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FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS, EDUCATION AND EXTENSION

AN ANALYSIS ON THE ADOPTION OF KEYHOLE GARDENS AND ITS CONTRIBUTION TO THE DIETARY DIVERSITY AND FOOD SECURITY OF SMALLHOLDER FARMERS IN CHIMANIMANI DISTRICT

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DECLARATION

I, Sally Gunda Gunda, solemnly declare that the research project I am submitting to fulfill the requirements for the Bachelor's degree in Agriculture Economics and Management at Bindura University of Science Education is entirely my own work and has not been previously submitted to any other academic institution.

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DEDICATION

To Amai Sally (my mother) for her undying love, as my support system and being my source of inspiration.

ABSTRACT

In many developing countries, food security has long been a pressing issue, particularly in drought-prone areas with limited rainfall. The situation has been exacerbated by deteriorating economic and social conditions, including high unemployment, which has further compromised food security and dietary diversity, especially in rural areas. The primary goal of this research was to assess the contribution and level of adoption of keyhole gardens on household food security and diversity in Chimanimani district. This study employed a participatory approach, engaging multiple stakeholders to collect both quantitative and qualitative data from a random sample of 169 households in the district. Data was gathered through questionnaires and interviews with key informants. To assess the impact of keyhole gardens on household food security, the researcher compared the mean scores of Household Dietary Diversity (HDD) between households with keyhole gardens and those without, providing insights into the contribution of these gardens to dietary diversity. The study's findings showed a notable difference in food security and dietary diversity between households with keyhole gardens and those without, indicating that keyhole garden owners enjoy greater food security and a broader range of food options. Based on these results, the study recommends that households adopt keyhole gardening to enhance food security and generate income. Additionally, the government, donors, and other organizations should provide support to households to overcome the challenges they face in maintaining gardens, thereby promoting food security and sustainable livelihoods.

Keywords: Dietary diversity, Food security, Keyhole garden, Household

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LIST OF ACRONYMS AND ABBREVIATIONS

AGRITEX	Agricultural Research and Extension Services.
ANOVA	Analysis of Variance.
CTDO	Community Technology Development Organisation
FANTA	Food and Nutrition Technical Assistance Project
FAO	Food and Agriculture Organisation
FNC	Food and Nutrition Council
FNSP	Food and Nutrition Security Policy
HDD	Household Dietary Diversity
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
IFAD	International Fund for Agricultural development
KHG	Keyhole Garden
KII	Key Informant Interviews.
NGO	Non-Governmental Organisation.
NNS	National Nutrition Survey.
RA	Research Assistant.
RLA	Rural Livelihoods Assessment.
SDG	Sustainable Development Goals
SIRP	Smallholder Irrigation Revitalisation Program
SPSS	Statistical package for the social sciences
WHO	World Health Organisation
ZimVAC	Zimbabwe Vulnerability Assessment Committee

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Sub-Saharan Africa is struggling to produce sufficient food to meet the demands of its growing population due to climate change-related challenges like droughts and unpredictable weather patterns. Climate change poses a significant threat to global food security, and its impact is already being felt in Southern Africa, where consumers have been facing rising food prices since 2006, with a peak in 2008 (Von Braun, 2008). Furthermore, many households in the region are experiencing severe food shortages (Altman et al., 2009), highlighting the urgent need for sustainable solutions to address food insecurity.

Multiple strategies are needed to address the issue of food production and security. Whether approaches are feasible depends on the pertinent political, social, and economic circumstances as well as the resources available to organize and carry out the intervention.

Community organizations with limited resources and support systems have widely embraced and implemented Keyhole Gardens as a tried-and-true local strategy in a range of contexts. The Consortium for Southern Africa Food Security Emergency (C-SAFE) created the keyhole garden in Lesotho using an idea that started with CARE in Zimbabwe. Keyhole gardens circular raised bed gardens with a center composting basket, designed maximize space, water efficiency, and nutrient. These gardens originated in Africa and have been increasingly recognized for potential to address issues of food insecurity, particularly in resource-constrained regions. Keyhole gardens offer numerous benefits that contribute to improving food security through sustainable and efficient gardening practices. Keyhole gardens are designed with a centraling basket that serves as a water and nutrient source for surrounding plants. The basket retains moisture and nutrients, reducing water consumption and ensuring sustained plant growth even in arid environments (Morgan, 2016). Also, the composting basket at the center of keyhole gardens promotes the recycling of organic waste into valuable nutrients for the soil. This nutrient cycling process enriches the soil, enhances plant growth, and reduces the reliance on chemical fertilizers, contributing to sustainable agricultural practices (Muyanga & Jayne, 2016).

Keyhole gardens play a vital role in the agriculture and livelihoods of many impoverished nations, serving as a valuable solution to address hunger, malnutrition, and micronutrient deficiencies, as noted by Kumar et al. (2015). The Food and Agriculture Organization (FAO) recognizes keyhole gardens as a crucial supplement for ensuring global food security and sustainable livelihoods (2010). In fact, cultivating food on small plots adjacent to human settlements is the oldest and most resilient form of farming, highlighting the significance of keyhole gardens in supporting local food systems.

Keyhole gardens have been proven to boost food availability and nutritional quality in various settings (Galhena et al., 2013). By offering a diverse range of nutritious foods, creating income opportunities through sales, and providing a reliable food source during agricultural challenges, keyhole gardening can substantially improve food security (Iannoti et al., 2009). Nevertheless, the exact ways in which household gardens address food insecurity and enhance diet quality require further exploration, as they likely differ across contexts. It is crucial to understand how socioeconomic factors interact with keyhole gardens, particularly in the context of larger diet and nutrition systems that shape household food security, dietary choices, and community-level nutritional and food supply outcomes.. Moreover, despite agriculture's prevalence, rural communities in many emerging nations suffer from poor dietary consequences and lag behind in social and economic indicators. (International Journal of Agricultural Extension and Rural Development Studies, Volume 16, Issue 5, May 2016).

Food and nutrition insecurity continue to be a challenge in these rural conditions, despite efforts to increase availability and access to different and nutritious foods in order to achieve a balanced diet. Expanding the use of keyhole gardens for native vegetables and herbs can enhance the availability and accessibility of wholesome, homegrown produce (Kumar et al., 2015). Kumar et al. suggest that promoting household food gardens and cultivating nutrient-rich crops that require minimal water can effectively mitigate food insecurity, malnutrition, and limited dietary diversity in disadvantaged rural areas, thereby improving nutritional well-being through sustainable and water-efficient farming practices.

Keyhole gardens are elevated garden beds with a central composting hub, typically circular in shape with a pathway leading to the center, resembling a keyhole. Their innovative design creates optimal growing conditions. The gardens feature a layered structure, including a drainage layer, a moisture-retentive layer, and alternating layers of organic materials like green clippings, compost, dry leaves, and soil, which work together to create a thriving environment for plants to grow.The central composting unit serves as a hub for nutrient distribution, offering several benefits: it collects compostable materials, acts as a central watering point, and facilitates the dispersal of nutrients from the compost to the surrounding soil, promoting healthy plant growth (Maiava, Personal Communication, April 2018). According to "How to Grow a School Garden," compost is the essential element that brings vitality and fertility to garden soil (Bucklin-Sporer & Pringle, 2010, p. 106). Keyhole gardens maximize this benefit by harnessing the power of compost. Research has demonstrated the effectiveness of keyhole gardens in diverse climates worldwide, providing numerous benefits to people in various regions. Originating in sub-Saharan Africa, keyhole gardening has adapted to different climates, showcasing its versatility and potential for global application.

The need for gardens in this rural in setting is connected to the increase in diseases that are related to poor diets, such as diabetes and heart disease, which is also occurring in Chimanimani (Raleigh, 2010).

The research paper highlights the water-conserving benefits of keyhole gardens in addressing the year-round vegetable needs of resource-poor farmers in rural Chimanimani. The region faces severe water scarcity during the 8-month dry season, resulting in minimal vegetable consumption among farmers, who mostly live below the poverty line, as seen in the Chimanimani village."

Keyhole gardens offer a practical solution for sustainable farming, utilizing local materials, minimal maintenance, and harvested rainwater and greywater. Their design adapts to diverse precipitation patterns, making them suitable for various climates (Pachpute et al., 2017). Studies consistently show that keyhole gardens enhance agricultural productivity, providing fresh produce for families and communities, making them a valuable asset for food security and sustainable living.

1.2 Problem statement

Chimanimani rural district is associated with poor sandy soils, rocky and mountainous terrain, drought conditions, floods, lack of pastures and higher incidence of HIV, ensuring a decent standard of living for all households within available physical, resource, and time restriction is the main concern of all families. Due to the risky circumstances, keyhole gardens can be considered an affordable way of producing nutritious vegetation and fruit that is adapted to the local climate and tradition, by providing a better opportunity for living by offering a food buffering resource in the case of reduced incomes, reducing the risks facing the Chimanimani residents (Pritchard at el, 2017). Chimanimani Districts has shown a different picture given the investments and efforts that has been put towards supporting e Chimanimani district has consistently reported alarming levels of food insecurity, poor dietary diversity, high malnutrition rates, and significant reliance on food aid, according to ZimVAC surveys. On the other hand, keyhole gardens have emerged as a sustainable agricultural intervention that holds the potential to address food security challenges among smallholder farmers Chinanimani. By promoting efficient use of resources and enabling diversified crop production, keyhole gardens offer a holistic approach to enhancing dietary diversity and improving food security outcomes in the region.

This study aims to investigate the potential of keyhole gardens in addressing these issues by enhancing food availability, access, and dietary diversity among households in Chimanimani district, where food scarcity, poor nutrition, and limited dietary options are prevalent. By exploring the impact of keyhole gardens, this research seeks to identify a sustainable solution to improve the district's food security and nutritional well-being. Establishment and existence of keyhole gardens by the Government and Non-Governmental Organizations.

Justification

Implementing keyhole gardens in Chimanimani district can enhance the well-being of smallholder farmers by providing access to nutritious food, reducing expenses on fertilizers and water, and generating income through surplus produce sales. However, the impact of keyhole gardens on household dietary diversity in this region remains unexplored. Therefore, investigating the contribution of keyhole gardens to household dietary diversity is crucial to determine their viability as a solution for smallholder farmers in Chimanimani district, and to understand their potential to improve food security and nutrition in the region.

1.3 Research questions

1.3.1 What are the essential components necessary for effective implementation of keyhole technology?

1.3.1 What is the difference in Household Dietary Diversity between KHG owners and non-KHG owners in chimanimani district?

1.3.2 To what extent are keyhole gardens accepted and adopted by smallholder farmers in Chimanimani district?

1.4 Main Objective

To assess the contribution of keyhole gardens on household food security and diversity in Chimanimani district

1.5 **Specific objectives**

1.5.1 To characterize the implementation of keyhole technology

1.5.2 To determine the level of acceptability and extent of adoption of keyhole gardens among smallholder farmers

1.5.3 To compare household dietary diversity of keyhole gardens owners and non KHG owners

1.5.4 Hypotheses (optional)

H0 (Null hypothesis): Adoption of keyhole gardens contribute in improving dietary diversity in Chimanimani.

H1 (Alternative hypothesis): Adoption of keyhole garden does not contribute in improving dietary diversity in Chimanimani.

1.6 Limitation of the study

Firstly, there may be limited access to smallholder farmers, as they may be scattered in remote areas. Secondly, the farmers may be reluctant to participate in the research or may not be willing to share information on their practices. Thirdly, there may be limited resources available to carry out the research, such as funding or time. Finally, the weather and climate conditions in Chimanimani may pose challenges to the research, such as flooding as it once prone to cyclone Idai

1.7 Organisation of the study

This study is structured into five chapters. Chapter 1 provides an introduction to the study, setting the stage for the research. Chapter 2 delves into a comprehensive literature review, examining existing knowledge on the topic. Chapter 3 outlines the research methodology and describes the study area, providing context for the investigation. Chapter 4 presents and discusses the findings, analyzing the results and their implications. Finally, Chapter 5 summarizes the conclusions drawn from the study, offers recommendations, and reflects on the policy implications of the research, providing a comprehensive wrap-up to the thesis.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of existing literature on the adoption keyhole gardens and there to dietary diversity and security among smallholder in Chimanimani. The review explores key concepts, theories, and empirical evidence related to sustainable agriculture, food security, and the utilization keyhole gardens as a potential intervention to address nutritional challenges in resource-constrained settings.

