

# IMPACT OF COVID-19 ON FOOD SECURITY STATUS AND PARTICIPATION IN FOOD SECURITY INTERVENTION PROGRAMS

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(Received 9<sup>th</sup> Feb 2025; accepted 14<sup>th</sup> Apr 2025)

**Abstract.** The Coronavirus pandemic (Covid-19) brought devastating effects to most people around the world especially communities who have always had no access to basic needs such as food, shelter, technology and water. Smallholder farmers were greatly affected by the pandemic since movement to purchase basic necessities was very limited during the pandemic. The purpose of this study was to investigate the impact of home gardens (trench, keyhole and tower gardens) on the food security status of rural households. Propensity score matching was used to assess farmers with and without home gardens to determine the impact of this program. The results revealed that having a keyhole, trench and tower gardens improves the food security status of the household. The intervention brought significant changes to smallholder farmers, as they were able to produce vegetables and crops to sustain their households during the Covid-19 pandemic. The study recommends that smallholder farmers should be enabled to establish home gardens to reduce food insecurity.

**Keywords:** *home gardens, keyhole gardens, smallholder farmers, rural household, propensity score matching*

## Introduction

An evaluation of household food security and nutrition is crucial because, eight years into the 2030 Agenda, nothing has been accomplished in terms of determining the food security status and household hunger. Assessing the effects of this worldwide pandemic on food security and nutrition is crucial as the Covid-19 pandemic spreads (Oko et al., 2022; Yu et al., 2024; FAO et al., 2020). According to the Food and Agriculture Organization (2020), the world is struggling satisfy its food demand, and it will be challenging to achieve the Sustainable Development Goals (SDGs) of eradicating hunger by 2030.

According to Aderemi et al. (2021) and the International Food Policy Research Institute (IFPRI) (2020), the hunger and nutrition conditions in many developing nations are classified as “serious,” “alarming,” or “extremely alarming.” Many developing countries now frequently assess and monitor their current levels of food and nutrition security because of this gloomier future. As a result, South Africa is putting procedures in place to coordinate and monitor its progress toward meeting the 2030 targets of the SDGs. According to Enilolobo et al. (2022) and Altman and Jacobs (2010), whether or not individuals and families are completely self-sufficient in food production, food security can be roughly defined as households having access to adequate, safe, and nourishing food for a healthy and productive existence. The broad concept of food security encompasses food production, nature, quality, access to food,

and human food supply (Chen et al., 2025; Lal, 2020; Carter and Gulati, 2014). The physical and financial resources of a population play a role in influencing access to food together with social and political issues.

Swanepoel et al. (2021) and Altman et al. (2009) contend that in order for a nation to attain food security, there needs to be enough nutritious food for every resident. The majority in most nations rely on food that is processed and stored for later use, with the exception of food that is obtained through subsistence farming. Therefore, it is the responsibility of the government, industry, and civil society to teach the average consumer about the nutritional value of food and to make it possible for them to receive proper health and sanitation facilities.

The seriousness of the matter has left about 52 out of 119 countries with the highest scores on the Global Hunger Index (GHI scores). As a country, South Africa is a food-secure nation producing enough staple food and with the capacity to export food to other countries such as Swaziland, Lesotho, Namibia, and Zimbabwe (Setsoafia and Renwick, 2022). However, findings from a study by Reddy et al. (2015) and Zurayk (2020) supported the argument that South Africa is food secure at the national level but equally concluded that the same cannot be said about it at the household level. As a result, governments were urged to modernize agriculture in Africa by coming up with several interventions.

With regards to the above the South African government has helped traditional leaders and municipal governments to support the communities by granting them access to land and to boost food production. Through the Department of Agriculture (DoA), the government has launched a number of agricultural community projects as part of its interventions to increase rural access to food, increase their incomes, and create jobs. Lack of support services, such as technical and management expertise to handle agricultural projects, is one of the key production challenges that small-scale farming households are facing (Hall, 2018). As a result, the Department of Agriculture is putting more effort into addressing this shortcoming and is currently in charge of overseeing the execution of policies that will lead to greater food security.

The KwaZulu-Natal (KZN) Province has established numerous food security initiatives as intervention programs. One Home One Garden, the Comprehensive Agricultural Support Programme (CASP), the Livestock Program, the Mechanization Program, the Mushroom Program, the Women, Youth, and People with Disabilities Program, the Small Livestock Program, the Indigenous Nguni Livestock Program, the Rural Development Program, the Impact Partnership, and the Land Care Projects are a few of them (von Fintel and Pienaar, 2016). Several households were supplied with seeds to produce food for home consumption in their households through the “One Home One Garden” campaign that has encouraged the visibility of gardens throughout the province. In some areas of KwaZulu Natal, tractors were made available to cultivate huge parcels of land for massification projects to increase crop production (Langyintuo, 2020).

Additionally, in 2020, the Institute of Natural Resources (INR) and the United Nations Development Programme (UNDP) teamed together to implement agricultural initiatives in KwaZulu Natal to address food security in 11 different wards of the Maphumulo Local Municipality. The programs were intended to increase local household food security and nutritional needs while also providing employment possibilities. Trench beds, tower gardens, and keyhole gardens were among the types of home gardens which smallholder farmers received assistance with. In addition, the

UNDP provided small livestock to households, including meat rabbits, indigenous chickens, and chicken layers (Oduniyi and Tekana, 2020; Yu et al., 2024; von Fintel, 2016).

