© Kamla-Raj 2019 J Hum Ecol, 68(1-3): 78-88 (2019)
PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608 DOI: 10.31901/24566608.2019/68.1-3.3169

Household Food Security, Dietary Diversity and Coping Strategies amongst Irrigators in Nqamakwe, Eastern Cape

Mzuyanda Christian and Lelethu Mdoda

Department of Agricultural Economics and Extension, North West University, Private Bag X2046, Mmabatho, 2735, South Africa

KEYWORDS Coping Strategy. Dietary Diversity. Food Security. Irrigators

ABSTRACT This study assessed food access in order to identify coping strategies used by farming households of Nqamakwe in South Africa. A stratified random sample of 100 farmers were interviewed face to face to find out consumption patterns and food coping strategies. The analysis was done using descriptive statistics and propensity score matching. The results specified that irrigation agriculture contributes meaningfully to domestic food production through enhanced food accessibility and nutritional variety. Assessments of usual treatment of the preserved (ATT) suggested that irrigation is able to impact on farmer's income by R1 245 and R1 254 by means of the Nearest Neighbor and Kernel matching methods respectively.

INTRODUCTION

The literature on food security is vast and diverse. But the common thread running through the writings is its important measure of well-being of an individual as well that of a nation. For instance, the 1948 Pronouncement of Human Rights states that, "Everybody has the right to a standard of living adequate for the health and well-being of himself and of his family, including food" (Danieli et al. 1999). Although food is one of the most common basic human needs, it remains a dream for most people in developing nations. The most recent depressing statistics by Food and Agriculture Organization (FAO) (2017) indicated that Africa remains the continent with high prevalence of undernourished countries affecting more than 256 million people. This clearly indicates food produced globally does not necessarily translate to equitable distribution among everyone.

South Africa as an emerging state is no exclusion and has its own reasonable portion to this delinquent. The country is understood to be food secure at the countrywide level in terms of food availability, however it is plagued by widespread nourishment uncertainty and malnutrition in both urban and rural areas (Department of Agriculture, Forestry and Fisheries 2013). For instance, Drimie and Ruysenaar (2010) reported that one out of two households (51.6%) are at risk of hunger; 15.9 percent eat fewer than acceptable energy; and around 22 percent of children below nine years of age are underdeveloped, leaving South Africa in a situation of chronic malnutrition. A projected 20 percent of South Africa's families were found to have deficient or rigorously inadequate nourishment admission (General Household Survey 2008). Nourishment uncertainty in South Africa has been exacerbated by tall joblessness rate (national rate at 25.2% and 29.4% in the Eastern Cape for the first quarter of 2013), insufficient societal well-being arrangements and an extraordinary HIV/AIDS occurrence rate (12.3% in 2012) (Statistics South Africa 2013).

The Eastern Cape is the third biggest province with a population of 6.6 million, with about 12.5 percent of the national population (Stats SA 2016). Of the 6.6 million people in the province, 60 percent live in rural areas (Christian et al. 2019). The province is divided into 7 district municipalities namely: Amatole, Alfred Nzo, Chris Hani, Nelson Mandela Bay and Ukhahlamba. The Jurisdiction's regular poverty level was projected as 74.9 percent in four regions which include O.R Tambo, Alfred Nzo, Joe Gqabi and Chris Hani (Kibirige 2013; Christian 2019). Joblessness proportion was projected at 35 percent and a huge sum of people (2.5 million) make a living through social grants and farming.

Address for correspondence:
Mzuyanda Christian
Department of Agricultural Economics and Extension,
North West University,
Private Bag X2046,
Mmabatho, 2735, South Africa
Telephone: 27(0)-73-929-4430,
E-mail: 33369623@nwu.ac.za

Most Eastern Cape farming households which include (smallholder and subsistence) depend on rain fed agriculture with poor formal education and less resource base for food manufacture which hints to small output (Khapayi 2016). The commencement of climate change, inadequate precipitation and infrequent intense floods results in regular crop disappointments which are having a severe consequence for the living of the populace in the Province. As a result the population of the Eastern Cape is tremendously poor and food insecurity hovers every year. The government has experienced a development of energizing the irrigation schemes in an effort to overcome the stated encounters. However, populations in most parts of the province are stagnant, facing food deficiencies. This provided an adverse imprint about the existence of these irrigation schemes. Consequently, thus why the smallholder irrigation scheme continued destabilised, resulting in its efforts unrealized. Therefore, an assessment must be completed on how the schemes have contributed to people's food security and Dietary Diversity in the Eastern Cape.

