Investigating the contribution and effect of cash transfers to household food security of rural smallholder farmers in the Eastern Cape Province of South Africa

Nyarai M. Mujuru1*, Ajuruchukwu Obi1, Lelethu Mdoda2, Syden Mishi3 and Mahali E. Lesala1

Abstract: Shocks such as Covid-19 pandemic and natural disasters erode the resilience of many poor households against hunger by further threatening productional capacities. It is projected that over 690 million people around the world went hungry in 2019 and the COVID-19 pandemic is increasing the vulnerabilities and insufficiencies of global food systems. Food security is a human right and the government of South Africa is legally bound by the constitution to ensure food security for all. However, food insecurity in the country is owing to insufficient access to food because of structural poverty and inequality dynamics with a strong racial footprint rather than a shortage of food. Additionally, the rising cost of living, limited investment in agricultural development, and high dependency ratios

ABOUT THE AUTHORS

Nyarai M. Mujuru is a scholar and lecturer, currently teaching Agricultural Economics at the University of Fort Hare, South Africa. Her areas of interest include food security, resource use efficiency, smallholder development, agro-entrepreneurship, and poverty. Ajuruchukwu Obi (PhD) is a Professor of Agricultural Economics with extensive research interests in resource and production economics, technology adoption, and climate-smart agriculture. Lelethu Mdoda (PhD) is a Senior Lecturer in the Discipline of Agricultural Economics, at the University of KwaZulu-Natal. He specializes in agricultural Economics, Agribusiness, climate change, resource economics, and economies of smallholder farmers. Syden Mishi (PhD), is an Associate Professor of Economics and Head of the Department at Nelson Mandela University. His research interest is in applied microeconomics, resource, and development economics, using behavioral and experimental techniques, and the valuation of natural resources. Mahali E. Lesala (PhD) is a Lecturer at the Department of Human Settlement. Her research interests include smallholder farmers’ development; the rural socioeconomic dynamics of renewable energy, and rural wealth creation.

PUBLIC INTEREST STATEMENT

Poverty and inequality remain severe global economic problems, particularly in the developing world such as South Africa. Cash transfers are a policy instrument that can help build household resiliency in obtaining access to food. The introduction of social protection is aimed at addressing multidimensional aspects of eradicating poverty and vulnerability goals in the global economic sphere. Additionally, several peer-reviewed studies suggest cash transfers played a significant and productive contribution in building sustainable livelihoods. Social protection offers guaranteed basic social security through income or consumption transfers to protect vulnerable groups (especially poor people) against livelihood risks and loss of income. Cash transfers are becoming an important intervention in rural households’, for example, cash transfers managed to reduce the poverty gap by 20% in Mexico while in South Africa by 47%. Furthermore, cash transfers have demonstrated a positive impact on human capital development through improved investment in education and the use of health facilities.
especially in low-income households are some of the factors contributing to food insecurity in the country. Consequently, household-level food security is a major challenge to the South African government and policymakers. The government has strong social and economic rights commitments in place to achieve this goal and improve the lives of rural communities that are dependent on agriculture as a source of livelihood. Using household survey data, the study seeks to investigate the role played by cash transfers on household productive capacities and food security status within the context of a small pace of transition from homestead to irrigated farming in the former homelands of the Eastern Cape Province. The lower bound poverty line of R 758 (on average $57 USD), was used to determine household food security status. Simple random sampling was employed to select 158 respondents. The propensity score matching method was employed using the Nearest Neighbour and Kernel matching techniques to estimate the treatment effects and compare the outcomes of participation in irrigation farming and receipts of cash transfers in comparison with the non-irrigators. Both matching methods revealed that irrigation farming enhanced the per capita food expenditure by at least ZAR 2 738.88 and ZAR 2 790.37, which then improves household food security. The findings also revealed that cash transfers increase the farmers’ production activities by ZAR 1 467.90 and ZAR 1 478.00. Evidently, the cash transfers necessitate the purchase of more and improved production inputs and access to climate-smart practices such as irrigation, which then improves irrigators’ production capacities and, as a result, reduces vulnerability and improves livelihoods and food security.

**Subjects**: Security; Welfare; Sociology of Knowledge; Quantitative Methods; Africa - Regional Development; Rural Development; Econometrics

**Keywords**: food security; human entitlements; cash transfers; productive impacts; South Africa

1. **Introduction and problem statement**

Food security is reflected in the sustainable development goals under Goal 2 “Zero Hunger” where countries are encouraged to support smallholder farmers’ ability to increase food production (United Nations, 2015). This is through realization that millions of people worldwide are food insecure, with the developing world accounting for a significant proportion of those numbers. It is imperative however to note that, many countries have food security enshrined in their constitutions. This study assesses food security within the rural farming community of South Africa, an emerging market economy riddled with triple challenges of unemployment, inequality and poverty, all threatening food security.

Ensuring food security for all remains a key global goal which ranks high on the Sustainable Development Goals (SDGs) as it did under the Millennium Development Goals (MDGs). One reason it assumes such significance today is the phenomenal rise in world population in absolute terms and the associated increase in urbanization. According to estimates by the World Bank (2015), the anticipated increase in world population can be estimated at nearly 80 million more people each year and it is likely to push the number of people on this planet to 9 billion by 2050. These trends in population growth and urbanization put more pressure on already strained farming systems. On top of these, climate change has emerged as a formidable threat, leading already to scarcities of water and land and weakening food systems even further. According to FAO (2013), about 60% more food is required if population numbers increase to nine billion by 2050. This
means that national governments must formulate policies to support efforts to enhance the productive capacities of their food systems.