These gardens are not a new thing, in the late 1970s the gardens were used in townships to provide communities with vegetable farming. These gardens entail excavating land of the about 2 m in size, around 1.5 spades deep. After that, a few rusted materials and organic waste from the households are added to this. After placing the dirt on top, mulch dry organic matter or wood pieces are applied. After a number of layers of the mulch the farmers can plant vegetables and swiftly grow food to consume in an optimal and quick-growing medium.

To provide access to fresh vegetables, a tower garden and a trench bed with a basic drip irrigation system are being implemented. For communities with access to irrigation water, the possibility of using grey water—that is, water from bathing or washing clothes or dishes—to irrigate vegetable gardens was investigated. Three commercial egg-laying hens, five native Boschveld chickens used for dual purposes, or two New Zealand white meat rabbits were added to the vegetable plots as an additional source of animal protein. There were 138 beneficiary families across 11 project sites where this work was carried out.

A successful collaboration between the Institute of Natural Resources NPC (INR) and the United Nations Development Programme (UNDP) in South Africa yielded exceptional results and positive impact on many livelihoods during the devastating times of the COVID-19 pandemic. Through the collaboration, between October and December 2020, UNDP and the INR implemented food security interventions in poor communities across the rural and peri-urban areas of KwaZulu Natal province.

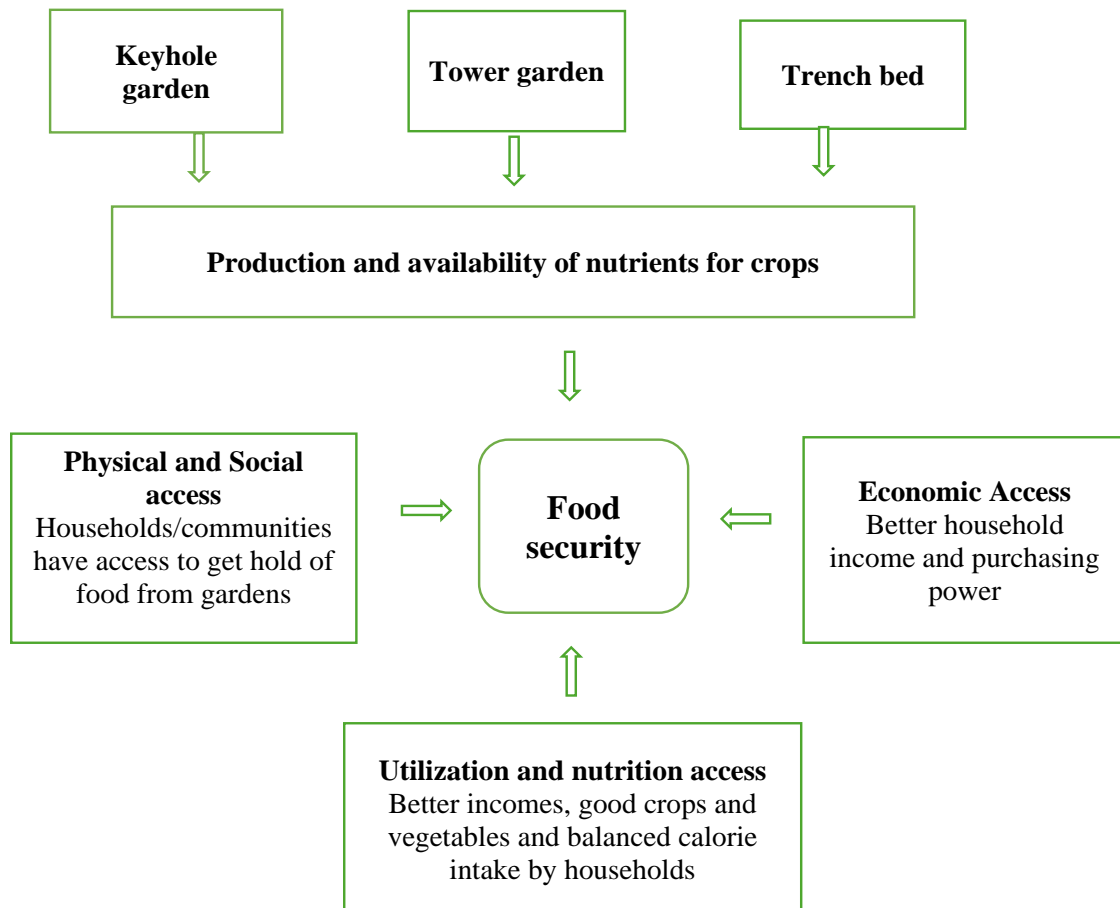
The impacts brought by the COVID-19 hard lockdown exacerbated the historical challenges of unemployment, poverty and inequality experienced in urban, peri-urban and rural communities of South Africa. Food prices skyrocketed while most people who were “breadwinners” lost their jobs. In dealing with these challenges; the project introduced three innovative vegetable production technologies (Keyhole garden, Tower garden and a Trench bed with a simple drip irrigation system) in order to improve access to fresh produce (*Fig. 1*). The use of grey water (water from bathing or washing clothes or dishes) to irrigate the vegetable gardens was explored as an option for communities with irrigation water. The vegetable gardens were complemented with one of three options for providing a source of animal protein – either three commercial egg-laying hens, five indigenous dual-purpose Boschveld chickens, or a pair of New Zealand white meat rabbits. This work was implemented in 11 project sites with 138 beneficiary households.