Objectives

The main objective of the paper was to evaluate and explore the effect of irrigation of family food production, consumption and ultimately nutritional assortment in Eastern Cape. The study specifically aims:

1. To identify and profile socioeconomic features of smallholder farmers in the study area.
2. To describe the importance of nutritional assortment and food security situation among farmers.
3. To investigate the effect of irrigation on household food security and dietary diversity in the study area.

METHODOLOGY

Study Area

This paper enclosed 20 villages positioned in Nqamakwe of Eastern Cape Province in South Africa. Nqamakwe is characterized by great heights of deficiency and recurrent drought which expose surrounding communities to increase vulnerability to food insecurity. The majority villages in this area had agriculture as their main source of livelihoods while some are involved in informal trading. The main farming activities include maize and sheep production. The rainfall pattern is uni modal and the period is usually short and lasts from March to June.

Research Design

The paper made usage of cross-sectional research design since it allows the investigators to concealment a big segment of the residents. Bryman and Bell (2015) precise a cross-sectional design as,

"*The collection of data on more than one case (usually a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually many more than two), which are then examined to detect patterns of associations.*"

Sample, Sampling Procedures

The study made use of stratified sampling to choose growers in this research paper. The growers were separated into the subsequent sections: irrigation operators and non-operators. After all section, unsystematic sampling was used to attain 50 irrigators and 50 non-irrigators.

Cochran's formula was used to calculate the sample size (Cochran 1963: 75)

$$n_0 = \frac{Z^2\, pq}{e^2} \qquad \text{..... (Equation 1)}$$

Where: n_0 is sample size
Z is critical value of confidence interval
p is the response distribution
q is 1-p
e is the margin of error

Data Collection

Data was collected through a pretested structured survey in this study. Targeted farmers were cross-examined using face to face in their households and with the use of local language (IsiX-

hosa). Data collected includes socioeconomic characteristics, consumption patterns and food access. In order to insure validity and reliability of data collected, the researchers employed university students and were given a two-day training on questionnaire administration.

Data Analysis

The data produced through questionnaires was entered in Excel then elated to SPSS version 24 and STATA 14 for examination and interpreted for both qualitatively and quantitatively. The study made use of descriptive statistics in the form of averages, ratio, means, ordinary deviation, and occurrence distribution to capture smallholder farmer's features. Thereafter, Probit model and tendency notch corresponding were used to examine the effect of irrigation on food security and nutritional assortment in the study area.

In order assess the effect of irrigation to a family food safety and nutritional assortment in the study area, Propensity Score Matching was used. The general formula is specified as follows:

$$Y_i = \alpha_0 + \sum_{i=1}^{n} \beta i Xi + \mu \quad \text{.....(Equation 2)}$$

Where, *Yi* is the reliant on adjustable denotation household food security (family revenue, total spending, family assets and family ingesting).

Xi's are the sovereign variables of the paper (for example, Societal endowments, participation in yield manufacture and auctions, Livestock possession, Non-farm doings as well as payments).

In this circumstance, there is an endogeneity delinquent, subsequently irrigation is solitary of the experiential physiognomies. The query is to guess the action outcome of this observational (non-experimental) study by linking the regular action outcome among the irrigation farmers and non-irrigation farmers of the study. And it can be expressed as follows:

$$ATT_i = E\{Y_{1i} - Y_{0i}/D = 1, P(X_i)\} \text{.....(Equation 3)}$$

Where

ATT = Assessment of Regular Action Consequence for the preserved and switch by prearranged variable (X_i).

Y_{1i} and Y_{0i} = Likely results of the preserved and unprocessed.

Subsequently present capacity be partiality tricky, the paper used propensity score matching where it chooses a switch set that does partake in irrigation to look like them with the preserved set on the foundation of resemblance in the experimental data. Since, the ATT strength is not been new for some defendants, tendency corresponding technique collections a restricted independence theory that all pertinent changes among the two collections be apprehended by their noticeable variables (X_i). Both FPSSI and NFPSSI are corresponding on the foundation of propensity scores.

$$Y_i^0 \perp / X \rightarrow E(Y_i^0 / P_i = 1, X_i) = E(Y_i^0 / P_i = 0, X_i)$$
.....(Equation 4)

The tendency counterpart can procedure diverse replicas to guesstimate the tendency notch. The study uses the probit ideal since involvement in irrigation agriculture is not accidental relatively pretentious by experimental, unnoticed or both aspects. The irrigation involvement classical evaluations the level of participation in the irrigation program and can be expressed as follows:

$$P(D_i - 1/Xi) = \phi(f(X_i) = \alpha_0 + \Sigma^{n}_{i=1} \square B_i X_i + \mu \quad \mu \approx N(0,\delta^2)$$
.....(Equation 5)