2.2 Definition of key terms

2.2.1 Food and nutrition security

The concept of food and nutrition security builds upon food security and nutrition security, emphasizing the importance of addressing nutrition issues throughout the entire food chain, particularly at the community and household levels. The term "food and nutrition security" was adopted to highlight the need for targeted actions at the local level, distinct from international, federal, and national initiatives. This shift in terminology aims to prioritize nutrition-focused interventions at the community and household levels, ensuring a more comprehensive approach to food and nutrition security (Committee on World Food Security, 2012).

Food and nutrition security encompasses two crucial concepts: food security and nutrition security. Food security, as defined by FAO (2011), means that all individuals have consistent access to a sufficient, safe, and balanced diet that meets their dietary needs and preferences, enabling them to lead an active and healthy life. This definition comprises four essential components: availability, access, stability, and utilization. By combining food security with nutrition security, we also consider the care and support necessary for optimal nutrition, ensuring that individuals not only have access to food but also the resources and knowledge to utilize it effectively for good health and well-being.

2.2.2 Nutrition security

Nutrition security is defined as a state where all individuals, at all times, have access to a sufficient, varied, diverse, nutrient-rich, and safe food supply that meets their nutritional needs for a healthy and active life. This concept encompasses not only the quality and quantity of food but also a clean environment, overall well-being, education, and adequate care (FAO, 2011;

AGN, 2011). In other words, nutrition security ensures that people have the necessary resources and support to maintain optimal nutrition, health, and quality of life.

2.2.3 Food and Nutrition Security

According to the Food and Agriculture Organization (FAO, 2011), food and nutrition security is achieved when all individuals have unrestricted access to a diverse, nutrient-rich, and safe food supply that meets their dietary needs and preferences, enabling them to lead an active and healthy life. This access encompasses not only physical availability but also social and economic access, and is complemented by a clean environment, good health, education, and adequate care. In essence, food and nutrition security ensures that everyone has the necessary resources and support to maintain optimal nutrition, health, and well-being.

2.2.4 Household Dietary Diversity

The Household Dietary Diversity Score (HDDS) is a useful tool for assessing household dietary patterns and access to a variety of foods. Developed by FANTA in 2006 (Bilinsky & Swindale, 2006), HDDS fills a significant research gap by providing a simple and straightforward method to evaluate household food security and compare food access between households. The HDDS survey consists of 12 questions about the frequency of consumption of different food groups over a 24-hour period, which helps to increase the accuracy of the data (FANTA, 2006). While not designed to assess individual diet quality, HDDS offers valuable insights into household dietary patterns and food security.

2.2.5 Keyhole gardens

A Keyhole Garden (KHG) is a sustainable and self-regenerating garden design featuring a keyhole-shaped bed and a central composting unit. Originating in Africa, where water scarcity and fertile land were limited, KHG was first popularized by the Consortium for Southern Africa Food Security Emergency (C-SAFE) in Lesotho to address food security, education, income generation, community development, and nutrition. Initially focused on supporting households affected by HIV/AIDS, chronic illness, and aging populations, KHG aimed to reduce physical labor while providing nutritious produce like leafy greens, root vegetables, and staple crops.

Today, KHG designs are adapted for in-house kitchen and fruit gardens, enabling self-sufficiency and The Keyhole Garden (KHG) operates on the principle of synergy, where multiple components work together to achieve a greater outcome than any single element could alone.

This innovative approach is particularly well-suited for urban areas, where land and water are scarce, and can be implemented in a decentralized manner. By utilizing household organic waste as compost, KHG promotes backyard and community gardening, reducing waste sent to landfills and associated costs. This approach also fosters local food networks, increases urban self-sufficiency, and builds resilient communities (Grenand Andersson, 2018).d high-value crop production through succession planting (Arias et al., 2013; Allen, 2018).

2.3 Determinants of Food Security

Food security is a complex multifaceted concept influenced by various factors that interact at individual, household, and community levels. Understanding the determinants of food security is crucial for designing effective interventions that address hunger, malnutrition, and food insecurity among smallholder farmers. The following are key determinants that impact food security:

2.3.1 Access to Resources

Access to land, water, seeds, and agricultural inputs significantly influences a smallholder farmer's ability to produce an adequate and diverse range of food for their household. According to Barrett (2010), resource constraints can limit agricultural productivity and food availability, leading to food insecurity in rural communities.

2.3.2 Income and Livelihoods

Household income plays a vital role in determining the affordability of food and access to diverse food options. Low income levels and limited livelihood opportunities can hinder households from purchasing nutritious foods, resulting in inadequate diets and malnutrition (Smith et al., 2000).

2.3.3 Climate and Environmental Factors

Environmental challenges such as erratic rainfall patterns, droughts, and natural disasters can disrupt agricultural production and food supply chains, impacting food security outcomes. Studies by Nelson et al. (2010) highlight the importance of climate-resilient agriculture in mitigating the effects of climate change on food security.

2.3.4 Nutritional Knowledge and Practices

Knowledge of nutrition, dietary practices, and food preparation methods influence food choices and dietary diversity among households. Lack of awareness regarding balanced diets and nutrition can contribute to micronutrient deficiencies and poor health outcomes (Ruel et al., 2020).

2.3.5 Social and Cultural Factors

Social norms, gender roles, and cultural beliefs shape food preferences, access to resources, and intra-household food distribution. Gender disparities in food access and decision-making can impact the nutritional status of women and children within households (FAO, 2011).

The United Nations Economic and Human Rights Agency (UNDESA, (2019) emphasize that medium-variant projections indicate that the world population could grow to about 8,5 billion by 2030, 9,7 billion by 2050. In order to meet the growing food demand for the growing population, food production and buffer stocks must be steadily increased. Sustainable Development Goal 2 aims to achieve zero hunger, in accordance with the Sustainable Development Goals (SDGs). This is one of the 17 Sustainable Development Goals set by the UN in 2015 (St. Jackson, 2017). SDG 2 states that food security should be achieved by 2030 by ending starvation and poor dietary standards. This can be made possible if small-scale food manufacturers, especially women, increase agricultural production and vulnerable developing communities, ensure the sustainable food production systems and improve land and soil qualities gradually; (SDG 2017).

SDG 2 emphasizes the interconnections between food security, nutrition, food supply, rural transformation and sustainable agriculture. Countries worldwide use different counter-strategies to respond to meet demands and prevent food insecurity and hunger to prevail. The interest in strengthening and intensifying local production of food has increased in recent years to alleviate the harmful effects of global food shocks and price fluctuations.

As a result, there is a lot that can be done with home gardens as a way to increase household food and nutrition security. Food security is recognized as a vital aspect in reaching "zero hunger" in the Sustainable Development Goals, and international agricultural strategies have been developed over the last decade with a significant emphasis on ensuring food security in the home. One of the approaches to improve the availability of healthful and nutrient-rich fruit and vegetables at a cheaper cost was to promote home gardens and provide input and knowledge that encourages households to manage household gardening (Dissanayake et al, 2017).

2.4 Food security in context

Chimanimani, a district in eastern Zimbabwe, faces significant challenges related to food security, which impact the well-being and livelihoods of its residents. The region is characterized by high poverty levels, limited access to agricultural inputs, and vulnerability to climate change impacts such as droughts and cyclones These factors contribute to food insecurity among smallholder farmers and rural communities in Chimanimani, leading to inadequate access to nutritious food, low dietary diversity, and malnutrition rates. The district is prone to climate-related disasters such as droughts and cyclones, which can have devastating effects on agricultural production and food security. Studies by The World Bank have documented the vulnerability of Zimbabwean communities, including those in Chimanimani, to climate change impacts and the resulting food insecurity (World Bank, 2020).

More so, the prevalence of poverty in Chimanimani limits households' ability to invest in agricultural inputs, access markets, and ensure food security. Researchers from the International Food Policy Research Institute (IFPRI) have highlighted the strong link between poverty and food insecurity in rural Zimbabwean communities, including those in Chimanimani (Wong et al., 2018).

Ensuring global food security has emerged as a critical challenge, with the ambitious goal of eradicating hunger and malnutrition worldwide. Governments, organizations, and policies must work together to support countries in achieving this objective, which is a fundamental aspect of the Sustainable Development Goals. The pursuit of zero hunger and food security is a pressing imperative, essential for the well-being and prosperity of individuals, communities, and nations alike.

2.5 Food Security Status in Sub Saharan Africa

Malnutrition poses a significant challenge for millions of African households, and the situation is being exacerbated by climate change. Rising temperatures and erratic weather patterns are leading to more frequent and prolonged droughts, both during and between growing seasons. While drought and other climate-related extremes are often cited as major contributors to food insecurity, according to the World Bank (2007b), they are not the sole determinants of food crises. Other factors also play a crucial role in shaping food security outcomes.

security safety net (NSW Ministry of Health, 2013) The Development Association (2020) highlights that climate change significantly impacts food production, leading to direct effects on precipitation, temperature, and market dynamics, ultimately influencing food prices and supply chain infrastructure. Sub-Saharan Africa's economic growth is closely tied to climate resilience, given its reliance on rain-fed agriculture and limited economic diversification. This vulnerability exacerbates malnutrition at the household level, particularly in African countries, where environmental and financial challenges persist. Food insecurity is a pervasive issue in underdeveloped countries (FAO, 2011), and recent factors influencing food prices have worsened household food insecurity in Sub-Saharan Africa. Despite periodic fluctuations, food costs are projected to rise over the next decade, aggravating food insecurity (Chijioke et al., 2011). Ensuring food security is now a global concern, especially in developing countries, due to various factors. In contrast, developed countries like Australia have a stable national food supply and established social support systems, ensuring food security for most of their population.

Severe food insecurity has severe consequences for citizens' fundamental rights, including access to adequate food and clean water. The United Nations Food and Agriculture Organization (FAO) recognizes food security as a basic human right (2005). Despite global and national efforts to address hunger and food insecurity, many individuals in developing countries, particularly in Sub-Saharan Africa, face obstacles in accessing food. Factors such as rising unemployment and poverty, high dependency ratios, inflation, and skyrocketing food prices, combined with the breakdown of formal food systems, leave households vulnerable to malnutrition. Food insecurity persists due to unstable and fluctuating economic conditions, as well as poor agricultural seasons, affecting both developed and developing countries.

2.6 Food Security Situation in Zimbabwe

The El Nino phenomenon severely impacted the 2018-2020 agricultural season, causing delays and disruptions in the first phase (October-December) and persistent dry spells and floods in the second phase. This, combined with the effects of the Fall Army Worm, led to a significant decline in crop production. As a result, the food security situation was expected to deteriorate between October and December 2019, with an estimated 3.58 million people requiring food assistance (ZimVAC, 2019). Furthermore, the ZimVAC (2020) reported that rural livelihoods were affected by a combination of climate-related shocks, the COVID-19 pandemic, and economic factors, including lockdown restrictions, leading to reduced household income and compromising food and nutrition security.

Zimbabwe, once a net exporter of agricultural products and a food-secure nation, is now grappling with severe food insecurity, with an estimated 5.5 million people expected to be affected (ZIMVAC, 2019). The country's food security has been compromised due to drought, inflation, and other challenges. The COVID-19 pandemic has further exacerbated the situation, particularly in rural areas, where communities have experienced a significant reduction in income, food supplies, and access to essential staples. The extreme food insecurity is primarily attributed to a sharp decline in indigenous cereal crops in 2020 and exorbitantly high food prices (ZIMVAC, 2020). As a result, poor households, who spend a substantial portion of their income on food, are disproportionately vulnerable to price fluctuations (Labadarios et al., 2011).

Fertilizer prices have remained persistently high, posing a significant threat to future food production in the country. Meanwhile, households are struggling with dwindling purchasing power due to shortages of essential items like flour, cooking oil, and fuel. Although prices for most food commodities are stable in US dollars, they are exorbitantly high in Zimbabwean dollars. Despite the government's declaration of the Zimbabwean dollar as the sole legal tender, other currencies are still widely used in border areas, towns, and cities (ZIMVAC, 2019). As a result, market systems have been disrupted, compromising food supply and access.