South Africa is noted to have high levels of food security at the national level due to production and food imports (Aliber & Mdoda, 2015) but huge income disparities within the economy have seen rural dwellers in the former homelands among the poorest (Matebeni, 2018). Seekings (2018) highlighted that poverty in Africa was on a decline from 1990 with about 57% extremely poor individuals to 2015 with about 41%. This reduction in poverty was attributed to increasing gross domestic product per capita across Africa. However, development has rarely been inclusive leading to increasing inequality and high poverty rates. Bicaba et al. (2017) noted that the growth elasticity of poverty was 0.7 for Africa compared to other developing parts of the world with an average of 2. South Africa has one of the most unequal societies in the world and this can be traced back to the Apartheid era when the majority of blacks were excluded from the mainstream economy. Therefore, high GDP per capita fails to capture the overall development in the country. Poverty rates remain high and more pronounced in certain regions than others, for example, in the Eastern Cape Province remain high with an adult poverty rate of 67.3% with unprecedented expanded unemployment levels of 48.3% (Statistics South Africa, 2017).

The constitution of South Africa is arguably among the most progressive in recognising economic and social rights in the world (Klug, 2010). Act 108 of 1996 frames civil, political, economic, social and cultural rights within a human rights framework. Food security is conceptualised as a human right within the constitution. Part of the Bill of rights states that “the state must take reasonable legislative and other measures, within its available resources, to achieve this right”. In addition, the government embarked on a land reform programme to address the imbalances of apartheid in realising the significance of access to land in fighting poverty. Several farmer support programmes were implemented and irrigation schemes revitalised in a bid to eradicate poverty, especially in the former homelands. Black South Africans were relocated into designated areas known as “homelands” under the Natives Land Act of 1913. Ciskei and Transkei were two designated states for the Xhosa-speaking people in the Eastern Cape Province and these were established in 1951 under the Bantu Authorities Act as shown in Figure 1. The government of South Africa has a solid targeted social grant system providing cash transfers for children, the disabled, the elderly, war veterans and those in dire need (Ferreira, 2017). Social grants have proved to be an effective strategy at reducing the incidence of extreme poverty and preventing inequality from worsening (Statistics South Africa, 2017; Sulla & Zikhali, 2018). Under perfect markets, cash transfers do not affect household production activities because production and consumption become separable (Singh et al., 1986). However agricultural sector, most especially, in less developed countries or communities is marred with imperfections in, credit, insurance, labour, output, and input markets, inter alia. Therefore, the provision of cash transfers is expected to lead to productive investment and spending and potentially create a household multiplier effect (Boone et al., 2013). It is imperative to do extensive research on cash transfers as this raises a lot of concerns for policymakers. Daidone et al. (2019) noted that there is a concern about cultivating a culture of dependency among cash transfer recipients and whether transfers would induce households to transition out of poverty and “graduate” from a social protection programme. It can be argued from the foregoing that households within agricultural zones are more likely to invest in agriculture compared to areas with less agricultural potential.

Miljkovic (2015) noted that most food security efforts have centred on availability which is a supply-side issue. These efforts have insisted on the use of new and advanced technologies to curb the problem of food insecurity. In as much as food insecurity is an economic problem, it also is a humanistic problem (Sen, 1981) which requires a humanistic approach rooted in the development of the human race (Miljkovic, 2015). From the World Bank’s participatory poverty assessments, a poor man in Kenya 1997 had this to say when he was asked to define poverty, “Don’t ask me what poverty is because you have met it outside my house. Look at the house and count the number of holes. Look at my utensils and the clothes that I am wearing. Look at everything and
write what you see. What you see is poverty”. Poverty strips one’s dignity, voice, power, and confidence; it is not only about satisfying the stomach. Omotesho et al. (2007) confirms that food security does not guarantee escape from poverty and food insecurity is a characteristic of poverty. Hence, eradication of food insecurity would alleviate poverty. According to FAO (1998), “food security is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 1998). Therefore, due to the multi-dimensional nature of food security, it must be assessed by a suite of indicators and methods and also demands diverse interventions from the policy. In this context, food security from a human perspective identifies and links social, economic processes, and policies that affect individual, household, and community food security. Fukuda-Parr and Taylor (2015) noted that the South African government had strong commitments and weak outcomes for economic and social rights in the post-independence era. Several attempts including the implementation and revitalisation of irrigation schemes in South Africa targeted at improving production and productivity have not yielded the desired results. Aliber and Mdoda (2015) cited the lack of policy response to production entitlement failures within smallholder farming systems in South Africa.
According to Sen (2004), human rights are closely related to capabilities that enable individuals to lead lives that they can value. Deducing on Sen’s entitlement analysis of acquirement, utilisation and shocks, human rights can be viewed as fundamental entitlements necessary for a dignified life. The study adopts Sen’s entitlement analysis as a framework for analysing the determinants of household food security. The Committee on World Food Security (HLPE, 2012), disaggregated the sources of food insecurity into Sen’s four categories of entitlement to food and clustered social protection responses that have food security objectives according to which entitlement deficit they address as shown in Table 1.

From Sen’s Entitlement Analysis, acquirement refers to the ability of a household to acquire enough food through production, exchange or transfer. Own production is a function of inputs, available technology, and the quality of the land. Households with access to such resources can produce food for consumption. Subsistence farmers, especially in former homelands of South Africa are locked in low productivity traditional technologies (Obi & Tebogo, 2011). These have negative implications on output, productivity and farm incomes. Exchange refers to income earned through wage employment or self-employment that allows for food purchases on the market. Off-farm work participation has been recognised as an important phenomenon in recent and past economic literature, especially in the context of developing countries (Anderson & Leiserson, 1980; Rief & Cochrane, 1990; Shand & Teck-ann, 1986). About 25% of farmers in Sub-Saharan Africa engage in non-farm activities and approximately 20% of them generate more than 75% of their income from this activity. Social transfers can be provided through institutionalised means of social protection schemes such as social grants for children, the disabled, and the elderly or through informal networks such as family, neighbours, or community. Table 2 depicts various entitlement categories the and government’s social protection instruments to combat hunger and poverty.