Where, ϕ signifies the usual increasing delivery purpose and $f(X_i)$ signifies a measurement of the respondent involved in irrigation farming ($D_i = 1$ for those who partake in irrigation farming) factors (X_i) of which comprises entirely the experimental covariates as direct relations without communication of advanced guideline relations that partake conclusion on the propensity near partake in irrigation farming and household food security. Each tested participants and non-participant have a projected tendency total, which is an incessant variable and can be stated as follows.

$$\hat{z}(X_i / T = 1) = \hat{z}(X_i) \quad \text{.....(Equation 6)}$$

The change amongst the regular consequences of the two collections is the appraised consequence of the admission to irrigation uncertainty the similarity is acceptable (Caliendo and Kopeinig 2008). On behalf of the equivalent of participants to non-participants on the foundation of the partiality total, there are four substitutes: nearest-neighbor, calliper (radius), stratification (interval) and kernel matching that are used to compute a bulk for all harmonized par-

ticipant-non participant set. For example, the stratification method divides the strata into five strata because five sub-classes often adequate to remove 95 percent of the partiality related with one solitary covariate.

Consequently, the influence of the irrigation is the despicable alteration in the consequence for the preserved and raw set for every division. In all division or lump, the regular variance amongst consequences of preserved explanations and switch explanations are assessed as follows:

$$AD^{s}_{q} = \frac{\Sigma_{izt}(q)\ Y_i^{T}}{N_q^{T}} - \frac{\Sigma_{jzt}(q)\ Y_j^{C}}{N_q^{C}} \quad \text{.....(Equation 7)}$$

Where, AD^{s}_{q} is the regular alteration lump q, I (q) is the usual of divisions in a bloc q; N^{T}_{q} and N^{C}_{q} are the quantity of preserved switch elements in the lump (q).

Subsequently, the examiner of ATT is calculated as a regular of every AD (UNDP 2009) plus is assumed by the subsequent equivalence: everyplace, Q is the number of lumps.

$$ATT = \Sigma^{Q}_{q=1}\ AD^{s}_{q} \frac{\Sigma_{izt}(q)\ D_i}{\Sigma_{\forall i}\ D_i} \quad \text{....(Equation 8)}$$

The kernel matching technique used prejudiced means of all discrete in the assessment group to brand the counterfactual consequence. The masses are designed founded on the detachment among every discrete from the evaluation set and the preserved statement of which the counterfactual is evaluated (Caliendo and Kopeining 2008). The Kernel corresponding ATT estimator is specified by:

$$ATT = \frac{1}{N^{T}} \sum_{i=iT} \{Y_i^{T} - \frac{\Sigma_{jzC}\ Y_j^{C}\ G\left(\frac{P_j - P_i}{h_n}\right)}{\Sigma_{kzC}\ G\left(\frac{P_k - P_i}{h_n}\right)}$$

.....(Equation 9)

Wherever, G, is the Kernel role and h_n is a bandwidth bound. The superior of bandwidth bound is more significant since it outlines the suitability and the alteration among the assessed and accurate fundamental the compactness purpose. The investigator wishes to reflect the alteration and the partiality of the estimate at onetime while selecting the bandwidth bound (Caliendo and Kopeinig 2008). After the corresponding procedure and producing important propensity scores, the study will then associates the regular consequences of the coordinated defendant sets (treated vs control) constructed on certain similar variables (such as entire expenses, household assets, ingestion, and family returns) to guesstimate whether there is a statistically important outcome of the preserved on the consequence.

RESULTS

Socio-economic Features of Farmers in the Study Area

Table 1 show socioeconomic characteristics of the interviewed farmers. The mean age of household heads on non-irrigators and irrigators was 89 years and 88 years respectively. The maximum age of household heads on non-irrigators and irrigators was 28 years and 31 years separately. Moreover, the mean age of males was 62 years and 60 years for females. These findings suggest that agriculture in the rural smallholder farming is mostly done by older people. The findings of age of farmers is comparable with that of Statistics South Africa Community Survey (2016) and AgriSA (2016) which reports that the mean size of South African farmers is 62 years.

Majority of farming households were regulated by males, the sizes being meaningfully greater among the irrigators at 10 percent level. Male's ascendancy among both smallholder irrigators and non-irrigators (66% and 59% correspondingly) in the study area may be accredited to job losses through economizing policies, retirement and the high joblessness rate particularly in the official subdivision that entails additional educated skilled labour. This is consistent with the findings by Frayne et al. (2014).