Food Access and Availability

Food insecurity arises when individuals lack access to sufficient food or cannot obtain it in a dignified manner. According to the Food and Agriculture Organization (FAO, 2013), food access is determined by two primary factors: economic access and physical access. Economic access is influenced by disposable income, food prices, and social support, while physical access is dependent on the physical infrastructure that supports access (Castetbon, 2017; Headey & Ecker, 2012). The availability of funds, income distribution, and food prices all play a crucial role in determining access to food (FAO, 2011). In some cases, food may be produced exclusively for export markets or priced out of reach for vulnerable populations, exacerbating food insecurity.

Households experience food insecurity when their access to food is uncertain or limited, leading to a persistent and potentially life-threatening issue (Koch, 2011). The root cause of food insecurity is the inability of households to access food, which is often triggered by factors such as low income and high food prices. This problem is further exacerbated by the decline in 4purchasing power among significant segments of the population, making it even harder for them to afford food. Rural communities are particularly vulnerable due to their limited purchasing power, which makes it more challenging to access essential food items from markets (Koch, 2011).

2.7 Current state of gardens in Zimbabwe

In Zimbabwe, home gardens or backyard gardens are a prevalent form of food production in rural and community settings. These gardens enhance household food security by providing direct access to diverse nutritious foods, increasing disposable income through reduced food expenses and potential sales revenue, and serving as a reliable food source during periods of scarcity. Moreover, home gardening is already a common practice among disadvantaged families in rural areas, highlighting its potential for broader impact.

For a long time, home gardening has been a common practice in Zimbabwe, but it has gained significant attention and funding from donors and institutions in recent years, particularly in response to the devastating effects of HIV/AIDS and malnutrition. A 2005 report by the Food and Agriculture Organization (FAO) highlighted the importance of home gardens, which have become increasingly vital due to chronic droughts, the Covid-19 pandemic, cash shortages leading to food insecurity, and the desire for households to maintain food self-sufficiency. According to ZIMVAC (2020), household gardens have served as a reliable foundation for food security, especially for vulnerable communities in the districts.

In addition to enhancing food security, home gardens are crucial in addressing malnutrition, which is often exacerbated by food shortages. NGOs, government agencies, and private sector players have been instrumental in promoting horticulture development, establishing communal gardens, and supporting individual household gardens (Bornnard et al., 2010). In response to the impacts of climate change and crop failures on staple crops, pulses, and nutritious vegetables and fruits, these stakeholders have been promoting community and household gardening initiatives, including the use of yield-enhancing technologies (Makumire, 2011).

Another significant factor contributing to the rise of household gardens in Zimbabwe is the creation of market opportunities for rural communities, facilitated by various NGOs (Tanyanyiwa & Bakasa, 2018). Recently, a large-scale program in Chimanimani, jointly implemented by the Government of Zimbabwe and partner organizations, enabled the establishment of numerous household gardens. Farmers received seed packs, inputs, and capacity-building training, empowering them to not only meet their food needs but also generate income. The NGOs involved facilitate market linkages, promoting healthy harvests, consumption, and increased household income.

2.8 Measuring Food security impact of keyhole household gardens

Despite the importance of measuring food security, a significant research gap exists in quantitatively assessing household and community food security. To address this, quantitative indicators of household nutrition and food security are essential. As highlighted by Shisanya and Hendriks (2017), food security is a multifaceted concept that encompasses three interconnected dimensions: food availability, access, and utilization. To tackle this complexity, the Food and Nutrition Technical Assistance (FANTA) project aimed to develop a scientifically sound, practical, and user-friendly approach to measuring the impact of food security interventions worldwide (FANTA, 2006).

For the purpose of this research, Household Dietary Diversity (HDD) and Food Access and Availability will serve as indicators of food security, allowing for a comparison between households with gardens and those without gardens, in order to assess the impact of household gardens on food security

Household Dietary Diversity (HDD) is a metric that evaluates the variety of foods consumed by a household over a given period. A more diverse diet is indicative of adequate caloric and protein intake, as stated by FANTA (2006). A higher dietary diversity score reflects a better and more nutritious diet. The HDDS questionnaire can be applied at both the community and household levels, making it a suitable tool for assessing community-level dietary diversity. Additionally, asking respondents about their dietary diversity is a straightforward and reliable approach. However, it is important to note that this method is only suitable for assessing dietary diversity over a 24-hour period, as longer recall periods may lead to inaccurate data. Nevertheless, researchers can extend the recall period depending on their specific needs and goals.

To more accurately assess diet quality, the Household Dietary Diversity Score (HDDS) calculates the number of different food groups consumed, rather than the number of individual foods. This approach recognizes that households consuming a variety of food groups, such as four or more, are likely to have a diet that provides a range of essential macro- and micronutrients. In contrast, consuming four different foods that all belong to the same food group, such as cereals, may not indicate a diverse diet. To calculate the HDDS, a set of nine food groups is used, including:

Grains (cereals) B. Starchy roots and tubers C. Vegetables D. Fruits E. Meat, poultry, and organ meatsF. Fish and seafood G. Legumes, pulses, nuts, and seeds H. Dairy products (milk and milk products) I. Fats and oils (including sugar and honey, and miscellaneous foods)

2.9 Keyhole Gardens as a Solution to Address Food Security Challenges in Chimanimani

Keyhole gardens are a vital component of food and nutrition security for families, providing a reliable source of fresh produce and contributing significantly to household food availability, accessibility, and utilization. While several studies have highlighted the importance of home gardens, few have quantified their impact. However, it is clear that KHG gardens play a crucial role in meeting family energy and nutrition needs, providing a steady supply of fresh fruits, vegetables, and animal products. The convenience and accessibility of home gardens make them an essential social benefit, particularly in urban areas where access to fresh produce may be limited.

2.9.1 Enhanced Nutritional Diversity

Keyhole gardens, with their design that allows for the cultivation of a variety of vegetables and herbs in a small space, can significantly contribute to enhancing dietary diversity among households in Chimanimani. Research by Mudege et al. (2019) has shown that incorporating keyhole gardens into farming systems can increase the consumption of nutrient-rich foods, ultimately improving the nutritional status of community members.

2.9.2 Year-Round Production

Keyhole gardens are designed to maximize water efficiency and utilize composting techniques, enabling continuous production of vegetables even in times of water scarcity. This feature is crucial in addressing seasonal food shortages and ensuring a consistent food supply throughout the year. Studies by Giller et al. (2017) have highlighted the role of keyhole gardens in promoting year-round food production and reducing reliance on external food aid in vulnerable communities.

2.9.3 Climate Resilience

Given Chimanimani's susceptibility to climate-related disasters, including cyclones and droughts, the adoption of climate-smart agricultural practices like keyhole gardens can enhance the resilience of farming systems. By conserving water, improving soil fertility, and adapting to changing weather conditions, keyhole gardens can help mitigate the impacts of climate change on agricultural production and food security. Research by WFP (2020) emphasizes the importance of climate-resilient farming techniques in building food security in vulnerable areas like Chimanimani.

2.9.4 Empowerment of Smallholder Farmers

Keyhole gardens offer a practical and cost-effective solution for smallholder farmers in Chimanimani to improve their food production capacity and self-reliance. By providing training and support for implementing keyhole gardens, organizations and development agencies can empower farmers to take control of their food security and livelihoods. Studies by FAO (2018) have shown that promoting small-scale agroecological practices like keyhole gardens can enhance farmers' resilience and ensure sustainable food production in challenging environments.

2.10 Theoretical Framework

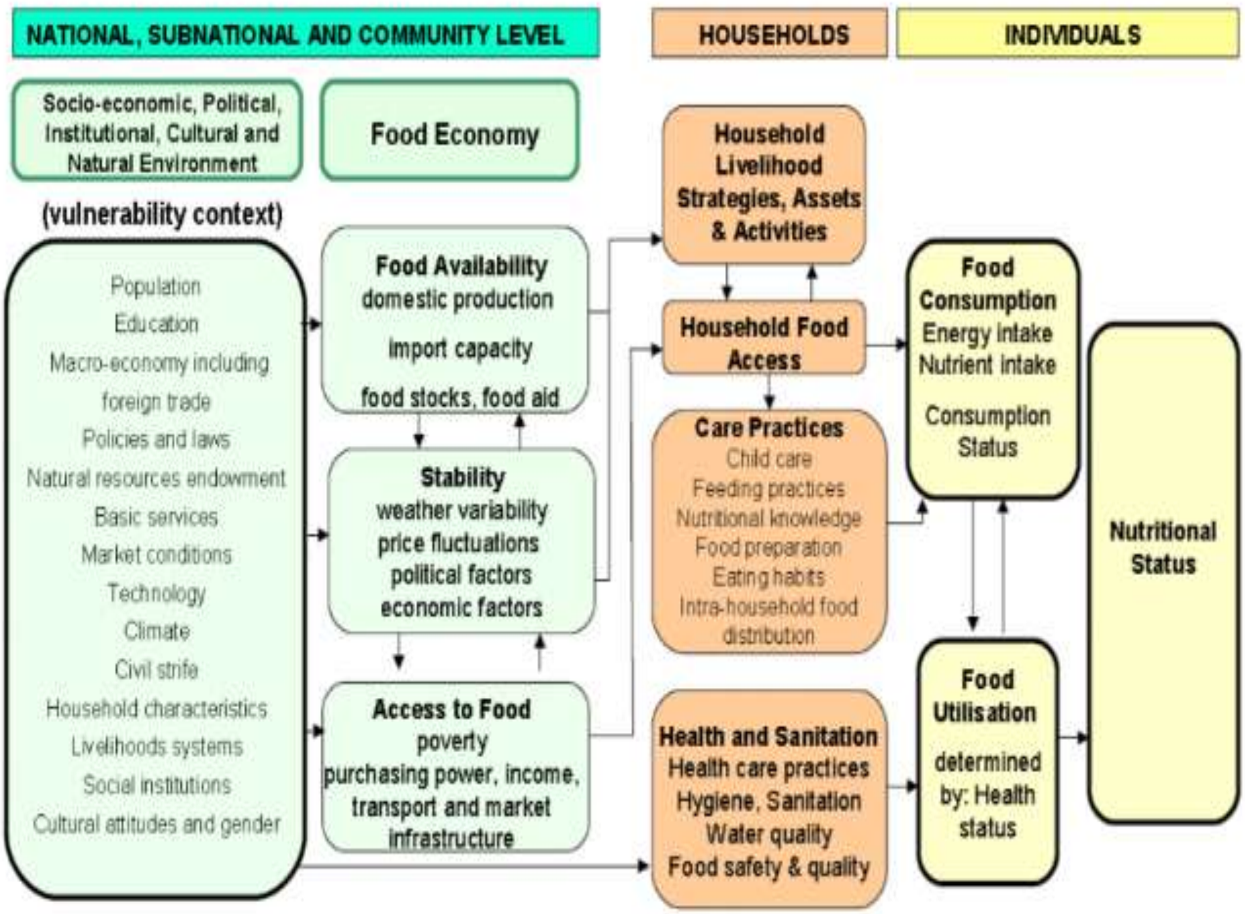
The FAO's FIVIMS (Food Insecurity and Vulnerability Information and Mapping System) is a collaborative initiative that monitors progress towards achieving the World Food Summit's objective of eradicating hunger and ensuring food security. The framework involves a comprehensive approach, comprising inputs, outputs, processes, and a conducive environment, to achieve optimal food and nutrition security. This enabling environment encompasses political, social, economic, and technical contexts at local, national, and international levels (Security, 2009).

Food security is achieved when all individuals and societies have access to sufficient resources to meet their dietary needs and preferences, ensuring an active and healthy life at all times (FAO, 1996). At the family level, this concept is referred to as household food security, prioritizing individuals within households. The four pillars of food security - availability, stability, access, and utilization - are essential to this concept. While nutrition is not explicitly mentioned in each pillar, it is a crucial link between national food systems, household economies, and individual well-being (Security, 2009)

The FIVIMS (Food Insecurity and Vulnerability Information and Mapping System) investigates the interconnections between food, agriculture, and nutrition to address the root causes of hunger and malnutrition sustainably. It emphasizes that achieving food and nutrition security requires a comprehensive approach that simultaneously addresses agricultural productivity, supply chain stability, livelihoods, incomes, food access, health, and care (NSW Ministry of Health, 2013)

FIVIMS integrates health and care components, expanding beyond maternal and child health to encompass all population groups, with a special focus on the food economy. Additionally, FIVIMS prioritizes individual consumption, recognizing its crucial role in food and nutrition security. The United Nations is well-positioned to promote this aspect, ensuring that increased food availability and access at the national level translates to improved energy and nutritional intake at the community and household levels. FIVIMS' unique strength lies in its promotion of food and agriculture-based initiatives to enhance access to diverse diets, recognizing that individual eating habits are the final link in a chain that begins with national food security and culminates in better household nutrition outcomes (Security, 2009).