The South African government used the economic and humanistic approaches after gaining independence to address the inequality and other imbalances of apartheid. The economic approach was used to address supply-side aspects of food security through huge investments in irrigation and land reform programmes to improve income levels through increased crop yields. On the other hand, a humanistic or social approach was used to enhance economic access to food through social grants. South Africa’s social grant system has grown to be among the largest in the developing world and it is well targeted ensuring that the elderly, disabled, children and other

| Entitlement category | Social protection instruments | Food security objectives |
|----------------------|--------------------------------|--------------------------|
| Production           | 2.1. Input subsidies           | Promote food production  |
|                      | 2.2. Crop and livestock insurance | Protect against harvest failure or livestock mortality |
| Labour               | 2.3. Public works Programmes   | Provide temporary employment |
|                      |                                | Create useful infrastructure |
|                      |                                | Promote agricultural production |
| Trade                | 2.4. Food price Stabilisation | Maintain market access to food |
|                      | 2.5. Food subsidies            | Keep food affordable for the poor |
|                      | 2.6. Grain reserves             | Ensure adequate market food supplies |
| Transfers            | 2.7. School feeding            | Reduce hunger |
|                      | 2.8. Supplementary Feeding     | Promote access to education |
|                      | 2.9. Conditional cash Transfers| Promote local food production |
|                      | 2.10. Unconditional cash transfers | Enhance, food consumption |
|                      |                                | Reduce hunger or poverty |
|                      |                                | Promote children’s access to education and healthcare |
|                      |                                | Reduce hunger or poverty |

Source: Adapted from Devereux (2006)
### Table 2. Types of social grants in South Africa

| Type of grant               | Amount per month | Conditions                                                                 |
|----------------------------|------------------|-----------------------------------------------------------------------------|
| Old age grant              | R1 600           | 60 years to 74 years. Individual income should not be more than R73 800 per annum or combined household income of R147 600 |
|                            | R1 620           | 75 years and above.                                                          |
| Disability grant           | R1 510           | 18–59 years. Individuals who are unable to work due to disability           |
| Foster child grant         | R920             |                                                                             |
| Care dependency grant      | R1 600           | Given to the main care giver of a child with a severe disability earning less than R192 200 (for single person) or R384 000 combined income. |
| Child support grant        | R380             | 0–18 years. Income should be less than R45 000 for singles and R91 200 combined |
| War veteran grant          | R2 000           | Above 60 years. not earn more than R86 280 if you are single or R1 72 560 if married not have assets worth more than R1 227 600 if you are single or R2 455 200 if you are married |
| Social relief of distress  | R350             | A temporary grant awarded to people in dire need.                           |
| Grant-in-aid               | R380             | For people receiving the old age, disability or war veteran grant who require full time care because of physical or mental disability. |

Source: The South African Government (www.gov.za)
deserving parties receive monthly cash transfers (Bicaba et al, 2017). Table 2 depicts the different types of social grants given by the South African government and the conditions that the recipients should meet to qualify.

The economy of the Eastern Cape comprises of mainly government services contributing 21%, trade, catering and accommodation (18%) and finance (16%) and the province contributes 7.6% to national GDP (Statistics South Africa, 2016). Agriculture contributed 1.7% to Eastern Cape Provincial GDP in 2018 (Eastern Cape Socio Economic Consultative Council (ECSECC), 2018) Even though the agricultural sector contributes less than 3% to GDP in South Africa, small scale household production remains vital for household food security (Aliber, 2015) especially in the former homelands. Figure 1 shows the map of South Africa before and after independence. In 1996, after the country gained independence, the homelands were dismantled under South Africa’s new democratic constitution and the country was consolidated into nine provinces. However, the grip of apartheid on these communities could not be instantly dismantled and despite several government efforts to uplift the former homelands they continue to operate under dire conditions.

Eastern Cape is the second largest province in terms of land area covering 13.8% of the country’s total area. The former homelands (Ciskei and Transkei) in the Eastern Cape Province are characterised by high poverty (67.3%), unemployment (37.4%), net-out migration (505 803) and a life expectancy of 67.1 for females and 59.6 for males compared to a national average of 66.4 and 60 years respectively (Statistics South Africa, 2019). Deducing from the province’s demographic structure it can be argued that there is high population dependency. The 0–19 age group comprises of 42% of provincial population while the above 60 age group makes up 11.3% giving a total of 53.3%. The economically active age group of 20–59 makes up 46.7% (Statistics South Africa, 2017). Households mainly derive their incomes from off-farm activities, farm activities and cash transfers from state welfare and migrant labour remittances. Mujuru (2015) found out that off-farm activities contributed 35% to household income, followed by crop production (31%) and cash transfers (grants and remittances 28%) in selected parts of the former homelands in the Eastern Cape Province which comprise the study area for this study. However, only 7.5% of the respondents participated in off-farm activities yet 92% are full-time farmers. As a result, crop income and social transfers remain important sources of income. Hence, any policy that does not focus on these two would fail in promoting the transition of smallholder farmers. IFAD (2011) and World Bank (2015) note that remittances act as a safety net and they have been found to be the world’s largest poverty reduction programme. These are mostly spent on basic necessities, however, over time it is estimated that between 20 to 30% of the remittances received can be used for savings and investment.

