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RESEARCH ARTICLE:

Assessing the Impact of Community Gardens in Mitigating Household Food Insecurity and Addressing Climate Change Challenges: A Case Study of Ward 18, Umdoni Municipality, South Africa

Merishca Naicker[1], Denver Naidoo[2] and Mjabuliseni Ngidi[3]

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Abstract

South Africa, while nationally acknowledged as food secure, grapples with persistent household food insecurity, particularly in rural areas. Addressing this issue, the implementation of community gardens has gained traction. This mixed methods study focuses on the impact of community gardens on food security at the household level, exemplified by the community gardens in ward 18 of Umdoni Municipality. These gardens not only provide sustenance but also generate supplementary income through surplus crop sales. However, climate change threatens food systems and vulnerable livelihoods, necessitating assessment. A survey of 120 community garden participants was conducted, employing questionnaires and focused group discussions to gauge perspectives on crop production and food security. The survey revealed that 58.3% of participants did not receive sufficient food from community gardens, while 41.7% reported adequate supply. Only 15.8% achieved food security, with the majority (40%) experiencing moderate food insecurity. Challenges cited encompassed shifting rainfall patterns, temperature fluctuations, heightened disease, and pest pressures, and altered planting seasons. Intriguingly, despite their establishment, community gardens appeared ineffective in substantially improving household food security. These findings underscore the need for enhancing productivity and climate resilience within community gardens. Future research could illuminate strategies to bolster garden productivity and mitigate climate change impacts.

Keywords: *food security; community gardens; climate change; crop production; poverty*

Introduction

Climate change, a pressing global concern, has escalated land surface air temperatures, precipitating land degradation and escalating food insecurity (IPCC, 2019). Heightened instances of warming, pest outbreaks, and shifts in precipitation patterns pose imminent threats to vulnerable livelihoods and food systems (IPCC, 2019). As the global population burgeons, hunger rises in tandem (Meybeck *et al*., 2018). The challenge of securing access to nourishing and safe sustenance engenders escalating food insecurity worldwide (FAO, 2019). Sub-Saharan Africa, marked by urbanization, adverse climatic conditions, and poverty, bears an exacerbated burden on its food supply, amplifying food insecurity (Crush and Tevera, 2011). Developing nations, South Africa among them, grapple with soaring food demand and changing climatic conditions, compounding food insecurity woes (Tan, 2014). South Africa, especially in rural pockets like Kwa-Zulu Natal, wrestles with rampant food insecurity due to an interplay of climate change, poverty, limited arable land access, the HIV/AIDS epidemic, and inflation (Masipa, 2017). The agricultural sector, a vulnerable cornerstone, stands imperilled, with climate change poised to exacerbate the crisis (IPCC, 2019). To address this dire situation, the South African government has implemented community gardens, particularly targeted at impoverished households and rural communities. However, the intricate interplay between climate change, crop production in these gardens, and household food security remains inadequately understood.

[1]University of KwaZulu-Natal, merishcanaicker@gmail.com | https://orcid.org/0000-0001-5838-9168
[2]University of KwaZulu-Natal, Naidook12@ukzn.ac.za | https://orcid.org/0000-0002-5320-0538
[3]University of KwaZulu-Natal, ngidim@ukzn.ac.za | https://orcid.org/0000-0003-1708-2965

This study bridges the existing gap in understanding the impact of current climatic dynamics on crop yields in community gardens and the consequential ramifications for participants' household food security status. Consequently, the study aims to delve into the nexus between community garden crop production and farmers' food security amidst the evolving climate. These gardens, varying in size according to community needs, serve as lifelines for low-income societies. By exploring the challenges posed by climate change to the food security of community garden participants, this research unveils the pivotal role of community gardens in countering food insecurity. Moreover, it equips participants with insights into optimal planting windows to bolster their food security standing. This paper elucidates the confluence of climate change, community gardens, and household food security. The subsequent sections present the research methodology, key findings, their interpretations, and the broader implications, culminating in a comprehensive understanding of the multifaceted challenges and opportunities at hand. Climate change, as defined by Meybeck *et al*. (2018), signifies a shift in a region's established weather patterns, encompassing alterations in annual precipitation and seasonal temperature fluctuations. While weather can oscillate within hours, changes in local climate span extensive periods, even spanning millennia. Developing nations, characterized by limited resources and adaptive capacity, face profound vulnerabilities to climate change impacts, further exacerbating their predicament.