Figure 2:1 Food Insecurity and Vulnerability Information and Mapping System



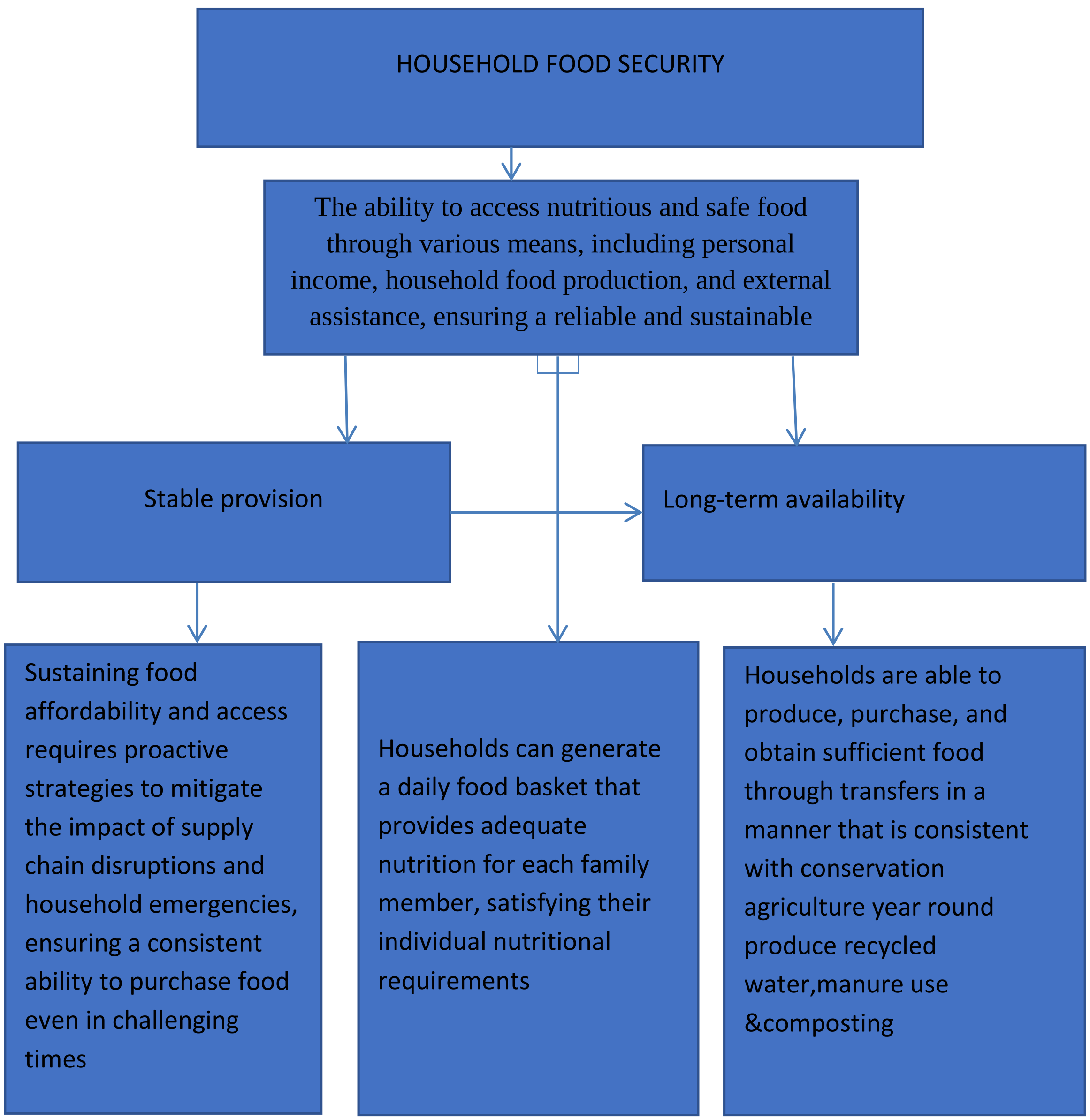
(FIVIMS)

Source: (Security, 2009)

2.11 Conceptual Framework

In countries prone to severe food shortages, such as those affected by water scarcity, heavy rains, and economic instability, governments often complement agricultural programs with public measures like job creation, income generation, and direct food assistance to safeguard household food security and nutrition for the most vulnerable populations. In Zimbabwe, there has been a growing emphasis on boosting local food production to mitigate the impacts of food shocks and price volatility. The government, through Agritex, and NGOs like CTDO, Sustainable Agriculture Technology, World Vision, FAO, and other partners, have been promoting home gardens as a strategy to enhance household food security and nutrition. Community participation has been recognized as a key approach to addressing food shortages, a common challenge facing many African countries.

Figure 2.2: The principles and values underlying household food security



Examining keyhole gardens

Although Keyhole gardens have been widely discussed, research by Nair (2006) highlights a significant lack of quantitative data on their benefits. This knowledge gap exists due to the absence of robust and widely applicable methods for studying home gardens, which are complex systems unlike single-species systems. This study aims to investigate and quantify the contributions of keyhole gardens to dietary diversification and household food security, addressing this existing research gap

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides an overview of the research methodology employed in the study. It begins by describing the study area's location and then delves into the data collection methods, techniques, and sources used. The chapter subsequently discusses the data management and analysis techniques employed, including the empirical tools used to analyze the data. The merits and demerits of each method are examined, and the limitations of the study are acknowledged. This chapter provides a comprehensive understanding of the research design, data collection, and analysis procedures used to investigate the research questions and achieve the study's objectives.

3.2. Description of study area

The study area is situated in Chimanimani District, a mountainous region in Manicaland Province, eastern Zimbabwe. The district, formerly known as Melsetter (1895-1982), is headquartered in the town of Chimanimani. Geographically, it borders Mozambique to the east, Chipinge district to the south, Buhera district to the west, and Mutare district to the north. Located at 19.75° latitude and 32.67° longitude, Chimanimani District covers an area of 356,808 square kilometers, making it the smallest of the seven districts in Manicaland Province. The main center, Chimanimani Village, is approximately 155 kilometers southeast of the provincial capital, Mutare. Chimanimani serves as the administrative hub for the district, hosting various government entities, NGOs, and private businesses. The local economy is largely agrarian, with most residents engaged in farming and animal husbandry, and few holding formal jobs. In this context, home gardens can play a vital role in enhancing food security and diversity, which is critical in areas like Chimanimani where food access is not the primary concern, but rather the lack of dietary variety and quality. While the rocky terrain and strong winds pose significant challenges to home gardening in Chimanimani, the community recognizes the value of keyhole gardens in promoting healthy eating and has expressed enthusiasm for their adoption, as evident from interviews and focus groups.

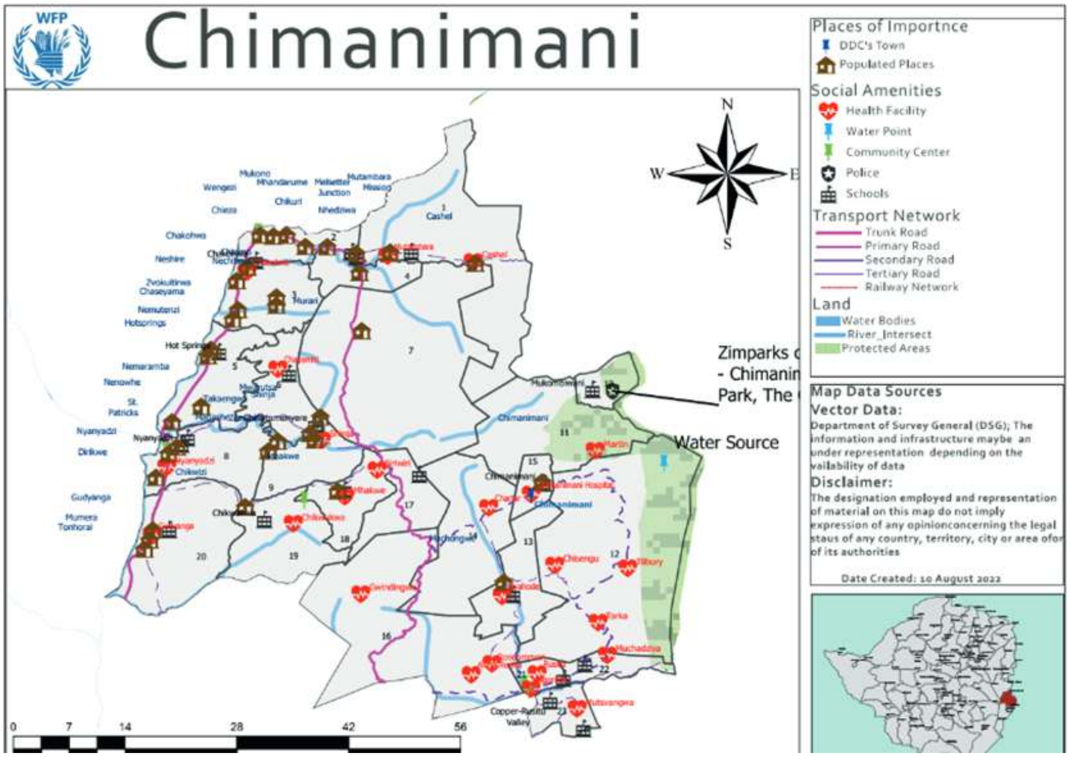


FIGURE 1.1 1 Map of Chimanimani District

3.3. Study design

This research employed a comprehensive multi-stakeholder participatory approach, combining both quantitative and qualitative data collection methods to ensure a robust and validated dataset. By using multiple methods, the study achieved triangulation, cross-verifying data from various sources to increase accuracy. Informal discussions were held with key stakeholders, including farmers, AGRITEX, MOHCC-Nutrition, SIRP, and household heads, to gather insights and contextualize the findings. A structured household questionnaire with open and closed questions formed the core research tool, while key informant discussions complemented the household survey data, providing a richer understanding of the research topic. This inclusive approach ensured a diverse range of perspectives and expertise, strengthening the study's validity and reliability.

3.4 Study Population

The research was conducted in three wards (2, 4, and 7) in the district, which have a total household population of 1867, 1127, and 1469, respectively, according to data from AGRITEX ward profiles. Notably, the district has a predominantly rural population, with 94% of residents living in rural areas, as per the 2022 census data. This context is important for understanding the study's findings and their implications for the local community.

Determination sample size requirements

To determine the sample size for the study a formula was used to calculate the representative sample from the population of 4137 households across the three wards .the initial sample size was determined using a standard procedure to ensure a reality representation of the population.

$$\boldsymbol{n_0 = z^2\, {}^{\alpha}\!/_{2} * p * q / e^2}$$

The z = value for selected alpha level of 0.025 in each tail (for 95% degree of confidence) =1.96, (p). (q) = an estimated of variance = 0.25, e = a desired margin of error , p is the estimated proportion of the population which has the attribute in question q=1-p.

$$\boldsymbol{n_0 = \frac{(1.96)^2 * 0.5 * 0.5}{0.05^2} = 206}$$

The final sample size was determined using Cochran's (1977) adjustment procedure as the initial 206 exceeds 5% of the total population. This calculation was necessary to adjust the sample to ensure it was representative of the population without being too large

$$\boldsymbol{n = n_0/1 + (n_0 - 1/N)}$$

=206/1+206/4137

=169

3.4.1 Research Assistants training

Three Research Assistants (RAs) underwent training on research ethics and questionnaire administration. Following the training, the instruments were refined through discussions on each question, ensuring clarity and precision. The training period enabled the RAs to comprehend the project's overall objectives and the specific information sought by each question, minimizing data collection errors. Practice sessions ensured consistency in questioning and data collection from the same sources. Additionally, the purpose of each question was explained, and instructions on completing the questionnaires were reviewed, ensuring that the RAs were well-equipped to collect high-quality data.