With so many interventions being implemented in KwaZulu Natal, it is essential to develop some monitoring tools to determine whether these programs have improved the food security, earnings, and opportunities for rural households. This is the premise and focus of the study, which focuses on the Maphumulo Local Municipality and seeks to understand how these initiatives have affected the sustainability and food security of rural households in KwaZulu Natal.

## Methodology

The KwaZulu-Natal Province in South Africa is home to the Maphumulo Local Municipality in the iLembe District. Maphumulo, KwaDukuza, Ndwedwe, and

Mandeni municipalities are the four local governments that make up the district. There are 11 wards in the Maphumulo Local Municipality, but only three were specifically chosen for this study. The wards 3, 6, and 10 were selected. In order to evaluate the effects of food security in these locations, a program was introduced to these households. Ward 3 is a restricted agricultural potential region, ward 6 is a low agricultural potential area, and ward 10 is a high agricultural potential area, according to a report from the Department of Agriculture and Environmental Affairs (DAEA) (2013).



**Figure 1.** A schematic graph about the keyhole- and tower garden and trench bed. Source: Authors (2021)

Three (3) subwards, or more than 50%, of each ward were chosen to account for regional differences in the proportion of farming households. Masiwela, Mpise, Mangongo, Mambulu, and Mabhobhane were subwards for ward 3. Mbitane, Sihlushwaneni, Sabuyaze, Entubeni, and Umpumulo were subwards for ward 6. Ntombiyahlunina, Tshobho, Nyamazane, Kwandaba, and Okhalweni were subwards for ward 10. To evaluate food security in the face of the Covid-19 epidemic, nine (9) subwards were chosen in total: Masiwela, Mangongo, and Mabhobhane in Ward 3; Mbitane, Sihlushwaneni, and Umpumulo in Ward 6; and Tshobho, KwaNdaba, and Okhalweni in Ward 10. These regions had good road systems and were easily accessible for gathering research participants.

### ***Assessment of food security in this study***

It might be difficult to evaluate food security and access in South Africa's rural communities. Specifically in the Maphumulo Local Municipality in KwaZulu Natal's deep rural areas, some of which are difficult to access by road. Therefore, it can be time-consuming and expensive to gather comprehensive data on household food access or individual nutritional intake. High-level technical proficiency is needed for both data collection and analysis. According to Brown et al. (2019) and FAO et al. (2017), questions on dietary variety can be answered at the household or individual level. Household dietary diversity is the number of distinct food groups ingested over a specified reference period. The inability of households to recollect a 24-h period or a few days of food intake prevents studies of food security at the household and intra-household levels from being conducted. Given that people have trouble remembering their last 24 hours' worth of meals, this study took a different method. In this study, food security in rural families was assessed quantitatively using various markers of household food insecurity, including dietary diversity, food access, and food sources (Bwalya, 2013). In this study, farmers who received assistance with home gardens were contrasted with those who did not. The study featured an experimental group and a control group to determine the effect of the gardens on the food security situation of rural household during the Covid-19 pandemic.

The types and quantities of foods planted by the farmers in their trench, keyhole, and tower gardens were the independent variables for household dietary variety. Since it can be challenging to remember what was eaten in the previous 24 h, this study quantitatively collected data on the types of meals consumed among the homes. To prevent bias, this study made several assumptions. Since the Covid-19 pandemic was in effect at the time of this study, farmers who received assistance with gardens were questioned about whether their food situation had changed. Potential crop types and output levels were examined in the study. This made it possible to assess the nutritional diversity and self-sufficiency of households. After then, vegetables and other crops were made from the garden harvest. Since there was little mobility to buy food during the epidemic, the key problem in this situation was the supply of food at the family level.

### ***Selection of participants***

The various wards in Maphumulo were chosen on purpose because they each have a varied level of agricultural potential. Farmers were divided into groups depending on whether they received assistance or not. Using a semi-structured questionnaire, the household heads were asked for this data. To minimize bias, 159 farmers from a remote area were also randomly chosen, in addition to the 197 farmers with keyhole, trench, and tower gardens who were involved in the study's data collection. Thus, 356 farmers made up the entire sample. Understanding the role of program interventions (trends and changes) that have occurred from the beginning of these home gardens in these rural locations was the goal of this study. Due to ownership of these backyard gardens, "sustainable" production results. These gardens can be a source of investment for farmers, increasing output and enhancing food security.

### ***Model specification***

This study used the Propensity Score Matching (PSM) technique, which involves estimating the likelihood of rural farmers with gardens and those without gardens based

on farm household characteristics using Tobit models Abadie (2003). Thereafter, individual farmers and those participating in joint efforts are matched based on propensity scores, and the average treatment effect (ATE) is estimated. The sample used for PSM was limited to the common support position, which is defined as the values of propensity scores when both treatment and control observations could be identified, to ensure the greatest comparability of the treatment and control groups. The primary problem in this case was the exogeneity and endogeneity of these outside groups in promoting food subsistence. Thus, support from non-governmental organizations was hypothesized as having positive welfare implications on food security status of rural farmers in the Maphumulo Local Municipality of KwaZulu Natal.