The agricultural sector, a cornerstone of many economies, confronts formidable challenges due to climate change (Saxena *et al*., 2020). All components of food security—availability, access, utilization, and stability—are demonstrably influenced by climate change, particularly its effects on food production driven by shifts in temperature and precipitation patterns. The consequences reverberate through societies, where rising food prices, population growth, economic shocks, and the unrelenting threat of climate change compound food insecurity (Egal, 2019). A failure to address these elements risks plunging regions into severe food insecurity, with cascading repercussions on malnutrition and well-being. The intricate interplay between community gardens, food production, and climate change is a dynamic aspect of this challenge. Community gardens, introduced as a measure to combat food insecurity, hold a dual role. They provide communities, particularly low-income households, with direct access to fresh produce and an additional income stream through surplus crop sales. However, these gardens operate within the larger framework of climate change vulnerability. El Nino, marked by heightened surface temperatures and reduced precipitation, poses a grave menace to crop production, particularly in African nations heavily reliant on agriculture (Tibesigwa *et al*., 2018). The burden on women in these societies, responsible for water collection, surges exponentially as water supplies dwindle. Community gardens, often managed by women, stand at the forefront of this challenge, navigating not only the impacts of climate change on crop yields but also bearing the brunt of increased water scarcity.

Climate change drivers pose formidable risks to food systems and the vulnerable (IPCC, 2019). The South African government, recognizing the urgency of addressing food insecurity, has enacted various initiatives within its food security policy. This policy takes a comprehensive approach, aiming to influence the organizational and economic paradigms that govern the food system, thus fostering advancements in both agriculture and the broader food industry. Encompassing markets, production, distribution, consumption, and nutrition, the policy operates across all facets of the food system, underscoring its multifaceted nature and the need for integrated strategies to tackle food insecurity challenges. In the South African context, rural areas, particularly in Kwa-Zulu Natal, experience pronounced food insecurity linked to climate change, poverty, limited access to arable land, the HIV/AIDS epidemic, and inflation (Masipa, 2017). These regions, dependent on agriculture, face amplified vulnerabilities, with climate change projected to exacerbate the situation (IPCC, 2019). This study aims to elucidate the specific interplay between community garden crop production, the challenges posed by climate change, and their impacts on household food security, offering insights into potential mitigation strategies to enhance resilience and address the growing food insecurity concern. By understanding how community gardens operate in the face of climate change, this research seeks to provide a comprehensive perspective on the challenges and opportunities in ensuring sustainable food security for vulnerable communities.

Methodology

This study's overarching aim was to comprehensively investigate the influence of community gardens on household food security, exemplified through the lens of specific community gardens. To achieve this goal, a mixed-method approach was judiciously employed, seamlessly blending qualitative and quantitative techniques. The study aimed to unravel the intricate interplay between community gardens, climate change, and the challenges posed to food security. The research design, a crucial blueprint for any study, outlines the strategic phases necessary for effective investigation, stemming from the research problem itself (Burkholder *et al*., 2016). In alignment with this principle, the study employed a mixed-method approach to meticulously dissect the multifaceted impact of climate change. This approach deftly scrutinized crop production within community gardens and the overarching food security status of households. The mixed-methods approach, known for harmonizing qualitative and quantitative data, was chosen to facilitate an in-depth exploration of the research problem (Creswell and Creswell, 2017). This comprehensive approach fostered an enriched understanding, seamlessly merging experiential narratives with empirical insights. The integrated method proved pivotal in comprehending the challenges community gardens face and their cascading effects on household food security. Creswell (2013) underscores how a mixed-method approach bridges numerical data with lived experiences, offering a holistic perspective that captures the essence of the studied phenomenon. The choice of methodology bore testament to the study's commitment to unravel complexities and integrate the voices of participants, establishing a comprehensive understanding of the challenges and opportunities in ensuring sustainable food security for vulnerable communities.

