J Hum Ecol, 57(1,2): 31-37 (2017)
DOI:10.31901/24566608.2017/57.1-2.05

Assessing the Impact of Irrigation Scheme on Smallholder Farming: The Case of Smallholder Maize Farming in Eastern Cape of South Africa

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KEYWORD Irrigation Scheme. Poor Farmers. Revitalization. Smallholder Farmers

ABSTRACT The South African government has long been committed to expansion of agricultural production through mechanization and pursued this goal under a series of interventions and reform programs that includes the construction and revitalization of irrigation schemes, subsidization of farm input factors and provision of credit facilities to rural poor farmers, communal and resettlement state land were also encouraged. The objectives of the study were to analyse the socio-economic features of the smallholder maize farmer and further to examine the performance of irrigation schemes located in the former homelands in the Eastern Cape Province. One hundred farmers comprising of thirty (30) homestead gardeners and seventy (70) smallholder irrigators were interviewed using a multistage sampling technique, structured questionnaires were used to collect data on demographic background of these farmers, data on production level, productivity in terms of costs and returns were also collected. Descriptive statistics such as means, percentages, frequency distributions and tables, as well as stochastic frontier model were used in analyzing the objectives. Results from the socio-economic features of the area were discussed with the use of descriptive statistics and were discussed. The Stochastic Frontier Model revealed the significant impact of the program on participating farmers, highlighting the significance of irrigation schemes to these smallholder farmer and other productive factors. While overall production and productivity remain low, triggering a hyperinflationary situation due to supply constraints, practical implications for agribusinesses are not uncommon.

INTRODUCTION

Irrigation and Agriculture in South Africa

South African's agriculture suffers from limited water availability. Only 49, 228 million m^3 per year of runoff water, mainly from rivers, is available for over 51.7 million people in South Africa, thus, only 952m^3 per year of water is available for use per person. According to Coissard (2010), for a country to be declared *water stressed*, 45 drops below 1,700m^3 per person is the annual water supply, while Backeberg (2005) for instance indicated a threshold of 1000m^3 of water supply per person per year. Therefore, the per capita water availability of 952m^3 per year is below the two thresholds, indicating that South Africa is a - *water stressed* country (Backeberg 2005). Furthermore, the country is faced with inconsistent rainfalls and semi-arid conditions which can hardly prevent high rates of water evaporation (Heyns 2003). For example, Backeberg (2005) revealed in his report the variation in rainfall patterns across South Africa ranging from over 800 mm/year in the East, less than 200 mm/year in the West, and about sixty-five percent (65%) of the area countrywide receiving less than 500 mm/yr. This amount of precipitation is insufficient to support the agricultural sector in the country. Therefore, irrigation is indispensable for maintaining agricultural production at acceptable levels. Irrigation farming utilizes more than fifty percent (50%) of South Africa's water resource on over 1.3 million hectares (Van-Averbeke et al. 2011). There are over 300 irrigation schemes in South Africa established 60 years ago on both smallholder and large commercial scale (Manona et al. 2010; Van-Averbeke et al. 2011). These irrigation schemes support over twenty-five percent of national agricultural production, and largest area eighty per-

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cent (80%) is used to mainly grow crops such as potatoes, vegetables, grapes, fruit and tobacco, maize and about twenty percent of the area is mainly under sugarcane and cotton production (Backeberg 2005; Manona et al. 2010; Van-Averbeke et al. 2011). Irrigation farming started as early as 1652 at the arrival and settlement of Europeans in South Africa on a private basis. From 1912 onwards systems have been developed to coordinate irrigation operations countrywide (Perret and Touchain 2002; Kodua-Agyekum 2009). The developed and coordinated category of irrigation schemes include, the irrigation board schemes, white settlement schemes and Bantustan schemes' food plots and community garden schemes (Perret and Touchain 2002). During the severe drought and economic depression of the 1930s, South African development and economic growth programs were directed toward irrigation farming as a remedy for increased agricultural productivity, food security and rural employment (Van Averbeke et al. 2011).