To match treated and untreated observations on the predicted probability of getting treated, propensity score matching was used to the features of the farmers' observables (Ravallion, 2007). Most often, propensity score matching is used to compare the effects of two treatments, whether or not a person participates in the program.

Match based on the propensity score

$$P(X) = \Pr(d = 1/X) \quad (\text{Eq.1})$$

$d$  indicates participation in the project.

Instead of attempting to create a match for each participant with the same value of  $X$ , the study matched the rural farmers on the probability of participation in a program or not (i.e. those with trench beds, tower gardens, keyhole gardens and those without).

The key assumption was that participation of the rural people in home gardens was independent of outcomes conditional on  $X_i$ . The approach to this study was to compare smallholder farmers with a trench, tower and keyhole gardens from these organizations (exogenous shock) and this was analyzed using the difference-in-difference technique shown in equation 2. This investigation follows the work of Douthwaite et al. (2002) with learning indicators that include acceptance, expansion diffusion and modification.

$$E[y_0|X, d = 1] = E[y_0|X, d = 0] \quad (\text{Eq.2})$$

This is false if there are unobserved outcomes affecting the participation of farmers in trench beds, tower gardens, and keyhole gardens. The data enables matching not just at the mean but balances the distribution of observed characteristics across treatment and control variables in the sampled households (Markelova et al., 2009).

In a first model referred to as regression on explanatory, we control for selection bias by including a large set of observable explanatory variables ( $X$ ) as control functions in the regression on household income. The model was regressed using Ordinary Least Squares (OLS). The ATEs were estimated using OLS as the regression coefficients were unbiased and consistent with the OLS model.

## Key findings

### *Descriptive characteristics of household heads*

Table 1 depicts the characteristics of agricultural household heads are described. The age range of the heads of farm households is between 31 and 50 years old. This suggests that most farmers are still in the prime of their careers and are therefore expected to

produce using the resources at their disposal. To keep young people employed in the rural agriculture industry, it may also be required to provide them with alternatives to farming. Additionally, for homes with and without home gardens, respectively, the majority (53%) and (55%) of households are headed by men. This is consistent with the KwaZulu Natal tradition that most homes are headed by men. In addition, most household heads are married with 52% and 46.5% in the comparison studies respectively. In the traditional farm system, where most homes consist of 1-4 family members, it has been found that husbands and children play a vital role in household family labor. *Table 1* demonstrates that the demographics of Maphumulo Local Municipality are dominated by small families notwithstanding the significant labor shortage in rural areas.

**Table 1.** Farm household heads personal characteristics (n = 356)

Variables	With intervention		Without intervention	
	Frequency	Percentage	Frequency	Percentage
<b>Age</b>				
< 30	16	7	10	6
31-40	63	27	21	13
41-50	48	20	24	15
51-60	33	14	41	26
> 60	77	32	63	40
<b>Gender of household head</b>				
Male	103	53	88	55
Female	94	47	71	45
<b>Marital status</b>				
Single	46	23	31	19.5
Married	103	52	74	46.5
Divorced	19	9.6	23	14.5
Widowed	29	14.7	31	19.5
<b>Educational level</b>				
Primary school	67	34	51	32
Secondary school	33	16.8	27	17
Tertiary education	49	24.9	65	40.9
No formal education	48	24.4	16	10.1
<b>Farm experience</b>				
1-5	98	50	71	44.6
6-10	38	19.3	37	23.3
11-15	27	13.7	24	15.1
> 15	34	13.7	24	15.1
<b>Household size</b>				
1 – 4	116	59	87	87
5 – 8	67	34	53	33.3
9 – 12	14	7	19	12
<b>Total</b>	<b>197</b>	<b>100</b>	<b>159</b>	<b>100</b>

Source: Computed from survey data, 2021

In terms of education, the majority of the sampled household heads are formally educated. This finding conforms to the results of previous authors such as Markelova et al. (2009) who observed that most rural farm household heads have formal education and some have taken pension or retired. This has implications on their farm activities as household heads are decision-makers and during this Covid-19 pandemic household heads had to adopt these gardens for food security. This enhances their ability to take full advantage of extension services and contribute to reduced poverty.

The majority of the sampled household heads do farming as their primary occupation. Although most of these rural farm households were hard-hit by the Covid-19 pandemic, several farm households had to implement other strategies or adopt new interventions for continued food production. Despite, these interventions most rural people depend on social grants and off-farm employment income (Obiakor et al., 2021; Chili and Murenha, 2011).

### ***Living conditions and access to social amenities among farm households***

The Covid-19 pandemic was a shock to all people in the world hence, it is important to know the available social amenities in rural areas of KwaZulu Natal. The major determinants of households' welfare are their respective access to basic social amenities and living conditions such as roads, clinics and stores. Thus, this study examined these key indicators in rural Maphumulo Local Municipality. *Table 2* shows that the majority (71.7%) of the sampled rural farm households in the study area reside in communities whose access roads were tarred but motorable and in some parts of the rural areas the roads were tarred and in a poor state.