3.4.1 Primary data collection

This study collected primary data through a household survey, utilizing a questionnaire that included both open-ended and closed-ended questions. Additionally, physical observations were conducted to supplement the survey data, providing a more comprehensive understanding of the research topic.

3.4.2.1 Formal Household Survey

The study collected primary data through household interviews using questionnaires administered to 169 randomly selected households, comprising both adopters and non-adopters of Keyhole Gardens (KHG). This mixed-methods approach aimed to gather both quantitative and qualitative data. The researcher, accompanied by three enumerators from SIRP's M&E team, conducted the interviews with technical assistance from local extension workers. The survey aimed to gather diverse perspectives from smallholder farmers on KHG practices and their sustainability, as well as household demographic information and the challenges farmers face in using this practice. This comprehensive approach enabled a deeper understanding of KHG adoption and its impact on households.

3.4.2 Secondary collection

Secondary data was gathered from existing studies on labor-saving gardening technology, providing valuable insights. Additionally, the researcher utilized tabular data sets to obtain information on the district's population and general characteristics. Grey literature from organizations like FAO and SIRP, which promote Keyhole Gardens (KHG), was also consulted. This method offered a quick and efficient way to gain a comprehensive understanding of the field. However, some online sources were inaccessible due to costs, making it challenging to obtain relevant information. Despite this limitation, secondary data collection provided a solid foundation for the research.

3.4.3. Physical observations

Systematic physical observations were conducted to gather information on the practice of Keyhole gardening technology, including evidence of its adoption, materials used, crops grown, and other related aspects. This involved direct observation of the gardens, noting details such as the presence of keyhole-shaped gardens, types of crops being grown, and materials used in their construction. This method provided valuable insights into the practical application of Keyhole gardening technology in the field.

This research employed a mixed-methods approach, combining both qualitative and quantitative data collection and analysis methods. Secondary data was obtained through desk research, while primary data was collected through field research using semi-structured interviews and structured questionnaires. The questionnaires generated quantitative data, while the face-to-face interviews using open-ended questions provided qualitative insights. A total of 169 questionnaires were administered across 3 wards, with 2 villages in each ward selected purposively. Each ward had an equal number of respondents, with 56 participants in each ward, ensuring a balanced representation of perspectives.

Data collection took place over a period of six days, with three enumerators from AGRITEX, supervised by the Researcher, collecting data from households. The household questionnaires were administered simultaneously with Key Informant Interviews (KII). To minimize the risk of COVID-19 transmission, respondents were provided with hand sanitizer and physical contact was avoided, in accordance with WHO guidelines. Throughout the data collection process, the team regularly referred to secondary sources to contextualize and validate the findings. The data collected from households covered a range of topics, including demographics, food access, availability, and diversity, as well as factors affecting household food security, the uses of Keyhole Gardens (KHG), crops planted, and the extension services provided to farmers.

3.5. Data Handling, Management and Analysis

3.5.1. Data entry

Data was collected using Kobo collect tool and it was entered into an excel sheet the researcher. Before entry, checked for errors, inconsistencies in data filling, inconsistencies in data entry and completeness of the data entered.

3.6. Data analysis.

The study employed statistical analysis using SSPS to examine the data. Qualitative data was summarized and analyzed using descriptive statistics, including frequencies, tables, charts, and graphs, to provide a comprehensive overview. Quantitative data was analyzed using binary logistic regression to identify significant relationships and predictors. The table below provides a detailed breakdown of how each research objective was analyzed, outlining the specific statistical methods and techniques used to address each question and hypothesis. This systematic approach ensured a rigorous and robust analysis of the data, providing reliable findings and conclusions.

TABLE 1.1 1 : OBJECTIVE, DATA TYPE AND STATISTICAL VARIABLES.

Objective	Data type	Statistical variables
To characterise the implementation of key hole garden technology in chimanimani	Qualitative data	• Garden size • Garden shape • Crops grown • Case study • Water availability

		• Access to resources • Access to knowledge and support
To determine the level of acceptability and extent of adoption of keyhole gardens among smallholder farmers	Descriptive statistics Categorical data Binary variable	• Sex of respondents(categorical variable male) • Adoption of KHG with two categories :none KHG and KHG owners • Pearson's chi-square test which is a non-parametric test used to determine whether there is a significant association between the two categorical variables (sex and adoption of KHG) • Frequency data and percentage data
To compare household dietary diversity of keyhole gardens owners and non owners	Continuous data	- Mean: The average household dietary diversity score for each group (KHG and None) - Std. Err.: The standard error of the mean - [95% Conf. Interval]: The 95% confidence interval for the mean - Contrast: The difference in

		mean scores between the two groups (KHG vs. None) - Std. Err.: The standard error of the contrast - t: The t-statistic for the contrast - P>|t|: The p-value associated with the t-statistic - [95% Conf. Interval]: The 95% confidence interval for the contrast Chi-square distribution

Categorization of Variables

the categorization of variables was done guided by research objectives. variables on each objective were categorized accordingly.

Characterizing the Implementation of Keyhole Technology:

Continuous Variables

- Size of the keyhole garden (e.g., square meters)

- Amount of compost used (kg)

- Number of different crops planted

- Crop yield in kilograms   - Watering frequency per week

Categorical Variables

- Type of keyhole garden design (e.g., traditional, modified)

- Soil preparation methods (e.g., double-digging, mulching)

- Crop types planted (e.g., leafy vegetables, root crops)

- Location of the keyhole garden (e.g., backyard, field)

- Maintenance practices (e.g., weeding frequency, pest control methods)

Determining the Level of Acceptability and Extent of Adoption of Keyhole Gardens

Continuous Variables

- Number of keyhole gardens owned by a farmer

- Years since the adoption of keyhole gardens

- Distance to the nearest water source (km)

- Age of the farmer (years)

Categorical Variables

- Farmers' perception of keyhole gardens (e.g., beneficial, challenging)

- Reasons for adopting keyhole gardens (e.g., increase in crop yield, water conservation)

- Willingness to recommend keyhole gardens to other farmers (e.g., yes, no)

- Frequency of keyhole garden use (e.g., daily, weekly)

Comparing Household Dietary Diversity of Keyhole Gardens Owners and Non-Keyhole Gardens Owners

Continuous Variables

- Household dietary diversity score (numeric scale)

- Total daily calorie intake (calories)

- Number of servings of fruits and vegetables consumed per day

Categorical Variables

- Ownership status (e.g., keyhole garden owner, non-keyhole garden owner)

- Food groups consumed (e.g., grains, legumes, dairy)

- Frequency of consumption of specific food items (e.g., weekly, monthly)

- Nutritional quality rating of diets (e.g., poor, fair, good)

3.8 Ethical Considerations

Throughout the data collection ethical principles were put to practices to ensure that they are adhered to by all parties that were involved in the research process especially in the field where interaction with the community was more. Confidentiality was maintained for all people interviewed and consent forms signed before the interviews. Curtsey visits to ward councillors, chiefs, headmen, and village heads were made when possible to show respect to local leadership. To avoid an inferiority mentality among the interviewees, the usage of the local language was preserved at all costs. Identification details of study participants will be kept anonymous. Completed questionnaires, notes and diaries will be kept under lock and key at the researcher's office up to 5 years beyond study period.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

The aim of this chapter is to present, analyse and discuss the findings of the study. The presentation and analysis of the results will be guided by the afore-mentioned research objectives in the first chapter.

4.2 To characterize the implementation of keyhole garden technology in Chimanimani District.

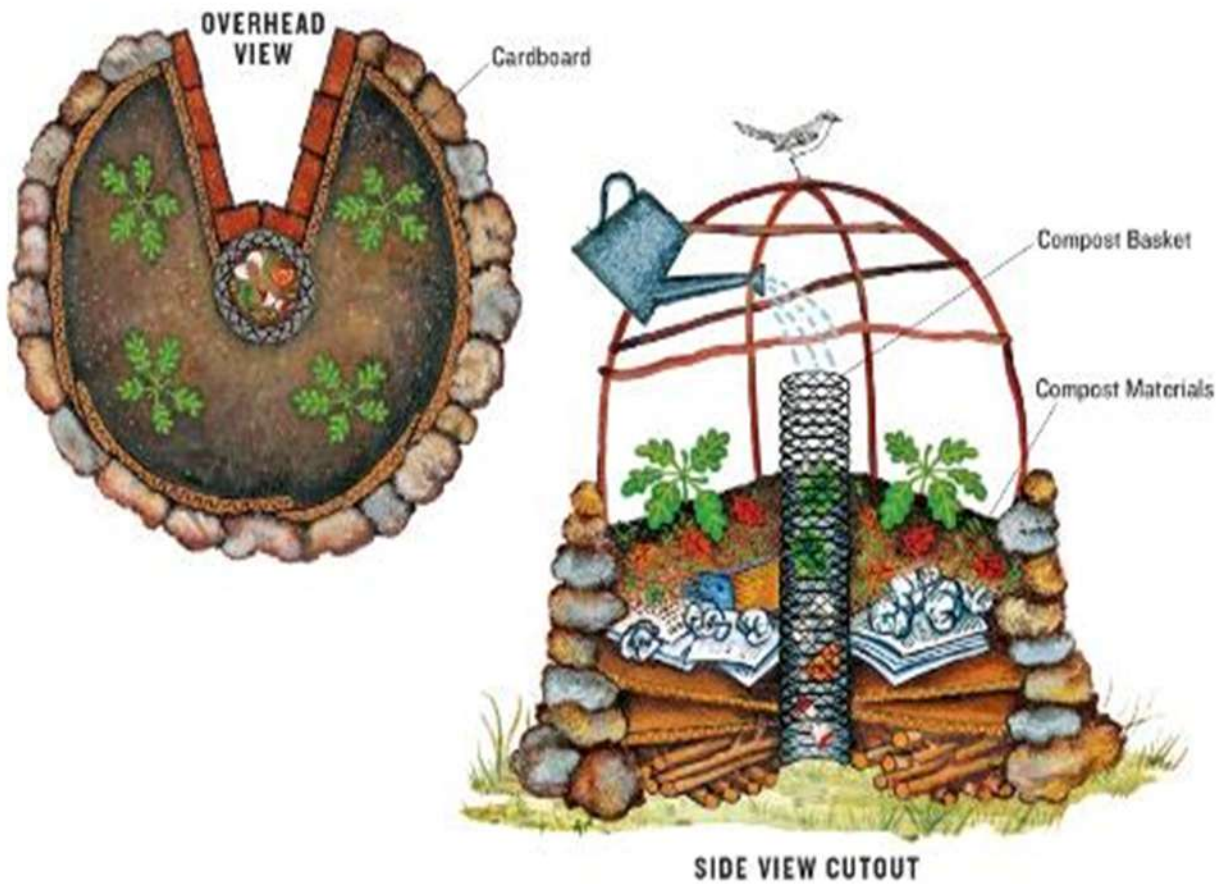


Figure 4. 1: Logistics of Keyhole Gardens

4.2.1 The Keyhole Garden

The Keyhole Garden (KHG) is a circular, raised garden bed surrounded by stones, closely aligned with permaculture principles. This design is rooted in Bill Mollison's original permaculture vision, which emphasizes growing productive and useful plants over ornamental ones. The KHG is a self-sustaining garden featuring a keyhole-shaped indentation and a central organic composting unit, promoting efficient water use and soil fertility. This design, as described by Hemenway (2015), embodies the principles of permaculture, which aims to create regenerative and sustainable ecosystems.