Irrigation schemes within South Africa’s homelands were started mainly with the motivation of improving black farmers’ incomes in the 1930 to 1960s. This was known as the smallholder canal scheme era. Plots of 1.28 ha to 1.71 ha were allocated to black families and these were comparatively smaller compared to the sizes of land developed for whites which ranged from 8–20 ha. The independent homeland era (1970–1990) saw additional irrigation schemes being set up which used modern technologies such as pressurised overhead irrigation (Department of Agriculture, Forestry and Fisheries, DAFF (2013). Due to various problems including management and maintenance most irrigation schemes became defunct leading to a new era. The irrigation management transfer and revitalisation era set off in the late 1990s after the country gained independence. According to DAFF (2013), this era was based on improving lives among the previously disadvantaged populations in rural areas and formal settlements. The 2015 irrigation strategy for South Africa identified possible expansion of irrigated land by 7 604 hectares in the Eastern Cape Province within a period of 5–10 years. Expansion is to be carried out through efficient use of existing water resources in irrigation schemes and the developing of new water schemes (Mmoda, 2017; National Planning Commission (NPC), 2011). Lack of government support coupled with weak monitoring mechanisms have been cited as a major hindrance to successful smallholder transition to irrigated farming (Christian, 2017; Perret, 2002)
This study is a part of a larger previous study in the same area and also a follow up study of research conducted previously. The broader study “Water use productivity associated with appropriate entrepreneurial development paths in the transition from homestead food gardening to smallholder irrigation crop farming in the Eastern Cape Province of South Africa” reported important insights on cash transfers and irrigation crop farming (Kibirige, 2013; Mujuru, 2015; Mujuru & Obi, 2020). As noted earlier, South Africa’s social protection system is a “socially just” permanent programme run by the government on a rights basis. There exist a legally binding “social contract” between the government and citizens as stipulated in the constitution. Devereux (2017) argued that such a system is more effective because it gives citizens who are active claimants of entitlements to social assistance the opportunity to plan ahead more confidently. As such, it is important to look closely into irrigation crop farming, social protection and household food security in rural parts of South Africa for inclusive development policy. Previous studies in South Africa on food security in farming households have neglected the human rights perspective. The study seeks to investigate the role played by social protection and participation in irrigation on the development of smallholder maize and cabbage farming within the context of a small pace of transition from homestead to irrigated farming. The study seeks to investigate the impact of cash transfers on irrigation participation and how irrigation participation eventually affects household food security status.

2. Materials and methods

2.1. Selection and description of study area

Rural households in Eastern Cape are involved in crop farming and they rely on social grants and remittances to a greater extent. The Eastern Cape Province is characterised with poverty and high unemployment levels. The province records high in ranking of number of social grant recipients over the years. Qamata and Tyefhu irrigation schemes were purposively selected to allow for inclusion of homestead gardeners and irrigators in the sample.

3. Research design

3.1. Theoretical framework

The study objectives are to determine the impact of social transfers on irrigation participation and the impact of irrigation access on household food security. However, the estimation challenge is that only the outcomes of farmers having access to irrigation can be observed. The so-called counterfactual, which is the outcome the participants would have been, had they not participated in irrigation farming, cannot be observed (Caliendo & Kopeinig, 2005). Thus, the missing data problem. Therefore, a simple comparison between irrigators and non-irrigators would yield biased estimates of the irrigation farming impact since both the irrigators and non-irrigators might reflect systematic differences in their outcomes and even in their characteristics, which might make them less comparable (Moyo, 2016). Even in the absence of irrigation, the two groups may differ, for example, in their family structures, personal motivation, etc. (Caliendo & Kopeinig, 2008). Without an appropriate benchmark for comparison, it would be equally difficult to attribute any changes in their outcomes to irrigation farming. The challenge is, therefore, to identify a suitable comparison group of non-irrigators whose outcomes provide an unbiased estimate of the outcomes that irrigators would have had they not participated in irrigation farming. In order to deal with the sample selection problem, the propensity score matching (PSM) technique was used. PSM is a semi-parametric method with the ability to construct a comparison group by sampling from the potential control/untreated group (who do not have access to irrigation) with comparable pre-treatment attributes to those who have access to irrigation (treated; Rosenbaum & Rubin, 1983). The model is based on the assumption that it is not possible for each farming household to be both an irrigator and a non-irrigator. This then necessitates the creation of a counterfactual of what can be observed by matching irrigators (treatment) and non-irrigators (control) groups.
Since the propensity to participate in irrigation farming is unknown, the first thing to do in the solicitation of the model is to guessestimate the anticipated likelihood that farmers will have access to irrigation, otherwise referred to as the propensity score. The propensity score matching method poises the detected distribution of covariances through access to irrigation and does not have access to irrigation-based upon observables (Christian & Obi, 2018; Godtland et al., 2004). In this instance, the propensity score would equal the probability of participation in irrigation and the matched sample would be selected from the counterfactual. This was carried out using a logit model, where the dependent variable is “participation” and the independent variables are the factors thought to influence participation. The outcome was applied to match farmers who do not have access to irrigation with those that do have access to irrigation. The estimation of the participation model results in the propensity score. The model is exemplified as follows:

\[ p(Z) = \Pr(D = 1|Z) = E(D|Z) \] (1)

