matches were found (61 irrigators as indicated in Table 4). Since ATT is the average treatment effect on the treated, the standard errors for the ATT were calculated using bootstrapping with 100 replications.

Table 4: Average Treatment Effects of the outcome variables

Outcome variable	ATT	Standard error	t-value
	Using nearest neighbour method		
Household income (R)	85804.46	43088.19	1.99
Food security situation (dummy)	0.631	0.340	1.86

Number of treated units used=61 and number of control units used =13			
	Using kernel matching method		
Household income (R)	69503.66	30611.07	2.27
Food security situation (dummy)	0.571	0.223	2.55
Number of treated units used= 61 and number of control units used = 36			

Using the nearest neighbour matching strategy, smallholder irrigation farming showed a positive effect on both the household income and household food security situation, shown by the significant *t*-values (1.99 and 1.86, respectively). Confirming results of the nearest neighbour approach, the kernel matching strategy results indicate that smallholder irrigation farming had a significant positive effect on both household income and household food security situation (*t*-values of 2.27 and 2.55, respectively).

The nearest neighbour matching method matched 61 treatment units with 13 control households, and concluded that irrigation access results in an increase of about R85 804.46 in annual household income over that of non-irrigators. Irrigators were 63% more likely to be food secure compared to non-irrigators. The Kernel matching method, on the other hand, identified 36 matching control households against 61 treatment households in calculating the impact estimate. The Kernel matching method concluded that irrigation access results in a gain of R69 503.66 in household income for irrigators. According to the Kernel method, irrigators were 57% more likely to be food secure than non-irrigators.

An assessment of the quality of the matching process showed that the balancing property was satisfied. Results of a two-sample *t*-test investigating the significance of the post-matching differences in the covariate means for the two groups did not portray any statistically significant difference between irrigators and non-irrigators. After matching, there were no statistically significant differences between the matched treatment and the control units.

DISCUSSION

The objective of this paper was to examine the contribution of smallholder irrigation farming to the livelihoods of rural households. Analysis of the data focused on the contribution of irrigation farming to household income and household food security, as the select livelihood outcome variables. Two groups of households were compared, namely, irrigators (scheme and non-scheme irrigators) and non-irrigators (home gardeners). Noteworthy is that irrigation farming contributes substantially to the household income and food security of irrigating households, indicating the significance of irrigation farming for improved rural livelihoods.

Results show that the smallholder farmers (independent irrigators, scheme irrigators and home gardeners) were typically men older than 55 years. These results are consistent with literature where most irrigators started their farming enterprises with money they had earned in sectors of the economy other than agriculture or using family savings (Vaughan, 1997; Du Plessis & Van Der Stoep, 2001; Oosthuizen *et al*., 2005; Tapela 2012). More than 60% of the household heads were male. The gender over-representation of men among irrigators might be linked to apartheid policies that had a male bias in land allocation.

Access to irrigation enabled farmers to diversify their crop mix, as households who irrigated grew a wider variety of crops and cultivated land more than once a year compared to non-irrigators. Irrigators had the highest proportion of households reporting always having enough food (29%) while home gardener households reported not having enough food most of the time (40%). This assessment of the food security situation confirms findings of other studies in Ethiopia, Kenya, South Africa and Zimbabwe, which show that households participating in irrigation farming never run out of food and their hungry months are reduced substantially, unlike their non-irrigating counterparts (Mudima, 2002; Ngigi, 2002; IFAD, 2005;

Benson, 2015; Dube & Sigauke, 2015).

Results from assessing sources of household income suggest that farming is the main source of income for irrigators while non-irrigators derive their income mainly from non-farm sources. The above also confirm findings of previous studies that social grants and social networks, in particular, are critical to many poor households in South Africa, with over 17 million people, up from 2.5 million in 1998, receiving social welfare grants from the government each month in 2017 (Tapela, 2008; Department of Social Development, 2010; AfDB, 2012; SASSA, 2017; Sinyolo *et al.* 2017). South Africa's rural livelihoods have always been characterised by a combination of land-based and non-farm activities, with a significant reliance on the country's comparatively well-developed system of state cash transfers (Neves & Du Toit, 2013). The diversity of rural livelihood strategies in South Africa has been documented in literature as heavily relying on remittances from relatives and for moral and material support from neighbours. Other households rely on membership of burial societies and church organisations as a livelihood coping strategy (Tapela, 2008; Neves & Du Toit, 2013).