Table 4. 1: SUMMURISED MAINTENANCE OF KHG

Ideal Plants for Keyhole Gardens	
Subterranean crops	Foliage crops
Garlic	Spinach
Beetroot	Herbs
Carrot	Tomatoes
Onion	Swiss chad
Incompatible crops for keyhole garden design	
Potatoes	maize
Squash	cabbage

Care and Upkeep of KHG	
Irrigation • Regular watering is essential to keep the garden soil consistently moist. • Clean water is used to water the topsoil. • Grey water (wastewater from handwashing, laundry, or dishes) is poured into the basket. • The thatch and composting materials in the basket act as a natural filtration system, purifying the grey water. • The cleaned water then nourishes the plants in the keyhole garden.	Basket • Uncooked vegetable scraps, dry manure, eggshells, and compost are added to the basket to replenish the soil. • The basket decomposes within 1-2 years and needs to be replaced. • The garden wall near the basket can be pulled away to access the basket. • The old basket is removed and replaced with a new one to maintain soil fertility and garden productivity.
Soil • To maintain the garden's fertility, it's essential	Garden construction • As the garden ages, its fertility may decline,

to replenish it with dry manure and topsoil, preventing the depletion of nutrients and ensuring the soil remains rich and fertile, capable of supporting healthy plant growth	leading to reduced vegetable growth. To revitalize the garden, it's necessary to rebuild it every 4-5 years, replenishing the soil with new nutrients and materials to restore its productivity and ensure continued healthy plant growth.
Benefits of the keyhole garden	
Soil fortification • The layers of organic materials decompose over time, adding nutrients to the soil. • The central composting basket continuously replenishes the soil.	Labour saving technology • The soil re-nourishment and moisture retention reduce the amount of time required to maintain the garden. • The garden shape makes it more accessible to sick or elderly gardeners
Water holding capacity • The layered design enables efficient water retention, reducing the need for frequent watering and maintaining soil moisture levels, resulting in a water-conserving garden that requires less irrigation	Cost maintenance The design should be cost-effective, using materials that are readily available and free to gardeners, with the only potential expense being seeds for planting, making it a highly accessible and affordable gardening solution
Continuous harvesting • The stone wall of the keyhole garden acts as a thermal buffer, absorbing solar heat during the day and releasing it at night, providing protection for the crops from harsh winter temperatures in Chimanimani, creating a microclimate that extends the growing season	

Table 2

4.2.2 Case Study

Chimanimani district

Constructing a keyhole garden system

A keyhole garden was established at a female headed household head ,leadfarmer Amai Mukoni of Muungani village in ward 7 chimanimani districts, whose house was discussed as a trial by SIRP program. A household with 11 family members, generating significant kitchen waste and cow dung from their kraal, is leveraging waste valorization to produce Biomass-based products through an integrated approach. As part of this initiative, a Keyhole Garden (KHG) was developed, tested, and showcased as a labor-saving technology, particularly beneficial for women, and user-friendly for elderly individuals. The KHG utilizes nutrients from kitchen food waste, demonstrating a sustainable and innovative solution for waste management and productive gardening.

The Keyhole Garden (KHG) project broke ground on February 10th. 2023 during the researcher attachment period at SIRP. The lead farmer's backyard was chosen as the site for building a keyhole garden, which was designed to be 7 square meters in area and 3 meters in diameter, with proportions tailored to fit the space.

Figure 4. 2: KHG Construction phase 1

The Keyhole Garden (KHG) was strategically placed to receive direct sunlight and rainfall, unobstructed. Its design features integrated compost bin, a layer for excess water drainage, and a specially designed moisture-retentive structure with multiple layers, consisting of dead leaves, paper, green chippings, and loamy red soil (Fungai, 2010). This thoughtful design enables efficient water management and nutrient-rich soil for optimal plant growth.

Figure 4. 3: KHG Construction phase 2

The Keyhole Garden (KHG) was constructed using locally sourced and recycled materials, including ash, paper, broken bricks, stones, dried leaves, animal bones, scrap grass, twigs, and garden soil. To begin, a keyhole-shaped structure was created by digging a 0.9-meter deep pit (0.2 meters above the KHG's topsoil layer) and thoroughly bordering it with stones. This innovative use of recycled materials reduced waste and created a sustainable gardening space.

Figure 4. 4: KHG Boundary construction

The outer boundary of the garden was constructed using broken bricks, cement, and cardboard (with a height of approximately 1 meter above ground level) to provide structural support and stability (stages 1 and 2). This creative use of materials created a sturdy and durable border for the Keyhole Garden.

Table 4. 2: MEASUREMENTS OF KEYHOLE GARGEN

- The keyhole garden has a diameter of 3 meters, covering an area of 7 square meters.
- The central compost pit has a diameter of 0.34 meters, with a surface area of 0.4 square meters.
- The garden is 0.63 meters above ground level, with 0.3 meters below ground level.
- The compost bin stands at 0.9 meters tall, with 0.2 meters above the soil surface.
- The effective planting area is 6.2 square meters

The garden's structure is defined by the brick and stone wall, which not only contains the garden's contents but also helps retain moisture. At the center of the keyhole garden, a circular compost bin (0.4 square meters, 0.34 meters in diameter) with perforations is positioned slightly above ground level, playing a crucial role in the garden's ecosystem

Figure 4. 5: KHG Compost making

The compost bin serves as a nutrient and water supply hub, enabling composting and water percolation throughout the garden's layers. At the base of the compost bin, a layer of stones (40-60 mm) facilitates slow nutrient release from the compost into the keyhole garden, acting as a foundation for efficient nutrient distribution

The area surrounding the compost pit was excavated and then lined with cardboard, followed by a layered structure composed of dried leaves, twigs, and grass, waste paper, and red loam soil. This layered sequence was repeated multiple times, building up to a height of 0.3 meters, to create a sturdy foundation for the compost pit. Once the base was established, a soil bed was placed on top, and additional soil was added until the desired height of 0.63 meters above ground level was reached, ready for planting.

Maize stalks provide a rich source of carbon and help absorb moisture, while dried leaves, twigs, and brown waste serve as nutrient-rich additives. The layered bed is designed with a gradual slope towards the outer walls, allowing moisture from the central compost bin to spread evenly throughout the bed (Allen, 2018). To prevent soil erosion and retain moisture, the topsoil layer is positioned below the outer walls. After construction, the Keyhole Garden (KHG) was watered for three days. On the third day, an additional layer of garden soil was added to create a uniform slope towards the edges, followed by thorough wetting of the soil.

After the construction of KHG, an effective plantation area of 6.2 m^2 was available for the study. The garden was divided into six sections accompanied with companion planting where Mrs Mukoni grew Rape,Spinach,tomatoes ,beetroot, carrots and herbs, Companion planting involves growing diverse crops together to enhance their growth and health. Techniques include pairing leafy greens with root vegetables or combining pest-repellent plants like onions or garlic with other crops. To maintain soil fertility and pest resistance, we planted at least four different vegetable varieties together in the keyhole garden the variety of vegetables ensured that farmers were able to prepare a four star diet.

Figure 4. 6: Stages in keyhole garden technology

Operation

The Keyhole Garden (KHG) was sustainably maintained by regularly adding kitchen waste from Amai Mukoni's household and cow dung from the Kraal to the composting bin, along with grey water or rainwater. in the study process, the compost bin was initially fed 1 kg of wet biodegradable waste (a mix of vegetable, fruit, and food waste) every 2 days, and later, it was fed 0.4-0.2 kg of waste twice a week, accompanied by 500 mL of grey water. The compost materials covered about 70% of the bin's height, ranging from 0.09-0.2 meters above the KHG's topsoil layer.

The composting basket received intermittent watering, twice a week, to maintain optimal moisture levels. To prevent nutrient leaching during heavy rainfall, the bin was covered. Keyhole Gardens are designed to retain water for extended periods, eliminating the need for frequent watering (How to Create a Keyhole Garden; Allen, 2018). The liquid produced through biological decomposition of organic matter contains essential nutrients like carbon, nitrogen, phosphorus, and potassium (Sanadia et al., 2019). The volume of this liquid depends on the moisture content of food waste and watering amount. As the water seeps into the soil bed, it carries nutrients along the bin, supporting plant growth (Allen, 2018). Moreover, The composting liquid produced through biological processes converts soil phosphate into a readily available form, essential for plant growth and various metabolic processes (Huang et al., 2017; Sarkar et al., 2019) , and possesses medicinal value.

The plants grew rapidly, with fruiting observed just 14 days after planting. After planting seeds and seedlings in their designated areas, the Keyhole Garden (KHG) was watered. On February

17th, 2023, seeds for tomato, rape, okra, spinach, covo, onions, carrot, and beetroot were sown, and their growth was noticeable within a week of sowing.

Figure 4. 7: Plant in KHG

leafy crops grew at a significantly faster rate than root vegetables, herbs, and flowers due to their rapid germination. Meanwhile, chillies, okra, and tomato plants took over a month to produce. The addition of biogenic solid and liquid wastes to the composting bin not only promoted plant growth but also maintained a clean and waste-free environment. Moreover, using waste materials to construct the Keyhole Garden (KHG) encouraged recycling and reuse. As part of the SIRP program's community outreach initiatives, local farmers from neighbouring villages and wards participating in the trial gained a deeper understanding of sustainable farming practices, recycling, and waste management, and were eager to replicate the concept in their own backyards

KHG modifications

Various kinds of KHGs were constructed within a very less space (small foot prints) in a garden or backyard with similar sizes but different in terms of outer layer rocks or bricks .Vegetables that were mainly grown by farmers were covo, rape, carrots and Tsunga unlike beetroot and spinach they disliked the beetroot taste and were not able to cook very well spinach . Even after two years since its construction, the Keyhole Garden (KHG) remains fully functional and thriving, requiring minimal upkeep and maintenance to date.

Figure 4. 8

Figure 4. 9

The study revealed that a significant majority (69%) of the farmers interviewed have adopted the keyhole garden technique for vegetable production, while 31% have not. This indicates a high level of adoption among the sample. When asked about their decision to continue or adopt the keyhole garden as a labor-saving technology, most adopters (51%) cited the ability to produce high-quality and nutritious vegetables as the main reason. Other motivations for adoption included its effectiveness in conserving moisture, water, and soil (10%), and facilitating early plant establishment (10%).

4.2. Level of acceptability and extent of adoption of keyhole gardens

The study revealed a significant level of adoption of the Keyhole garden labor-saving technology, with 69% of the interviewed farmers utilizing this technique, compared to 31% who have not adopted it. The adoption rate of Keyhole Gardens is remarkably high, surpassing 50% of the sample size. The accompanying graphic illustrates the extensive adoption of both household and Keyhole gardens in Chimanimani, showcasing the broad acceptance and effectiveness of this innovative farming approach.

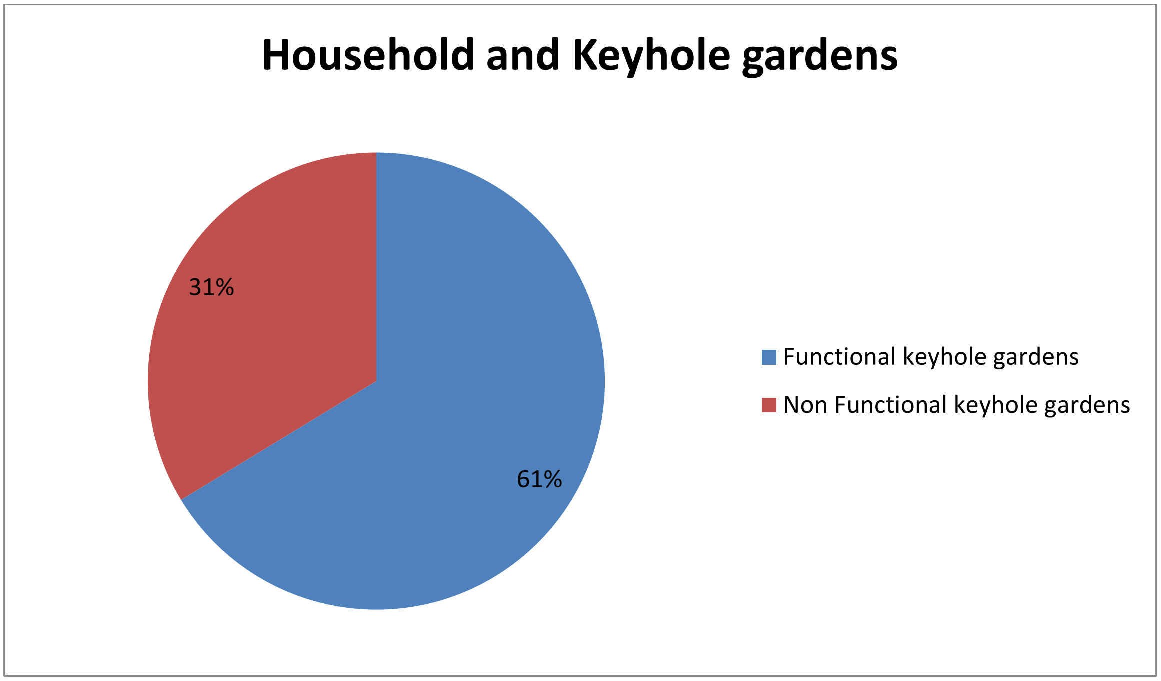


Figure 4. 10: HOUSEHOLDS AND KHG

TABLE 5.5 1: GENDER DISTRIBUTION AND T- STATISTICS OF KHG ADOPTION

Sex of respondents	Adoption of Keyhole gardens		Total
	None KHG	KHG	
Female	31 18.34%	77 45.56%	108 63.91%
Male	21 12.43%	40 23.67%	61 36.09%
Total	52	117	169