**Table 2.** Distribution of rural farm households by access to social amenities (n = 356)

Variables	With support		Without support	
	Frequency	Percentage	Frequency	Percentage
<b>Access road</b>				
Tarred and in a poor state	98	49.7	73	46
Un-tarred but motorable	86	43.7	53	33.3
Tarred but in good state	13	6.6	33	20.7
<b>Electricity</b>				
Linked to the national grid	162	82.3	123	77.4
Not linked to the national grid	35	17.7	36	22.6
<b>Water source</b>				
Pipe-borne	103	52.3	79	49.7
Bore-hole	64	32.5	42	26.4
Stream	30	15.2	38	23.9
<b>Communication service</b>				
Post office	86	43.7	52	32.7
Landline phone	8	4.0	17	10.7
Cellphone network	103	52.3	90	56.6
<b>Health services</b>				
Private hospital	38	19.3	49	30.8
Govt health centre	132	67	103	64.8
Traditional healers	27	13.7	7	4.4

Source: Computed from survey data, 2021

The price of moving products and services in rural areas in Maphumulo Local Municipality is impacted by the condition of the roads in those areas. Poor road access in rural areas tends to decrease the transportation of food to local shops and supermarkets and enhance the poverty situation, according to Musemwa et al. (2013) and Jayne et al. (2019). It is significant to highlight that in South Africa, communities that are connected to the national power grid account for over 90% of rural farm families. This has ramifications for value addition that rural farms can provide, such as preserving their produce in refrigerators. According to Battersby (2020), this study was interested in learning how Covid-19 and its accompanying control measures, such as lockdown limitations, affected food security. Since most rural regions have few amenities, having access to them is essential. However, whereas 52.3% of respondents used pipe-borne, 43.7% and 32.7% of respondents, respectively, had access to postal service. On the other hand, South Africa has a strong foundation for its rural communication infrastructure.

Hence, the study assessed if farmers subscribe to these mobile networks such as MTN, Vodacom, Cell C, etc. Telecommunication does influence crop production among farmers as it aids information on production and extension services (e.g. information on trench beds, tower gardens, keyhole gardens and how to grow certain crops). Trench beds, tower gardens, keyhole gardens are highly intensive gardens that can produce nutritious and healthy vegetables and crops. *Table 2* also shows that only a few (19.3% and 30.8% for the two respective groups) of the survey, communities have no access to private health services. This has implications on the health conditions of the rural people, especially during the Covid-19 pandemic as supported by Béné (2020) who also identified the challenges faced by people in accessing health facilities in rural areas. This study revealed that rural people had to visit rural clinics for health support and Covid-19 related matters during the pandemic. Most of the household heads claimed they had nursery and primary schools in their communities close to the clinics. This is an indication that the children of rural people have access to primary education. Surprisingly, some rural people do believe in traditional spirits and healing and about 13.7% and 4% of the study groups highlighted they do visit traditional healers when they have problems about health or spiritual problems, respectively.

### ***Crops cultivated by farmers***

This study considered looking at the types of crops cultivated by both the supported and unsupported farmers in these rural areas. The reason for considering this aspect was to establish what other means do farmers make to meet households' food security status with either being a participant or not in these intervention programs (Altman and Ngandu, 2010). The farmers who were not supported grew some of these crops and vegetables in their back yards without implementing the trench, tower and keyhole gardens.

Farmers were asked about the various crops that they grew in their home gardens. The purpose was to assess if they had access to nutritious food during the pandemic. The participants revealed that most of the crops, especially vegetables are grown in both seasons (winter and summer). The participants stated that vegetables such as onions, beetroots, butternut, cabbage, spinach, carrots, amadumbe, potatoes, sweet potatoes and tomatoes assisted them to have enough food for their nutritional requirements. The different types of crops grown gave them a variety of choices to consume during the pandemic.

The participants who were supported also mentioned that all the seeds, garden tools and fertilizers that were received contributed a lot to their food security status. In addition, the participants also mentioned that although butternut and sweet potatoes are not the kind of a vegetables that can be consumed as a staple food it was used for breakfast in place of bread. *Table 3* also shows that butternut, cabbage and spinach are also preferred as they can be harvested several times over three months. Spinach lasts for months while consumed at home for food security as well as generating income at the same time, compared to other vegetables.

**Table 3.** Types of crops cultivated by rural households (n = 356)

Types of crops	With support		Without support	
	Frequency	Percentage	Frequency	Percentage
Cabbage	23	11.70	9	5.66
Spinach	16	8.12	17	10.69
Onions	8	4.06	0	0
Carrots	7	3.55	2	1.26
Beetroots	3	1.52	6	3.77
Tomatoes	13	6.60	7	4.40
Butternut	27	13.70	21	13.20
Maize	26	13.20	43	27.04
Beans	17	8.63	34	21.38
Potatoes	19	9.64	13	8.18
Sweet potatoes	34	17.26	2	1.26
Amadumbe	4	2.03	5	3.15
<b>Total</b>	<b>197</b>	<b>100</b>	<b>159</b>	<b>100</b>

Source: Computed from survey data, 2021

The household heads with trench, keyhole and tower gardens were delighted with the intervention as some of their harvest fresh and the quantities improved in a short period unlike the farmers who were not supported had a few glitches in their total output. KwaZulu Natal province has some areas that have enough rainfall and in some parts the areas are dry but from these interventions, farmers were able to get good yields. Hence, it can be noted that participation in these intervention programs could influence the participation of households in new intervention methods depending on the household's satisfaction with previous programs.