Figure 1: Map of the South Africa showing the study area situated in KwaZulu-Natal (World Atlas)

The research was conducted in Dlangezwa, located in Ward 18 of the Umdoni local municipality in KwaZulu-Natal. This rural area grapples with infrastructure deficiencies and widespread poverty. Limited informal tuckshops necessitate residents to seek food from beyond their locale due to the absence of chain stores. Income primarily stems from social grants supplemented by livestock ownership. Annual rainfall averages 906mm, concentrated in summer, while temperatures vary from 22.4°C in July to 27.8°C in February. Houses lack electricity, relying on gas or open flames for cooking. This detailed portrayal not only establishes the study's context but also offers insights into the region's challenges and vulnerabilities. Describing rainfall and temperature patterns provides an initial glimpse into the climate, vital for understanding the environment. Additionally, the absence of electricity accentuates the community's vulnerability to climate change impacts. These intricacies paint a comprehensive picture, forming the backdrop against which the research's exploration unfolds.

Within Ward 18, the population is largely composed of elderly individuals and children, with unemployment prevalent and only a minority engaged in subsistence farming. Participants, aged 18 and above, were purposefully selected from the community garden participants, yielding a representative sample of 120 individuals. To ensure representativeness, a deliberate random sampling approach was adopted, following Etikan *et al*. (2016) framework. This methodology combined both purposeful and random sampling, recruiting a diverse group of 120 participants. Purposeful random sampling mirrored the pertinent population, allowing for comprehensive data collection that encompassed community gardens, demographics, climate change understanding, attitudes, community dynamics, household food security, and climate change initiatives by the agricultural department and local municipality. Leveraging robust random sampling, the study adeptly gathered precise quantitative data while minimizing biases, fostering reliability. In contrast, qualitative insights were derived through cost-effective purposeful sampling, aligning with Van Ryzin's (1995) approach. This enabled exploration of respondents' perspectives on climate change's effects on community gardens, household food security, and cultivated crops. However, the trade-off between depth and representativeness underscores the limitations of non-generalizable results stemming from the hybrid approach. Conscientious methodological balance, extracting insights from a complex and multifaceted topic (Mujere, 2016).

This study employed a comprehensive data collection strategy, integrating both quantitative and qualitative approaches. The research tools encompassed focused group discussions, key informant interviews, and questionnaires, with 120 community garden participants surveyed. The quantitative facet was captured through surveys, while qualitative dimensions were explored via focused group discussions involving 8-12 participants across 10 sessions. Additionally, 12 key informant interviews were conducted with local municipality and department of agriculture employees. This intricate approach synergistically amalgamated numerical precision and qualitative depth, resulting in a holistic understanding of the research topic. The study's data analysis employed a multifaceted approach. A logical regression model was utilized to evaluate the impact of community gardening on farmers' food security status, considering communication patterns and identifying social phenomena. Frequency and descriptive analyses illuminated population dynamics, while quantitative data from questionnaires underwent SPSS analysis for insights into adaptability.

Qualitative data, including demographics and perceptions, were subjected to descriptive statistics. Focused group discussion data underwent thematic and content analysis, while the Household Food Insecurity Access Scale (HFIAS) determined food security status. The Household Food Insecurity Access Scale (HFIAS) is a widely used tool to assess and classify food security levels within households. It evaluates experiences related to food access using a series of questions, categorizing households based on their ability to obtain adequate and nutritious food. The HFIAS criteria encompass various conditions, such as anxiety about food supply, reduced meal portions, and food deprivation. Responses to these questions help classify households into different food security levels. This classification offers valuable insights into households' vulnerability to food insufficiency, informing strategies to address food security challenges. Investigating climate change's influence on community gardens and surveyed households' food security employed the logical regression model, with the dependent variable being food insecurity, expressed as a binary outcome. The binary variable acquired the 1 if the household was food secure and 0 if the household was found otherwise. the common logistic model can be penned as follows:

The general

$$Q_i = f(Y_i) = \frac{1}{1 + e^{-\left(\varphi + \sum \Psi_i X_i\right)}} \tag{1}$$

Where Q_i is the probability that an individual is being food insecure given x_i, x_i represents the i^{th} explanatory variables φ and Ψ are regression parameters to be estimated. e is the base of the natural logarithm.

Heckpoisson Model: The model comprises of one equation for the count outcome, does the household receive enough food from the community garden, and one equation for a binary selection indicator does the household receive enough food from the community garden. The indicator is always observed and takes values of 0 or 1. But the outcome of food insecurity status is observed = 1, that is, we have complete information about the covariates of interest and selection status. Nevertheless, the value of the primary outcome of interest, does the household receive enough food from the community garden, is sometimes unknown. More correctly, the count outcome is assumed to have a Poisson distribution, conditional on the covariates, with a conditional mean. The study used the Heckpoisson model to assess if the household receives enough food from the community garden and its effect on the household food insecurity status because of its ability to fit the outcomes of count data and correct for sample selection biases.