The findings indicated that 57 percent of the respondents were married and the remaining percentage (43%) of respondents falls into the single, divorced or widowed groups. The mean family sizes were 4.17 on non-irrigators and 5.80 to irrigators. The study also exposed that family amounts were in the assortment of 1 to 12 per household. The maximum family size was 11 people per household below non-members and 12 on members of irrigation schemes. The household size is an indication of the quantity of labour available for use by households. The result is closely related with the findings of Assefa (2008) and Kaswamila et al. (2004) which show minimum family size of 2 and 3 and maximum family size of 13.

Table 1: Socioeconomic features of smallholder farmer characteristics

Characteristics	*Description*	*Category of farmers*		*Overall sample*
		Irrigating farmers (%)	*Non-irrigating farmers (%)*	
Gender	Male	66	59	63
	Female	34	41	37
Occupation of farmers	Farmer	71	56	64
	Wage employment	6	11	8
	Unemployment	23	33	28
		Mean Value	*Mean Value*	*Average Mean*
Age	Number (years)	62	58	60
Level of education	Years spent at school	7.3	7.2	7.25
Household size	Number of people in HH	5	4	5
Farming experience	Years of involvement	11	10	10.5

Source: Outcomes from SPSS (Version 20) produced from field survey 2015

The results further indicated that the average mean for a number of years spent in school, for irrigating household is higher (7.3) compared to (7.2) for non-irrigating household. The maximum number of years spent at school by non-irrigators is 17 years and minimum is zero. The overall farming experience is 25 years compared to 11 years for irrigators and 10 years for non-irrigators. This means that the members of irrigation schemes are more experienced in terms of farm activities than non-irrigators. Most of experienced household heads, were able to get more productivity of crops by timely sowing of crops, avoid flood irrigation hence saving water and balanced use of fertilizers on account of their experience. The majority of respondents were doing agriculture over the last 1 to 11 years.

Food Security Situation among Smallholder Farmers and Food Security Status of Household

Agricultural families were grouped into irrigators and non-irrigators. The results specified that around 70 percent of the irrigators stated presence food-secure associated to 60 percent of the non-irrigators (Table 2). Nearby remained a substantial alteration in the nutrition safety state of irrigators and non-irrigators. These outcomes approve intelligence by the Nourishment Safety Inventiveness that nutrition manufacture rise in emerging farming is perceived as a likely answer to the nutrition uncertainty happenstances in the remote zones of Eastern Cape

Table 2: Food security status among farmers in the study area

Crop	*Irrigators percent*	*Non-irrigators percent*
Food secure	70	60
Food insecure	30	44

Source: Results from SPSS (Version 22) produced from field survey, 2015

(Mzuyanda and Ajuruchukwu, 2018). The results also endorse discoveries of additional readings in Ethiopia, Kenya and Zimbabwe, which display that families partaking in irrigation agriculture certainly not run out of food and their starving months are concentrated significantly, different from their non-irrigating counterparts (IFAD 2005; Benson 2015).

Food Production on the Household Level

It is imperative to covenant with the query of the degree to which people yield their individual nutrition and how much that food improves to their existing stages of nourishment safety (Baiphethi and Jacobs 2009). Countless scholars have concentrated on methods of cumulative the production of deluge water and irrigation water use for agrarian invention to expand food safety, nourishment and well-being (Backeberg and Sanewe 2013; Mzuyanda and Ajuruchukwu 2018). As renowned in Ellis et al. (2003), the character of survival agribusiness in pastoral livings of the diverse undeveloped families can be inspected over exploratory the gen-

eral portion of specific ingesting by worth in family revenue transversely diverse revenue levels.

Crop Grown by Household

Farmers in both groups seemed to participate in farming (crop and vegetables) for diverse aims. Table 2 displays various crops cultivated by farmers in the growing season of 2017/18. Big schemes of smallholder growers in the zone remained ingrained maize, Beans, potatoes, butternut and vegetables with an ordinary of 65 percent. When likening the two sets, irrigators produced frequently maize (77%), potato (75%), vegetables (61), butternut (53%) and beans (48%) while non-irrigators produced frequently maize (76%), potato (72%), vegetables (70%), butternut (68%) and beans (54%). The outcomes are summarized and showed in Table 3.

Even though greatest of the certain yields are fully-fledged during the year, maximum amount of vegetables are developed through winter season particularly potatoes and maize with beans in the summer. Growers in the study zone are doing crop rotation, where they produce maize and Beans from October end to December and regularly produce in the winter season around May. Vegetable crops such as potatoes, spinach and cabbages are full-grown throughout May to end August (Cousins 2013).