Where \( D = (0, 1) \) is a binary indicator of access to irrigation while \( Z \) represents the vector of qualities. Thus, the restrictive supply of \( Z \), provided by \( p(Z) \) is parallel in both having access to irrigation and not having access to irrigation. PSM then matches irrigators to non-irrigators with similar propensity score using the matching algorithms, that is, Nearest neighbour matching (NNM) and kernel matching technique. NNM involves taking each treated individual in turn and identifying the non-treated individual with the closest propensity score. Kernel matching uses multiple comparators for each treatment group member. Thus, all members of the non-treatment group are used, to some extent, to construct a match for each treatment group member, although the contribution of those for whom the match is poor may be negligible and it weights the contribution of each comparison group member, so that more importance is attached to those comparators providing a better match. The next step in PSM is estimation of the treatment effects, which is the difference between the projected results after having access to irrigation and not having access to irrigation and is known as the average treatment effect (ATE) of the population. The population’s average treatment effect (ATE) can be expressed thus:

\[ \tau_{ATE} = E(\tau) = E[Y(1) - Y(0)] \] (2)

Equation 2 shows the differences between the expected outcomes of irrigators and those that a farmer would have had without irrigation. Accordingly, PSM gives an average treatment effect on treated (ATT), which is considered a better indicator of whether to continue promoting irrigation farming than population-wide average effects (ATE; Rosenbaum & Rubin, 1983). The idea is to compare the impact outcomes of the participants with outcomes of the comparison group so that they show similar characteristics, the propensity scores, and to view the difference as the estimate of ATT. The ATT provides a distinction between the predictable results either with or without treatment for farmers who took part in the treatment. The ATT may be projected as shown in the subsequent equivalence once the propensity score is calculated;

\[ \tau_{ATT} = E(Y_{1i} - Y_{0i}|D_i = 1) = E[E(Y_{1i} - Y_{0i}|D_i = 1, p(Z_i))|p(Z_i)] \] (3)

\[ = E[E(Y_{1i}|D_i = 1, p(Z_i)) - E(Y_{0i}|D_i = 0, p(Z_i))|D_i = 1] \]

Where \( Y_{1i} \) and \( Y_{0i} \) are the values generated from the outcome variable of interest for the farmers who have access to irrigation and not having access to irrigation respectively, while \( i \) refer to the farmers. The expression shows that each group has an opportunity to participate in irrigation and it allows for estimation of the impacts by comparing the observed outcome \( Y_{1i} \) of the treated with the outcome \( Y_{0i} \) of the untreated group. We therefore, perceive a corresponding impact for the group without treatment to indicate what would have been in the absence of irrigation. That is, the untreated values' effect (those who do not have access to irrigation) aids the development of a counterfactual for the group that is treated, and the ATT is being estimated. In this case, the ATT refers to the average influence of having access to irrigation on household food security status.
4. Conceptual framework

Using Sen’s Entitlement Analysis, households can acquire food through three channels viz production, exchange and transfer. Rural households mainly engage in subsistence agriculture where production is mainly for consumption and the surplus is normally sold at low farm gate prices. Due to a low participation (7%) in off-farm activities by respondents (Mujuru & Obi, 2020), the study focuses on food production and transfers as the majority of households are in these entitlement categories. Household transfers in this study comprise government grants and remittances. To promote food production in the former homelands, the government of South Africa embarked on a land reform programme earmarked at redistributing land to formerly disadvantaged groups. Farm production occurs either on homestead or irrigation plots. A variety of crops and vegetables is grown on homestead plots and these are mainly rain-fed and within close proximity to the household dwelling. Irrigation schemes were set up and farmers received various support in the form of input subsidies, extension services and tractor services, among others. The South African social grant system comprises of unconditional social transfers as depicted in Table 1. The government uses two major instruments to combat hunger and poverty in the Eastern Cape Province and these are school feeding programmes and social grants. Figure 2 depicts various food entitlement categories and how they can be linked to increased food access.

5. Sampling procedure and data collection methods

A multi-stage sampling procedure was employed where the first stage was a purposive selection of the study sites and respondents were selected using simple random sampling. Three municipalities were chosen for comparative purposes based on the existence of agricultural activity. For a detailed table on the sampling procedure see, (Mujuru & Obi, 2020) as well as a detailed description of the study sites. The comparative analysis of study sites was part of the broad project but it was not implemented in this particular study (Kibirige, 2013; Mujuru, 2015).

The data used for the empirical application of this study is a random sample survey conducted in Tyhufu and Qamata and collected using structured questionnaires. The survey data included information about crop production and marketing activities as well as household demographic characteristics. Information on crop farming covered land preparation, planting, fertiliser application, weeding, harvesting, output and input prices, and others on irrigated and non-irrigated plots in the specific study sites. Table 3 depicts the variables used in the analysis.
Table 3. Variable measurement

| Variable                  | Description and unit of measurement |
|---------------------------|--------------------------------------|
| Food Security             | Household food security status: Food secure = 1, Food insecure = 0 |
| Age²                     | Age squared of household head in years |
| Gender                   | Gender of household head: Male = 1; Female = 0 |
| Farming experience       | Experience in the farming of household head in years |
| Years in school          | Number of years spent in school by the household head |
| Household income         | Total household income in Rands |
| Access to extension      | Does the household head have access? Yes = 1; No = 0 |
| Access to credit         | Does the household head have access? Y = 1; No = 0 |
| Farm size                | The area under cultivation in the particular season |
| Irrigation participation |                                       |
| Cash transfer            | Yes = 1, No = 0                       |
| Farm production          | Sum of grants and remittances         |
|                          | Total output in kilograms             |

6. Data analysis

The lower bound poverty line of R758 as at April 2017 was used to determine household food security status. The cost-of-basic-needs approach was used in constructing the poverty lines for South Africa. This approach links welfare to the consumption of food and non-food goods and services. The lower bound poverty line refers to the food poverty line plus the average amount derived from non-food items of households whose total expenditure is equal to the food poverty line. A study carried out by Mende et al. (2014) showed that monetary food poverty lines as well as calorific poverty lines gave almost similar food security incidences. Hence, they concluded that use of either approach reasonably gives reliable results and hence the approaches should receive equal attention. A household with per capita monthly income less than the poverty line is considered to be food insecure and per capita household income above the poverty line is considered food secure. The following expression was used to determine household food security status:

\[ FS_i = f(Y_i; PL_t) \]

Where \( FS_i \) is the \( i^{th} \) household food security status, \( Y_i \) per capita household income and \( PL_t \) is poverty line at time \( t \). Food security status was assigned a value of 0 to denote food insecurity where \( Y_i < PL_t \) and where \( Y_i \geq PL_t \) a household is considered to be food secure and a value of 1 was assigned.