The binary regression models that are employed in comparable studies (Mussa and Mwakaje, 2013), would not be suitable for the present analysis. The Heckpoisson is estimated in two stages as shown in equations (2) and (3).

The Heckpoisson model is stipulated as follows.

$$E(HDDS_i \mid X_j, \in_{1j}) = \exp(X_j\beta + \in_{1j}) \qquad \text{The Heckpoisson model} \qquad (2)$$

$$S_j = \begin{cases} 1, if\ P_j\varpi + \varepsilon_{2j} > 0 \\ 0, if\ \ otherwise \end{cases} \qquad \text{The Selection equation} \qquad (3)$$

Where $\varepsilon_1 \sim N(0,\partial)$

$$\varepsilon_2 \sim N(0,1)$$

$$corr(\varepsilon_1,\varepsilon_2) = \rho$$

When $\rho \neq 0$, standard Poisson regression based on the observed y yields biased estimates. Heckpoisson provides consistent, asymptotically, efficient estimates for the limitations in such models. Contrasting the standard Poisson regression, the Poisson model with sample selection allows under dispersion and over dispersion. Where is the binary indicator showing whether the household gained enough food from the community gardens or not? The Poisson model (equation 2) is used to assess the impact of the community gardens on the household food security status (the indicator is only observed if = 1). Although the selection section of the model, equation (3), is used to evaluate the variables influencing involvement in community gardens. Due of the strong collinearity between the inverse mills ratio (IMR) in the selection model and predictors in the outcome model, the two Heckpoisson model equations share predictors that could introduce biases. To overcome the problem, the exclusion restriction approach (ERA) was applied. The ERA allows one or more of the predictors in the selection model to be excluded in the second stage to yield consistent estimates Schwiebert (2012).

Ethics, characterized as "accepted standards of behaviour" (Creswell, 2013), is pivotal in research endeavours. The ethical landscape encompasses both researchers and participants, each with distinct responsibilities. Researchers must be cognizant of their obligations, while participants have the right to respect and safeguarding. This study adhered to ethical principles, obtaining clearance from the College Humanities and Social Science Research Ethics Committee at the University of KwaZulu Natal (Ethical Registration Number: HSSREC/00002402/2021). Ensuring respondents' well-being was paramount, ensuring fairness and minimizing potential risks. Ethical considerations included informed consent, confidentiality, and privacy rights (Creswell, 2013). A preliminary meeting with extension officers and local leaders facilitated community access, bolstered by written consent from the Department of Agriculture. Participants were well-informed that their participation was voluntary, with no obligation to partake in the study. Ethical standards were upheld to safeguard the rights and well-being of all involved.

Results and Discussion

The composition of participants in the community gardens exhibited variations in size, as indicated in Figure 1. Among the gardens surveyed, 25.0% comprised six participants, while 15.0% consisted of 7 or 8 participants. Gardens with four participants accounted for 12.5%, and 10% featured 12 participants. Notably, in community gardens with a substantial participant count, 3.3% consisted of only two participants. This observation implies that the revenue generated from surplus sales might be limited. However, the additional support contributes to household income augmentation, potentially bolstering resilience against food insecurity (Galhena *et al*., 2013).

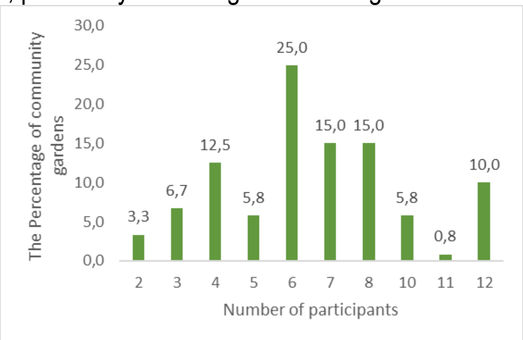

Figure 1: The number of participants in community gardens

The size of community gardens directly impacts the quantity of crops that can be cultivated, with smaller gardens naturally accommodating fewer crops. To address this limitation, smaller gardens are advised to focus on crops with rapid growth cycles, enabling more frequent harvests and a consistent food source (Eigenbrod and Gruda, 2015). In the study, communal gardens spanned 1 to 6 hectares, with a predominant portion (45.8%) measuring two hectares. The crops cultivated in these gardens significantly enhance households' food security. Certain crops, such as beans and maize, are dried and stored for utilization during winter, a period challenging for cultivation. Consequently, community gardens play a pivotal role in provisioning year-round sustenance to households.