Results from the PSM method indicated that household income for irrigators is at least 54% higher than for non-irrigators and irrigators are at least 57% more likely to be food secure than non-irrigators. Evidence presented suggests that smallholder irrigation farming is potentially transformative to poor communities through improving household income and providing food.

It may be concluded that, although smallholder irrigation farming has been reported as a failed intervention in South Africa, particularly due to collapsed irrigation schemes, operational irrigation schemes play an important role in rural livelihoods. This provides a strong motivation for continued investment in smallholder irrigation farming in South Africa as part of a strategy to improve rural livelihoods and to grow the rural economy. Special attention should be given to significant factors that influenced participation in irrigation farming and also factors that significantly distinguished independent irrigators from scheme irrigators and non-irrigators, which included age, gender, entrepreneurial attitude, membership to associations, and access to assets. The contribution of smallholder irrigation to rural livelihoods can be further enhanced by focussing on policies that encourage female participation in irrigation farming, equip households with entrepreneurial and enhance household access to natural, physical and financial resources. Policies that enhance the efficiency of farmer' associations in encouraging more farmers to become irrigators are also important. As independent irrigators benefit more from smallholder irrigation farming, independent irrigation should be promoted as an option for expanding smallholder irrigation farming. Thus far, no systematic study has been done of independent irrigators in South Africa, but research reports show that they exist in this country.

Considering that these farmers have developed irrigation enterprises on their own without financial or other support from government or other formal institutions, they present a very interesting alternative to government-led irrigation development. It is, therefore, appropriate to include this group of smallholders as one of the distinct populations of smallholder irrigators for study under the auspices of NDP of the country. Moreover, indications are that South African independent irrigators have a knack for entrepreneurship, which is one of the focal points of this project. Policies for expanding smallholder irrigation should be integrated into the overall strategy of growing the rural economy within the National Development Plan of the country.

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REFERENCES

1. Abric, S., Sonou, M., Augeard, B., Onimus, F., Durlin, D., Soumaila, A. & Gadelle, F. (2011) Lessons learned in the development of smallholder private irrigation for high-value crops in West Africa. World Bank Report. https://doi.org/10.1596/27375.
2. African Development Bank (AfDB), Organisation for Economic Co-operation and Development (OECD), United Nations Development Programme (UNDP), United Nations Economic Commission for Africa (UNECA). (2012) African Economic Outlook-South Africa. Available at: www.africaneconomicoutlook.org. Last accessed 19.07.2012.
3. Aliber, M. (2003) Chronic poverty in South Africa: incidence, causes and policies. World Development 31(3), 473-490.
4. Asian Development Bank (ADB). (2003) Water and poverty – a collection of case studies: Experiences from the field.
5. Backeberg, G.R. (2006) Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture? Irrigation and Drainage 55(1), 1-12.
6. Belete, A., Igodan, C.O., M'Marete, C. & Van Averbeke, W. (1999) Analysis of rural household consumption expenditure in South Africa: the case of foodplot holders in the Tyefu irrigation scheme in the Eastern Cape Province. Agrekon 38(2), 194-201.
7. Bembridge, T. (2000) Guidelines for rehabilitation of small-scale farmer irrigation schemes in South Africa. WRC Report No. 891/1/00. Water Research Commission, South Africa: Pretoria.
8. Benson, T. (2015) Association between irrigated farming and improved nutrition in farm households in Malawi. Agrekon 54(3), 62-86. DOI:10.1080/03031853.2015.1084940.
9. Crosby, C.T., De Lange, M., Stimie, C.M. & Van Der Stoep, I. (2000) A review of planning and design procedures applicable to small-scale farmer irrigation projects. Water Research Commission Report number 578/2/00. Water Research Commission, South Africa: Pretoria.
10. De Lange, M. (1994) Small-scale irrigation in South Africa. Water Research Commission Report number 578/1/94. Pretoria: Water Research Commission.
11. Denison, J. & Manona, S. (2007) Principles, approaches for the participatory revitalisation of smallholder irrigation schemes. Volume 1: A rough guide for irrigation development practitioners. Water Research Commission Report number TT 308/07. Water Research Commission, South Africa: Pretoria.
12. Department of Agriculture, Forestry and Fisheries (DAFF). (2012) Draft business plan-revitalization of irrigation schemes, part 1 irrigation infrastructure. Department of Agriculture, Forestry and Fisheries, South Africa.
13. Department of Government Communication and Information System (GCIS). (2015) South Africa YearBook 2014/15. Republic of South Africa.
14. Department of International Development (DFID). (1999) Sustainable livelihoods guidance sheets.
15. Department of Social Development. (2010) Available at: http://www.dsd.gov.za/index.php?option=com_content&task=view&id=278&Itemid=82. Last accessed 07.10.2011.
16. Dube, K. & Sigauke, E. (2015) Irrigation technology for smallholder farmers: a strategy for achieving household food security in lower Gweru Zimbabwe. South African Journal of Agricultural Extension 43(1), 1-11.
17. Ellis, F. (1998) Household strategies and rural livelihood diversification. The Journal of Development Studies 35(1), 1-38.
18. Hanjra, M.A., Ferede, T. & Gutta, D.G. (2009) Pathways to breaking the poverty trap in Ethiopia: investments in agricultural water, education and markets. Agricultural Water Management 96(2009),