### Empirical results of the study

*Table 4* shows that access to these gardens is a significant factor in explaining the food security status of the household. There is a notable relation between the number of gardens and support received by these farmers is significant. In other words, the probability of having access to a home garden increases the chances of being food-secure than a household without a home garden. The intervention given to these farmers proves a point that they can harvest better vegetables and crops as compared to those without this support and this is supported by Barbier and Burgess (2020) who found that any form of support tends to have an impact on the welfare of rural communities.

The average number of home gardens was three and each was very labour-intensive in terms of the construction involved. This finding indicates that farmers are more likely to be involved in the construction of these gardens to meet their food security status. Although farmers need joint cooperation in their villages to enhance food security, farmers who are not involved in these interventions appear to be struggling in terms of food availability especially nutritious vegetables and crops. Farmers can take advantage of the support they are getting from UNDP to improve food security and combat related diseases from good nutrition.

**Table 4.** *Impact of interventions on farmers with and without support (n = 356)*

Variable	With support		Without support	
	Mean for those with support (st.dev)	Impact of support (st.error)	Mean for those without support (st.dev)	Impact of not having support (st.error)
<b>Full sample</b>				
<b>Stratified by household income per capita</b>				
Number of home gardens owned	2.7 (0.10)**	3.2 (0.31)*	0.3 (0.56)	0.73(0.83)
Produced enough food Dummy (1-Yes and 0-No)	0.92(0.01)**	1.65 (0.56)	0.04(0.28)	0.33(0.21)
Household sold food Dummy (1-Yes and 0-No)	0.65(0.44)***	0.23(0.58)***	0.47(0.13)	0.27(0.55)
Household size (no. of members)	4(0.14)*	3(0.14)	3(0.45)*	5(0.84)
Dependency ratio (children/adults)	3(0.45)	5(0.73)	3(0.32)	2 (0.12)
Education of household head (years)	-0.12 (0.05)**	-0.15 (0.05)**	0.48(2.03)	0.07(0.05)
Age of household head (years)	-0.00 (0.00)**	-0.00 (0.03)	0.03(0.39)	1.8(0.26)
Dummy for the male household head	-0.00 (0.04)	-0.01 (0.00)	0.43(1.63)	0.26(0.03)
Distance to nearest shop	0.01(0.23)*	0.03(0.13)	0.67(2.57)	0.56(3.89)
Distance to nearest clinic or hospital	-0.03(0.00)**	-0.03(0.00)**	0.56(0.04)**	0.20(0.83)**
Pseudo R <sup>2</sup>	279	243	236	275
Log-likelihood	0.1468	0.1579	0.2458	0.143
Correctly classified observations	-245.72	-203.12	-261.37	-287.41

Standard errors in parenthesis (), \*, \*\*, \*\*\*denotes significance at 10%, 5% and 1% level

It is also important to note that the insignificance of all other variables in explaining the impact of the interventions and individual membership to these projects should be interpreted as a positive result. This suggests that the only observables in which treated and control farmers differ is in types of gardens, size of the gardens and access to resources to construct the tower, keyhole and trench gardens. This confirms the validity of the study's control group (which is farmers who did not receive any form of assistance regarding these home gardens).

The econometrics analysis (PSM) is found to be robust to different estimation techniques and alternative models' specifications. The results show that interventions targeted at farmers have a great impact in terms of food security and sustainability considering farmers had limited mobility during the Covid-19 pandemic to access food. Hence, a member of these interventions benefited a lot compared to the farmers who were not assisted with these rural projects. The income effect was not analyzed in this study as the gardens were only constructed to support households with vegetables and crops. Any excess produce from these gardens was given to close family members and neighbours, with none being sold.

While participation in these interventions seems to increase agricultural output and increased crop production, on the other hand, the construction of home gardens required a lot of labour as many materials were used. In this regard, the welfare of rural households greatly improved during the pandemic despite the challenges farmers faced in the construction of the trench, keyhole and tower gardens.

*Table 4* shows that propensity score matching (PSM) results are more significant for those with gardens at 5% and 10% than those not assisted with home gardens. It emerges that age, distance to the nearest shops, gender of the household and household size are the only significant factors that help explain an improved living standard amongst the farmers who had support. In particular, the study notices that age is an important factor that determines the adaptability of interventions amongst rural people as depicted by Arouna et al. (2020).

The chances of improving the livelihoods of the rural people during the pandemic can be seen by the significant probability of being a member of the interventions than those without support, this is also shown by the threshold (approximately 3 home gardens per household or more). This is because people in rural areas of the Maphumulo Local Municipality are constrained by resources used in the construction of these home gardens such as implements and that forces them to construct smaller trench beds, keyhole and tower gardens. It is also important to note that the insignificance of all other variables in explaining the success of the farmers without support services is crucial to these rural people or farmers and should be interpreted as a positive result. This suggests that the only observables in which treated groups of farmers with access to resources and technical support have a better understanding of how to construct and produce vegetables and crops for food sustainability and food security.