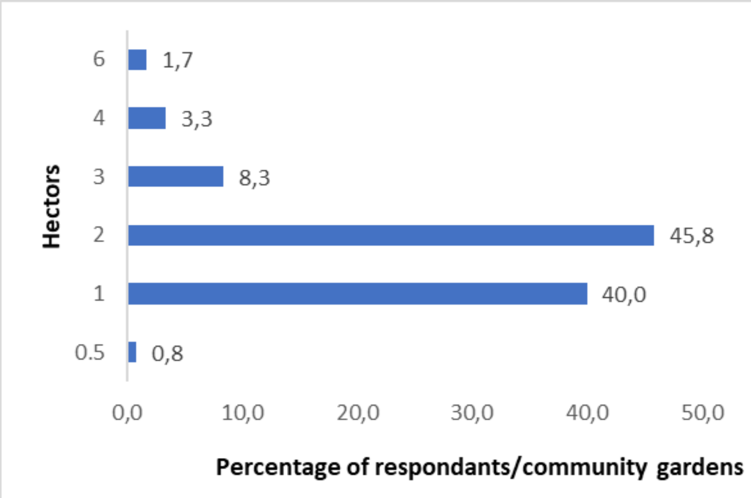

Figure 2: Size in hectors of community gardens.

The vitality of irrigation for plant growth, development, and survival is emphasized by Azanu *et al*. (2016). Examining irrigation practices, the findings reveal that merely 4.2% of the surveyed population irrigates their crops four times weekly. In contrast, a majority of 29.2% irrigates their crops three times weekly (Figure 3). The frequency of irrigation is intrinsically linked to farmers' financial inputs. Inadequate irrigation poses risks, including crop damage and stunted growth, which imperil household food security, aligning with Chijioke *et al*. (2011). Essentially, deficient irrigation jeopardizes the stability pillar of food security by undermining crop quality and yield.

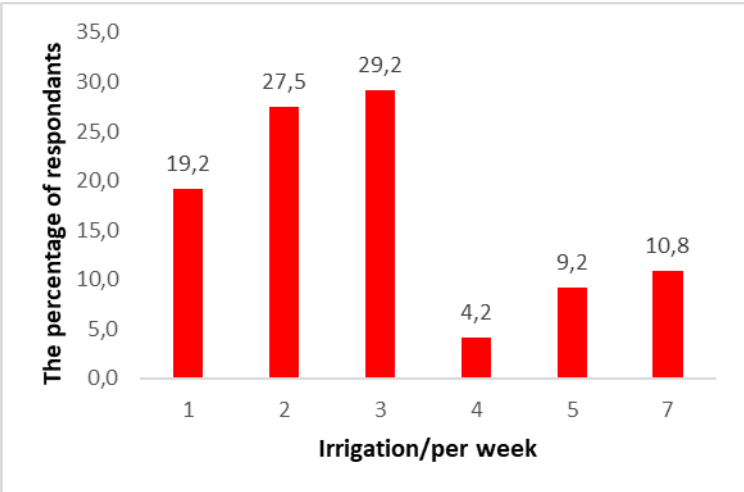

Figure 3: How often per week is the crop irrigated in the community gardens.

The escalating temperatures exacerbate infectious diseases and heat-related ailments, while waterborne and crop-related illnesses compound poverty and unemployment (Woodward *et al*., 2014). Meteorological shifts in the locale, depicted in Figure 4, are primarily characterized by altered rainfall patterns (42.2%), followed by heightened heat (33.5%) and cold spells (7.5%). Notably, 16.2% of participants lacked awareness regarding past climate changes, and a mere 0.6% reported enduring waterlogging. Notably, no instances of frequent floods were reported by respondents. Focused group discussions (FGDs) underscore that elevated temperatures and water scarcity significantly impact meal preparation practices and contribute to food deficits within households. Rising temperatures accelerate water evaporation from surfaces, intensifying water scarcity. Extreme weather events like droughts trigger water shortages, subsequently curtailing water availability for households. Consequently, water reuse and reduced irrigation lead to compromised crop quality (Verpoorten *et al*., 2013; Hanjra *et al*., 2012). The discernible interplay of temperature, water scarcity, and crop quality underscores the intricate relationship between climate change and household well-being.