1596-1604.
19. Hanjra, M.A., Ferede, T., & Gutta, D.G. (2009) Reducing poverty in sub-Saharan Africa through investments in water and other priorities. Agricultural Water Management 96(7), 1062-1070.
20. Heckman, J., Ichimura, H., Smith, J. & Todd, P. (1998) Characterizing selection bias using experimental data. Econometrica 66(5), 1017-1098.
21. Hendriks, S. L. (2015) The food security continuum: a novel tool for understanding food insecurity as a range of experiences. Food Security 7(2015), 609-619. DOI:10.1007/s12571-015-0457-6.
22. Hendriks, S.L. & Lyne, M.C. (2003) Agricultural growth multipliers for two communal areas of KwaZulu-Natal. Development Southern Africa 20(3), 423-444.
23. Hope, R.A., Gowing, J.W. & Jewitt, G.P.W. (2008) The contested future of irrigation in African rural livelihoods: Analysis from a water scarce catchment in South Africa. Water Policy 10, 173-192.
24. Human Sciences Research Council (2014) State of poverty and its manifestation in the nine provinces of South Africa. Beyond 10 years of unlocking potential, National Development Agency, South Africa.
25. Hussain, I. & Hanjra, M.A. (2004) Irrigation and poverty alleviation: review of the empirical evidence. International Water Management Institute (IWMI), Sri Lanka: Colombo.
26. Hussain, I., Giordano, M. & Hanjra, M.A. (2003) Agricultural water and poverty linkages: case studies on large and small systems. Centre for Poverty Analysis. International Water Management Institute (IWMI), Sri Lanka: Colombo.
27. International Fund for Agricultural Development (IFAD). (2012) The sustainable livelihoods approach. Available at: http://www.ifad.org/sla/index.htm. Last accessed 22.01.2013.
28. Irajpoor, A.A. & Latif, M. (2011) Performance of irrigation projects and their impacts on poverty reduction and its empowerment in arid environment. International Journal of Environmental Science and Technology 8(3), 533-544.
29. Johnston, P., Hanchigonta, S., Sibanda, L.M. & Thomas, T.S. (2012) Southern African agriculture and climate change: A comprehensive analysis – South Africa summary note.
30. Kergna, A.O. & Dembele, D. (2018) Small-scale irrigation in Mali: Constraints and opportunities. FARA Research Report, Volume 2 No. 13 (2018).
31. Krantz, L. (2001) The sustainable livelihood approach to poverty reduction: An introduction. Swedish International Development Cooperation Agency (Sida), Division for Policy and Socio-Economic Analysis.
32. Labadarios D., Davids, Y.D., Mchiza, Z., & Weir-Smith, G. (2009) The assessment of food insecurity in South Africa. Pretoria: Centre for Poverty, Employment and Growth, Human Sciences Research Council.
33. LaFlamme, M. & Davies, J. (2007) Developing a shared model for sustainable aboriginal livelihoods in natural-cultural resource management, CRC-Desert knowledge. Available at http://www.desertknowledgecrc.com.au/research/inlandpublications.html.
34. Lipton, M. (2005) Can small farms survive, prosper, or be the key channel to cut mass poverty? Presentation to FAO Symposium on Agricultural Commercialisation and the Small Farmer, Rome, 4-5 May 2005.
35. Lipton, M., Litchfield, J., Blackman, R., De Zoysa, D., Qureshy, L. & Waddington, H. (2001) The impact of irrigation on poverty. Poverty Research Unit at Sussex, UK: University of Sussex.
36. M'Marete, C.K. (2003) Climate and water resources in the Limpopo Province. Department of Agricultural and Rural Engineering, South Africa.
37. May, J. (2000) Poverty in South Africa: Meeting the challenge. Cape Town: David Philip.
38. McCartney, M., Rebel, L-M, Sellamuttu S.S. & De Silva, S. (2010) Wetlands, agriculture and poverty reduction. Research Report 137, International Water Management Institute (IWMI). Sri Lanka: Colombo. doi: 10.5337/2010.230:39p.
39. Mendola, M. (2007) Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. Food Policy 32(2007), 372-393.