Overall, irrigating families have a habit of growing cash crops and vegetables for the market. A share of the yield was spent at household although the majority of manufacture was referred to the marketplace. These outcomes endorse conclusions by De Cock et al. (2013) those families harvest for both family intake and the marketplace. These conclusions approve declarations that farming plays a key part in the livings of pastoral societies. It was, nevertheless, problematic to measure the true role of individual food manufacture as families did not retain farm archives. They might not remember the precise magnitudes that were reserved for family ingesting and marketing.

Farmers specified diverse explanations why they are growing such crops. Findings showed that smallholder farmers generally, they grow crops because they attain income (32.4%), staple food (27.5%), easy to find market (13.6%) and are easy to grow (10.8%). Reasons for high yields (5.9%), community grow such crops (5.9%) and feed for livestock (3.9%) did not count as much as motivators behind growing crop.

Description of Yields by Irrigators and Non-irrigators

From the Table 4, (69%) of the irrigated farmers indicated that the yield was good and (12%) indicated it was average while (19%) reported that their yields could be described as poor. The (19%) who reported their yields were bad in this case, indicated they did not consider irrigation scheme to be worth their efforts but for some reasons, they had to be involved in it. On the other hand, (26%) of the non-irrigated farmers

Table 4: Descriptions of yields by irrigators and non-irrigators

Farming type	*Perception of yields in percentages*		
	Good	*Average*	*Poor*
Irrigators	69	12	19
Non-irrigators	26	18	56

Source: Outcomes from SPSS (Version 22) generated from field survey, 2015

Table 3: Crops full-grown by smallholder farmers in the area

Crops	*Irrigators*		*Non-irrigators*		*Key season*
	Frequency	*Percent*	*Frequency*	*Percent*	
Vegetables	61	65	75	70	Winter
Maize	77	72	71	76	Summer
Beans	48	45	50	54	Summer
Potato	75	70	67	72	Winter
Butternut	53	57	73	68	Summer

Source: Results from SPSS (Version 22) produced from field survey, 2015

said their yields were good, (56%) reported it was bad while the remaining (18%) noted it was average. Good yield to these farmers as they described it, meant the kind of yield that afforded them the ability to recoup their investment and have enough for the household consumption. Recouping their investment did not only depend on the yield but on the market prices offered if even there were buyers.

Food Expenditure on the Household Level

Although the amount of revenue consumed on food is not a straight degree of food uncertainty, bestowing to Engel's Law, a comparative great segment of food spending is frequently connected to deprived families (Mhlongo and Daniels 2013). Earlier, pastoral family's harvested utmost of the food spent at family, whereas city families obtained maximum of their food. Nevertheless, current scholars have revealed a rise in necessity on marketplace acquisitions by both urban and rural families, in certain circumstances attainment of 90 percent of the food provisions. Subsequently, food expenses in certain portions of Sub-Saharan Africa assortment among 60 and 80 percent of the overall family revenue for low-income families, with South African families expenditure, on regular, 37 percent of their revenue on food (Baiphethi and Jacobs 2009). It is significant that spending on food will be contingent on other bounds counting alteration in food values and closeness to shops (De Cock et al. 2013).

The share of food spending in entire family spending for the diverse categories of families was calculated (Table 5). It is obvious that an important share of entire domestic spending drives to food procurement.

General, families in the section consumed 30.9 percent of their domestic revenue on food. Nevertheless, for irrigators, the amount of revenue consumed on nutrition is reasonably inferior (26.3%) while the real sum consumed on nutrition is intricate associated to additional families cross-examined (R990.1). Non irrigating families had 31.4 percent of revenue engaged up by nutrition attainments, corresponding to arrangement irrigators (31.7%). Self-governing irrigators are, consequently, believed the richest families as their amount of revenue consumed on food is the slightest linked to altogether families in the trial.

Nutritional Assortment

Table 6 displays the variety of foods amongst diverse family types. Family were asked food types consumed per week (Last seven days).

Table 6: Diversity of food types consumed in a week by type of farmers

Nutrition types spent per week	*Type of farmer*	*Mean*	*ANOVA (p-values)*
Vegetable	Irrigators	5 (2.67)	0.02***
	Non irrigators	6 (2.08)	
Fruits	Irrigators	3 (2.06)	0.32
	Non irrigators	4 (2.01)	
Meat	Irrigators	4 (2.52)	0.43
	Non irrigators	3 (2.01)	
Eggs	Irrigators	3 (2.56)	0.21
	Non irrigators	2 (2.20)	
Dairy	Irrigators	4 (2.94)	0.7
	Non irrigators	3 (2.88)	

NB: Statistics in digression are Standard Deviations
*, **, *** = significant at 10%, 5% and 1% levels of significance.
Source: Outcomes from SPSS (Version 22) produced from field survey, 2015