This ratifies the validity of the control group (which is farmers who have not received any form of assistance) and the potential reason underlying the insignificant impact of these interventions. Several farmers had challenges associated with inputs used in the construction of these gardens. The farmers could not share information from the different areas simply because the study wanted to explore if there are significant differences between the farmers. It is crucial to find a mechanism that helps both farmers without compromising the quantity and quality of produced on these home gardens.

## **Conclusion and recommendations**

Food access was a serious issue in rural areas of the Maphumulo Local Municipality of KwaZulu Natal and many other parts of South Africa. The intervention programs that were introduced to farmers are an indication that more can be done in rural areas to uplift rural poverty. However, it was observed that most of the farmers that benefitted from these interventions and were able to put adequate food on their tables. Most households sourced water from boreholes and very few used water from the river.

The robustness of these findings is supported by the fact that two separate farmers were differentiated by these gardens which made others food secure and others not. In particular, the distinction made between farmers with access to the keyhole, tower and trench gardens and those that are not, allows us to advance and test the hypothesis that beyond heterogeneity in members' behavior, heterogeneity in behavior among these farmers plays also an important role in determining the impact of these interventions in promoting food security.

The policy implications and recommendations from this study include support to smallholder farmers in terms of technical and productive resources to increased production. There is also a need for the provision of adequate and functioning social amenities in the rural areas to keep farmers in their communities. This further encourages livelihood and crop production as a means for food and economic security amongst farmers who were assisted with home gardens. The pandemic was an eye-opener to smallholder farmers as they were not prepared and hence, it important for smallholder farmers to prepare for such shocks that may negatively affect their household food security status.

**Acknowledgements.** The authors gratefully acknowledge the support from research assistants who assisted in the collection of the data. Thanks also goes to Dr M Tshuma for his helpful comments and suggestions in this article.

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**APPENDIX**

**THE IMPACT OF COVID-19 ON FOOD SECURITY STATUS AND PARTICIPATION IN FOOD SECURITY INTERVENTION PROGRAMS**

*IMPORTANT: QUESTIONS THAT NEED GENERAL HOUSEHOLD INFORMATION MAY BE ANSWERED BY ANY AVAILABLE HOUSEHOLD MEMBER*

**SMALLHOLDER FARMER QUESTIONNAIRE**

**SECTION A: DEMOGRAPHICAL INFORMATION**

A1	A2	A3	A4	A5	A6	A7	A8
Respondents' gender? 1. Male 2. Female	How old is the respondent? ..... ..... .....	What is the marital status of the respondent? 1. Single 2. Married 3. Widowed 4. Divorced	What is the highest level of education the respondent has completed? 1. Primary education 2. Secondary education 3. Tertiary education	What is the respondent's ethnic group? 1. African (Black) 2. Caucasian (White) 3. Coloured 4. Indian 5. Other	How many dependents does the respondent have? ..... ..... .....	How many years have you been farming? ..... ..... .....	Respondent's occupation. 1. Employed 2. Pensioner 3. Full time farmer 4. Other ..... .....

**SECTION B: GENERAL FARM QUESTIONS**

B1	B2	B3	B4	B5	B6	B7	B8
What type of farm production system do you run? 1. Crop farmer 2. Animal farmer 3. Mixed farmer 4. Vegetable farmer 5. Other ..... .....	How big is your farm in hectareage? ..... .....	What is the farm ownership? 1. Owned with title deed. 2. Leasing it privately. 3. Leasing it from gvt 4. Other ..... .....	Do you get any extension visits? 1. Yes 2. No If yes, how many times: ..... ..... .....	How many household members assist with farming activities? .....	What is your primary source of income? 1. Farming 2. Fixed salary 3. Wages from odd jobs 4. Government grants 5. Other ..... ..... .....	Do you consider yourself a subsistence, smallholder or commercial farmer? 1. Subsistence 2. Smallholder 3. Commercial	Do you have any vegetables or crops cultivated in your farm? 1. Yes 2. No If yes, mention ..... ..... ..... .....

B9	B10	B11	B12	B13	B14
What is the purpose of farm produce? 1. Own consumption. 2. Selling. 3. Both 4. Other ..... ..... .....	Do you produce enough from the gardens? 1. Yes 2. No If yes, state the reason ..... ..... .....	Which soil amendments do you utilize? 1. Fertilizers 3. Compost 4. Animal manure 5. Other: ..... .....	Do you rear any animals on your farm? 1. Yes 2. No If yes, which ones, 1. Cattle 2. Sheep 3. Pigs 4. Chicken 5. Goats 6. Other: ..... .....	Do you know how much you spend on your production inputs? 1. Yes 2. No If yes, how much? ..... .....	Do you make any profits from the vegetables and crops you are growing and selling? 1. Yes 2. No If yes, which crops ..... ..... .....

**B15. During the COVID -19 did you have any challenges with the produced crops? Mention.**

.....  
 .....  
 .....

**B16. How do you overcome the challenges mentioned above?**

.....  
 .....  
 .....