7. Results and discussion

In this section the descriptive statistics are profiled first. The means, standard deviation and frequencies of socio-economic characteristics are outlined. Other descriptive statistics on gender perspectives and dependence on cash transfers are reported. The analysis of variance (ANOVA) to compare mean incomes of irrigators and homestead gardeners is presented next. Lastly, PSM results on cash transfers, access to irrigation and food security status are presented.

8. Socio-economic profiles of farmers

The sample statistics revealed that the most frequently observed gender of household head was male with (\( n = 103, 65.2\% \)) representation. These results were in line with Agidew and Singh (2018) and Selepe et al. (2015), that farming in majority of rural areas is spearheaded by males. The majority of farmers were aged 61 and above (\( n = 82, 52\% \)) and the young and economically active between 30 to 40 years were only (\( n = 13, 8\% \)). High illiteracy levels are observed, those who never attended formal education constitute (\( n = 48, 31\% \)) and only (\( n = 13, 8\% \)) had tertiary education that is a minimum of 13 years excluding repeating years. Farming was the most popular economic
activity amongst respondents, ($n = 145, 92\%$) were primarily farmers. The majority of respondents had 0 to 10 years of farming experience ($n = 98, 62\%$), 11 to 20 years ($n = 31, 20\%$), 21 to 30 years ($n = 17, 11\%$) and above 30 years ($n = 12, 7\%$). Majority of the respondents had 1 to 5 household members ($n = 111, 70\%$), and ($n = 4, 3\%$) had 11 household members and above. The most frequently observed annual income group was between ZAR5 001 to ZAR10 000 ($n = 82, 52\%$) and household incomes below R10 000 were ($n = 25, 16\%$). Off-farm labour income is the biggest contributor to household income in the study area with only 7.5\% of respondents employed outside farm activities contributing 35\%. Off-farm activities included trading, civil servants and casual jobs. The means for income variables were observed as follows; cash transfers R4090.36, farm income R3470.27 and total household income R7560.64. Such a huge disparity between farm

| Variable                  | Mean      | S.E       | S.D       | Min  | Max  |
|---------------------------|-----------|-----------|-----------|------|------|
| Years in school           | 5.24      | 0.355     | 4.45      | 0    | 16   |
| Experience                | 12.22     | 0.956     | 12.024    | 0    | 50   |
| Household size            | 4.49      | 0.198     | 2.49      | 1    | 14   |
| Cash transfers            | 4090.36   | 276.32    | 3473.34   | 0    | 22 400 |
| Farm income               | 3470.27   | 320.17    | 4024.50   | 0    | 18 000 |
| Household income          | 7560.64   | 379.9     | 4775.26   | 500  | 23 000 |

| Frequency (n) | Percentage (%) |
|---------------|----------------|
| Irrigation participation |       |
| Irrigators    | 108 68.4       |
| Homestead gardeners | 50 31.6 |
| Access to extension |       |
| Yes           | 92 58.2        |
| No            | 66 41.8        |
| Access to credit |       |
| Yes           | 12 7.6         |
| No            | 146 92.4       |
| Cash transfer recipients |     |
| Male homesteads (n = 39) | 39 100 |
| Female homesteads (n = 11) | 10 91 |
| Male irrigators (n = 64) | 53 83 |
| Female irrigators (n = 44) | 37 84 |
| Total         | 139 88         |
| Food security status |       |
| Food secure    | 84 53.2        |
| Food insecure  | 74 46.8        |

Source: Survey data
income and off-farm labour income further reveals the existence of predominantly low incomes in the agricultural sector and supports transformation and reallocation of farmers as an engine of rural development (Nagler & Naudé, 2014; Naudé, 2016). Results from this study show that the composition of household income matters for policy. Cash transfers contribute 28% to total household income. The government of South Africa through Social Security programmes plays a major role in improving food security in the country. Without social grants and remittances, the levels of food insecurity in the former homelands of South Africa will become appalling.

The average years in school was 5 years with a minimum of 0 and maximum of 16 years. The mean of farming experience was 12 years and a maximum of 50 years was observed. The average household size was 5 members and a minimum of 1 and maximum of 14 were recorded. These summary statistics are presented in Table 4. Participation in irrigation was 68.4% and homestead gardeners were 31.6%. The majority of farmers, 92.4% had no access to credit and 58.2% had access to extension services. Cash transfers consist of government social grants and remittances. The observation shows majority of farmers having one form of cash transfer or the other, 86.7% while only 13.3% did not receive any cash transfer.

9. Household food security status
One of the objectives of the study was to assess how irrigation participation affects household food security. Irrigation participants are households who are farming on irrigation schemes and non-participants are still practicing homestead gardening or farming. A detailed descriptive analysis of the sample was carried out and the results are presented in Table 5. The results in Table 5 show that irrigators are less food secure than homestead gardeners. From the combined data of the two irrigation schemes, it is observed that 51.9% of irrigators are food secure compared to 56% of homestead gardeners. However, at Qamata irrigators are more food secure (78%) than homestead gardeners (56.5%); at Tyefu irrigation scheme 76.9% of irrigators were found to be food insecure. Overall, 46.8% of respondents were food insecure while 53.2% were food secure. Mohammed et al. (2014) found out that only 23% of smallholder farmers in Borno State, Nigeria were food secure. High levels of food insecurity are common among smallholder farmers (Babatunde et al., 2007; Khan & Gill, 2009; Mensah et al., 2013; Mohammed et al., 2014; Omotosho et al., 2007).