Table 5: Overall monthly family spending and spending on food by type of family

Farm type	*Measurement*	*Overall family spending*	*Spending on nutrition*	*Amount of food spending*
Irrigators	Mean	Mean = 5060.2	Mean = 933.3	31.6
	Maximum	Max = 53550	Max = 3500	
	Minimum	Min = 662	Min = 300	
	Standard Dev	SD = 10318.5	SD = 795.17	
Non irrigators	Mean	Mean = 4806.4	Mean = 990.1	26.3
	Maximum	Max = 25801	Max = 4500	
	Minimum	Min = 750	Min = 100	
	Standard Dev	SD = 4639.4	SD = 902.3	

Source: Outcomes from SPSS (Version 22) produced from field survey, 2015

Here was a substantial alteration among the occurrences of intense vegetables among the diverse natures of families at 5 percent level. Vegetable consumption was supplementary recurrent inclusive at five stretches per week. Non irrigators paid vegetables six stints a week while scheme irrigators used up vegetables five stretches a week. For the respite of the food categories, fruits, meat, eggs and dairy, there were no substantial variances in the occurrence of ingesting of these food types ranging from 2 to 4 times per week.

Food Shortages

Solitary of the universal structures of food uncertainty in South Africa is that it is frequently periodic. It mostly accords with the vigorous farming period or rainy period. To this outcome we have strained to realise uncertainty there is discernable alteration in the effectiveness of nourishment insufficiency among irrigators and non-irrigators. Astonishingly, there is no change concerning the judgment of food deficiencies among irrigators and non-irrigators. The nutrition deficiency months begins as early as August (which is the commencement of showery period and so farming events in the study areas) and spreads up to November (which is the commencement of reap seasons). No family from the irrigators set has stated food deficiency in August. September is the greatest considerate nutrition deficiency month among no irrigators, while October is the uppermost food deficiency month for irrigators.

Approximately partial of the non-irrigators specified nutrition deficiency in the month of September. Nonetheless, there is an unambiguous change concerning the occurrence proportion of conveyed food deficiency among the two sets. The number of growers recording food deficiency in each month is meaningfully inferior for irrigators set. It is stimulating to note that irrigation has not eradicated the food insecurity.

Coping Strategies Common among Farmers

Assessing the nature of strategies used by farmers to cope with food insecurity, percentages were used. The irrigators and non-irrigators have marginally diverse coping devices in the beginning of food shortage delinquent. The results are presented in Table 7.

The majority (52%) of interviewed farmers indicated that reducing number of meals per day has been the most coping strategy used. While others (51%) indicated that seeking assistance to neighbour and sometimes to relatives has been their coping strategy of food insecurity. These findings indicate that smallholder farmers relied on different coping strategies to counter their food insecurity in the study area.

The Effect of Smallholder Irrigation on Family Food Security and Dietary Diversity

The nearest neighbour and Kernel corresponding approaches were used to assess the effect of irrigation involvement on homestead revenue from crop invention. Table 8 displays outcomes from the PSM model that was assessed for evaluation devotions with the action consequence model results. Two identical examiners', the nearest neighbour and the Kernel constructed corresponding algorithms were active as robustness checks.

Table 7: Coping strategies by irrigators and non-irrigators

Coping strategy	*Percentages*			
	Sometimes	*Often*	*Always*	*Never*
Use of off-farm income	36.5	25.6	15	0
Take credit	30	0	0	0
Borrow from neighbours	51	33	0	0
Sell animals	30	14	0	36
Reduce number of meals per day	52	31	0	0

Source: Outcomes from SPSS (Version 22) produced from field survey, 2015

Table 8: Propensity score matching to measure the impact of access to irrigation on household income

Matching method	*Number of household heads*		*Household income*			*Standard error*	*t-test*
	Treated	*Control*	*Treatment*	*Control*	*ATT*		
Nearest neighbour	104	36	2044.01	622.12	1245.0	124.14	9.01***
Kernel matching	104	58	1977.67	643.41	1254.7	206.13	5.53***

Notes: ***, ** and * means significant at 1%, 5% and 10% levels, respectively
Source: Results from Stata (Version 13) produced from field survey, 2015

DISCUSSION

The corresponding consequences specify that irrigation has a constructive substantial effect on the livings position of irrigators. Irrigating farmer's revenue was established to be between R1 245 and R1 254 more than the non-irrigators based on the corresponding technique approved.