**SECTION C: FARM PRODUCTION QUESTIONS ON THE KEYHOLE, TOWER GARDEN AND TRENCH BEDS**

C1	C2	C3	C4
<b>What crops do you grow from the list below?</b> 1. Maize 2. Spinach 3. Cabbage 4. Onions 5. Carrots 6. Tomatoes 7. Potatoes 8. Other (Specify) ..... ..... .....	<b>On which of these do you grow the vegetable or crops?</b> 1. Keyhole garden 2. Tower garden 3. Trench garden ..... ..... ..... .....	<b>How much produce do you harvest?</b> 1. 0-5 bundles 2. 6-10 bundles 3. 10 + bundles ..... ..... .....	<b>Do you sell your harvested crops, or do you utilize then for your household/farm, or do you do both, and how many bundles or Kgs do you sell or use in the house/farm (per commodity)?</b> 1. Household use 2. Sell to communities 3. Give to relatives and neighbours 4. Other (specify) ..... ..... .....

**C4.1. If you sell, where?**

1. Formal Market	2. Informal Market	3. Sell on request	4. All of the Above	5. Other .....
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**C4.2. If utilize for household/farm, what purpose?**

1. Eating in the house.	2. Sharing with relatives and neighbours	3. For sale to people.	4. Other (Specify) .....
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**SECTION D: KNOWLEDGE AND AWARENESS KEYHOLE, TOWER GARDENS and TRENCH GARDENS**

D1	D2	D3	D4	D5	D6	D7
<b>Do you know how to build keyhole, trench and tower gardens?</b> 1. Yes 2. No Example: ..... .....	<b>Do you know which materials to use for these gardens?</b> 1. Yes 2. No If yes, where do you know it from? ..... .....	<b>Do you know how to produce these crop or vegetables on these gardens?</b> 1. Yes 2. No ..... .....	<b>Do you know how much these gardens produce?</b> 1. Yes 2. No If yes, how many bundles or kgs..... ..... .....	<b>Do you have any interest in growing vegetables or crops on these gardens?</b> 1. Yes 2. No ..... .....	<b>What vegetables products are you aware of right now?</b> ..... ..... ..... .....	<b>Are you aware that these vegetables and crops can be commercially produced as an alternative to other crops?</b> 1. Yes 2. No ..... .....

**D7.1. If yes, where did you learn this information?**

.....  
 .....  
 .....  
 .....

**D8. Are you aware that crops and vegetables can grow easily with less inputs and less water on these home gardens?**

1. Yes	2. No
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**D9. Do you think you would make more money producing and selling these vegetables as opposed to other crops?**

1. Yes	2. No	3. I don't know
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### DISTRIBUTION OF RURAL FARM HOUSEHOLDS BY ACCESS TO SOCIAL AMENITIES

	Questions	Very aware (1)	Somewhat aware (2)	Not very aware (3)	Not aware at all (4)
<b>D10</b>	<b>Are you aware of quality of the roads</b> 1. Tarred and in a poor state 2. Un-tarred but motorable 3. Tarred but in good state				
<b>D11</b>	<b>Are you aware of electricity</b> 1. Linked to the national grid 2. Not linked to the national grid				
<b>D12</b>	<b>Are you aware of the water source</b> 1. Pipe-borne 2. Bore-hole 3. Stream				
<b>D13</b>	<b>Are you aware Communication service</b> 1. Post office 2. Landline phone 3. Cellphone network				
<b>D14</b>	<b>Are you aware that health services</b> 1. Private hospital 2. Govt health centre 3. Traditional healers				

#### D15. What is the distance to the market in kms?

1. Less than 5 km	2. More than 5 km
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#### D16. What is the distance to health facilities?

1. Less than 5 km	2. More than 5 km
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**D17. Do you think you would make more money producing and selling these vegetables as opposed to other crops?**

1. Yes	2. No	3. I don't know
--------	-------	-----------------

**SECTION E: PERCEPTION OF SMALLHOLDER FARMERS WILLINGNESS TO SORGHUM CROP PRODUCTION**

No:	Crops/Vegetables	With	Quantities	Without gardens	Quantities
1	Cabbage				
2	Spinach				
3	Onions				
4	Carrots				
5	Beetroots				
6	Tomatoes				
7	Butternut				
8	Maize				
9	Beans				
10	Potatoes				
11	Sweet potatoes				
12	Amadumbe				
13	Other:				

**SECTION F: PERCEPTION OF HOUSEHOLDS KEYHOLE GARDENS, TRENCH GARDENS AND TRENCH GARDENS**

	<b>Statements</b>	<b>Strongly willing (1)</b>	<b>Slightly willing (2)</b>	<b>Willing (3)</b>	<b>Slightly less willing (4)</b>	<b>Not willing (5)</b>
<b>F1</b>	Are you willing to increase these gardens?					
<b>F2</b>	Are you willing to cultivate most of your vegetables and crops on these gardens?					
<b>F3</b>	Are you willing to teach your family members to build these gardens?					
<b>F4</b>	Are you willing to expand production in these gardens?					
<b>F5</b>	Are you willing to promote the production of other crops on these gardens?					
<b>F6</b>	Would you be willing to participate in programs or initiatives that promote the construction of these gardens and promote them?					



*Map of the location of the study*