10. Gender perspectives
A gender analysis of cash transfers across farm types was carried out and results show that, the highest observed cash transfer recipients were males (n = 92, 89.3%), out of a total of 103 males in the study 92 received cash transfers and 57.6% of them are irrigators. For homestead gardeners the frequency of cash transfer recipients was (n = 39, 100%) for males and (n = 10, 91%) for females. This implies that all the male homestead gardeners in the study received at least one

| Table 5. Food security of irrigators and homestead farmers |
|--------------------------------------------------------|
| Food insecure (n, %) | Food secure (n, %) |
|----------------------|--------------------|
| Qamata               |                     |
| Farm type            |                     |
| Irrigation (n = 56)  | n = 12, 21.4%       |
| Homestead (n = 46)   | n = 20, 43.5%       |
| Total                | n = 32, 31.4%       |
| Tyefu                |                     |
| Farm type            |                     |
| Irrigation (n = 52)  | n = 40, 76.9%       |
| Homestead (n = 4)    | n = 2, 50%          |
| Total                | n = 42, 75%         |
| Combined             |                     |
| Farm type            |                     |
| Irrigation (n = 108) | n = 52, 48.1%       |
| Homestead (n = 50)   | n = 22, 44%         |
| Total                | n = 74, 46.8%       |

Source: Survey data
Figure 3. Cash transfers as a proportion of household income.

Table 6. ANOVA single factor analysis of household incomes: Irrigators Vs non-irrigators

| SUMMARY |
|---------|
| Groups | Count | Sum | Average | Variance |
| Homesteads | 50 | 413,784,3 | 8275,686 | 12,173,690 |
| Irrigators | 108 | 1,350,986 | 12,509,13 | 43,694,767 |

ANOVA

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---------------------|----|----|----|---|---------|--------|
| Between Groups      | 6,13E+08 | 1 | 6,13E+08 | 18,125 | 3,56E-05 | 3,901,761 |
| Within Groups       | 5,27E+09 | 156 | 33,793,916 | | | |
| Total               | 5,88E+09 | 157 | | | | |

Source: Generated results from survey data

form of cash transfer. There was a slight difference of 1% in the number of cash transfer recipients for male (83%) and female irrigators (84%). Comparing the two farm types, in total, homestead gardeners record the highest proportion of cash transfer recipients (n = 49, 98%). Overall, 88% of the respondents received cash transfers. These results make us to investigate if cash transfers are a deterrent for participation on irrigation schemes and the PSM analysis was carried out.

11. Household dependence on cash transfers

Household dependence was calculated as the proportion of cash transfers to total household income and converted to a percentage. Results were categorically analysed with respect to type of farm and are presented in Figure 3. Five intervals were set to depict the extent of dependence following Dou et al. (2017) and these are labelled on the x-axis. The first interval shows number of households with the lowest proportion (below 10%) of cash transfers and hence no dependence. The 10 – 30% interval shows low dependence and moderate dependence (31–70%) The results show that 15% of irrigators and 8% of homestead gardeners do not rely on cash transfers. In the highest dependence interval of above 70%, 34% of homesteads and 41% of irrigators were observed. It can be concluded from the results in Figure 3 that majority of households in the study area heavily rely on cash transfers as a source of income. These results concur with Dou et al. (2017).

Preceding the PSM analysis, an analysis of variance (ANOVA) was carried out to determine if there are significant differences between household incomes of irrigators and homestead farmers. Table 6 shows the results.
Table 7. Propensity score matching to measure the impact of access to irrigation on household food security status

| Output Variable | ATT     | Standard Error | P-value |
|-----------------|---------|----------------|---------|
| Nearest Neighbours Matching Method | Household income | 2 738.878 | 490.8413 | 0.000*** |
| Kernel matching Method | Household income | 2 790.374 | 367.7501 | 0.000*** |

***, ** and * means significant at 1% and 5% levels, respectively.

Table 8. Propensity score matching to estimate the impact of cash transfer on household productive capacities on irrigation users

| Output Variable                        | ATT     | Standard Error | P-value |
|----------------------------------------|---------|----------------|---------|
| Nearest Neighbors Matching Method      | Household productive capability (irrigation users) | 1 467.935 | 594.4645 | 0.014** |
| Kernel Matching Method                 | Household productive capability (irrigation users) | 1 478.0713 | 441.3829 | 0.023** |

***, ** and * means significant at 1% and 5% levels, respectively.

It can be deduced from Table 6 that irrigators have higher mean incomes per annum (R12 509.13) than non-irrigators (R8 275.69). The null hypothesis states that the mean incomes of irrigators and non-irrigators are equal. With a p-value of 3.56 E-05 showing significance at 1% level and F > F-critical we reject the null hypothesis and conclude that the means are different.

12. Treatment effects of irrigation farming on household food security status

Two matching algorithms for the estimation of the treatment effect were employed. The treatment effect estimation result of irrigation farming is presented in Table 7.

Both the NNM and Kernel matching methods point to the fact that irrigation access has a significant effect on household income which contributes significantly to food security status. Based on the results, the average treatment effect on the treated (ATT) of irrigation access on household income for the user’s ZAR 2 738.87 and ZAR 2 790.37 for nearest-to-neighbor matching and kernel-based matching respectively. Implicatively, the usage of irrigation has increased the mean per capita food expenditure of the irrigation users by ZAR 2 738.87 and ZAR 2 790.37 more than the non-irrigators depending on the matching method used. These findings were consistent with the findings of Adeboyo et al. (2018); and Sinyolo et al. (2014), who also found that irrigation access has a constructive substantial effect on the livings position of irrigators. And confirm that irrigation farming has the potential to improve the efficiency of farms and the overall gain from farming, leading to household food sufficiency and better living.