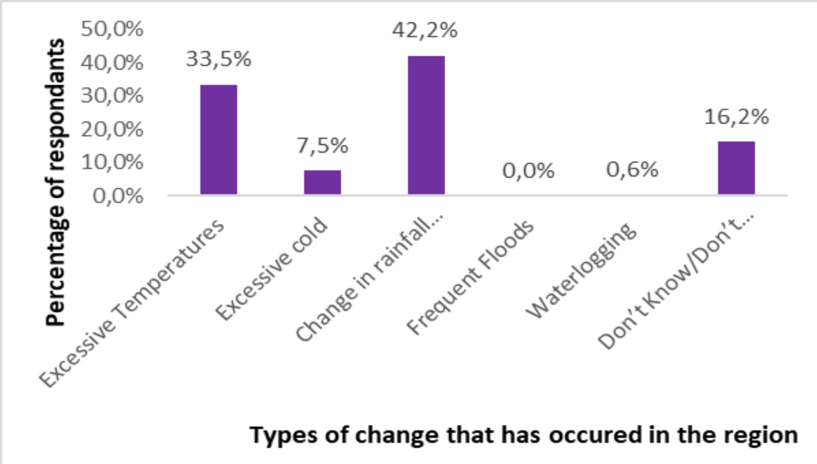

Figure 4: Types of Change in a climate that has occurred in the respondent's region

The study's findings reveal important insights into factors impacting food security within the community. Extension officers play a significant role, as 78.3% of respondents reported frequent visits and valuable guidance. Regarding cultivation practices, 88.3% of gardens utilize manure and fertilizer, with 80.0% using manure alone, leading to improved soil quality. However, garden size poses a challenge, with 41.7% finding their gardens too small for effective crop production. Crop loss emerges as a common issue, primarily due to theft (62.9%) attributed to lack of fencing. Floods and terrain also contribute to losses (10%). Addressing these challenges, along with promoting disease and pest management, is crucial for enhancing food security (Pereira, 2017). Although drought is not a prevailing concern (65.8% experienced no crop loss), cultivating drought-resistant crops remains important (Ahmed *et al*., 2013). Livestock damage affects 67.5% of the population, mainly due to inadequate fencing. Key informant interviews underscore water scarcity for irrigation and the need for marketing training to maximize income from garden produce (Meenar and Hoover, 2012). While 58.3% received insufficient food from gardens, surplus crops alleviate financial burdens and enhance nutritional status (Trefry *et al*., 2014). Community gardens introduce an essential strategy for improving household food security status at the community level (Darby *et al*., 2020). Commonly grown crops include onions, spinach, and cabbage, while beetroot and brinjal are less prevalent. Dry stock, like maize and beans, supplement diets during periods when no crops are available. Overall, the study provides actionable insights to enhance community garden effectiveness and consequently improve food security within the community.

The Household Food Insecurity Access Scale (HFIAS) model, utilized in this study, assesses household food security by means of a nine-question survey (Castell *et al*., 2015). Integrated with the questionnaire, this tool was employed to categorize households into food security levels, encompassing mild to severe food insecurity (Coates, 2013). This approach facilitates a comprehensive understanding of surveyed households' food security status. Despite South Africa's inclusion of the right to food in its bill of rights, food insecurity persists within rural households. The application of the HFIAS exposed that 84.2% of the surveyed population experienced food insecurity, while a mere 15.8% demonstrated food security. Within the HFIAS categories, 29.2% of households displayed mild food insecurity, with 40.0% facing moderate food insecurity, signalling compromised food quantity or quality due to financial constraints or age. However, focused group discussions contradicted this, indicating that community gardens provided ample produce for families and surplus was sold for income enhancement. The analysis underscores the multifaceted nature of food insecurity. While quantitative measures like the HFIAS focus on food access, qualitative insights provide a deeper understanding of how factors beyond mere access, such as income generation from surplus sales, contribute to alleviating the challenges associated with compromised food quantity and quality. The mention of surplus produce being sold for income enhancement emphasizes the economic role of community gardens in enhancing food security. This aligns with the idea that increased income can empower households to access a broader range of food items, thereby improving overall food security beyond the scope of the community garden's immediate outputs. This juxtaposes the HFIAS findings of moderate food insecurity in several households, potentially attributed to produce sales. Households might have opted to sell the produce to acquire essential items, thus not fully consuming it to enhance their food security status.