However, there was unfair distribution of access to irrigation facilities in terms of land sizes, where white farmers receiving areas under the large irrigation schemes (8 ha to 20ha), often 10 times larger than the 1.5 ha allocated to black farmers (Van Averbeke et al. 2011). Even the smallest irrigation plots allocated to black farmers collapsed due to the management gaps and institutional failures that existed among the smallholder irrigation scheme operators (Van Averbeke et al. 2011). The revitalization of these schemes began in 1994 through the introduction of canal irrigation schemes in the Eastern Cape and these included Ncora, Keiskammahoek, Tyefu, Shiloh and Zanyokwe. Despite these developments, smallholder farms still faced low outputs and productivity (Van Averbeke et al. 2011).

Objectives of the Study

- To analyse the socio-economic features of the smallholder maize farmer
- To examine the performance of irrigation schemes located in the former homelands in the Eastern Cape Province

Research Questions

- What are the socio-economic features of the smallholder maize farmer?
- How does the performance of irrigation schemes located in the former homelands in the Eastern Cape Province affected the smallholder maize farmers?

METHODOLOGY

The study was carried out in Qamata and Tyefu communities in the Eastern Cape (EC) Province of South Africa. The EC is one of the nine provinces of South Africa, bordering with the provinces of the Western Cape, the Free State, KwaZulu-Natal and Lesotho in the north (Eastern Cape Provincial Legislature 2003). The area is made up of thirty-nine (39) municipalities of which thirty-seven (37) and two (2) are categorized as local and metropolitan municipalities, respectively. The area is referred to as the traditional home of the *Xhosa* tribal group of South Africa. The vast interior of the Province ranges from the dry Karoo in the west to the rolling hills and cascading rivers of the Transkei in the East. It is made up of two regions: the Western and the Eastern regions. The area lies within latitudes and longitudes $32^{0}00^{/}$S and $26^{0}00^{/}$E. The land area covering of EC is approximately 169, 580 sq. km, which is about 13.9 percent of the South African total area (Eastern Cape Department of Rural Development and Agrarian Reform (ECDRAR) 2013). Out of the 51, 770, 560 persons which make up South Africa's total population, the area is estimated to have 6, 562, 053 persons (Statistics South Africa 2012). In order words, the population of people living in the rural area accounted for sixty percent of the total population. The demographic features of ECP is characterized by high level of illiteracy, high level of poverty, high unemployment rate, poor infrastructural facilities and lack of other basic amenities. According to ECDRAR (2013) and Eastern Cape Socio-Economic Consultative Council (ECSECC) (2015), the contribution of agriculture to the Gross Domestic Product (GDP) of the area has been on the decline. Due to the nature of the study, some purposive and random sampling techniques were adopted for the study. Information regarding the operational status of the irrigation schemes in the Eastern Cape Province (ECP) of South Africa was accessed through stakeholder meetings with the officials of the Department of Rural Development and Agrarian Reform (DRDAR), and officials at the Municipal offices, as well as the community

members. Based on the information gathered, the two smallholder irrigation schemes and the surrounding communities were identified. Out of the thirty-seven (37) municipalities that make up the ECP of South Africa, two (2) municipalities namely: Qamata and Tyefu irrigation schemes were purposively chosen because they are considered the largest small-scale irrigation schemes in the Transkei and Ciskei homelands, respectively. A research team involved in data collection who sought support from extension officers and were assisted by community authorities. A random selection technique was adopted in selecting thirty (30) homestead maize gardeners and forty (40) smallholder maize irrigators in Qamata area, while five (5) homestead maize gardeners and twenty five (25) smallholder maize irrigators in Tyefu area, respectively. This resulted in a total of 70 farmers being interviewed in Qamata and 30 farmers in Tyefu irrigation schemes, respectively. In all, an overall sample size of 100 smallholder maize farmers were selected for the study. Descriptive statistics such as frequencies and percentages were used to describe the socio-economic features of the smallholder maize farmers in the study area and stochastic possibility frontier was used to calculate the efficiency of the maize farmers under the homestead and irrigation scheme.