13. Treatment effects of cash transfer on household productive capacities of irrigation users

The study also examined the effects social protection in the form of cash transfers has on irrigation farming among smallholder farmers. Both the NNM and Kernel matching methods were applied and we present the results in Table 8.

Based on the findings, both matching algorithms point to the fact that receipt of cash transfers has evidently brought significant improvements in the production capacities of farming households. The average treatment effect on the treated (ATT) of cash transfers on productive capacities
of irrigation farmers was ZAR 1 467.93 and ZAR 1 478.07 for nearest to NNM and kernel-based matching respectively. This implies that households that participate in irrigation farming and receive the cash transfers have the capacity to purchase and use more agricultural inputs and in return gain a higher gross margin from the production activities as compared to the non-participant households. Hence, they are ZAR 1 467.93 and ZAR 1 478.07 mean per capita of cash transfers, better off compared to the non-irrigators. These results are consistent with Daidone et al. (2019) and Mdoda et al. (2019) findings that cash transfers resulted to an expansion and increase in agricultural output where in their case, the households producing rice and groundnut had a larger share of at least 145.9 new Zambian Kwacha—ZMW, income generated after harvest.

14. Conclusion and recommendations
Small-scale irrigation schemes in former Transkei and Ciskei homelands of Eastern Cape Province were established mainly to improve welfare and rural livelihoods through improved food security, employment and eradication of poverty. Despite the national and provincial efforts through improved access to land, extension services and modern technologies such as improved farm inputs and irrigation, smallholder farmers’ productivity remains low and it is bound to continue declining. Boosting physical output is most certainly a key solution to the food security problem and efficient use of irrigation will definitely play an important role in the face of water scarcity due to climate change.

The study sought to investigate the impact of cash transfers on irrigation participation and how irrigation participation eventually affects household food security status. The study utilized descriptive statistics as well as the propensity score matching (PSM) technique. It can be concluded that irrigation participation has increased the mean per capita food expenditure of the irrigators, which enhanced household food security in the study area. Additionally, cash transfers resulted in the increased household productive capacity of irrigation users. High dependence on cash transfers was observed in the study area.

Enhanced market incentives are necessary to boost the incomes of smallholder crop producers who often face stiff competition from large-scale farmers. Farm management will certainly be influenced in one way or another by these changes. Non-farm wage jobs are a source of additional income amid land and water resource constraints coupled with the seasonality problem of farm income. It is, therefore, of considerable policy interest to obtain an understanding of social, demographic, infrastructural, and seasonal factors that may influence non-farm job activities in the Eastern Cape Province as this is paramount to improving the food security of smallholder farmers.

The results of the study have implications for scheme and farm management. Huge amounts of money have been invested into the revitalization of irrigation schemes. If these schemes were properly managed the funds could be directed toward other crucial innovations that would enhance food security. The government cannot achieve the efficiency objective of irrigation schemes alone hence the need for partnerships with NGOs, NPO, and public-private partnerships. Such partnerships should utilize other avenues such as the provision of extension services, capacity building, and managerial training as well as financial literacy. Given the importance of off-farm income, farmers need to employ proper division of household labour between farm and off-farm activities. Smallholder farmers need a shift of mindset as well; through training, they should start to view their farms as enterprises that need proper management to succeed. Financial management skills need to be imparted to farmers so that they are better able to handle their income through farm investments instead of consuming all of it.

The agenda of alleviating poverty, creating employment and ensuring food security will always be unfinished hence new areas for research; policy and capacity strengthening need to be sought constantly through academic research. Although a considerable number of variables were included in the model, this study has focused only on a limited range of factors influencing irrigation participation and household food security. Therefore, it cannot claim to have apprehended enough evidence to enunciate on such a complex subject. It is therefore necessary to conduct further investigations into
intra-household factors that influence food security. The aspects of diet and nutrition also need to be investigated because having an income does not satisfy the conditions for nutritious food. Control over household income in the study area also needs to be looked into to ascertain its distribution within the household. A study on factors that affect the participation of farmers in off-farm activities is paramount to enhancing food security in the province. In addition, the effectiveness of adopting irrigation towards poverty alleviation as well as the efficiency of policy (social grants) should be evaluated by their impact on the quality of life of those who are at risk of hunger.

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Author details
Nyara M. Mujuru1
E-mail: nmjuru82@yahoo.co.uk
Ajuruchukwu Obi2
Lelethu Mdoda1
Syden Mish3
Mahali E. Lesala1

1 Department of Agricultural Economics and Extension, University of Fort hare, Private Bag X1314, Alice, Eastern Cape 5700, South Africa.
2 Discipline of Agricultural Economics, School of Agricultural, Earth and Environmental Sciences, College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg South Africa, 3209.
3 Department of Economics, Nelson Mandela University, P. O Box 77 000, Summerstrand, Port Elizabeth 6031, South Africa.

Authors’ contributions
N.M.M. formulated the research investigation under the supervision of A.O. Data collection was carried out by N.M.M., M.E.I. and L.M. Data analysis and draft manuscript compilation were done by N.M.M and S.M. Research scrutiny and scientific validation were carried out by all the authors. Funding and administration were undertaken by A.O. The manuscript is the effort of all authors. All authors have read and agreed to the submission of the manuscript for publication.

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Availability of data and material
Data can be provided upon reasonable request.

Code availability
Stata (Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

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