Table 1: The Household Food Insecurity Access Scale (HFIAS) status of the surveyed households, 2021

Food security status of respondents		
Participants N=120	**Number**	**(%)**
Food secure.	19	15.8
Food insecure	101	84.2
Participants N=120	**Number**	**(%)**
Food secure.	19	15.8
Mildly food insecure	35	29.2
Moderately food insecure	48	40.0
Severely food insecure	18	15.0

There is a correlation of 0.22 between the observed outcomes and the errors that occur during the selection process. In other words, there is a relationship between the variables that are being studied (outcome) and the errors that might arise during the process of selecting and analysing data.

In the context of the Poisson model's empirical results presented in table 2, this correlation value of 0.22 suggests that there is a significant relationship between the observed food security status (outcome) and the errors or uncertainties that could be introduced during the data selection and analysis process. The positive value of 0.22 indicates that certain unobservable factors that contribute to food insecurity status tend to coincide with unobservable factors that exacerbate the severity of food insecurity experienced by households. Furthermore, the mention of the Wald test suggests that statistical testing was performed to assess the significance of this correlation value. The fact that the null hypothesis of zero correlation can be rejected based on the Wald test implies that there is indeed a meaningful connection between the observed food security outcomes and the selection errors. This result highlights the complexity and interplay of various factors influencing food security within households. Among the seventeen predictor variables in the model, six were found to have statistically significant impacts on household food security.

Table 2: The impact of community gardens on household food security

	Coefficient	**Std.Err.**	**P>z**
Household food insecurity access scale			
Gender	0.001	0.150	0.994
Age3	-0.003	0.006	0.654
Education Level	-0.130	0.131	0.320
Household Head	-0.097	0.148	0.510
Household Members	0.010	0.024	0.682
Ethnic Group	-0.442	0.220	0.045**
Marital Status	0.048	0.011	0.000***
Household_Monthly_Income	-0.011	0.029	0.693
Occupation	-0.133	0.037	0.000***
MANURE USE	-0.889	0.222	0.000***
FERTILIZER USE	-1.284	0.447	0.004***
Old_Age_Grant	-1.473	0.390	0.000***
Child_Support_Grant	0.237	0.534	0.657
Disability Grant	0.069	0.401	0.864
Care_Dependency_Grant	-0.934	0.491	0.057*
Grant-in-aid	-0.405	0.384	0.291
Climate change perception	0.133	0.049	0.007***
1.COMMGARDENS	-1.136	0.369	0.002***
Constant	4.129	0.728	0.000***
COMMGARDENS			
Access to extension visits	-0.595	0.335	0.075*
Constant	-0.453	0.137	0.001***

/Athrho	0.227	0.346	0.512
/Lnsigma	-0.626	0.150	0.000***
rho	0.223	0.328	
sigma	0.534	0.080	
Log pseudolikelihood	-426.45783		
Prob > chi2	0.000***		
Wald test of indep. eqns. (rho = 0)	0.43		

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level

The study aimed to investigate the relationship between community gardening and household food insecurity (Castañeda-Navarrete, 2021). The results indicated a statistically significant negative association between participation in community gardening and food insecurity at the 1% level. The beta coefficient of -1.136 suggested that a one-unit increase in community garden participation led to a 3.7% reduction in the likelihood of households experiencing food insecurity while holding another factors constant. This finding aligns with Castañeda -Navarrete's study, which emphasized the importance of generating sufficient crops to meet dietary needs and access to markets (Castañeda-Navarrete, 2021). Dizon *et al*. (2021) and Nicholson *et al*. (2021) further supported the notion that community gardening contributes to food and nutritional security in rural households. The African ethnic group predominated among respondents, demonstrating a significant negative correlation with household food security status (Hadley and Patil, 2008). Marital status of the household head was also significant and positively correlated with food insecurity (Adepoju and Adejare, 2013). Surprisingly, occupation exhibited a negative correlation with food security, possibly due to increased income enabling more food purchases. Both manure and fertilizer use displayed significant negative correlations with food insecurity, indicating their role in enhancing soil quality and harvests.