RESULTS AND DISCUSSION

Description of the Socio-demographic Variables of Smallholder Farmers

The Table 1 shows that most farm households were headed by males, the proportions being significantly higher among the homestead food gardeners at a five percent (5%) level. Male dominance among both smallholder irrigators and homestead food gardeners representing fifty-nine percent (59%) and seventy-eight percent (78%) respectively in the study area may be attributed to loss of jobs through retrenchment policies, retirement and the high unemployment rate especially in the formal sector that requires more educated skilled labor. Secondly, over ninety percent (90%) farm plots on irrigation schemes and dry land were allocated to men due to the bias of the African cultural rules and norms which deny woman's legal rights to own such a crucial agricultural resource (Koduа-Agyekum 2009). Since Qamata and Tyefu irrigation scheme areas were mainly administered by Tribal Authorities, tribal rules and cultural norms were prevalent during the distribution of farm plots. According to the results presented in Table, there are relatively more women participating in irrigation farming representing (41%) than in homestead food gardening which represent

Table 1: Demographic features of the farmers in the study area

	Description	*Smallholder irrigator (n =70) (%)*	*Homestead food gardener (n = 30) (%)*	*Overall sample (n=100) (%)*	*Chi-square test*
Sex of Household Head	Male	59.0	78.0	69.0	5.290**
	Female	41.0	22.0	31.0	
Level of Formal Education	Non	35	20	28	5.647
	Primary	36	48	42	
	Secondary	26	32	29	
	Tertiary	3	0	1	
Major Occupation	Farmer	94	90	92	3.742
	Self-employed	4	6	5	
	Civil servant	2	4	3	
		Mean-value	*Mean-value*	*Average Mean value*	*T-test*
Household Size		4.537	4.400	4.469	0.358
		(2.698)	(1.990)	(2.344)	
Age of Farmer (Years)		60.232	61.900	61.066	-0.777
		(12.289)	(13.117)	(12.703)	
Years Spent in School		4.944	5.900	5.422	-1.303
		(4.574)	(4.142)	(4.358)	
Faming Experience (Years)		10.833	15.200	13.017	2.147**
		(11.821)	(12.036)	11.928)	

Source: Computed from Field Survey Data, 2014.

twenty-two percent (22%). The increased number of women participating in irrigation farming may be due to affirmative action programs and policies in recent years which promote women's access and control over or inherit farm plots. Although there is an increase in women's ownership of plots, that may not be the case for women participating in homestead food gardening where the traditional norms are still prevalent (Kodua-Agyekum 2009).

Types of Irrigation Systems used by Smallholder Farmers

Six major types of irrigation systems were identified to be very common to smallholder farmers in Qamata and Tyefu irrigation scheme areas, and these are namely furrowing, sprinkler, hose pipe, bucket, and flooding and pivot irrigation systems. Sprinkler and Furrowing were the most commonly used irrigation system among smallholder irrigators representing forty-seven percent (47%) and forty-five (45%), respectively whereas homestead food gardeners irrigated their crops using mainly hose pipes representing thirty-seven percent (37%) connected to water taps followed by furrowing which represent twenty-nine percent (29%). All farmers at Qamata irrigation scheme use furrowing type of irrigation with exception of some days when they are allowed to apply the flooding type of irrigation. Tyefu irrigation scheme mainly uses sprinkler type of irrigation system though water flows by gravity as in the Qamata irrigation scheme. Watering crops using buckets was mainly done by homestead food gardeners who fetched water from the canal for that purpose. The flooding type of irrigation requires larger volumes of water, hence limiting its use by homestead food gardeners. Overall, furrowing representing thirty-seven percent (37%) was the most used type of irrigation followed by sprinkler with thirty percent (30%), hose pipe with nineteen percent (19%), buckets representing eleven percent (11%), flooding with two percent (2%) and pivot with two percent (2%) types of irrigations, respectively.