Table 8 specifies that in cooperation the nearest neighbour and Kernel corresponding approaches point to the fact that irrigation admission has a substantial outcome on family revenue. Icheria (2015) found a similar evidence. The nearest neighbour corresponding technique recognised 36 identical families as switch while the Kernel identical technique acknowledged 58 corresponding families as switch, and was somewhat traditional connected to the nearest neighbour identical technique in conniving the effect assessment. However, both matching methods specify that admission to irrigation schemes permits farmers to accept technologies and strengthen cultivation, prominent to rise in productivity, great production and superior revenues from farming.

The results suggest that irrigated farmers get between R1245.0 and R1251.7 more than the non-irrigated farmers subject on the corresponding technique used. This is unswerving with the results of preceding readings (Tesfaye et al. 2008; Gebregziabher et al. 2009; Kuwornu and Owusu 2012; Sinyolo 2013; Daniel 2014; Sithole et al. 2014).

CONCLUSION

The main objective of the study was to assess the impact of irrigation of household food security and dietary diversity in Eastern Cape, South Africa. Irrigation, together straight and in-directly, has a boundless influence on improving growers' livings through diverse sizes, such as variation of crops full-grown, as well as amplified farming invention, family revenue, service openings and contribution in communal resolutions. It was demonstrated that the tested irrigator families' annual ordinary revenue consumes enhanced.

RECOMMENDATIONS

Consequently, using irrigation has an effect on refining the revenue stages of the irrigator families of the study area. The Eastern Cape Department of Agrarian Reform must develop a drive to spread the returns of the smallholder irrigation enterprise to the growers through improvement managers; by setting up farmer exercise hubs on better-quality agronomic practices, crop protection features, irrigation practices, and product promotion; and by submission a credit provision to permit fast development in the overview of skills and agricultural practices, value haggling control and effectiveness of smallholder irrigation schemes.

LIMITATIONS

In investigating the impact of irrigation on household food security and dietary diversity, this study did not include gender-related issues. Therefore, the study does not investigate whether male or female-headed households had similar or different experiences with respect to the impact of irrigation on household food security. Furthermore, with respect to economic feasibility, the study did not investigate whether this irrigation scheme was economically viable or worth pursuing. Instead, aspects that were di-

rectly related to food security at household level such as crop production levels, income levels, crop diversification and the role of income from irrigation in increasing dietary diversity and acquisition of assets, were investigated. Available resources, crop production before and after irrigation and the benefits and problems experienced by irrigating and non-irrigating farmers were also investigated.

ACKNOWLEDGMENTS

The authors would like to thank DAAD-NRF and WRC for funding the research, farmers, district agriculture office workers, and all those who contributed during data collection.

REFERENCES

Agri SA 2015. Youth in Agriculture. From <https://mg.co.za/article/2015-06-18-the-youth-are-agricultures-future> (Retrieved on 18 March 2016).

Assefa, M 2008 *Socio-economic Assessment of Two Small-scale Irrigation Schemes in Adami Tullu Jido Kombolcha Woreda, Central Rift Valley of Ethiopia*. Dissertation for MSc Degree. Netherlands: Wageningen University.

Backeberg GR, Sanewe AJ 2013. Systems Approach to Water Use For Food Production and Energy Generation. *Paper presented during the First World Irrigation Forum of the International Commission on Irrigation and Drainage* held in Mardin, Turkey, 29 September to 1 October 2013.

Baiphethi MN, Jacobs PT 2009. The contribution of subsistence farming to food security in South Africa. *Agrekon,* 48(4): 7-22.

Benson T 2015. Association between Irrigated Farming and Improved Nutrition in Farm Households in Malawi. Agrekon, 54(3): 62-86. From <http://dx.doi.org/10.1080/03031853.2015.1084940> (Retrieved on GIVE DATES).

Bryman A, Bell E 2015. *Business Research Methods*. UK: Oxford University Press.

Caliendo M, Kopeinig S 2008. Some practical guidance for the implementation of propensity score matching. *J Econ Surv,* 22(1): 31-72.

Christian M, Obi A, Ikechi A 2019. Adoption of Irrigation Technology to Combat Household Food Insecurity in the Resource-constrained Farming Systems of the Eastern Cape Province, South Africa. South African Journal of Agricultural Extension, 47(2): 94-104. From <http://dx.doi.org/10.17159/2413-3221/2019/v47n2a506> (Retrieved on 9 September 2019).

Cochran WG 1963. Sampling Techniques. 2nd Edition. New York: John Wiley and Sons, Inc. From <https://www.statisticshowto.datasciencecentral.com/ probability-and-statistics/find-sample-size/.> (Retrieved on 15 May 2018).

Cousins B 2013. Smallholder irrigation schemes, agrarian reform and accumulation from above and from below in South Africa. *Journal of Agrarian Change,* 13(1): 116–139.