Old age grants and care dependency grants were also significant and negatively correlated with food security, as they provided additional income to households. Climate change perception exhibited a significant positive correlation with food insecurity, highlighting the link between these factors. The size of community gardens demonstrated a negative correlation with food security, suggesting that smaller gardens could exacerbate food insecurity due to insufficient produce. Access to extension officer visits negatively correlated with food insecurity, indicating that more visits lowered food insecurity by providing crop advice and climate change mitigation strategies. Community gardens play a pivotal role in enhancing food security among disadvantaged populations, with factors like garden size, extension officer support, and demographic variables influencing their impact (Castañeda-Navarrete, 2021; Dizon *et al*., 2021; Nicholson *et al*., 2021). This study underscores the complex interplay between community gardening and food security, offering valuable insights for addressing food insecurity at the community level.

Conclusion

The study's findings demonstrate the substantial impact of community gardens on alleviating household food insecurity, while simultaneously revealing the adverse effects of climatic events on food security status. Despite the positive influence of community gardens, the study identifies a predominant classification of respondents as moderately food insecure, underscoring the persistent challenge of food insecurity within the study area. This situation is attributed to the detrimental consequences of climate change, leading to compromised crop quality and reduced yields. The study suggests that the success of community gardens is intricately linked to climate change dynamics, with changes in weather patterns and pest prevalence significantly influencing agricultural outcomes. Although participants exhibit an awareness of climate change, a limited comprehension of its severe implications is evident. The importance of addressing these challenges is emphasized, involving strategies such as optimized crop production techniques, expanded garden sizes, effective irrigation practices, and enhanced security measures against losses due to theft and animal damage. Integrating these measures with the cultivation of crops characterized by rapid growth cycles and high nutritional value holds the potential to enhance household food security. In essence, the study highlights the multifaceted relationship between community gardening, climate change, and food security, accentuating the need for comprehensive strategies to bolster the effectiveness of community gardens in mitigating food insecurity.

Recommendations

From the study, the following are general recommendations as well as recommendations for future studies:

- Diversify Crop Selection: Community gardens should focus on cultivating a diverse range of crops, including drought-resistant varieties, to enhance food security throughout the year.
- Promote Efficient Irrigation Practices: Encouraging more frequent and effective irrigation practices can mitigate risks associated with inadequate watering and improve crop yields.
- Climate Resilience Strategies: Communities should explore climate-resilient agricultural practices, such as water-efficient irrigation methods and planting crops that are adapted to changing weather patterns.
- Extension Officer Support: Strengthening the role of extension officers is crucial for providing valuable guidance to garden participants, disseminating climate adaptation strategies, and addressing cultivation challenges.
- Crop Storage and Preservation: Developing methods for proper crop storage and preservation can ensure a stable food supply during challenging periods, such as winter.
- Community-Based Education: Implement educational programs to raise awareness about the impact of climate change on agriculture and provide training on sustainable gardening practices.
- Social Support Networks: Foster community engagement and support networks among garden participants to share knowledge, experiences, and resources for improving garden productivity.
- Investment in Infrastructure: Address issues such as crop theft by investing in infrastructure like fencing and protection mechanisms to safeguard produce.
- Market Access: Provide training in marketing and income-generation strategies to maximize the benefits from surplus produce sales.
- Policy Support: Advocate for policies that promote community gardening, sustainable agriculture, and climate change adaptation at local and regional levels.
- Longitudinal Study Design: Consider conducting a longitudinal study to track changes in community gardens' impact on household food security over time. This approach would provide a deeper understanding of the sustainability and long-term effects of gardening practices.
- Expanded Sample Size: Enlarge the sample size to encompass a broader range of households and community gardens. A larger and more diverse sample can provide a more representative picture of the community and yield more reliable statistical results.
- Weather Data Collection: Gather comprehensive weather data over an extended period to accurately correlate climate changes with gardening outcomes. Historical weather records can provide a stronger basis for understanding the influence of climate variability.
- Multi-Location Studies: Conduct studies in diverse geographical locations to capture variations in climate, culture, and socioeconomic contexts. Comparative analyses across regions can reveal common trends and unique dynamics.
- Gender and Equity Analysis: Investigate the gendered aspects of community gardening and food security, considering how gender roles and access to resources influence outcomes. Additionally, explore equity implications within different participant groups.
- Climate Change Adaptation Strategies: Research innovative strategies that community gardens can adopt to adapt to changing climate conditions, including innovative water management techniques and crop diversification approaches.

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