Constraints to Smallholder Irrigation Farming

From the results generated using SPSS software multiple response technique where some respondents provided more than one option making total number of 221 responses, and as represented in Table 2, it was concluded that these farmers are faced with a lot of challenges. The outcome of the analysis indicated, that thirty percent of smallholder irrigator farmers reported that inadequacy of water supply by the irrigation scheme was reported as their major constraints which have a negative impact on their productivity. It may be ascribed to limited number of irrigations per week directed to farmers by the irrigation scheme managers. Qamata and Tyefu irrigation schemes are among the small-scale irrigation schemes which were transferred. However, through the researcher's observations and explanations from the extension workers at both schemes, the scheme's operations seemed to have worsened since the transfer.

At least thirty percent of farmers indicated that the high costs of repairs and rehabilitation of the scheme are a major problem. Further, the government agents who managed and operated the irrigation schemes did not orientate the smallholder farmers on how to make the irrigation scheme facilities operational there by creating a skills gap and this makes it hard for farmers to carry out the day to day operations of the scheme as reported by fifteen percent (15%) of the farmers. Moreover, in an exclusive interview with some of the farmers' committee members of the scheme at Qamata, it was revealed that farmers did not know how to open the water valves connected to pipes from the dam that allows water to flow into their fields and lacked the technical knowledge on how the whole irrigation system operates.

Table 2: Challenges faced by smallholder irrigators on the schemes challenge

	Number of responses	*Percentage*
Inadequate water	66	30
High costs of repairs and rehabilitation	66	30
Hard to operate	34	15
Poor management	23	10
Not profitable	12	5
Not productive	6	3
Lack fencing	6	3
underutilized	4	2
Theft	2	1
Limited land and rigid land and water user rights transfers	2	1

Note: SPSS Version 11
Source: Computed from Field Survey Data, 2014

Farmers' Benefits from Group Membership

Table 3 indicates that sixty-one percent (61%) of the sampled farmers belong to smallholder

irrigators group while fifty-nine percent are in the homestead food gardeners group. Benefits accrued to being members of these farmers groups are enormous that farmers will always want to be member. The group serves as a major source of supply of farm labor to both smallholder irrigators representing forty-five percent (45%) and homestead food gardeners representing fifty percent (50%). Remarkably, farmer groups arrange a form of subsidy on farm inputs to members such as smallholder irrigators representing twenty-six percent (26%) and homestead food gardeners representing twenty-nine percent (29%) and served as a collective marketing agent to smallholder irrigators twenty-six percent (26%) and homestead food gardeners seventeen percent (17%). The group membership also allows both smallholder irrigator and homestead food gardeners access to farm related information and credit access through group loans from microfinances and other financial institutions.

Technical Efficiency and Irrigation

Table 4 depicts that the overall technical efficiency combining both the smallholder irrigators and homestead food gardeners was estimated and a t-test was carried out to compare the performance of the two groups. Both the smallholder irrigators and homestead food gardeners were technically efficient at about 98.80 percent. The results indicate a slight difference between technical efficiency scores of smallholder irrigators and homestead food gardeners; the overall representation indicates a significant difference at one percent (1%) level where smallholder irrigators were technically more efficient than homestead food gardeners. These stochastic production frontier results are closely related and confirm the VRS technical efficiency scores generated by the DEA modelling approach, suggesting that farmers do not operate at the same optimal scale/frontier.