40. Moyo, T & Machethe, C.L. (2016) The relationship between smallholder irrigation and household food availability and dietary diversity in Greater Tzaneen Municipality of Limpopo Province, South Africa. Journal of Sustainable Development 9(4); 165-178.
41. Mudau, K.S. (2010) Farmers' strategies and modes of operation in smallholder irrigation schemes in South Africa: a case study of Mamuhohi irrigation scheme in Limpopo Province [Unpublished dissertation]. South Africa: University of Pretoria.
42. Mudima, K. (2002) Socioeconomic impact of smallholder irrigation development in Zimbabwe: A case study of five successful irrigation schemes. In Sally, H. and Abernethy, C.L. (eds). Proceedings of private irrigation in sub Saharan Africa. IWMI, FAO, ACP.
43. National Planning Commission (NPC). (2011) National Development Plan: Vision for 2030. South Africa.
44. Neves, D. & Du Toit, A. (2013) Rural livelihoods in South Africa: Complexity, vulnerability and differentiation. Journal of Agrarian Change 13(1), 93-115.
45. Ngigi, S. (2002) Review of irrigation development in Kenya. In Sally, H. and Abernethy, C.L. (eds). Proceedings of private irrigation in sub Saharan Africa. IWMI, FAO, ACP-EU.
46. Ngqangweni, S.S. (2000) Promoting income and employment growth in the rural economy of the Eastern Cape through smallholder agriculture. Ph.D Thesis; University of Pretoria, South Africa.
47. Nhundu, K. & Mushunje, A. (2012) Irrigation development: A food security and household income perspective, problems, perspectives and challenges of agricultural water management, Dr. Manish Kumar (Ed.), InTech, DOI: 10.5772/30865. Available at: https://www.intechopen.com/books/problems-perspectives-and-challenges-of-agricultural-water-management/irrigation-development-food-security-and-household-income-perspective. Last accessed 29.11.2016.
48. Nkala, P., Mango, N. & Zikhali, P. (2011) Conservation agriculture and livelihoods of smallholder farmers in central Mozambique. Journal of Sustainable Agriculture 35, 757-779.
49. Ntsonto, N.E. (2005) Economic performance of smallholder irrigation schemes: a case study in Zanyokwe, Eastern Cape, South Africa.
50. Oni, S. A., Maliwichi, L. L. & Obadire, O. S. (2011) Assessing the contribution of smallholder irrigation to household food security, in comparison to dryland farming in Vhembe district of Limpopo province, South Africa. African Journal of Agricultural Research 6(10), 2188-2197.
51. Pandya, M. & Bhatt, K. (2010) Impact of irrigation on agricultural growth and poverty alleviation in India. International Journal of Agricultural and Statistical Sciences 6(2), 493-497.
52. Phiri, O. (2008) Urban agriculture as a strategy for poverty alleviation: The case of Buffalo City, South Africa. Journal of Social Development in Africa 23(1), 111-138.
53. Rosenbaum, P.R. 2002. Observational studies. New York: Springer.
54. Rosenbaum, P.R. & Rubin, D.B. (1983) The central role of the propensity score in observational studies for causal effects. Biometrika 70(1), 41-55.
55. SASSA. (2017) Fact sheet: Issue no 1 of 2017. A statistical summary of social grants in South Africa. South Africa Social Security Agency (SASSA), Pretoria. Available at: www.sassa.gov.za. Last accessed 15.11.2017.
56. Sinyolo, S., Mudhara, M. & Wale, E. (2017) Assessing the impact of social grant-dependency on participation of KwaZulu-Natal rural households in farming: Application of the generalised propensity score method. Journal of Agriculture and Rural Development in the Tropics and Subtropics 6(3), 483–499.
57. Smith, J. & Todd, P. (2005) Does matching overcome Lalonde's critique of non-experimental estimators? Journal of Econometrics 125(2005), 305-353.
58. Stats SA (Statistics South Africa). (2017) Media release (31 May 2017). General household survey, 2016. Available at: http://www.statssa.gov.za/?p=9922 Last accessed 14.12.2018.
59. Stats SA (Statistics South Africa). (2014) Poverty trends in South Africa: An examination of absolute poverty between 2006 and 2011. Report No. 03-10-06. Statistics South Africa, Pretoria.