Danieli Y, Stamatopoulou E, Dias CJ 1999. *The Universal Declaration of Human Rights: Fifty Years and Beyond*. Amityville, NY: Baywood Pub Co.

Daniel Z 2014. *Participation of Farmers in Irrigation Schemes in Tanzania: A Case of Kwamadebe Irrigation Scheme in Kondoa District*. MSc Thesis, Published. Morogoro, Tanzania: Sokoine University of Agriculture.

De Cock N, D'haese M, Vink N, Van Rooyen CJ, Staelens L, Schönfeldt HC, D'haese L 2013. Food Security in Rural Areas of Limpopo Province, South Africa. Food Security, (5): 269-282. From <http://dx.org/10.1007/s12571-013-0247-y> (Retrieved on 16 February 2018).

Department of Agriculture, Forestry and Fisheries; Directorate: Food Security. *Strategic Outlook (2013 – 2015).*

Drimie S, Ruysenaar S 2010. The integrated food security strategy of South Africa: An institutional analysis. *Agrekon*, 49(3): 316-337. doi.org/10.1080/03031853.2010.503377

Frayne B, Mccordic C, ShilombolenI H 2014. Growing out of poverty: Does urban agriculture contribute to household food security in Southern African Cities? *Urban Forum,* 25(2): 177–189.

Gebregziabher G, Namara R, Holden S 2009. Poverty reduction with irrigation investment: An empirical case study from Tigray, Ethiopia. *Agricultural Water Management,* 96: 1837-1848.

IFAD (International Fund for Agricultural Development) 2015. Video Published on March 19, 2015. From <https://www.youtube.com/watch?v=h4 Mh-Nym-6CA>.

Kaswamila A, Masuruli BM 2004. The Role of Traditional Irrigation Systems in Poverty Alleviation in Semi-Arid Areas: The Case of Chamazi in Lushoto District, Tanzania. *Research Report No.* 04.3. REPOA, Dar es Salaam, Tanzania.

Icheria BK 2015. Household food insecurity and coping strategies among small scale farmers in Tharaka Central Division of Tharaka South District, Kenya. *International Journal of Humanities Social Sciences and Education (IJHSSE),* 2(2): 75-93.

Khapayi M 2016. Factors limiting and preventing emerging farmers to progress to commercial agricultural farming in the King William's town area of the Eastern Cape Province, South Africa. *S Afr Tydskr Landbouvoor /S Afr J Agric Ext,* 44(1): 25- 41.

Kibirige D 2013. *The Impact of Human Dimensions on Smallholder Farming in the Eastern Cape Province of South Africa*. PhD Thesis, Unpublished. Alice, South Africa: University of Fort Hare.

Kuwornu J, Owusu E 2012. Irrigation access and per capita consumption in farm households: Evidence from Ghana. *Journal of Development and Agricultural Economics,* 4(3): 78-92.

Mhlongo V, Daniels R 2013. Food Expenditure Patterns in South Africa: Evidence from the NIDS. From <http://hdl.handle.net/11090/6879>.

Mzuyanda C, Ajuruchukwu O 2018. Impact of irrigation adoption on rural farmer's welfare in Eastern Cape Province of South Africa: A propensity score matching approach. *African Journal of Agricultural Research*, 13(46): 2641-2650.

Sinyolo S 2013. *The Impact of Smallholder Irrigation and Water Security on Household Welfare: The Case of Tugela Ferry Irrigation Scheme in KwaZulu-Natal, South Africa*. MSc Thesis, Published. Pietermaritzburg, RSA: University of KwaZulu-Natal.

Sithole NL, Lagat JK, Masuku MB 2014. Factors influencing farmers' participation in smallholder irrigation schemes: The case of Ntonjeni Rural Development Area. *Journal of Economics and Sustainable Development*, 5(22): 2-3.

Statistics South Africa 2008. *General Household Survey 2007.* Pretoria: Statistics South Africa.

Statistics South Africa 2013. *Mortality and Causes of Death in South Africa, 2012: Findings From Death Notification.* Pretoria: Statistics South Africa.

STATSSA 2016. Community Survey of Agricultural Farming Households. From <http://www.statssa. gov. za/?s=community+survey+2016+agricultural+ house holds&sitem=publications> (Retrieved on 18 June 2016).

Tesfaye A, Bogale A, Namara R, Bacha D 2008. The impact of small-scale irrigation on household food security: The case of Filtino and Godino irrigation schemes in Ethiopia. *Irrigation Drainage Systems,* 22(2): 145-158.

Paper received for publication in May, 2019
Paper accepted for publication in June, 2019