The t-test of T. E. for Smallholder Irrigators and Homestead Gardeners for Maize Enterprise (100)

Table 5 shows the results obtained when the efficiency levels of smallholder irrigators and homestead food gardeners were compared using STATA model. Judging from the empirical, homestead food gardeners are less efficient to smallholder irrigators at one percent level. This

Table 3: Farmers' benefits from group membership farmer benefit

	Smallholder irrigators (n = 70) (%)	*Homestead food gardener (n =30) (%)*	*Overall sample (n =100) (%)*
Group membership	61	59	60
Access to labor	45	50	48
Access to agro- inputs	26	29	28
Collective marketing	25	17	21
Access to farm information	0	4	2
Access to credit	3	0	1

Note: SPSS Version 11
Source: Computed from Field Survey Data, 2014

Table 4: The t-test of technical efficiency for smallholder irrigators and homestead food gardeners

	Sample size	*Mean efficiency*	*Standard error*	*Standard deviation*
Smallholder irrigators (y)	70	0.988017	0.000001	0.000076
Homestead food gardeners(x)	30	0.987964	0.000010	0.000071
Combined	100	0.9880012	0.000006	0.000078
Mean difference	0.0000536	0.000013		

Source: Computed from Field Survey Data, 2014
Satterthwaite's degrees of freedom = 98 t = 4.1224
Ho: mean(y) - mean(x) ≠ 0
Ho: diff = 0
Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 1.0000 Pr (T > t) = 0.0001 Pr (T > t) = 0.0000

Table 5: The t-test of T.E for smallholder irrigators and homestead gardeners: Maize enterprise type of farmer

	Sample size	*Mean efficiency*	*Standard error*	*Standard deviation*
Smallholder irrigators (y)	70	0.4835	0.0281814	0 .24242
Homestead food gardeners(x)	30	0.3432	0.0371633	0.206917
Combined	100	0.4421	0.0234501	0.240292
Mean difference	0.1403	0.0497723		

Source: Computed from Field Survey Data, 2014
Satterthwaite's degrees of freedom = 98 t = 2.8198
Ho: mean(y) - mean(x) = 0
Ho: diff = 0
Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.9971 Pr (T > t) = 0.0058 Pr (T > t) = 0.0029

is as a result of the use of improved technology for increased farmers' technical efficiency. Smallholder irrigators on the average were 48.35 percent technically efficient while homestead food gardeners on the average were 34.32 percent technically efficient in maize production. These results suggest that homestead food gardeners should shift from the type of irrigation systems they use in maize production to that of smallholder irrigators in order to be more technically efficient. So that there will be an increase in the total productivity in the area.

CONCLUSION

Smallholder irrigation scheme has a lot of potentials to offer to farmers in increasing their productivity if properly administered. From the study maize farmers with the use of irrigation scheme/technology perform significantly better than their counter parts in homestead gardening which is the primary aim of this study to know if the irrigation scheme is relevant to their farming life but not without any constrains of challenges. It is also observed that government still provides extension services to smallholder irrigators at the Qamata and Tyefu irrigation schemes. This singular gesture does not go down well with these farmers as majority interviewed complained bitterly with the services provided by these extension officers. Almost, seventy-five percent (75%) of these farmers are calling for more support from the government in respect to inputs provision, and more skilled extension officers in technical aspects of irrigation systems. However, fifteen percent (15%) of the farmers called for the role of NGOs to be enhanced to support farmers in different aspects of their farming business. The remaining respondents that comprises of ten percent (10%) of the sample indicated that the community authorities should intervene to solve some of these challenges especially the problem of land access and transfer of water use rights for improved operation of the system. Lastly, ten percent (10%) of farmers' response showed that farmers are skeptical of their ability to handle, manage and operate the irrigation schemes themselves. The irrigation scheme is very important to smallholder maize farming in the study area.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the Water Research Commission (WRC) and Govan Mbeki Research Development Centre (GMRDC) for the funding aid and logistics assistance provided in the course of carrying out the study.

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Paper received for publication on July 2016
Paper accepted for publication on December 2016