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60. Stats SA (Statistics South Africa). (2012) Poverty profile of South Africa: Application of the poverty lines on the LCS 2008/2009. Report No. 03-10-03 (2008/2009). Statistics South Africa, Pretoria.
61. Tapela, B. N (2008) Livelihoods in the wake of agricultural commercialisation in South Africa's poverty nodes: insights from small-scale irrigation schemes in Limpopo Province. Development Southern Africa 25(2), 181-198.
62. Tekana, S.S. & Oladele, O.I. (2011) Impact analysis of Taung irrigation scheme on household welfare among farmers in North West Province of South Africa. Journal of Human Ecology 36(1), 69-77.
63. Van Averbeke, W. & Mohamed, S.S. (2006) Smallholder irrigation schemes in South Africa: past, present and future. Centre for Organic and Smallholder Agriculture, Department of Crop Sciences, Tshwane University of Technology, Pretoria, South Africa. Available at: http://www.sancid.org.za/files/keyNotesAdd.doc. Last accessed 06.11.2012.
64. Van Averbeke, W., Denison, J. & Mnkeni, P. (2011) Smallholder irrigation schemes in South Africa: a review of knowledge generated by the Water Research Commission. Water SA 37(4).
65. Webb, P., Coates, J., Frongillo, E. A., Lorge Rogers, B., Swindale, A. & Bilinsky, P. (2006) Measuring household food insecurity: why it's so important and yet so difficult to do. Journal of Nutrition 136, 1404S-1408S.
66. Winters, P., Davis, B. & Cural, L. (2002) Assets, activities and income generation in rural Mexico: Factoring in social and public capital. Agricultural Economics 27(2), 139-156.

FOOTNOTE

[1] R90 000 and R212 000 were equivalent to US$10 388 and US$24 470 in 2012, respectively.

[2] The study's approach to assessing a household's food security situation was based on the household head's perception and self-reported experience of access to food over the 12 months prior to the interview. Given the open-ended nature of the food security definition, this study only covered an aspect of food security without specifically considering all the pillars of food security i.e. food availability, access to food, food utilisation and stability (Vink, 2012, Webb *et al.* 2006; Hendriks, 2015).

[3] The sign 'R' stands for the currency of South Africa, the Rand.

[4] Entrepreneurial attitude was determined through averaging scores from farmers on questions capturing personality traits that have been linked to entrepreneurship, such as, need for achievement, locus of control and risk-taking propensity. Farmers with the highest score of 1 were regarded as being entrepreneurial.

[5] R130 645, R117 698 and R56 854 were equivalent to US$12 658, US$11 404 and US$5 509, respectively.

[6]Salaries and wages were derived from employment during 2012-13 and employment-related pension earned during the same period.

[7] R95 564 and R36 963 are equivalent to US$9 259 and US$3 581, respectively