	30.77%	69.23%	100%
Pearson chi^2(1) = 0.5993 Pr = 0.043			

Chi-Square Tests

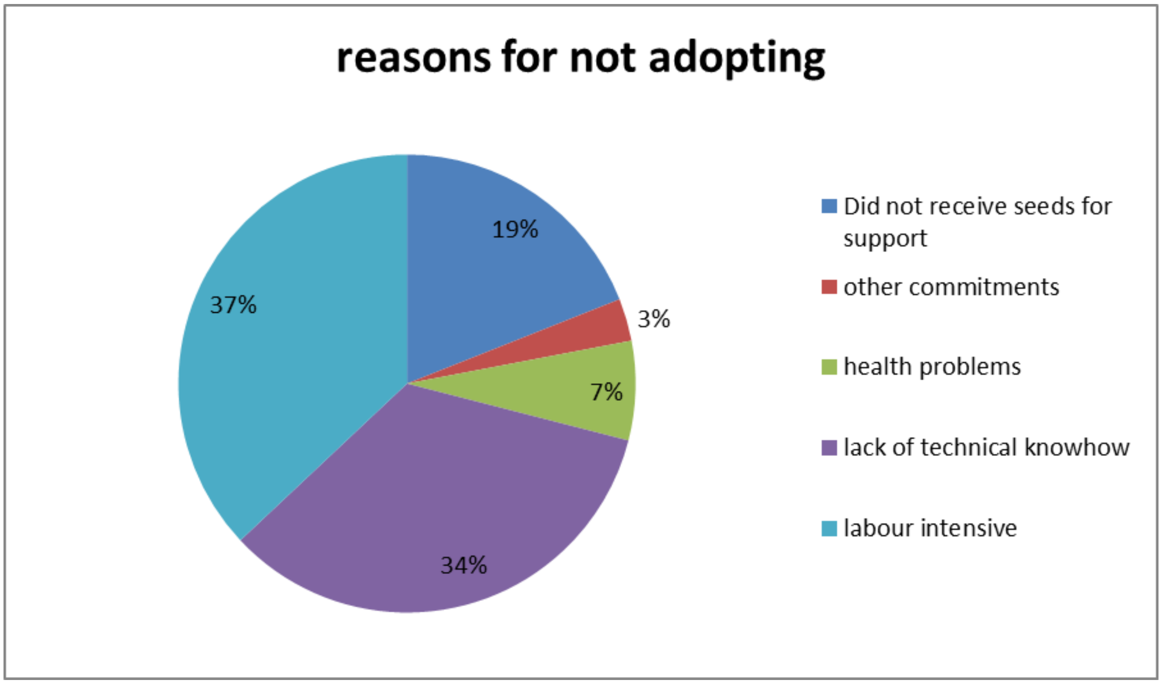
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.599[a]	1	.439		
Continuity Correction[b]	.361	1	.548		
Likelihood Ratio	.594	1	.441		
Fisher's Exact Test				.489	.273
Linear-by-Linear Association	.596	1	.440		
N of Valid Cases	169				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 18.77.

Table 6.Chi-Square Tests

63.91% of females have adopted keyhole gardens, compared to 36.09% of males. The Pearson chi-square test ($\chi^2(1) = 0.5993$, Pr = 0.043) indicates a statistically significant difference in adoption rates between females and males. This shows that gender affects the level of acceptability of adoption of keyhole gardens

TABLE 6.6 1: REASON FOR NOT ADPOTING KHG TECHNOLOGY



4.2.1 Discussion

4.2.1.1 Reasons for adopting keyhole gardens

The study revealed that a significant majority, nearly 70%, of the participating households had food gardens, a finding consistent with previous research by the African Food Security Urban Network (AFSUN) in 2012, which reported that 60% of families in the outskirts of Harare were actively engaged in growing vegetable crops. This suggests a strong interest in urban agriculture and food self-sufficiency among households in the region.

From the findings of the study, it can be noted that the most households are headed by males. It can also be noted that households that female household heads are either divorced or widowed. The information presented indicate that all female headed households have gardens and most of these women are unemployed. This represents a 100% garden establishment rate in female headed households as compared 64.79 to in male headed households. This is consistent with the findings of Samantaray et al (2009), who found that vegetable agriculture is dominated by women, and that they oversee the vegetable production system from harvesting to sale.

The establishment of a KHG garden in this regard, is to reduce the burden associated with income and food shortages that these women face. The fact that they do not have a partner to assist them forces them to establish backyard gardens to supplement the little income that they obtain from other sources.

The researcher confirmed that KHG allows individuals to reconnect with the food system, promoting a sense of ownership and responsibility for their food security. For Chimanimani farmers, 35% of them are living in a remote and mountainous terrain, accessing markets and purchasing food its very challenging. KHG provides a reliable source of fresh produce, ensuring food security and reducing reliance on external markets.

KHG promotes healthy eating habits by providing fresh and nutritious produce. Chimanimani farmers, who often face limited access to healthcare, can benefit from the nutritional benefits of KHG-grown produce. A study revealed that KHG adopters in the region consumed an average of 2.5 servings of fruits and vegetables daily, exceeding the recommended daily intake.

KHG employs regenerative agriculture techniques, enhancing soil health and reducing plastic packaging waste. Chimanimani's mountainous terrain is prone to soil erosion and KHG's emphasis on soil conservation and mulching helps mitigate this issue. By adopting KHG, farmers reduce their environmental footprint and promote ecological balance in the fragile mountain ecosystem.

Fifthly, KHG offers a unique opportunity for rural women in Chimanimani to take leadership roles in food production, enhancing their economic and social status. Women in the region often bear the responsibility of food production and management, and KHG empowers them to take control of their food system. According to a survey, 60% of KHG adopters in Chimanimani were women, who reported an increase in their economic independence and social recognition.

4.4.2Pearson chi-square test result

The adoption rates of keyhole gardens among females and males in Chimanimani reveal a significant gender disparity. A remarkable 63.91% of females have embraced this innovative gardening practice, compared to 36.09% of males. This difference in adoption rates is not merely a coincidence, as the Pearson chi-square test reveals a statistically significant difference between the two genders ($\chi^2(1) = 0.5993$, Pr = 0.043).

This finding suggests that females in Chimanimani are more receptive to the benefits of keyhole gardens, which include improved food security, enhanced nutrition, and sustainable agriculture practices. The higher adoption rate among females may be attributed to their traditional roles as caregivers and food managers, making them more invested in ensuring a reliable source of fresh produce for their families.

The significance of this gender disparity lies in the potential for keyhole gardens to empower rural women in Chimanimani. By taking leadership roles in food production and management, women can gain economic independence, social recognition, and a sense of accomplishment. The adoption of keyhole gardens can be a transformative experience for these women, enabling them to break free from traditional gender roles and become agents of change in their communities.

4.21.1. Reasons for not adopting keyhole gardens

The adoption of new agricultural practices and technologies is crucial for improving agricultural productivity and sustainability. However, various factors can hinder farmers from adopting these innovations. A recent survey revealed that a significant proportion of farmers did not adopt a particular agricultural practice or technology due to several reasons.

Firstly, 19% of farmers did not receive seeds for support, which is a critical input for adopting new agricultural practices. This lack of access to quality seeds is a significant constraint for smallholder farmers, as highlighted by Horton et al. (2010). Without the necessary seeds, farmers are unable to adopt new practices, which can limit their productivity and sustainability.

In addition, 3% of farmers had other commitments that prevented them from adopting the new practice or technology. Farmers often have multiple livelihood strategies, and may prioritize other activities over agricultural innovation, as noted by Kanter et al. (2018). This highlights the need for policies and programs that address the multiple demands on farmers' time and resources.

7% of farmers faced problems that prevented them from adopting the new practice or technology. This could include various challenges such as pests, diseases, or weather-related issues, as noted by Baidu-Forson et al. (2017). These problems can be significant barriers to adoption, and require targeted support and solutions.

Fourthly, 34% of farmers lacked the technical knowhow to adopt and effectively use the new practice or technology. This lack of knowledge and skills is a significant constraint, as highlighted by Feder et al. (2004). Farmer training and education are critical for addressing this knowledge gap and enabling farmers to adopt new technologies.

Lastly, 37% of farmers perceived the new practice or technology as labour intensive, which may have deterred them from adopting it. Labor constraints are a significant factor in farmers' decisions to adopt or reject new agricultural technologies, as noted by Mutsaers et al. (2017). This highlights the need for labour-saving technologies and practices that can reduce the burden on farmers.

4.3. HOUSEHOLD DIETARY DIVERSITY STATUS OF THE GARDEN OWNERS AND NON-GARDEN OWNERS IN CHIMANIMANI.

The goal of the study was to look at the Household Dietary Diversity status of gardeners and non-gardeners in Chimanimani. The respondents' dietary diversity scores were calculated using information from their seven days dietary recall. To compare the mean household dietary scores between two groups (KHG and non-KHG owners), a T- statistical tool was used. Confidence intervals indicate that the analysis is focused on determining whether there is a significant difference in the mean household dietary diversity scores between the two groups. The results of this analysis can be used to inform decisions and policies related to household dietary diversity and food security. The findings show that there is a substantial difference in HDD between households with keyhole gardens and those without.

4.3.1. Results

Findings on Dietary Diversity of Keyhole Garden Owners

Keyhole garden owners were found to have a higher dietary diversity score compared to-keyhole garden owners. This indicates that households with keyhole gardens consumed a wider variety of foods from different food groups, leading to improved overall dietary quality. Also, the consumption of fruits, vegetables, and other nutritious crops was significantly higher among keyhole garden owners. Keyhole gardens likely facilitated access to fresh produce, contributing to better nutrition and potentially reducing the risk of malnutrition or diet-related diseases.

More so, keyhole garden owners demonstrated a better nutritional profile in terms of micronutrient intake, with higher levels of vitamins, minerals, and antioxidants in their diets. This suggests that keyhole gardens play a role in enhancing the nutritional status of households and promoting a balanced diet.

Findings on Dietary Diversity of Non-Keyhole Garden Owners

Non-keyhole garden owners, on the other hand, were found to have lower household dietary diversity scores compared to keyhole garden owners. Their diets may have been more limited in terms of variety and nutritional quality, potentially due to limited access to fresh produce or reliance on staple foods. The study identified gaps in the consumption of key food groups among non-keyhole garden owners, such as fruits, vegetables, and protein-rich foods. This lack of dietary diversity could increase the risk of micronutrient deficiencies and impact overall health and well-being.

Moreover, non-keyhole garden owners may benefit from interventions aimed at improving dietary diversity, such as promoting backyard gardening, nutrition education, or access to fresh food markets. Enhancing food security and nutrition outcomes among this group could lead to positive health impacts and improved overall well-being.

Overall, the findings suggest that keyhole gardens have the potential to positively influence household dietary diversity and nutritional outcomes among smallholder farmers. By promoting the adoption of keyhole gardens and sustainable agriculture practices, efforts can be made to enhance food security, boost nutrition, and improve the well-being of communities in Chimanimani and similar agricultural settings.

TABLE 7.7 1: 7 DAYS CONSUMPTION RECALL

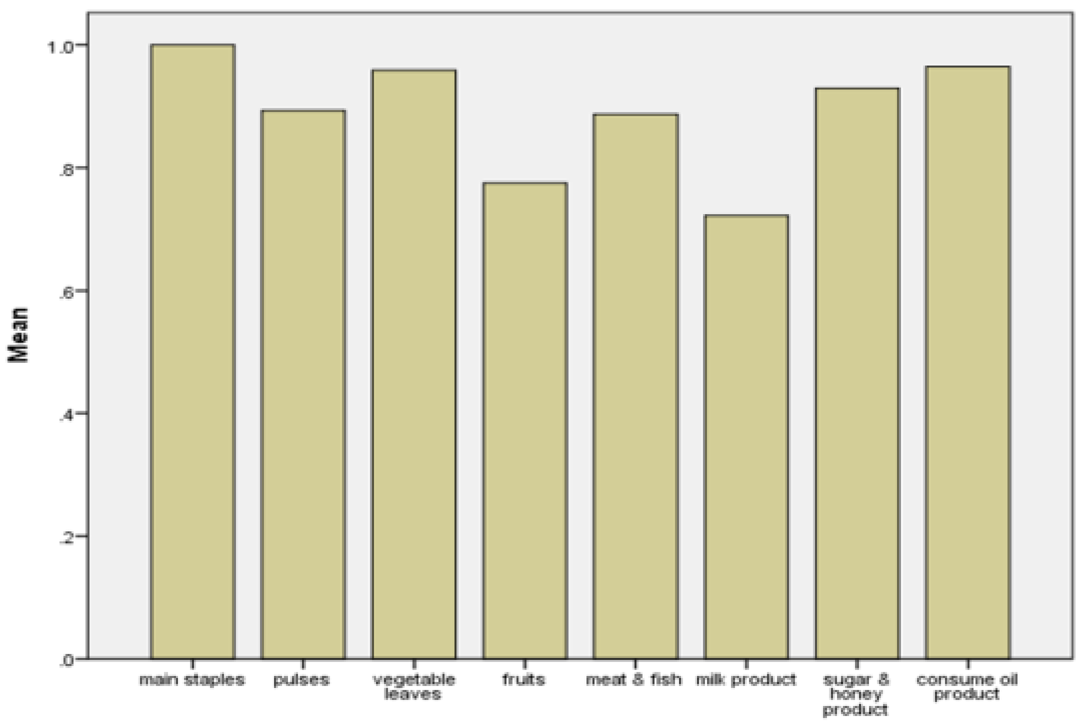


TABLE 8.8 1: HDDS OF KHG OWNERSHIP (CROSS TABULATION)

		KHG ownership		Total
		non KHG owner	KHG owner	
	lower hdds<3	1	1	2
HDD score	Medium hdds 4 to 6	12	27	39
	high hdds 7 to 8	39	89	128
Total		52	117	169

Source;2023

This table shows the distribution of households by KHG ownership and HDDS scores. Most households 117 own a KHG, while 52 do not. Among non-KHG owners, 39 households have high HDDS scores, while 12 have medium scores, and only 1 has a low score. Among KHG owners, 89 households have high HDDS scores, while 27 have medium scores, and 2 have low scores. Overall, this table suggests that KHG ownership is associated with higher HDDS scores, indicating greater dietary diversity and food security

TABLE 9.9 1: PAIRWISE COMPARISONS OF MEAN HDDS OF KHG OWNERSHIP

HDD SCORE	Mean	Std .Err.		[95% Conf. Interval]
None KHG	.8444312	.0132235		0.8183245 .8705379
KHG	.810414	.0088156		.7930095 .8278184
HDDS_SCORE	Contrast	Std. Err.	t P>|t|	[95% Conf. Interval]

KHG vs None KHG	-.0340172	.0158926	-2.14	0.034	.0653936 - .0026409

Source: Survey 2023

In the T-statistical test The mean HDDS score for households that do not own a keyhole garden (None) is 0.8444312 , with a 95% confidence interval of 0.8183245 to .8705379 and standard deviation of 0.0132235 . The mean HDDS Score for households that own a keyhole garden (KHG) is 0.810414 , with a 95% confidence interval of 0.7930095 .8278184. The contrast (difference) in mean HDDS SCORE between KHG and None is0.0340172 , with a standard error of .0158926 .The t-statistic is -2.14 which indicate and negative difference between the two groups , with a p-value of 0.034, indicating a statistically significant difference between the two groups.

The HDD was treated as the dependent variable. The null hypothesis was "there is no difference between the means of the two groups. From the table above, a p-value of 0.034 is less than 0.05 and also the test statistics (-2.14) its outside the 95% confidence interval range with this prompts the researcher to reject the null hypothesis in favour of the alternative hypothesis and conclude that there is significant difference between the mean HDD of households with Keyhole gardens and those without Keyhole gardens. The results of the study indicate that households with functional gardens have a significant advantage when it comes to food variety and dietary diversity. This finding is in line with previous research conducted by Taboka (2016) and Carney (2013), which demonstrated that gardening has numerous benefits, including reducing food insecurity, improving dietary intake, and strengthening family relationships.

Chapter summary

The chapter presented and discussed the results in relation to the subject under study. The presentation analysis of the results was guided by the research objectives.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study's findings suggest that implementing Keyhole gardens is vital for enhancing dietary diversity and food security in households in the region. Households with gardens are more likely to be food secure, generate additional income, and better cope with economic challenges, including high unemployment rates. While household gardens significantly contribute to dietary diversification and food security, they still face obstacles related to funding, input availability, and labor supply, particularly for elderly individuals.

The findings indicate that the keyhole garden technology has been adopted in Chimanimani district to some extent, primarily due to the provision of input support to farmers. However, the adoption rate remains limited, as some farmers have discontinued using the technology after input support ceased from SIRP. Additionally, a lack of technical expertise has hindered other farmers from adopting the technique, highlighting the need for ongoing support and training to ensure sustained adoption and widespread implementation.

This limitation prevents them from fully leveraging the potential of Keyhole gardens, hindering their ability to optimize their benefits. Therefore, targeted interventions are necessary to tackle these challenges and improve the livelihoods of households in the Chimanimani district.

5.2 Recommendations

The study's findings led to the following recommendation

5.2.1Extension services

According to the study, households tend to focus on growing low-value crops, which highlights the importance of promoting diverse seed planting to enhance dietary diversity. Additionally, there is a need to educate households on treating farming as a business venture by introducing high-value crops and establishing market connections. This will foster more sustainable livelihoods and income generation through keyhole gardening, ultimately improving the overall well-being of households.

In essence, the study suggests that households should be encouraged to diversify their crops, adopt a more commercial approach to farming, and develop links with markets to increase their income and sustainability through keyhole gardening.

5.2.2. farmers

One of the significant challenges farmers face in building keyhole gardens is labour. To achieve 100% adoption and assist vulnerable groups like the elderly and handicapped, farmers should work together in groups and voluntarily construct keyhole gardens. Additionally, they should avoid relying solely on donor support and instead exchange seedlings among themselves to achieve the desired structure of planting at least four vegetables in the six segments of the keyhole garden so as to attain a nutritious four star diet.

KHG may not offer a wide range of food options, potentially leading to dietary monotony. While gardens can provide a variety of fruits and vegetables, the options may become repetitive and boring, leading to a lack of interest in healthy eating.

To address these limitations, KHG owners should complement their garden produce with other food sources. This can include purchasing diverse food items from local markets, raising small animals like chickens, goats, or cattle for protein sources, learning preservation techniques like canning, drying, or fermenting to enjoy KHG produce throughout the year, joining community groups or cooperatives to share knowledge, resources, and food varieties, and seeking guidance from nutritionists or healthcare professionals to ensure a balanced diet.

while KHG have the potential to improve household dietary diversity, it is essential for KHG owners to diversify their food sources to ensure a comprehensive and resilient food system. By doing so, households can reduce their dependence on a single source, promote overall food security and nutrition, and enjoy a more varied and balanced diet.

5.2.3.Policy makers

The adoption of keyhole gardens is impacted by technical knowledge and gender. As a result, the government should offer refresher training programs on labour-saving technology to extension workers, who can then ensure that all smallholder farmers, regardless of gender, have the necessary technical expertise to successfully implement keyhole gardens

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QUESTIONNAIRE ON THE ASSESSMENT OF THE CONTRIBUTION OF KEYHOLE GARDENS GARDENS TO HOUSEHOLD DIETARY DIVERSITY

My name is Sally Gunda Gunda. I am a student at Bindura University of Science Education studying for a Bachelor of Science Agriculture Honours in Agriculture Economics and Management. I am doing a study on the An analysis on the adoption of keyhole gardens and its contribution to the dietary diversity of smallholder farmers in Chimanimani district.May you

provide me with the relevant information to the questions below. The interview may take a maximum of 30 minutes. The recommendations of the study are going to be shared with interveners, policy makers and nutrition expects. All information provided by interviewee will be treated as STRICTLY CONFIDENTIAL for mutual benefit of both the researcher and the respondents.

Enumerator name………………...…………… Name of respondent……………………

District name…………………………………... Village name…………………................

Ward………………………………….............. Date..……………………………........

A. HOUSEHOLD DEMOGRAPHIC AND SOCIO ECONOMC INFORMATION					
1. Head of household					
a. Gender	Male		Female		
b. Age					
c. Marital status	Married	Single	Divorced	Widowed	
d. Highest level of education of household head					
	No formal or informal education	Informal education	Primary	Secondary	Tertiary education
e. Highest level of education of any household member					
	No formal or informal education	Informal education	Primary	Secondary	Tertiary education
2. What is your principal occupation?					

3. What is the size of your household?			
4 Do you have a functional keyhole household garden		Yes	No
5. What are your sources of income? (Rank 1 as the most important source of income)			
	Source	Amount in the last 4 weeks	Rank
	Crops production / sale		
	Vegetables production / sale		
	Livestock production/ sale		
	Poultry production / sale		
	Salary/wages		
	Pension/grants		
	Trade (transport, resale of goods)		
	Sale of wild foods		
	Craftwork (mats, baskets, pots)		
	Community projects		
	Remittances		
	Other (specify)		

	6. Are you receiving any support from the Government /NGOs in form of input food assistance, training?

Organization	Input		Market value

B. HOUSEHOLD FOOD SECURITY STATUS

1. What are your sources of food? (Rank 1 as the most important source of food)

Own crop production	Purchase	Wild food collection		Food aid
Own livestock products	Barter	Food for work		Steal
Food at work	Gifts of food	Loans		Stocks
Food at school	Fishing	Hunting		Friends/relatives

Other sources of food(Specify):

2. What types of foods did you or anyone else in your household ate yesterday during the day and night at your home. (didn't eat=N and ate=Y) and number eaten in the last 7 days. What are the food sources??

	N/Y	Last 7 days (1-7)	If yes Source
Any foods made from maize, wheat, rice or any other locally available grain e.g stamp, pap, bread			

Any potatoes or any other food made from roots or tubers,			
Any vegetables			
Any fruits			
Any meat, poultry or offal			
Any eggs			
Any fresh or dried fish and seafood			
Any foods made from beans, peas or nuts			
Any cheese, yogurt, milk or other milk products			
Any food made from oil, fat or butter			
Any sugar or honey			

C. KEYHOLE GARDENING

1. What agricultural activities do you practice other than gardens?			
Livestock	Crops	Gardening	None

2.(For those with gardens only) Which vegetables/fruit do you currently grow? (Rank 1 as the most commonly grown vegetable)					
			Purpose of production		
Vegetable/fruit	Rank	Area (L x W)	Consumption	Sale	Other specify

2b.How do you use the money obtained from selling garden produce?					
Food	Health	Education	Livestock	Others specify	
Food accessed from the garden or purchased through garden produce in the past 4 weeks					
Garden produce		Food purchased through garden produce sales			

3. What do you consider to be the main problem in vegetable production? (Rank 1 as the most important problem)			
Problem	Rank	Problem	Rank
Labour		Low temperature	

Input supply		Low rainfall	
High costs of inputs		Hail storm	
Lack of equipment		Lack of water sources	
High temperatures		Theft	
Low temperatures		Lack of Capital	
Land shortage		No proper structures (no fence)	
Late planting		Lack of skills	
No markets		Pests	
Other (specify):			

4. Can you produce vegetables all year round	YES	NO

Rank the reasons why you cannot grow the vegetables all year round

Reason	Rank	Reason	Rank
Laborious		Low temperature	
Lack of Input supply		Low rainfall	
High costs of inputs		Hail storm	
Lack of equipment		Lack of water sources	
High temperatures		Theft	
wild life / domestic animals		Lack of Capital	
Land shortage		No proper structures (no fence)	
Late planting		Lack of skills	
No markets		Pests	

Other (specify):